Annotated Bibliography

Peter P. Wakker

March 16, 2025

This bibliography subsumes all preceding versions. References to past versions remain effective.

Elucidation on keywords and annotations:

- Annotations are between signs {% and %} above references.
- Use of keywords (are bold): using the FIND function, the keywords below give related references. For example, the keyword
  ambiguity seeking
  gives 116 references on it.

KEYWORDS:

ambiguity seeking:

ambiguity seeking for losses:

ambiguity seeking for unlikely:

ambiguous outcomes vs. ambiguous probabilities: some authors make this distinction although I favor that *by definition* all uncertainty is modeled through the state space.

ambiguity attitude taken to be rational:

Ambiguity = amb.av = source.pref, ignoring insensitivity:

Arrow's voting paradox ==> ordinality does not work:

backward induction/normal form, descriptive:

Best core theory depends on error theory: Starting 2000, many empirical studies in decision theory do not just fit a deterministic decision theory to data with statistics such as t-tests done at the end, but they use a probabilistic choice model with errors in choice incorporated, and have this probabilistic choice model integrated with the deterministic decision model. The latter is then called the core theory.

binary prospects identify U and W: For binary prospects, most nonexpected utilities agree, and are rank-dependent utility. These prospects suffice to identify utility U and the weighting function W.

bisection > matching: Since the 1980s, with a revival in experimental economics starting around 2005, decision theorists have compared choice-based methods such as bisection and the choice list with direct matching. Now (2012) most people prefer choice-based methods.

biseparable utility: the rank-dependent utility (RDU) model for binary prospects;

biseparable utility violated: the models that do not agree with RDU for binary prospects;

calculating RDU: means to calculate RDU and new prospect theory

calculation costs incorporated: incorporating calculation costs into decision making

cancellation axioms: axioms necessary for additively decomposable representations on product sets, studied by Krantz et al. (1971) and many others;

CBDT: case-based decision theory;

CE bias towards EV: certainty equivalent measurements generate biases towards expected value maximization;

Choice enhances noncompensatory heuristics:

coalescing: A prospect written as (1/3:2, 1/3:2, 1/3:0) may be evaluated differently than (2/3:2, 1/3:0). Similar terms are collapsing or event splitting (or outcome splitting);

cognitive ability related to discounting:

cognitive ability related to risk/ambiguity aversion:

cognitive ability related to likelihood insensitivity (= inverse S):

coherentism: Representational view of utility is that all that it should do is represent choice consistently, and this is the only requirement. No external criteria should be imposed. This is like coherentism. See also; paternalism/Humean-view-of-preference; see also search keys starting with "risky utility";

Compare different measurement methods:

confirmatory bias: of new evidence, people select only what reinforce their opinions, leading to divergence of opinions rather than the rational convergence;

completeness criticisms: completeness means requiring a preference between every pair of prospects/choice options;

collapse: see coalescing;

concave utility for gains, convex utility for losses: (see also "risk averse for gains, risk seeking for losses," and please don't confuse risk aversion with concave utility etc. unless expected utility is the explicit working hypothesis!);

consequentialism/pragmatism: putting everything relevant in consequences makes model intractable;

not explained here (see preference for flexibility for future influence);

correlation risk & ambiguity attitude:

criticism of monotonicity in Anscombe-Aumann (1963) for ambiguity: see also the more general: **restrictiveness of monotonicity/weak separability**

criticisms of Savage's basic framework; (see also: R.C. Jeffrey model)

criticizing Knight (1921) for low quality:

criticizing the dangerous role of technical axioms such as continuity:

crowding-out:

deception:

deception when implementing real incentives: (usually done to protect subjects from suffering losses);

decreasing ARA/increasing RRA: ARA = absolute risk aversion, and RRA = relative risk aversion;

decreasing/increasing impatience:

desirable to extend preferences while satisfying/maintaining conditions:

derived concepts in pref. axioms:

DFE-DFD gap but no reversal: Decision from experience usually finds less pronounced inverse S probability weighting than decision from description, but the reversal (S-shape instead of reversed S-shape) claimed in first papers on DFE does not hold. (Or it does?)

discounting normative:

dominance violation by pref. for increasing income: (see also: preferring streams of increasing income);

Dutch book: (see also "ordered vector space" or "reference dependence test");

dynamic consistency:

dynamic consistency. NonEU & dynamic principles by restricting domain of acts:

dynamic consistency: **favors abandoning time consistency, so, favors sophisticated choice**:

dynamic consistency: **favors abandoning forgone-event independence, so, favors resolute choice**:

dynamic consistency: favors abandoning RCLA when time is physical:

DC = stationarity: confusing dynamic consistency (= time consistency) with stationarity (or not):

endogenous midpoints:

extending preference relations using conditions:

equate risk aversion with concave utility under nonEU: Under EU, risk aversion (preferring expected value of prospect to prospect) can be equated with concave utility. Under nonEU this is no longer correct. Unfortunately, many authors, the majority of economists and finance people today, continue to equate risk aversion and concave utility under nonEU. An explanation can be that people want to use a term for concave utility but want to avoid "diminishing marginal utility" because, in the ordinal spirit, they do not want to give empirical meaning to marginal utility. (Thus Arrow, 1951, ECMA, p. 423 wrote: "diminishing marginal utility had lost its meaning.")]Well, it is just incorrect under nonEU, unfortunately.

equity-versus-efficiency:

EU+a*sup+b*inf:

event/outcome driven ambiguity model: event driven: ambiguity primarily modeled through an event function (e.g., Schmeidler's 1989 RDU/CEU). Savage's P4 then usually holds.

event/outcome driven ambiguity model: outcome driven: ambiguity primarily modeled through an outcome function, utility (mostly recursive EU, e.g., KMM's smooth model).

event splitting: see coalescing;

finite additivity:

foundations of probability:

foundations of quantum mechanics:

foundations of statistics:

free will/determinism:

game theory can/cannot be viewed as decision under uncertainty: (see also: game theory as ambiguity):

game theory as ambiguity:

gender differences in risk attitude:

gender differences in ambiguity attitudes:

Harsanyi's aggregation:

homebias:

inconsistency in repeated risky choice:

independence/sure-thing principle due to mutually exclusive events:

information aversion: (see also "value of information"):

insurance frame increases risk aversion:

intertemporal separability criticized:

intuitive versus analytical decisions: (see also "reflective equilibrium");

inverse S: (see also ("risk seeking for small-probability gains")

inverse S (= likelihood insensitivity) related to emotions:

R.C. Jeffrey model:

just noticeable difference: (other terms used in the literature are minimally perceptible threshold/difference or just noticeable increment);

law and decision theory:

linear utility for small stakes:

loss aversion without mixed prospects: people who think to obtain estimates of loss aversion without considering mixed prospect, which is impossible (see also loss aversion: erroneously thinking it is reflection);

loss aversion: erroneously thinking it is reflection: (see also loss aversion without mixed prospects);

losses from prior endowment mechanism: implementing real incentives for losses by first giving subjects prior endowment and then letting them later pay back from that.

losses give more/less noise:

marginal utility is diminishing:

measure of similarity:

Monty Hall's problem: see **three-doors problem**:

Nash equilibrium discussion:

natural-language-ambiguity:

natural sources of ambiguity:

Newcomb's problem:

nonadditive measures are too general:

nonconstant discount = nonlinear time perception: deviations from constant discounting may not so much be nonconstant discounting of well-perceived time, but rather constant discounting of misperceived time.

normal/extensive form:

one-dimensional utility:

optimal scale levels:

ordered vector space:

ordering of subsets: (see also preference for flexibility);

own small expertise = meaning of life: In 2022 this has been renamed as: **ubiquity fallacy**: Many researchers try to suggest that their small expertise can answer all the main questions in life; they confuse ubiquity with explanatory power. There is an explanation at https://www.youtube.com/watch?v=FDvBrcytU7Q&t=52s
1:10 – 3:25 for the special case of ergodic theory.

part-whole bias: (special case for uncertainty: coalescing)**;**

parametric fitting depends on families chosen:

paternalism/Humean-view-of-preference: whether preferences should always be taken as is, or whether one may change them to improve them; see also: coherentism

PE doesn't do well: the probability equivalent, also called standard gamble, does not perform well.

PE higher than CE: (see also "PE higher than others" and "CE bias towards EV"): the standard gamble gives (assuming expected utility) higher utilities than the certainty equivalent method.

PE higher than others: (see also "PE higher than CE"); the standard gamble gives higher utilities than other methods.

preferring streams of increasing income: (see also: dominance violation by pref. for increasing income);

present value:

principle of complete ignorance:

probability elicitation: (see also "proper scoring rules" and "survey on belief measurement");

probability communication:

probability intervals:

probability triangle:

probability weighting depends on outcomes: (other than sign-dependence);

Probability weighting linear in interior:

producing random numbers: (people are not able to produce really random numbers);

proper scoring rules: (see also "probability elicitation");

proper scoring rules-correction:

Prospect theory/Rank-Dependent Utility most popular for risk:

Prospect theory not cited: Many experimental economists do not cite prospect theory. They then have no very good descriptive quantitative theory for risk attitudes, usually using expected utility to fit data. They cannot consider the cognitive insensitivity component of risk attitude (implying the empirically prevailing fourfold pattern and inverse S probability weighting) and instead focus on the risk aversion/seeking component. This tradition, that I regret, was initiated by Holt & Laury (2002)—who did cite prospect theory but in an irrelevant manner. Priority claims can then be problematic. Authors then often suggest that Holt & Laury (2002) invented (or "popularized") the empirical measurement of risk attitudes and/or the use of choice lists, ignoring a preceding half century where this was all done extensively. They sometimes cite the early Binswanger

(1981), but many citations are missing, and only experimental economists are cited. Sometimes Kahneman & Tversky (1979) are cited but only for an irrelevant detail, as did Holt & Laury (2002).

PT, applications:

PT falsified: see also **probability weighting depends on outcomes;**

qualitative probability: see ordering of subsets;

QALY overestimated when ill:

quasi-concave so deliberate randomization:

questionnaire for measuring risk aversion:

questionnaire versus choice utility: see also "coherentism"; compares utility based on revealed preference only with utility measured in different ways, such as using introspection.

random incentive system:

random incentive system between-subjects: (paying only some subjects):

ranking economists:

ratio bias: In a task of an algebraic nature, some people use an additive procedure and others use a multiplicative one. Thus, in tasks where addition is appropriate, a bias is observed in the direction of multiplication, and vice versa. And thus, we usually observe a risk attitude between constant absolute and constant relative risk aversion. A prominent psychologist once told me that this bias was the best kept secret in decision experiments, and that it explained the majority of all empirical findings in the field;

ratio-difference principle: (see also ratio bias)

RCLA: (= reduction of compound lotteries assumption): is called collapse independence when for uncertainty (events instead of probabilities)

real incentives/hypothetical choice: (see also "crowding-out" and "losses from prior endowment mechanism," "stated preference" is a common term for hypothetical choice);

real incentives/hypothetical choice, for time preferences:

real incentives/hypothetical choice, explicitly ignoring hypothetical literature:

reference dependence test: (= asset-integration test: see also losses from prior endowment mechanism);

relative curvature:

reflection at individual level for risk: (positive or negative correlation between risk aversion for gains and losses);

reflection at individual level for ambiguity: (positive or negative correlation between ambiguity aversion for gains and losses);

relation age-risk attitude

restrictiveness of monotonicity/weak separability:

Explanation: Monotonicity w.r.t. money outcomes in the sense of the more money the better is trivial, using the objective ordering on real numbers that everyone agrees on. However, if monotonicity concerns a subjective ordering, as when outcomes are complex multiattribute things, then monotonicity implies weak separability and can be more restrictive than many people are aware of. Btw., many interactions between attributes can be taken as a violation here. See also: **criticism of monotonicity in Anscombe-Aumann (1963) for ambiguity**;

revealed preference: violations of the RIS (random incentive system) can also be related to this point.

risk averse for gains, risk seeking for losses: see also "concave utility for gains, convex utility for losses";

risk seeking for small-probability gains:

risk seeking for symmetric fifty-fifty gambles:

risky utility u = strength of preference v (or other riskless cardinal utility, often called value):

risky utility u = transform of strength of preference v:

risky utility u = transform of strength of preference v, latter doesn't exist:

SEU = risk: argue (where I disagree) that Savage (1954) justified considering SEU to be risk;

second-order probabilities:

second-order probabilities to model ambiguity:

SEU = SEU: People, mostly psychologists, who erroneously think that the subjective probabilities of Ramsey (1931)/Savage (1954) are equal to transformed objective probabilities; Ramsey and Savage only provide arguments supporting EU and *against* transforming objective probabilities

SPT instead of OPT: Many authors, seeking to use OPT (original prospect theory of 1979) for nonmixed prospects $(p_1{:}x_1,\ldots,p_n{:}x_n)$ with multiple gains, $x_1 > \cdots > x_n \geq 0$, do not use the formula that Kahneman & Tversky had in mind: $U(x_n) + \sum_{1 \leq j \leq n-1} w(p_j)(U(x_j) - U(x_1))$, but instead use what Camerer & Ho (1994) called separable prospect theory (SPT): $\sum_{1 \leq j \leq n} w(p_j)U(x_j)$. The latter formula is the separate-probability transformation model (separable prospect theory) that psychologists including Edwards often used. That K&T did not have this in mind follows because for n = 2 they use the former formula and not the latter, and because on p. 18 of their 1975 working paper (extending their p. 12) version they use the analog of the former and not of the latter formula. The latter text, as well as their 1981 paper, show that they did have the analog of SPT in mind for mixed prospects. Wakker (2023 Theory and Decision) explains the case.

SIIA/IIIA: comparisons between the condition called independence of irrelevant alternatives in social choice and the different condition of the same name in individual choice;

simple decision analysis cases using EU: nice didactical examples to illustrate expected utility;

small risks overinsured:

small worlds: Savage's (1954) topic;

social risks > nature risks in coordination games:

social sciences cannot measure:

sophisticated choice:

source-dependent utility: this topic concerns not only utility-driven, but also event-driven ambiguity models because there it can still happen empirically that utility is source dependent.

source preference directly tested:

standard-sequence invariance: (see also Tradeoff method);

state-dependent utility:

state space derived endogeously:

strength-of-preference representation:

substitution-derivation of EU:

survey on belief measurement:

survey on nonEU:

suspicion under ambiguity: in Ellsberg-urn type experiments, subjects may fear that the experimentor rigged the urns against them ("suspicion");

testing color symmetry in Ellsberg urn:

time consistency stated ambiguously: of the three relevant time durations (time of decision, time of consumption, and difference between the two) only stating that one changes, without stating which of the other two then also changes

time preference:

time preference: **comparing risky and intertemporal utility**:

time preference, fungibility problem: (money received at some timepoint in an experiment may not be consumed immediately, but instead saved at market interest rate; leading many researchers to prefer consumption outcomes rather than monetary payment outcomes when studying discounting)

three-doors problem: (also known as Monty Hall's three doors problem or three-prisoners problem);

tradeoff method: see also standard-sequence invariance;

tradeoff method's error propagation:

total utility theory:

ubiquity fallacy: (formerly called "own small expertise = meaning of life"): Many researchers try to suggest that their small expertise can answer all the main questions in life. They confuse ubiquity with explanatory power. There is an explanation at
https://www.youtube.com/watch?v=FDvBrcytU7Q&t=52s
(1:10 – 3:25)
for ergodic economics.

uncertainty amplifies risk:

universal ambiguity aversion: authors assuming that people are always averse to ambiguity, modulo noise;

utility concave near ruin:

utility depends on probability:

utility elicitation:

utility elicitation: different EU methods give different curves: (see also: PE higher than CE);

utility families parametric:

utility measurement: **correct for probability distortion**:

utility of gambling:

updating: mistakes in using Bayes' formula:

updating: nonadditive measures: (see also: updating under ambiguity)

updating: testing Bayes' formula:

updating under ambiguity: (see also: updating: nonadditive measures)

updating under ambiguity with sampling: (how ambiguity attitudes are updated after sampling info; not included are: theoretical papers; general papers on updating without explicit mention of ambiguity; general dynamic decisions; decisions from experience; see also: updating: nonadditive measures); studies on decision from experience (DFE) are not always included

updating: discussing conditional probability and/or updating:

value-induced beliefs:

value of information: (see also "information aversion");

(very) small probabilities:

violation of certainty effect: (see also "risk seeking for symmetric fifty-fifty gambles");

violation of risk/objective probability = one source: (see also "PT falsified; probability weighting depends on outcomes")

SLEAPING KEYWORDS: A**HP**: **anonymity protection**; **adaptive utility elicitation**; **PT: data on probability weighting**; **Christiane, Veronika & I**; c**ommon knowledge**; **decision under stress**; **equilibrium under nonEU**: see also game theory for nonexpected utility; **error theory for risky choice**; **game theory for nonexpected utility** (see also equilibrium under nonEU); **games with incomplete information**; **HYE**; **Kirsten&I**; **maths for econ students**; **methoden & technieken**; **Nash bargaining solution**; **preference for flexibility** (since 2000 there is much literature on choice menus); **reflective equilibrium**; **PE gold standard**; **statistics for C/E**; **Z&Z** (on health insurance)

NOTATION AND TERMINOLOGY:

Prospect can refer to choice options in every choice situation. Mostly prospect refers to lotteries (probability distributions over outcomes, which mostly are money amounts), or to acts (mapping states to outcomes, as in Savage 1954).

$\alpha_p\beta$ = (p:α, 1−p: β) denotes a prospect (lottery) giving outcome α with probability p and outcome β with probability 1−p.

$\alpha_E\beta$ = (E:α, E^c: β) denotes a prospect (act) giving outcome α under event E and outcome β under event E^c.

ABBREVIATIONS:

AA: Anscombe-Aumann

AER: American Economic Review

ARA: absolute risk aversion

AHP = analytical hierarchy process

BDM: Becker-DeGroot-Marschak

C/E = cost-effectiveness

CE = certainty equivalent

CEU = Choquet expected utility

CPT = cumulative prospect theory (I usually write PT)

DC = dynamic consistency

def. = definition

DFD: decision from description

DFE: decision from experience

DUR = decision under risk

DUU = decision under uncertainty

EU = expected utility

EV = expected value

HYE = healthy years equivalent

IIA = independence of irrelevant alternatives

inverse S: inverse S-shaped probability transformation

JRU: Journal of Risk and Uncertainty

KMM: Klibanoff, Marinacci, & Mukerji (2005)

nonEU = nonexpected utility

OPT: original prospect theory of 1979 (if you like: old prospect theory)

PE: probability equivalent method, used to measure utility under EU, and alternative there to the certainty equivalent method (CE). In the health domain, people often use the term standard gamble instead of PE; in other domains standard gamble often refers to both PE and CE.

PT = prospect theory; I prefer to use this term for the new 1992 version of prospect theory, also often called cumulative prospect theory

QALY = quality adjusted life years

RA: risk aversion

RCLA: reduction of compound lotteries

RDU: rank-dependent utility

RIS: random incentive system

RRA: relative risk aversion

SEU = subjective expected utility

TTO = time tradeoff method

WTA: willingness to accept

WTP: willingness to pay

REFERENCES

{% Particular ways of processing samples are in plausible agreement with rank-dependent deciding. %}

Aaberge, Rolf (2011) “Empirical Rules of Thumb for Choice under Uncertainty,” *Theory and Decision* 71, 431–438.

{% **free will/determinism** %}

Aarts, Henk (2006) “Onbewust Doelgericht Gedrag en de Corrosie van de Ijzeren Wil,” inaugurale rede, Department of Social Psychology, Utrecht University, Utrecht, the Netherlands.

{% **equity-versus-efficiency**; A discussion follows after this paper. %}

Abasolo, Ignacio & Aki Tsuchiya (2004) “Exploring Social Welfare Functions and Violation of Monotonicity: An Example from Inequalities in Health,” *Journal of Health Econonomics* 23, 313–329.

{% %}

Abbas, Ali E. (2005) “Maximum Entropy Utility,” *Operations Research* 54, 277–290.

{% **one-dimensional utility**; Analyzes the case where expected-utility, multiattribute-utility, etc., preferences remain unaffected after transformations of the arguments. Does this as a general principle, with constant absolute risk aversion and constant relative risk aversion as two special cases. %}

Abbas, Ali E. (2007) “Invariant Utility Functions and Certain Equivalent Transformations,” *Decision Analysis* 4, 17–31.

{% %}

Abbas, Ali E. & David E. Bell (2011) “One-Switch Independence for Multiattribute Utility Functions,” *Operations Research* 59, 764–771.

{% %}

Abbas, Ali & James Matheson (2009) “Normative Decision Making with Multiattribute Performance Targets,” *Journal of Multi-Criteria Decision Analysis* 16, 67–78.

{% %}

Abbas, Ali & János Aczél (2010) "The Role of Some Functional Equations in Decision Analysis," *Decision Analysis* 7, 215–228.

{% **PT: data on probability weighting**;

Finds that probability transformation for gains ≠ for losses. %}

Abdellaoui, Mohammed (1995) "Comportements Individuels devant le Risque et Transformation des Probabilités," *Revue d'Économie Politique* 105, 157–178.

{% **PT: data on probability weighting**;

utility elicitation;

tradeoff method: First, the tradeoff method is used to elicit utility. Then these are used to elicit the probability weighing function. More precisely, first a sequence x_0, ..., x_6 is elicited that is equally spaced in utility units. Then equivalences $x_i \sim (p_i,x_6; 1-p_i,x_0)$ elicit $p_i = w^{-1}(i/6)$ and, thus, the weighting function.

concave utility for gains, convex utility for losses: P. 1506 Finds concave utility for gains (power 0.89), convex utility for losses (power 0.92).

P. 1508 finds more pronounced deviation from linearity of probability weighting for gains than for losses.

inverse S: this is indeed found for 62.5%. 30% had convex prob transformation, rest linear. P. 1507: bounded SA is confirmed.

P. 1510: finds nonlinearity for moderate probabilities, so, not just at the boundaries.

P. 1502: uses real incentives for gains but not for losses.

P. 1504: finds 19% inconsistencies, which is less than usual, but this may be because the consistency questions were asked shortly after the corresponding experimental questions (**inconsistency in repeated risky choice**).

P. 1506: fitting power utilities gives median 0.89 for gains and 0.92 for losses.

P. 1510: no reflection, w^+ (for gains) is different (less elevated) from w^- for losses, also different than dual, so, PT is better than RDU. This goes against complete reflection. It supports the, today commonly believed, partial reflection.

reflection at individual level for risk: correlations at individual level are not reported. Preference patterns not for risk attitude but for utility and probability weighting. For utility found a bit (Table 3; 21 concave for gains is in majority, 13, convex for losses; 8 convex for gains have no convex for losses but mostly mixed). For probability weighting not reported. %}

Abdellaoui, Mohammed (2000) "Parameter-Free Elicitation of Utility and Probability Weighting Functions," *Management Science* 46, 1497–1512. https://doi.org/10.1287/mnsc.46.11.1497.12080

{% **tradeoff method**: is applied theoretically in a dual manner, on probability transformation; %}

Abdellaoui, Mohammed (2002) "A Genuine Rank-Dependent Generalization of the von Neumann-Morgenstern Expected Utility Theorem," *Econometrica* 70, 717–736.

{% Hypothetical choice was used, and discussed on pp. 851 & 862.
tradeoff method: use it in intertemporal context. Now not subjective probabilities, but discount weights, drop from the equations.

P. 847: the asymmetry found between discounting for gains and for losses may have resulted from the assumption, common in the early days, of linear utility, which works out differently for gains (where utility is concave) than for losses (where utility is close to linear and even some convex). This paper corrects for utility but still finds asymmetry (p. 859). They find, though not very clearly, that discounting is less for losses than for gains, but the deviation from constant discounting is the same.

risky utility u = strength of preference v (or other riskless cardinal utility, often called value): Measure intertemporal utility, not going to the unnatural detour of risky choice as for instance Andersen et al. (2008 Econometrica) did, but, more naturally, using only intertemoral choice. Find that it agrees well with utility as commonly measured under risk (p. 860).

P. 855: **convex utility for losses**: Do it in an intertemporal context. With nonparametric analysis, they find linear utility for losses (slightly more convex but insignificant), and concave utility for gains. With parametric analyses, they have no significant deviations from linearity although it is in direction of concavity for gains and convexity for losses. There it agrees with utility as commonly measured under risk.

P. 857: For gains 55 had decreasing impatience and 12 had increasing.

For losses, 47 decr, 18 incr., and 2 constant. They find almost no evidence for the immediacy effect, which drives quasi-hyperbolic discounting.

P. 860: if not correcting for utility curvature, then overly strong discounting, but the deviation is not big at the aggregate level.

Note that this paper measured both utility and discounting using merely intertemporal choice, also with parametric fitting, and is probably the first to do so. It precedes the Andreoni & Sprenger (2012) papers on this point. %}

Abdellaoui, Mohammed, Arthur E. Attema, & Han Bleichrodt (2010) "Intertemporal Tradeoffs for Gains and Losses: An Experimental Measurement of Discounted Utility," *Economic Journal* 120, 845–866. https://doi.org/10.1111/j.1468-0297.2009.02308.x

{% **probability elicitation**; **inverse S; ambiguity seeking for unlikely; natural sources of ambiguity;**

event/outcome driven ambiguity model: event driven

correlation risk & ambiguity attitude: reported in Figures 12 and 13 on p. 715. Correlations between risk aversion on the one hand, and ambiguity aversion and a-insensitivity (ambiguity-generated insensitivity) on the other, are significantly positive and high for all three ambiguity sources (between 0.5-0.86). Figure A3-A4 in the web-appendix do the same for the Ellsberg experiment. The correlations are lower (0.37-0.53) but still significant.

real incentives/hypothetical choice: This paper did the experiment both with hypothetical choice and with real incentives. The main text only reports the incentivized data.

source-dependent utility: Although this paper uses an event-driven ambiguity model, it would still be possible that utility were source dependent. But it is not found empirically here.

testing color symmetry in Ellsberg urn: §III.C confirms it.

random incentive system between-subjects: In a pilot we asked subjects, given the same expected value, if they preferred high payments to some or rather lower payments to all. They clearly indicated a preference for the former. This (+ classroom experiments giving me the same impression) makes me in general, given the same expected value, prefer the between- implementation of high payment for some to the common moderate-payment-for-all. We describe our finding in our Online Appendix (§A.2): "For the second experiment, we asked subjects in a pilot study which form of the random incentive system would motivate them better, the traditional form paying one randomly selected choice for each subject, in which case prizes will be moderate, or one were only one choice of one subject will be played for real but the prize is very large. The subjects expressed a clear preference for the single-large prize system that accordingly was implemented in our experiment."

P. 701 top: "Source functions reflect interactions between beliefs and tastes that are typical of nonexpected utility and that are deemed irrational in the Bayesian normative approach." %}

Abdellaoui, Mohammed, Aurélien Baillon, Laetitia Placido, & Peter P. Wakker (2011) "The Rich Domain of Uncertainty: Source Functions and Their Experimental Implementation," *American Economic Review* 101, 695–723.
https://doi.org/10.1257/aer.101.2.695
Direct link to paper

{% **tradeoff method**; **PE higher than CE**; typo on p. 363 (definition of expo-power): z should be x. %}

Abdellaoui, Mohammed, Carolina Barrios, & Peter P. Wakker (2007) "Reconciling Introspective Utility with Revealed Preference: Experimental Arguments Based on Prospect Theory," *Journal of Econometrics* 138, 336–378.
https://doi.org/10.1016/j.jeconom.2006.05.025
Direct link to paper

{% %}

Abdellaoui, Mohammed & Han Bleichrodt (2007) "Eliciting Gul's Theory of Disappointment Aversion by the Tradeoff Method," *Journal of Economic Psychology* 28, 631–645.

{% An introduction to the special issue in honor of me (Wakker), which I like of course. The authors clearly know me and my peculiarities well. Several of the papers collected here have a special meaning for me, showing more how the organizers know me well. %}

Abdellaoui, Mohammed, Han Bleichrodt, Enrico Diecidue, & Horst Zank (2022) "Introduction to the Special Issue in Honor of Peter Wakker," *Theory and Decision* 92, 433–444.
https://doi.org/10.1007/s11238-022-09886-9

{% The authors measure matching probabilities, and also a-neutral probabilities through exchangeable events, where they interpret the latter as beliefs. Matching probabilities are taken to capture ambiguity attitudes, as this is in source theory. They do so for an ability test concerning themselves and concerning others, to study overconfidence, and to separate the role of beliefs from the role of ambiguity attitude there. They argue, and I agree, that the literature on overconfidence did not pay sufficient attention (or not at all) to the role of ambiguity attitude. %}

Abdellaoui, Mohammed, Han Bleichrodt, & Cédric Gutierrez (2024) "Unpacking Overconfident Behavior when Betting on Oneself," *Management Science*, forthcoming.
https://doi.org/10.1287/mnsc.2021.00165

{% Measure prospect theory, using the well-known method of Abdellaoui, Bleichrodt, & Paraschiv (2007), which can also find loss aversion. The novelty is that they do it for professional managers instead of students. N = 46. They did some tests of prospect theory, and the theory was never violated.

Hypothetical choice. Find, as usual:

concave utility for gains, convex utility for losses: They find this (p. 421). As usual, utility is less convex for losses than it is concave for gains.

risk averse for gains, risk seeking for losses: they find this (p. 420)

Unusual: find less loss aversion, and even quite some of the opposite: gain seeking.

But they find almost no loss aversion (p. 423). The increased rationality of their subjects may have mad this as the first move to EU.

reflection at individual level for risk: they find the opposite, a negative correlation between the powers for gains and those for losses (p. 422).

Pp. 424-425: compares the professional managers to the students of

Abdellaoui, Bleichrodt, & Paraschiv (2007). Utilities for gains are similar, utilities for losses are less convex, and, obviously, loss aversion is much less. %}

Abdellaoui, Mohammed, Han Bleichrodt & Hilda Kammoun (2013) "Do Financial Professionals Behave According to Prospect Theory? An Experimental Study," *Theory and Decision* 74, 411–429.

{% **natural sources of ambiguity;**

This paper considers the source method of Abdellaoui et al. (2011 American Economic Review). It considers New York & Rotterdam temperature. Unlike the 2011 paper, it does not measure subjective probabilities on a continuum in a parameter-free way, but it uses parametric fitting. Beta-distributions fit best, better than normal or others. Given that cross-checks in the 2011 paper revealed no violations of probabilistic sophistication under real incentives, this paper does not do such cross-checks. It interprets the subjective (so, choice-based; I prefer the term a-neutral) probabilities as beliefs.

The paper also fits the smooth ambiguity model (= recursive expected utility). They use a finite mixture model with the smooth model and PT (the latter done for binary-gain prospects so that it is biseparable utility and captures Choquet expected utility, multiple priors, and most event-driven ambiguity models). 80% of subjects did PT and 20% did smooth. Utilities did not change across sources (such changes is what the smooth model does, having different U for first and second stage and combining it using backward induction), but the source function did, showing source dependence of that. Calibration of choice-based probabilities was good.

The authors obtain inverse S source functions, with Rotterdam (where the experiment was done) slightly but still significantly more elevated than New York. %}

Abdellaoui, Mohammed, Han Bleichrodt, Emmanuel Kemel, & Olivier L'Haridon (2021) "Measuring Beliefs under Ambiguity," *Operations Research* 69, 599–612. https://doi.org/10.1287/opre.2020.1980

{% N = 48;

Discuss pros and cons of parametric fitting.

First paper to use the method to elicit PT as follows: First consider a subset of prospects with one fixed probability and fit PT with some parametric utility (usually log-power), where the probability weight is just one parameter. This gives reliable estimates of probability weighting. Then this parameter is used to estimate utilities of other outcomes.

random incentive system between-subjects: One subject is paid. They used very large outcomes, such as 10,000 euros, in the experiment, but for real incentives scaled down by a factor 10 (oh well). For losses they found slightly concave utility, but yet risk seeking.

concave utility for gains, convex utility for losses: find concave utility for gains, and slightly concave utility for losses.

risk averse for gains, risk seeking for losses: they find this.

reflection at individual level for risk: Table 4 p. 256 gives weak counterevidence, not counting mixed or neutral: of 25 risk averse for gains, 15 are risk averse for losses and only 10 are risk seeking; of 3 risk seeking for gains, all 3 are risk seeking for losses.

They also estimated power of utility (under PT) but do not report correlations.

The finding of concave utility for losses, but risk seeking, is a nice empirical counterpart to Chateauneuf & Cohen (1994).

inverse S: find it, both for gains and losses, fully in agreement with the predictions of PT.

Use a measurement method where utility is measured through parametric fitting, assuming power utility. %}

Abdellaoui, Mohammed, Han Bleichrodt, & Olivier L'Haridon (2008) "A Tractable Method to Measure Utility and Loss Aversion under Prospect Theory," *Journal of Risk and Uncertainty* 36, 245–266.
https://doi.org/10.1007/s11166-008-9039-8

{% Exemplary study into intertemporal choice, providing the first complete quantification. One good thing is that they derive both discounting and utility from intertemporal choice, which is the obvious natural way to go and first thing to try for anyone who thinks about it. Abdellaoui, Attema, & Bleichrodt (2010) and Andreoni & Sprenger (2012 AER, "Estimating Time Preference from Convex Budgets") also did such a thing, only using intertemporal choice, but less completely than this paper. In retrospect it is hard to understand why papers such as Andersen et al. (2008 Econometrica) detoured to risky choice to get utility from there.

First, in Rotterdam, intertemporal choices were measured with both gains and losses, and then this is best done hypothetically, as the authors argue on p. 229 bottom and I agree. Use only two nonzero payoffs, one always at present, and for gains and losses measure present values. For mixed they match a loss outcome; always done by bisection-choice (p. 230 last para). Use linear-exponential utility. P. 235 Table 3 lists the other discount families tested, besides generalized hyperbolic: its special cases of constant discounting, proportional, and power; further families that are no special cases: quasi-hyperbolic, fixed cost, constant sensitivity, and constant absolute.

P. 236: For gains utility is close to linear. Moderate loss aversion, of 1.3 or so.

P. 237: moderate discounting. §2.1.7: Data fitting much better with sign-dependent discounting. The (rational) discount factors for gains and losses were strongly correlated (0.7 corelation), but the (irrational) deviation from constant discounting not at all, with more deviation for losses (p. 238)

P. 238 (footnote 6 cites personal communication with Prelec on it) generalized hyprbolic fits the data poorly, with especially the α parameter (deviating from constant discounting) unstable.

P. 238 §2.1.8: Mixed model gives ¾ subjects linear U for gains, concave for losses (**concave utility for gains, convex utility for losses**), modest discounting and loss aversion. ¼ had concave U for both gains and losses, and much discounting and loss aversion.

P. 239-240, §2.1.9 (with Table 7 on p. 241): Constant sensitivity fitted the data best, although its superiority over quasi-hyperbolic and fixed-costs was not significant. The authors corrected for number of parameters using AIC.

Given present value, it can only be constant sensitivity and not the extension by Bleichrodt, Rohde, & Wakker (2009).

P. 239, here in hypothetical, only one subject had increasing impatience.

reflection at individual level for risk (positive or negative correlation between risk aversion for gains and losses): Find positive correlation between concavity of utility for gains and convexity for losses (0.32; p = 0.007), but this is utility for intertemporal choice, and not for risky choice. They also find positive correlation (0.70; $p < 0.001$) for discounting for gains and losses.

P. 240 ff.: 2nd experiment in Paris, repeated only gains, but now with real incentives and individual interviews. (Details of future payment: p. 242 top, before §2.2.1. Every subject had a 1/20 chance of real play (**random incentive system between-subjects**).

P. 244 §2.2.3: data similar to hypothetical, except for two differences: way higher discount parameter β (so, less discounting), and now more (26%) subjects had increasing impatience.

P. 246 §2.2.6 (Table 11): again constant sensitivity fitted best, now ex aequo with generalized hyperbolic, and superiority over fixed-cost was not significant.

P. 247 §3 (discussion) and §4 (conclusion, p. 248): sign-dependence, and possibility to accommodate increasing impatience, are desirable. %}

Abdellaoui, Mohammed, Han Bleichrodt, & Olivier L'Haridon (2013) "Sign-Dependence in Intertemporal Choice," *Journal of Risk and Uncertainty* 47, 225–253.

https://doi.org/10.1007/s11166-013-9181-9

{% The first disseminated and citable working paper version of this was in March 2010.

Most choices were done hypothetically. The authors considered losses and intertemporal choices, and for those hypothetical is best I think. In the Rotterdam half of the experiment (N = 65), all was done hypothetically (p. 2157), also for gain-risks (here real incentives could have been implemented with no problem), so as to have ceteris paribus in comparisons. In the Paris half of the experiment (N = 50), real incentives were used for gain-risks, paying 1/20 subjects stakes up to €200. (**random incentive system between-subjects**)

risky utility u = transform of strength of preference v: this paper investigates the question empirically, with mature interpretations and discussions.

§2, p. 2154 last para, suggests separability over states of nature, but they mean so in a rank-dependent (comonotonic) manner, as eplained a few lines below.

They use the method of Abdellaoui et al. (2008) to measure utility and probability weighting. The same method can obviously be used in intertemporal choice, with the discount value of a timepoint rather than the decision weight of a probability as unknown parameter. It is strange that until recently people never treated time just the same as risk before in the literature when doing parametric fitting to get utility, but here it is done. Abdellaoui, Attema, & Bleichrodt (2010) and Andreoni & Sprenger (2012 AER) preceded them in this regard.

P. 2156, Eq 3 seems to assume that a future payoff automatically involves uncertainty, captured by a decision weight, but unlike most works in the literature this decision weight is not taken as part of the discount weight, but is taken as a separate parameter, which may be hard to identify. In the Kreps-Porteus (1978) model, the authors interpret the late utility function as purely capturing risk attitude, and the early one to capture intertemporal attitude.

The authors use exponential U to fit data with loss aversion so as to avoid the mathematical problems of power utility when estimating loss aversion.

Find more noise for risk than for time (p. 2159). Paris experiment, unlike Rotterdam, did personal interviewing, leading to less noise (p. 2159).

Rotterdam results:

P. 2159: Utility was different for risk than for time. For risk it was usual S-shape, but for time it was linear for gains and concave (instead of convex) for losses. An explanation of the latter could be an underestimation of the discount factor of the future time (always 1 year), because the authors always considered a larger gain/loss at the later timepoint (Table B.2 in appendix). This can make utility extra convex for gains and extra concave for losses, so as to amplify the effects of extreme outcomes.

P. 2160: Loss aversion might be the same for risk and time. Utilities and loss aversion for risk and time were not significantly correlated, which is a negative result, suggesting much noise.

P. 2160: Paris results did not find significant convexity for loss-utility. More loss aversion for risk than for time.

P. 2162: violation of time separability can distort results.

P. 2163 footnote 6 proposes how to measure utility unaffected by probability weighting for risk, or, in general, to measure one parameter unaffectedly by another. It elaborates the point if one probability p is used, as is the case here. The idea is as follows: (1) Take any indifference, and use it to express w(p) in terms of utilities. (2) Next, replace every appearance of w(p) by that expression. What results is equalities with only utilities, giving utility without speculation on w(p). A difference with the tradeoff method is that the authors' method does not disentangle probability weighting and utility, but is a general method for solving equalities. In the tradeoff method, if one makes a mistake in probability weighting w(p) and, for instance, erroneously assumes expected utility (w(p) = p) whereas the subject does prospect theory with nonlinear probability weighting, then mistakes in utility assessment might slip in when deriving the utilities of what is called the gauge outcomes. However, utility inferences of the gauge outcomes are simply not used in the tradeoff method. In the authors' method, if one erroneously assumes expected utility, whereas the subject perfectly well satisfies PT, then one erroneously thinks that there are inconsistencies in the utility measurements, which one will try to capture by partly changing the estimated utility values and partly capturing the deviations through an error term.

The conclusion (p. 2163) nicely summarizes the paper, and here it is:

"Utility under risk and utility over time were different and uncorrelated with utility curvature more pronounced for risk than for time. Utility under risk was concave for gains and convex to linear for losses. Utility for losses was closer to linear than utility for gains. Intertemporal utility was close to linear. Our subjects were loss averse both in decision under risk and in decision over time, but it was stronger for risk. Loss aversion for risk and time were uncorrelated, suggesting that even though loss aversion is important in both domains, it is volatile and affected by framing." %}

Abdellaoui, Mohammed, Han Bleichrodt, Olivier L'Haridon, & Corina Paraschiv (2013) "Is there One Unifying Concept of Utility? An Experimental Comparison of Utility under Risk and Utility over Time," *Management Science* 59, 2153–2169.
https://doi.org/10.1287/mnsc.1120.1690

{% This paper measures utility for different sources that should give the right utility for all models considered. It does so by using the Wakker-Deneffe TO method (**tradeoff method**), using only two-outcome prospects where all theories agree, being bisparable. More precisely, it uses a sign-dependent generalization that also covers PT.

Loss aversion is measured by taking the kink of the overall utility at the reference point, or $-U(-\alpha)/U(\alpha)$ for several α's > 0. More precisely, they get $\alpha_E\beta \sim 0$ for $\alpha > 0 > \beta$, then $\gamma \sim \alpha_E 0$ and $\delta \sim o_E\beta$, from which it follows that $U(\gamma) =$

–U(δ). Then γ/δ is an approximation of loss aversion, under the reasonable assumption of locally linear utility at either side of 0 (but kink at 0).

So, it can see whether utility is really different for different sources. (I take loss aversion as part of utility here. This is debatable and it can also be taken as a separate component, besides basic utility.) The most sensitive point of utility curvature is loss aversion, and the paper develops a special technique for measuring it. It finds that utility does not depend on the source. As sources it uses the classical Ellsberg known/unknown urn. The paper does find ambiguity aversion, so, the utility-based theories are really falsified here. (**event/outcome driven ambiguity model: event driven**)

Find same loss aversion for risk as for ambiguity.

They test sign-comonotonic tradeoff consistency, a necessary and (under richness assumptions) sufficient preference condition for PT. Find it satisfied. %}

Abdellaoui, Mohammed, Han Bleichrodt, Olivier l'Haridon, & Dennie van Dolder (2016) "Measuring Loss Aversion under Ambiguity: A Method to Make Prospect Theory Completely Observable," *Journal of Risk and Uncertainty* 52, 1–20. https://doi.org/10.1007/s11166-016-9234-y

{% **concave utility for gains, convex utility for losses**: find concave utility for gains, convex for losses

reflection at individual level for risk: p. 1667 Table 3: Of people with concave utility for gains, by far most (26) have convex utility for losses and only 1 has concave. Of people with convex utility for losses, still quite some (6) have convex utility for losses, but now 3 have concave utility. They also fitted power utility and, nicely, report correlation between gains and losses (p. 1669), being 0.389 (which means reflection at the individual level).

Table 1 gives a nice summary of the various definitions of loss aversion used in the literature.

They first measure some utilities for gains and losses through the **tradeoff method**, getting some utility midpoints. Using that, they measure $w^{-1}(0.5)$ for both gains and losses. Then they know so much that from indifferences between mixed prospects they can measure loss aversion efficiently. %}

Abdellaoui, Mohammed, Han Bleichrodt, & Corina Paraschiv (2007) "Loss Aversion under Prospect Theory: A Parameter-Free Measurement," *Management Science* 53, 1659–1674.

{% **probability intervals**: Hill (2019) showed that α in the α maxmin model can be identified if one adds events with objective probability intervals. This paper reports an experiment using this result. For every subjective event E one can specify an objective "matching probability-interval," bringing all the same preferences and, hence, the same probability interval. It is the probability-interval analog of matching probabilities. It takes quite some effort to implement this way in an incentive compatible manner in an experiment, but this paper does it. The paper finds plausible results, supporting the method. It should be noted though that the paper only does it for (many) partitions {E,E^c}, so that it in fact elicits probability intervals and not sets of priors.

I often argued that the multiple priors model in its generality is too general to be elicited. An exception is the very simple case of two states of nature, with an event E and its complement E^c. Then multiple priors models are biseparable utility models, and can be elicited. This paper considers this very simple case, but for several events. Put differently, it elicits upper and lower probabilities of some events. This is different than multiple priors, which involves entire probability distributions. %}

Abdellaoui, Mohammed, Philippe Colo, & Brian Hill (2021) "Eliciting Multiple Prior Beliefs," working paper.

{% N = 52. Bisection to get indifference of 2-outcome prospects, always risk resolved at the time of payoff, this being at different times (latest in a year from now), one time of payment ambiguous. Use the Abdellaoui et al. (2008) method to elicit PT, with the fixed probability used for utility measurement equal to 1/3 for the best outcome, following the suggestion of Tversky & Fox (1995 p. 276, 2nd column), because w(1/3) is approximately 1/3 on average.

real incentives/hypothetical choice, for time preferences: don't explain how they make future payment credible.

Measure PT at two different timepoints. Utility is not different, but probability weighting is more optimistic at the later timepoint, confirming similar finding by Noussair & Wu (2006) under EU. It is also more sensitive at later timepoints.

Find, as usual, concave utility. %}

Abdellaoui, Mohammed, Enrico Diecidue, & Ayse Öncüler (2011) “Risk Preferences at Different Time Periods: An Experimental Investigation,” *Management Science* 57, 975–987.

{% Matching probabilities of lotteries that pay either now or at some fixed future time. Probability weighting better fits/predicts than utility curvature. Insensitivity and pessimism increase as the time of payment gets later (**violation of risk/objective probability = one source**:). Here the timing of resolution of uncertainty varies, not of outcome. %}

Abdellaoui, Mohammed, Enrico Diecidue, Emmanuel Kemel, & Ayse Onculer (2022) “Temporal Risk Resolution: Utility versus Probability Weighting Approaches,” *Management Science* 68, 5162–5186.

{% N = 39. Do choice list, matching on outcomes rather than on probability, with always one prospect riskles, and fit **biseparable utility.** They use the method used in many papers by Abdellaoui, where the probability p is kept fixed, and then w(p) is derived from data fitting as the only parameter of probability weighting needed, and is then used to obtain the utility function. The main contribution of this paper is to demonstrate, using data, that their method is less dependent on assumptions about probability weighting than methods that use different probabilities.

The paper has some strange claims. For example, the paper writes, 3rd page penultimate para: “A major strength of the HL probability scale method is that it allows a direct estimation of individual degrees of relative risk aversion on the basis of a specific utility function.” However, as far as I can judge, for ANY data set and method one can fit power utility just as well as for the HL method.

3rd-4th page writes, again about HL: “probability scale ... First, the method is highly tractable: only one table has to be used to obtain an indicator of risk aversion, and this can be implemented either through a computer-based questionnaire or through a simple pencil and paper questionnaire.” Again, cannot any indifference obtained by any measurement method be used the same way?

The third main drawback at the end of §2.3 (that "it uses a the probability scale to measure risk attitudes under expected utility." The authors have put forward that their novelty relative to HL is that they use "the outcome scale rather than the probability scale" (abstract; beginning of §2.3 calls this the main difference between what the authors do and what HL does): doesn't this same drawback hold for any method assuming EU, also if, as in the case of this paper, matching is in the outcome scale? So, it is assuming that EU, and not matching in the probability scale, matters. Later the paper explains that they use only one fixed probability p, implying that only that one w(p) has to be estimated and in that sense the paper relies less on matching in the probability scale.

The results show that HL type measurements with PE have the resulting utility function depend much on the parametric probability weighting function assumed, but the authors' method does not. (**PE doesn't do well**) %}

Abdellaoui, Mohammed, Ahmed Driouchi, & Olivier l'Haridon (2011) "Risk Aversion Elicitation: Reconciling Tractability and Bias Minimization," *Theory and Decision* 71, 63–80.

{% N = 61. Losses and mixed were only hypothetical. For gains, half did hypothetical and for the other half two subjects could play one gain-choice for real (= **random incentive system between-subjects**). This paper never finds differences between real incentives and hypothetical. (**real incentives/hypothetical choice**)

Paper assumes PT, with binary prospects. It first uses Abdellaoui's semi-parametric method to measure utility, where one and the same probability/event is always used for the most extreme nonzero outcome, impying that its weight is the only parameter beyond utility to be fit. Then power utility is fit. With utility available, decision weights for all kinds of events/probabilities are elicited. All up to this is based on measured certainty equivalents. Loss aversion is measured using power utility with the T&K'92 assumption that u(1) = u(−1) = 1, where € is unit of payment.

One difference with usual studies of decision from experience (DFE) is that the subjects are informed beforehand about what the set of possible outcomes is.

concave utility for gains, convex utility for losses: find concave U for gains, close to linear (bit convex) utility for losses, both for DFE and for description

(DFD).

reflection at individual level for risk: They have the data within-subject but do not report it. §5.1 writes that of the subjects with concave utility for gains, about as many had convex as concave utility for losses. This to some extent suggests independence of gain/loss utility shape. Great majority was loss averse.

inverse S: Find it for DFD. Note that no parametric family was assumed to determine the decision weights. Intersects diagonal at about $p = 0.25$. Not really different for gains and losses, though some more elevation and some higher sensitivity to losses (§5.2).

For DFE one can take objective probabilities of events, or observed frequencies from sampling, in the analysis of decision weights. Doing the first, most results are the same as with DFD. The only differences are: Utility is more concave for losses (slight majority concave here), but still close to linear. Probability is less elevated for gains than with DFD, although still overweighting $p = 0.05$. For losses probability weighting is equally elevated as for DFD, so, it is less elevated than for gains with DFE. Doing the second, sampled frequencies, gives no clear differences.

The abstract summarizes the main comparisons between DFD and DFE: decision weights for gains are lower with DFE, and no big differences otherwise.

The paper claims, in some places, to show that DFE and DFD are different, but it mostly shows that there are almost no differences. Most remarkable is that this study does not find the opposite of inverse S-shaped weighting that most studies on DFE do. The paper does not discuss this point much (**DFE-DFD gap but no reversal**). This point is probably generated by the methodological difference of telling subjects what the possible outcomes are. The paper cites Erev, Glozman, & Hertwig (2008) on this in §7.2, but not in a very explicit manner. If I understand well, Erev, G&H found this also. %}

Abdellaoui, Mohammed, Olivier L'Haridon, & Corina Paraschiv (2011) "Experienced versus Described Uncertainty: Do We Need Two Prospect Theory Specifications?," *Management Science* 57, 1879–1895.

{% PT fits well for married couples, as for individuals. The attitudes for couples are usually a mix of the individuals, with more weight for the female attitude, especially for unlikely events. Use two-stage data-fit method of Abdellaoui, Bleichrodt, & l'Haridon (2008). %}

Abdellaoui, Mohammed, Olivier L'Haridon, & Corina Paraschiv (2013) "Individual vs. Couple Behavior: An Experimental Investigation of Risk Preferences," *Theory and Decision* 75, 157–191.

{% Propose a parametric probability weighting function family of the form

$w(p) = \delta^{1-\gamma}p^{\gamma}$ if $0 \le p \le \delta$ and

$w(p) = 1 - (1-\delta)^{1-\gamma}(1-p)^{\gamma}$ if $p > \delta$

with $0 \le \delta \le 1$, $0 < \gamma$.

The function is **inverse S**, has many nice properties, is given a preference foundation, and fits data well. It intersects the diagonal at δ. To get pessimism or optimism, δ should be chosen 0 or 1 after which the power family results. It seems that $\delta = 0$ and $\delta = 1$ give about the same curves.

Under inverse S, δ reflects elevation (anti-index of pessimism, because w is concave and above diagonal up to δ) and γ reflects sensitivity (curvature; anti-index of inverse S).

For gains the neo-additive weighting function (called linear by the authors) fitted data better, but for losses their function did. %}

Abdellaoui, Mohammed, Olivier L'Haridon, & Horst Zank (2010) "Separating Curvature and Elevation: A Parametric Probability Weighting Function," *Journal of Risk and Uncertainty* 41, 39–65.

{% **updating under ambiguity with sampling** %}

Abdellaoui, Mohammed, Brian Hill, Emmanuel Kemel, & Hela Maafi (2020) "The Evolution of Ambiguity Attitudes through Learning," working paper.

{% **real incentives/hypothetical choice**: find no difference in patterns, but less error for real incentives.

Do decision under risk both with monetary outcomes and with time as outcome. For time, subjects were told beforehand that the experiment would last approximately 2 hours, where it might be 1 or 3. The time unit designated a time to wait in the lab with no amusing/useful things like computers or mobile phones available. They were anchored to think 2 hours, but then it could become more (gains) or less (losses).

concave utility for gains, convex utility for losses: (§5.1) They find pronounced concavity for gains, and moderate concavity, and not convexity, for losses. For time less concavity for gains than for money. Loss aversion lower for time than for money (end of §5.1).

inverse S: (§5.2) confirmed for time and money, and for gains and losses.

On average more inverse S for time than for money, both for gains and for losses. For time, probability weighting has more elevation for both gains (optimism) and losses (pessimism). Which is not very nice for PT. Probability weighting depending on outcomes can be taken as a violation of PT (**PT falsified; probability weighting depends on outcomes**). The symmetry for gains and losses is nice for reflection. Would be interesting to see if at the individual level there is much difference between probability weighting for time and for money, but the paper does not report it. (Statistics may not be easy.)

losses from prior endowment mechanism: this they do. For money there is the usual problem that subjects may integrate the prior endowment with the loss and, hence, not perceive losses, which is why they do money only hypothetically, something that I agree with. For time such integration is less likely because time loss is not so easily integrated with the prior endowment OF MONEY (they are paid for the time loss). This makes this paper the most convincing implementation of real incentives for losses that I have seen in the literature (in 2022). Abdellaoui, Gutierrez, & Kemel (2018) will use similar incentives. Casari & Dragone (2015) do a similar thing. %}

Abdellaoui, Mohammed & Emmanuel Kemel (2014) "Eliciting Prospect Theory when Consequences Are Measured in Time Units: "Time Is not Money"," *Management Science* 60, 1844–1859.
https://doi.org/10.1287/mnsc.2013.1829

{% Subjects choose between lotteries paid at different times. The resolution of uncertainty always is immediate. They find the usual inverse S probability weighting, even while they chose a design where random errors go against inverse S; see, e.g., p. 468 middle para. (**inverse S**) This is useful to show that inverse S is not (just) noise. They also do find present bias in the presence of risk.

Some may have suggested that it disappears under risk, but this study finds it doesn't. They fit power utility to the data, but assume it to be the same for risk and time, an assumption that I like. They discuss this on p. 468 3rd para. They use Prelec's two-parameter family.

Every subject had 1/10 probability of real incentive, but stakes were up to €500. (**random incentive system between-subjects**) The authors explain on p. 463 bottom that this is necessary to get real curvature of utility, and I fully agree.

P. 468 2nd para explains that the EU-utility correction of Andersen et al. (2008) may do more harm than good.

P. 468: "Together, these studies underline the importance of explicitly designing experimental stimuli in a way that allows the different dimensions to be identified. Estimating complex models on data that are not especially designed for that purpose is bound to generate biased inferences if the resulting estimations are accepted without question." This is a good observation, relevant for many data fittings. The conclusion (p. 463), 1st para, explains that they took their stimuli with plenty variations in outcomes and probabilities to properly estimate probability weighting and utility curvature separately.

P. 463 last para: if doing the EU correction for utility, then discounting is 6% per year. Bringing in probability weighting increases it to 14%.

The authors considered hyperbolic, quasi-hyperbolic, but also the constant-sensitivity family of Ebert & Prelec (2007) for discounting, but do not report which fitted better. %}

Abdellaoui, Mohammed, Emmanuel Kemel, Amma Panin, & Ferdinand M. Vieider (2019) "Measuring Time and Risk Preferences in an Integrated Framework," *Games and Economic Behavior* 115, 459–469.

{% %}

Abdellaoui, Mohammed, Emmanuel Kemel, Ferdinand M. Vieider, & Fan Wang (2023) "Beyond Discounted Expected Utility: An Axiomatic Setup and a Descriptive Horse Race," working paper.

{% Halevy (2007) found an almost perfect relation between ambiguity aversion and violation of RCLA. This paper finds some relation, but only weak, with much else going on. They find that compound risk aversion is increasing in the winning probability, nice in harmony with likelihood insensitivity, as they point out on pp. 1306-1307. %}

Abdellaoui, Mohammed, Peter Klibanoff, & Laetitia Placido (2015) "Experiments on Compound Risk in Relation to Simple Risk and to Ambiguity," *Management Science* 61, 1306–1322.

{% This paper criticizes Bernheim & Sprenger (2020, Econometrica) (BS). I list five major problems below, as explained extensively in my annotations to the paper in this file and more concisely in Wakker (2023, *Journal of Behavioral and Experimental Economics* 107, 101950). I here write only about something else: how our paper here was rejected by Econometrica.

Five problems of BS:

1. The experiments were poor, with overly complex stimuli and too low incentives.
2. BS ignored much preceding literature that showed their found violations of rank dependence in better experiments, and BS ignored much preceding literature with positive evidence of rank dependence. They incorrectly criticize preceding literature by erroneously arguing that commonly used counting tests are invalid.
3. SB used a wrong formula of 1979 prospect theory.
4. Their remedy of complexity aversion does not work, with the prevailing (existing! but not cited) empirical evidence opposite to their claims.
5. Their §3.2 & §4.1 use only prospects with one nonzero outcome to identify both probability weighting and utility, but this is a well-known mistake (unidentifiable joint power).

This paper was submitted to Econometrica, but was rejected with four unanimously negative referees. I think, if a paper should clearly be accepted, then providing four negative referees is a bit overdoing it. One referee said no more than that our paper was too negative. The other three referees all, remarkably, used the same linguistic tric to downplay our paper. They all wrote that they focus on our main criticism, for which they all chose Problem 1 above. Thus, they ignored the other four problems, which I think cannot be done for problems that serious. Then they criticized us for not having provided new evidence on that Problem 1 but only citing existing literature, arguing that we should have provided new experimental evidence and should have shown how the experiment could have been done properly. That is, we should have investigated in detail what happens if one only makes the mistakes of Problems 2-5, but not of Problem 1. The editor sided with these judgments, reiterating them in his decision letter. We were not invited to provide such evidence in a resubmission, but our paper was just rejected. Looks like, to criticize a claim 2 + 2 = 5, one has to provide new experimental evidence! %}

Abdellaoui, Mohammed, Chen Li, Peter P. Wakker, & George Wu (2020) "A Defense of Prospect Theory in Bernheim & Sprenger's Experiment," working paper. Direct link to paper

{% N = 101 student-subjects. **random incentive system between-subjects**: described in §3.4.1.

losses from prior endowment mechanism: they use the same good system as Abdellaoui & Kemel (2014)

Consider discounted utility when the outcomes refer to time duration, which is time to work, and also when it is money. A reference point is framed and then gains or losses are considered. It is a contract specifying that one is supposed to work for four hours, but then it can reduced or increased. It can concern 4 work hours on an early date, or on a late date. They allow for nonconstant discounting and nonlinear utility. They use the tau-discounting of Bleichrodt, Potter van Loon, & Prelec (2022), and also constant sensitivity of Ebert & Prelec (2007). Bleichrodt, Kothiyal, Prelec, & Wakker (2013 p. 69) preferred the term unit invariance for this family. P. 17 writes that all parametric families performed similarly well, but that the authors prefer the constant sensitivity family because it is the only one that allows for both insensitivity and over-sensitivity.

For losses, they find many violtions of impatience, preferring an early to a late loss. There is more heterogeneity for utility and discounting for time duration than for money. %}

Abdellaoui, Mohammed, Cédric Gutierrez, & Emmanuel Kemel (2018) "Temporal Discounting of Gains and Losses of Time: An Experimental Investigation," *Journal of Risk and Uncertainty* 57, 1–28. https://doi.org/10.1007/s11166-018-9287-1

{% %}

Abdellaoui, Mohammed & Bertrand R. Munier (1994) “The Closing-In Method: An Experimental Tool to Investigate Individual Choice Patterns under Risk.” *In* Bertrand R. Munier & Mark J. Machina (eds.) *Models and Experiments in Risk and Rationality*, Kluwer Academic Publishers, Dordrecht.

{% %}
Abdellaoui, Mohammed & Bertrand R. Munier (1996) “Utilité Dépendant des Rangs et Utilité Espérée: Une Étude Expérimentale Comparative,” *Revue Economique* 47, 567–576.

{% %}
Abdellaoui, Mohammed & Bertrand R. Munier (1997) “Experimental Determination of Preferences under Risk: The Case of very Low Probability Radiation,” *Ciência et Tecnologia dos Materiais* 9, Lisboa.

{% Describes how different heuristics apply to different regions of the probability triangle. %}
Abdellaoui, Mohammed & Bertrand R. Munier (1998) “The Risk-Structure Dependence Effect: Experimenting with an Eye to Decision-Aiding,” *Annals of Operations Research* 80, 237–252.

{% **tradeoff method**: Test it when formulated dually, i.e., directly on probability weighting. Find that rank-dependence does sometimes provide a useful generalization of EU. A more detailed test than Abdellaoui & Munier (1999, in Machina & Munier, eds), which preceded this one. %}
Abdellaoui, Mohammed & Bertrand R. Munier (1998) “Testing Consistency of Probability Tradeoffs in Individual Decision-Making under Risk,” GRID, Cachan, France.

{% **tradeoff method**: Test it when formulated dually, i.e., directly on probability weighting. Reports an indirect test in **probability triangle**s whose consequences are a standard sequences $(u(x_3) - u(x_2) = u(x_2) - u(x_1))$. With this at hand probability tradeoff consistency can be tested across triangles. %}

Abdellaoui, Mohammed & Bertrand R. Munier (1999) "How Consistent Are Probability Tradeoffs in Individual Preferences under Risk?" *In* Mark J. Machina & Bertrand R. Munier (eds.) *Beliefs, Interactions and Preferences in Decision-Making*, 285–295, Kluwer Academic Publishers, Dordrecht.

{% %}

Abdellaoui, Mohammed & Bertrand R. Munier (2000) "Substitutions Probabilistiques et Décision Individuelle devant le Risque: Expériences de Laboratoire," *Revue d'Economie Politique* 111, 29–39.

{% N = 41.

natural sources of ambiguity;

real incentives/hypothetical choice: used flat payment and hypothetical choice, because utility measurement is only interesting for large amounts that cannot easily be implemented.

inverse S & **uncertainty amplifies risk**: confirm less sensitivity to uncertainty than to risk. This implies: **ambiguity seeking for unlikely**

tradeoff method to elicit utility, (**concave utility for gains, convex utility for losses**) gives concave utility for gains (power-fitting gives power of about 0.88 on average) and some convex, but close to linear, utility for losses. They use mixed prospects, and thus can let the standard sequence start at 0 and they get utility over a domain $[0, x_6]$, including 0 (see just before §3.1, p. 1387). They use an uncertain event E, not given probability, to measure the standard sequence. They measure matching probabilities, $x_p0 \sim x_E0$.

Test two-stage model of PT with $W(E) = w(B(E))$, axiomatized by Wakker (2004). Here W is measured from PT by first measuring utility using the tradeoff method (§3.1), and then extending Abdellaoui's (2000) and Bleichrodt & Pinto's (2000) method for measuring probability weighting to uncertainty: $1_E0 \sim x$ then $W(E) = U(x)$, assuming $U(0) = 0$ and $U(1) = 1$ (§3.2). B, called choice-based probability by the authors, is measured through matching probabilities: $1_E0 \sim 1_p0$ then $B(E) = p$ (§3.3). (That is, they do this only for gains.) They then derive w as $w(p) = W(B^{-1}(p))$.

W satisfies bounded SA (= inverse S extended to uncertainty) for almost all subjects. Bounded SA is similar for gains and losses, but elevation is larger for losses. Bounded SA also holds for the factor B (p. 1395 bottom of first column), and for w. Hence, all common hypotheses of diminishing sensitivity of Fox & Tversky (1998), Tversky & Fox (1995), Wakker (2004), and others are confirmed. One small deviation is that for losses they find overweighting of unlikely events but no significant underweighting of likely events (§5.4, p. 1394).

ambiguity seeking for unlikely gains and **ambiguity seeking for losses**are confirmed by bounded SA

tradeoff method's error propagation: do so on p. 1394, §5.3 end.

reflection at individual level for ambiguity: Although they have the data at the individual level, they do not report these. They do it neither for utility (§5.2), where they even fitted power and exponential utility, so could (but do not) correlate parameters, nor for ("overall") decision weights (§5.3), nor for the estimations of the risky probability weighting functions in §5.5.

For example, p. 1397 2nd para (about the function carrying matching probabilities into decision weights, which should be the probability weighting function under risk) mentions "at the level of individual subjects," but it is paired t-tests. Those, while corrected for errors at the individual level, only test hypotheses about group averages. No correlations between gain-loss parameters are given, for instance, and nothing in their results suggests that these would be positive or negative.

For group averages, they find the same insensitivity (inverse S, called bounded subadditivity by the authors) for gains as for losses, both for overall decision weights W^+ and W^- and for the risky probability weighting functions w^+ and w^- derived from $W^+(E) = w^+(B(E))$ and $W^-(E) = w^-(B(E))$ with B the matching probabilities. But elevations are higher for losses than for gains.

Although the beginning of the paper takes matching probabilities B as beliefs (so that ambiguity attitude is entirely belief), as commonly done in the Tversky et al. two-stage approach, the paper later points out that it will also incorporate source preference (p. 1386 2nd column middle) and said more firmly at bottom of p. 1398, where it nicely follows on p. 1399 with Tversky's view that source preference may not be central for transitive individual preference but rather a contrast effect.

P. 1398: "The similarity of the properties of judged probabilities and choice-based probabilities comes as good news for the link between the psychological concept of judged probabilities and the more standard economic concept of choice-based probabilities." %}

Abdellaoui, Mohammed, Frank Vossmann, & Martin Weber (2005) "Choice-Based Elicitation and Decomposition of Decision Weights for Gains and Losses under Uncertainty," *Management Science* 51, 1384–1399.
https://doi.org/10.1287/mnsc.1050.0388

{% **tradeoff method**. This is the third-best paper I ever co-authored. Unfortunately, the journal printed its papers taking twice as many pages as other journals. In the days of paper copying this was perfectly OK because two journal pages together made up one A4 page, but after the year 2000 where we work with pdf files and printing it deters many people not aware of this. Whereas in any other journal the paper would have taken 37 pages, in this journal it takes 73. %}

Abdellaoui, Mohammed & Peter P. Wakker (2005) "The Likelihood Method for Decision under Uncertainty," *Theory and Decision* 58, 3–76.
https://doi.org/10.1007/s11238-005-8320-4
Direct link to paper

{% %}

Abdellaoui, Mohammed & Peter P. Wakker (2020) "Savage for Dummies and Experts," *Journal of Economic Theory* 186, article no. 104991.
https://doi.org/10.1016/j.jet.2020.104991
Direct link to paper

{% This paper presents source- and rank-dependent utility (SRU), a convenient joint generalization of the smooth ambiguity model and rank-dependent utility for ambiguity, axiomatizing it as well as all of its specifications. It thus serves well to compare the various approaches.

The authors consider a two-stage model of uncertainty as do Anscombe-Aumann (1963). The first-stage events (whose uncertainty is resolved first; left in the decision tree) are uncertain, for the second-stage events probabilities are given, as in Anscombe-Aumann, although the results of this paper could readily be extended to the case where second-stage events also have no given probabilities. The authors use a tradeoff-consistency-type preference tool (**tradeoff method**) to provide, at one end of the spectrum, a new axiomatization of Anscombe-Aumann expected utility that does not use probability mixing. At the other end of the spectrum, they provide a recursive RDU model that generalizes recursive EU (the smooth model) and Schmeidler's (1989) RDU by allowing nonEU (rank-dependent utility) not only for the first-stage events but also for the second-stage events. Every intermediate model, covering almost the whole domain of recursive models, can be characterized by turning on or off the corresponding tradeoff consistenty condition. The paper shows how to incorporate sign dependence and how to do comparative concavity of utility.

A central question in current (2023) ambiguity theory is whether models are better outcome driven, as is the smooth model, or better even driven, as rank-dependent utility and multiple priors. This paper provides good tools to address the central question. %}

Abdellaoui, Mohammed & Horst Zank (2023 "Source and Rank-Dependent Utility," *Economic Theory* 75, 949–981. https://doi.org/10.1007/s00199-022-01434-4

{% **foundations of statistics**: proposes a test statistic based on likelihood ratios, but also considering their performance under the alternative hypothesis, and claims to agree with Bayesian principles (I did not check). %}

Abdey, James S. (2013) "Discussion Paper: P-Value Likelihood Ratios for Evidence Evaluation," *Law, Probability and Risk* 12, 135–146.

{% About associativity-functional equation %}

Abel, Niels H. (1826) "Untersuchungen der Functionen Zweier Unabhängigen Veränderlichen Grössen x and y, wie f(x,y), Welche die Eigenschaft Haben, dass f[z,f(x,y)] eine Symmetrische Function von x,y und z ist," *Journal für die Reine und Angewandte Mathematik* 1, 1–15, Academic Press, New York. Reproduced in *Oevres Completes de Niels Hendrik Abel,* Vol. I, 61–65. Grondahl & Son, Christiani, 1881, Ch.4.

{% Workers on tedious tasks agree with Köszegi & Rabin's (2006) expectation-based theories. %}

Abeler, Johannes, Armin Falk, Lorenz Goette, & David Huffman (2011) "Reference Points and Effort Provision," *American Economic Review* 101, 470–492.

{% **PE doesn't do well**: surely not if evaluated using EU;

Typical of decision analysis is that simple choices are used to (derive utilities and other subjective parameters and then) predict more complex decisions. This paper performs this task in an exemplary explicit manner. The authors first use simple choice questions (PE with risk for chronic health states and TTO with time tradeoffs for chronic health states; if I rememer right, they use the term standard gamble and SG instead of my PE) to get basic utility assessments. For PE they calculate utility both assuming EU and assuming PT. Then they use the findings to predict preferences between more complex risky prospects (involving no real intertemporal tradeoffs), and between more complex (nonchronic) health profiles (involving no real risk). For decisions under risk, PT better predicts future choices than EU. It does so both when PE-PT utilities are used as inputs, and when TTO-based ("riskless"!) utility measurements are used as inputs. Bleichrodt (08Jan10, personal communication) told that TTO utility inputs and then PT work as well as PE inputs (no significant differences), which supports **risky utility u = strength of preference v (or other riskless cardinal utility, often called value)** with intertemporal utility instead of strength of pr. But if I understand well, for intertemporal decisions TTO utilities did somewhat better than PE utilities, although with one exception the differences were not significant. %}

Abellan-Perpiñan, Jose Maria, Han Bleichrodt, & José Luis Pinto-Prades (2009) "The Predictive Validity of Prospect Theory versus Expected Utility in Health Utility Measurement," *Journal of Health Economics* 28, 1039–1047.

{% Find maximum endurable time (MET): health states for which people want to live a short time, but not more, violating monotonicity. Choice and ranking gives preference reversals. %}

Abellan-Perpiñan, Jose Maria, Jorge-Eduardo Martinez-Perez, Jose-Luis Pinto-Prades, & Fernando-Ignacio Sanchez-Martinez (2024) "Testing Nonmonotonicity in Health Preferences," *Medical Decision Making* 44, 42–52. https://doi.org/10.1177/0272989X231207814

{% Find that power utility fits best for EQ-5D, better than linear or exponential. That is, they take model QT^r with Q quality of life and T duration for chronic health states. They also consider nonchronic health profiles. Optimal fitting r is r = 0.65. Impressive sample of about N = 1300 (see p. 668), representative of Spanish population. %}

Abellán, José M., José Luis Pinto, Ildefonso Méndez, & Xabier Badía (2006) "Towards a Better QALY Model," *Health Economics* 15, 665–676.

{% For the fusion operation a Choquet integral is used. The paper shows how to identify the capacities, connecting between different levels of complexity. %}

Abichou, Bouthaina, Alexandre Voisin, & Benoit Iung (2015) "Choquet Integral Capacity Calculus for Health Index Estimation of Multi-Level Industrial Systems," *IMA JOURNAL OF Management Mathematics* 26, 205–224.

{% %}

Abouda, Moez & Alain Chateauneuf (2002) "Characterization of Symmetrical Monotone Risk Aversion in the RDEU Model," *Mathematical Social Sciences* 44, 1–15.

{% %}

Abouda, Moez & Alain Chateauneuf (2002) "Positivity of Bid-Ask Spreads and Symmetrical Monotone Risk Aversion," *Theory and Decision* 52, 149–170.

{% Preference laundring is a nice term for correcting preferences for biases. A more common term is preference purification. %}

Abrahamson, Mans (2023) "Preference Laundering," work in progress.

{% **tradeoff method**: Used in hypothetical choices on risky choices with number of fatalities (0-1000). They find mostly convex utility functions, as often happens with losses. %}

Abrahamsson Marcus & Henrik Johansson (2006) "Risk Preferences Regarding Multiple Fatalities and Some Implications for Societal Risk Decision Making—An Empirical Study," *Journal of Risk Research* 9, 703–715.

{% **foundations of probability**; Proposes a variation of the frequency definition of probability that cannot be applied to single events. %}

Abrams, Marshall (2012) “Mechanistic Probability,” *Synthese* 187, 343–375.

{% **anonymity protection**; uses Choquet integral to determine distances when linking data, applying fuzzy measure (= nonadditive measure) to subsets of attributes. Nice connection of two things I worked on in my youth. %}

Abril, Daniel, Guillermo Navarro-Arribas, & Vicenç Torra (2012) “Choquet Integral for Record Linkage,” *Annals of Operations Research* 195, 97–110.

{% **foundations of quantum mechanics** %}

Accardi, Luigi (1986) “Non-Kolmogorovian Probabilistic Models and Quantum Theory,” text of invited talk at 45-th ISI session, Amsterdam, the Netherlands.

{% Seem to find competence effect. %}

Ackert, Lucy F., Bryan K. Church, James Tompkins, Ping Zhang (2005) “What’s in a Name? An Experimental Examination of Investment Behavior,” *Review of Finance* 9, 281–304.
https://doi.org/10.1007/s10679-005-7594-2

{% **ubiquity fallacy**: opening sentence: “If this is the age of information, then privacy is the issue of our times.” The closing sentence of the paper is in the same style: “should be sufficiently flexible to evolve with the emerging unpredictable complexities of the information age.” So are expressions such as “seismic nature” (p. 509 1st column last line). It is a style that, apparently, impresses average researchers and attracts many citations from them.

P. 509 3rd column middle para gives as example of privacy intrusion (physical privacy): “such as when a stranger encroaches in one’s personal space.” But I think that then there are more important concerns (safety, health, wealth) than privacy.

The paper distinguishes between social sciences and behavioral sciences (abstract: “connect insights from social and behavioral sciences”):, but I would think that the second is a small subset of the first, and this writing overestimates the role of behavioral sciences.

The paper organizes studies around three themes: (1) that people are uncertain about privacy threats, and their preferences over them; (2) that people's concerns are context dependent (psychologists' favorite conclusion); (3) malleability of privacy concerns.

The paper uses the, overly broad, term privacy paradox for the apparent findings that people's verbal expressions of their concerns about privacy deviate much from their actual behavior. This finding will not be surprising to economists, especially given the vagueness of privacy risks.

Several reported findings may be due to experimenter demand. %}

Acquisti, Alessandro, Laura Brandimarte, & George F. Loewenstein (2015) "Privacy and Human Behavior in the Age of Information," *Science* 347, 509–514.

{% **three-doors problem**: The funny popular paradoxes such as the three-door problem, the waiting-time paradox, etc. %}

Aczel, Amir D. (2004) "*Chance. A Guide to Gambling, Love, The Stock Market and just about Everything Else*." Thunder's Mouth Press, New York.

{% Theorem 2.1.1.1 (on p. 34) and top of p. 35: Cauchy equation implies that f is linear as soon as f is continuous at one point or bounded from one side on a set of positive measure. Only stated there for functions on $\mathbb{R}$. Stated for functions on $\mathbb{R}^n$ in Theorem 5.1.1.1 on p. 215.

P. 151 (also 240, with f^{-1} instead of f): Quasi-linear mean is CE (certainty equivalent) under EU of 2-outcome prospects with fixed probabilities. Translativity is constant absolute risk aversion and homogeneity is constant relative risk aversion (both only of CEs but then it follows for preference). Theorem 3.1.3.2 then gives linear-exponential (CARA) and log-power (CRRA).

Section 5.3.1 gives functional equations characterizing arithmetic means. That is, they characterize subjective expected value as in Ch.1 of my 2010 book in terms of properties of certainty equivalents.

§5.3.2 (Theorem on p. 242) characterizes quasilinear weighted means, which are the CEs of EU for all binary probability-contingent prospects. The main axiom used is bisymmetry.

§6.2 studies associativity, F(Fx,y),z) = F(x,F(y,z)) and the like. They usually give additive representation $F(x,y) = f^{-1}(f(x) + f(y))$ and the like. Readers who know Gorman's (1968) theorem may recognize separability of (x,y) and of (y,z) in (z,y,z), and then the result comes as no surprise.

§6.4 uses bisymmetry to get $f^{-1}\big(qf(x)+(1-q)f(y)\big)$ (Theorem on p. 287) and nonsymmetric generalizations (Theorem 1 on p. 287).

§6.5 has the autodistributivity property $F[x,F(y,z)] = F[F(x,y), F(x,z)]$ as a nice alternative to bisymmetry, still axiomatizing $f^{-1}\big(qf(x)+(1-q)f(y)\big)$ (Theorem on p. 298).

§7.1, 7.2 have many equations such as $F(G(x,y),z) = H(x,K(y,z))$, with many different functions involved, giving additively decomposable solutions with many different functions involved (Theorem on p. 329). Often differentiability is used.

Ch. 8 considers vectors and matrices but, unfortunately, generalizes the preceding results as binary operations on vectors rather than as n-ary operations on reals. The latter, and not the former, would have given extensions to more than two states of nature. Pity for me. %}

Aczél, János (1966) "*Lectures on Functional Equations and Their Applications.*" Academic Press, New York.

(This book seems to be a translation and updating of a 1961 German edn.)

{% %}

Aczél, János (1987) "*A Short Course on Functional Equations.*" Kluwer, Dordrecht.

{% Aczél's citation on Catalonian oath of allegiance to Aragonese kings (15th century); I got it in 1992:

"We, who are as good as you, swear to you, who are not better than us, that we do accept you as our king and sovereign lord, provided that you do observe all our liberties and laws—but if you don't, then we won't." %}

{% %}

Aczél, János (1997) "Bisymmetry and Consistent Aggregation: Historical Review and Recent Results." *In* Anthony A.J. Marley (ed.), *Choice, Decision, and Measurement: Essays in Honor of R. Duncan Luce*, 225–233, Lawrence Erlbaum Associates, Mahwah, NJ.

{% **restricting representations to subsets** %}
Aczél, János (2005) "Utility of Extension of Functional Equations—when Possible," *Journal of Mathematical Psychology* 49, 445–449.

{% %}
Aczél, János (2014) "*On Applications and Theory of Functional Equations.*" Academic Press, New York.

{% %}
Aczél, János & Claudi Alsina (1984) "Characterizations of Some Classes of Quasilinear Functions with Applications to Triangular Norms and to Synthesizing Judgements," *Methods of Operations Research* 48, 3–22.

{% Functional equations (interval scale differentiable equation), when crossing boundaries $x_1 = x_2$, "shift." %}
Aczél, János, Detlof Gronau, & Jens Schwaiger (1994) "Increasing Solutions of the Homogeneity Equation and of Similar Equations," *Journal of Mathematical Analysis and Applications* 182, 436–464.

{% A psychophysical application is given where w(1) = 1 is not necessary. %}
Aczél, János & R. Duncan Luce (2007) "A Behavioral Condition for Prelec's Weighting Function on the Positive Line without Assuming W(1) = 1," *Journal of Mathematical Psychology* 51, 126–129.

{% %}
Adamou, Alexander, Yonatan Berman, Diomides Mavroyiannis, & Ole Peters (2019) "Microfoundations of Discounting," London Mathematics Laboratory, London, UK.

{% This paper starts from the well-known fact that time inconsistency at household level can be generated from aggregation where all individuals are time consistent. It provides methodological contributions with an empirical application. %}

Adams, Abi, Laurens Cherchye, Bram De Rock, & Ewout Verriest (2014) "Consume Now or Later? Time Inconsistency, Collective Choice, and Revealed Preference," *American Economic Review* 104, 4147–4183.

{% %}

Adams, David R. (1981) "Lectures on L^p-Potential Theory," University of Umea, Department of Mathematics, Umea, Sweden.

{% He may have shown that Savage's finitely additive probability measures lead to violations of strict pointwise monotonicity and other things? %}

Adams, Ernest W. (1962) "On Rational Betting Systems," *Archiv für Mathematische Logik und Grundlagenforschung* 6, 7–18 and 112–128.

{% %}

Adams, Ernest W. (1966) "On the Nature and Purpose of Measurement," *Synthese* 16, 125–169.

{% %}

Adams, Ernest W. & Robert F. Fagot (1959) "A Model of Riskless Choice," *Behavioral Science* 4, 1–10.

{% %}

Adams, Ernest W., Robert F. Fagot, & Richard E. Robinson (1970) "On the Empirical Status of Axioms in Theories of Fundamental Measurement," *Journal of Mathematical Psychology* 7, 379–409.

{% **foundations of statistics**: The authors mention many drawbacks of p-values, and propose an alternative that also concerns power (probably close to likelihood ratio) and that allows determination of the maximally likely effect. %}

Adams, Nicholas G. & Gerard O'Reilly (2017) "A Likelihood-Based Approach to P-Value Interpretation Provided a Novel, Plausible, and Clinically Useful Research Study Metric," *Journal of Clinical Epidemiology* 92, 111–115.

{% Individual decisions versus group decisions with many factors analyzed and referenced that amplify or moderate extreme decisions. They study a large data set of people who betted on ice breakups in Alaska. There are of course selection effects with more than average risk seeking, for instance, as the authors point out.

P. 885 points out that there is no easy way to interpret the differences found as being closer to rationality. %}

Adams, Renée & Daniel Ferreira (2010) "Moderation in Groups: Evidence from Betting on Ice Break-ups in Alaska," *Review of Economic Studies* 77, 882–913.

{% %}

Adamski, Wolfgang (1977) "Capacitylike Set Functions and Upper Envelopes of Measures," *Mathematische Annalen* 229, 237–244.

{% Investigate how receipt of new info affects risk attitude, i.e., how people change consumption of beef after info on mad cow disease. %}

Adda, Jérôme (2007) "Behavior towards Health Risks: An Empirical Study Using the "Mad Cow" Crisis as an Experiment," *Journal of Risk and Uncertainty* 35, 285–305.

{% %}

Adler, Matthew D. (2019) "*Measuring Social Welfare: An Introduction*." Oxford University Press, New York.

{% %}

Adler, Matthew D., Maddalena Ferranna, James K. Hammitt, & Nicolas Treich (2021) "Fair Innings? The Utilitarian and Prioritarian Value of Risk Reduction over a Whole Lifetime," *Journal of Health Economics* 75, 102412.

{% Use quantum decision theory to analyze Ellsberg's paradox. I tried to read in 2017 but lacked the prior knowledge of quantum theory to be able to understand. %}

Aerts, Diederik, Sandro Sozzo, & Jocelyn Tapia (2014) "Identifying Quantum Structures in the Ellsberg Paradox," *International Journal of Theoretical Physics* 53, 3666–3682.

{% Cognitive dissonance: A hungry fox sees delicious grapes but they are too high. He says to himself that they must have been too sour. Retold by La Fontaine (1621-1695.) %}
Aesopos (–600) "The Fox and the Grapes."

{% Provides his famous revealed preference axiom, necessary and sufficient for utility maximization, in consumer theory when choice sets are budget sets. Many people say that this paper is inaccessible, and needed being popularized by Varian (1982). Varian did not properly credit Richter (1966) and I think most credit should go to Richter. %}
Afriat, Sydney N. (1967) "The Construction of Utility Functions from Expenditure Data," *International Economic Review* 8, 67–77. https://doi.org/10.2307/2525382

{% Provided an index for how far observed choices are from maximizing a weak order preference relation. I guess that the distance is how many choices should be changed. %}
Afriat, Sydney N. (1972) "Efficiency Estimation of Production Functions," *International Economic Review* 13, 568–598. https://doi.org/10.2307/2525845

{% Reformulate Popper's claims about inductive probability probabilistically. %}
Agassi, Joseph (1990) "Induction and Stochastic Independence," *British Journal for the Philosophy of Science* 41, 141–142.

{% For the last author, his first name is Israel and his surname is D, as he let me know by email on 27 Dec. 2023.
Seem to use hypothetical choice, and to find that groups are less ambiguity averse than individuals for gains, and less so for losses. %}
Aggarwal, Divya, Uday Damodaran, Pitabas Mohanty, & Israel D (2022) "Risk and Ambiguous Choices: Individual versus Groups, an Experimental Analysis," *Review of Behavioral Finance* 14, 733–750. https://doi.org/10.1108/RBF-02-2021-0017

{% Deliberate randomization: Subjects who deliberately randomize by deliberately alternating choices in repeated choice situations, do so the same way in different choice contexts. %}

Agranov, Marina, Paul J Healy, & Kirby Nielsen (2023), "Stable Randomisation," *Economic Journal* 133 2553–2579.
https://doi.org/10.1093/ej/uead039

{% **quasi-concave so deliberate randomization**: find evidence for quasi-convexity w.r.t. probabilistic mixing, supporting concave probability weighting in RDU.

In one treatment (Part I), subjects get repeated choice, as usually done, separated by other stimuli so they don't notice. But in another treatment (Part III) the repeated choices are put together so subjects see it and it is explicitly told to subjects that it is repeated choice. Use RIS for implementation of Parts I & III, but in addition also pay all choices in Parts II and IV, arguing that portfolio (income) effects in these parts are not likely to happen. Also in Part III, subjects have many inconsistencies, well here it is deliberate randomization (71% of subjects had it sometimes). It is probably rather that subjects want to avoid responsibility for the choice made, something also nicely illustrated by Cettolin & Riedl (2019 JET). When asked, most subjects gave hedging and diversification as reasons.

In Part IV, subjects had an extra option: Not they choose, but the computer chooses randomly; they had to pay a very small amount for choosing this option. It is like avoiding responsibility as in Cettolin & Riedl (2019 JET). 29% sometimes chose this option.

There may be a confound of experimenter demand: Subjects will figure that the experimenters want them to change choice because, why else ask? Same way as if you put a big orange button on the keyboard then subjects will sometimes push it because, why else would it be there? But experimenter demand is often hard to avoid.

P. 56 3rd para, on probabilistic choice: They find that utility difference (as in Luce's 1959 model) does not predict random choice very well because dominance-or-not, being salient, is important. Rather, questions being easy because of (almost) stochastic dominance or not matters.

Inconsistent choice is correlated with violating EU, but not with risk aversion or violations of RCLA. %}

Agranov, Marina & Pietro Ortoleva (2017) “Stochastic Choice and Preferences for Randomization,” *Journal of Political Economy* 125, 40–68.

{% **quasi-concave so deliberate randomization**: a convenient and concise, efficient, summary. %}

Agranov, Marina & Pietro Ortoleva (2022) “Revealed Preferences for Randomization: An Overview,” *American Economic Review, Papers and Proceedings* 112, 426–430.
https://doi.org/10.1257/pandp.20221093

{% **Best core theory depends on error theory**: Show that all kinds of revealed preference data give different conclusions if an error theory is included. %}

Aguiar, Victor H. & Nail Kashaev (2021) “Stochastic Revealed Preferences with Measurement Error,” *Review of Economic Studies* 88, 2042–2093.
https://doi.org/10.1093/restud/rdaa067

{% %}

Aha, David W., Cindy Marling, & Ian D. Watson (2005, eds.) “*The Knowledge Engineering Review, Special Edition on Case-Based Reasoning*” 20, Cambridge University Press, Cambridge UK.

{% **time preference**; some nice results, in particular Theorem 11: not! **DC = stationarity**; they carefully distinguish. Theorem 11 says that stationarity and time consistency (they call it dynamic consistency) are equivalent if we have time invariance (they call it constant time preference).

P. 540, on rationality of preference separability, is naïve, as is the rationality claim on p. 544 2/3. I also disagree with claims on p. 554 because every preference condition involves hypothetical choice in the sense there.

P. 562 1st para points out that every discount model can be taken as nonlinear time *perception*. %}

Ahlbrecht, Martin & Martin Weber (1995) “Hyperbolic Discounting Models in Prescriptive Theory of Intertemporal Choice,” *Zeitschrift für Wirtschafts -und Sozialwissenschaften* 115, 535–566.

{% %}
Ahlbrecht, Martin & Martin Weber (1996) “The Resolution of Uncertainty: An Experimental Study,” *Journal of Institutional and Theoretical Economics* 152, 593–607.

{% **time preference**;
Seems that pattern of increasing/constant/decreasing impatience was not affected by adding front-end delays. %}
Ahlbrecht, Martin & Martin Weber (1997) “An Empirical Study on Intertemporal Decision Making under Risk,” *Management Science* 43, 813–826.

{% **dynamic consistency: favors abandoning RCLA when time is physical.**
source dependent utility: empirically test Kreps & Porteus (1978) model, whose predictions are rejected. §1 gives elementary accessible description of the KP model. %}
Ahlbrecht, Martin & Martin Weber (1997) “Preference for Gradual Resolution of Uncertainty,” *Theory and Decision* 43, 167–185.

{% Extends Mertens & Zamir (1985) to multiple priors. %}
Ahn, David S. (2007) “Hierarchies of Ambiguous Beliefs,” *Journal of Economic Theory* 136, 286–301.

{% **R.C. Jeffrey model**; **ordering of subsets**: This paper axiomatizes a model of maximization of average expected utility over sets, similar to Jeffrey (1965). The objects are interpreted as probability distributions over outcomes where the set reflects ambiguity over which is the right probability distribution. In this axiomatization, both probability μ and utility u are subjective/endogenous, implying that the model is essentially the same as Jeffrey (1965) and Bolker (1966, 1967) in a mathematical sense. There are some technical differences

regarding continuity and Ahn's model having singletons present in the domain and JBB not.

The model can be considered to be a modification of maxmin EU or it's α-maxmin generalization. The usual Pratt-Arrow characterization of φ^* being more concave than φ is given in Proposition 4 and is now taken as more ambiguity averse. %}

Ahn, David S. (2008) "Ambiguity without a State Space," *Review of Economic Studies* 75, 3–28.

{% Consider three states of nature denoted x, y, z. The subjects are told that y has probability 1/3, and are told that x and z have unknown probability. Subjects were not told more. In reality, x and z also have objective probability 1/3. (The authors generated event x by first letting a number p_x be selected at random (uniform distribution) from [0,2/3], and then let x be chosen with probability p_x, and z with probability $2/3 - p_x$; see footnote 3 on p. 201). However, this is only a roundabout manner for generating probability 1/3. Given that this procedure was not told to the subjects, so it does not matter for them, and given that any researcher who knows probability calculus knows that it is just objective probability 1/3, no use doing this two-stage procedure.)

Let subjects choose prospects organized similarly as budget sets. The axiom of revealed preference is reasonably well satisfied. (**revealed preference**)

Consider the following models:

(1) "Kinked," being RDU (for uncertainty; also known as CEU) with fixed decision weight 1/3 for state y (amounting to EU for known probabilities). Thus, RDU for the remaining states is like **biseparable utility**, and comprises most other models such as Gilboa & Schmeidler's (1989) maxmin EU, Schmeidler's (1989) RDU, α-maxmin, and Gajdos et al.'s (2008) contraction expected utility. The authors, fortunately, do combine it with RDU for risk (§8) and not just with EU for risk.

(2) Recursive EU, where as second-order distribution they take the uniform prior over [0,2/3], and where the two utility functions are exponential with possibly different exponents. It is useful to note that the rho parameter of utility for risk can be identified from bets on s_2, and then the parameter for ambiguity

can be identified from bets on s_1 and s_3 while keeping the payment under s_2 equal 0.

§7, e.g. footnote 11 on p. 212: they favor least-squares data fitting without probabilistic error theory.

The find that RDU (“kinked”) fits better than recursive.

The do not reject the H_0 of SEU for 64% of the subjects. Problem with such within-subject tests is that it assumes stochastic independence of within-subject choices, and needs many choices per individual to get statistical power. %}

Ahn, David S., Syngjoo Choi, Douglas Gale, & Shachar Kariv (2014) “Estimating Ambiguity Aversion in a Portfolio Choice Experiment,” *Quantitative Economics* 5, 195–223.

{% Their model is called partition-dependent SEU.

Consider decision under uncertainty in an Anscombe-Aumann framework, with partition-dependent SEU, as follows. They do not take an act as a function from S to outcomes, as Savage did, but (as did Luce) as a 2n-tuple, so that the act and its preference value can depend on the partition chosen. Thus, they can accommodate event splitting (**coalescing**) and so on. In their model there exists a utility function u and a nonadditive measure ν. For a partition $(E_1,\ldots E_n)$ of S, SEU is maximized w.r.t. u and $P(E_j) = \nu(E_j)/(\nu(E_1) + \cdots + \nu(E_n))$, so, with ν for single events but normalized.

They present axiomatizations. First, they assume usual axioms giving SEU within each partition. They use Anscombe-Aumann axioms. (I would have preferred tradeoff consistency; oh well …) This within-partition representation does not yet relate between-partition representations in any sense. A monotonicity condition implies the same u for all partitions. For the rest (for the role of ν), they consider two special cases:

CASE 1. The collection of partitions considered is nested: For all two partitions, one is a refinement of the other. Then an extra sure-thing principle characterizes the model with ν: if acts f and g agree on event E, then the preference between f and g is not changed if the common outcomes on E are replaced by other common outcomes, but also not if the partition outside of E is changed (so, refined or coarsened). This axiom ensures the consistent conditioning in $P(E_j) = \nu(E_j)/(\nu(E_1) + \cdots + \nu(E_n))$, from always the same ν.

CASE 2. The collection of partitions considered is the collection of all partitions. Then besides the version of the s.th.pr. of Case 1, also an acyclicity axiom is imposed.

P. 656: To the authors' knowledge, they are the first to incorporate framing and partition-dependence in a formal model. However, Luce preceded here. A brief but not very accessible account of his ideas is in Luce (1990, Psychological Science 1). A complete account is in the book Luce (2000). Luce also worked on such models in the 1970s, such as in Ch. 8 of Krantz et al. (1971). Luce used the term experiment instead of the term partition, and the elements of Luce's experiment need not always give the same union (so, they are conditional on their union). Ahn & Ergin always have S as the total union.

The topic of partition dependence is even more central in Birnbaum's work. He does write formal models but does not do formal work with them such as axiomatizations (although he does give derivations of logical relations between preference conditions). He does comprehensive empirical work, testing every empirical detail of framing. Birnbaum, Michael H. (2008, *Psychological Review* 115, 463–501) provides a comprehensive summary. He usually (always?) assumes known probabilities. There is also much empirical evidence on event splitting by Loomes, Sugden, Humphrey, and others.

The authors relate their work to support theory. ν is indeed an analog of the support function. A difference pointed out by the authors is that support theory focuses on probability judgment (Tversky and I started working on a decision theory but he died too soon) whereas they have preferences between acts. A difference not pointed out by the authors is that in support theory there are not only the (partitions of) hypotheses but also there is another layer, of events, and there is a distinction between implicit and explicit unions. Mainly this distinction between hypotheses and events drives why support theory deviates from classical models. Thus, I disagree with the claim on p 663 that this paper provide an extension of support theory to decision theory, or that they provide a decision foundation.

P. 657: The authors relate their model to unforeseen contingencies. A big difference is that in this paper the union of events in a partition is always S, whereas with unforeseen contingencies there are typically events outside of S.

A topic for future research is to what extent the particular partition-dependence proposed here, with consistent conditioning on one nonadditive measure, is of interest empirically or normatively.

The EU assumed within given partitions of course runs into empirical violations of EU, although there is empirical evidence that using the same partition for describing all acts reduces the violations.

The model of this paper is also reminiscent of the source method by Abdellaoui, Baillon, Placido, & Wakker (2011 American Economic Review), where different sources are different partitions. One difference is that the source method does not give up extensionality, and acts are functions from states to outcomes. Another is that the source method allows for violations of EU throughout, also within a source/partition. In the source method, there can be subjective probabilities within each source but they can be transformed differently for different sources. %}

Ahn, David & Haluk Ergin (2010) "Framing Contingencies," *Econometrica* 78, 655–695.

{% The authors consider time inconsistencies, and then naïve choice making. They propose two indexes of naivity. Naivity shows up if an agent strictly disprefers an a-priori-strictly-beneficial commitment, not for wanting to be sophisticated, but for mispredicting future choice. One comparative notion for being more naïve is if dispreferring more of such commitments. The second is by how much money is lost because of naivity (via indirect utility). These are two preference conditions that do not assume any model. The authors emphasize this point much. They extend the indexes to probabilistic future choice. The two indexes of this paper are equivalent for deterministic choice if two conditions hold: (1) only monetary outcomes matter; (2) choice sets are determined only by how much money one has to spend. The authors on p. 2325 mention the equivalence without mentioning the restrictions.

Footnote 2 explains that the authors consider single-choice choice functions, so that a selection has to be made if there are several optimal, mutually indifferent, choice alternatives. I did not try to find out how the authors then can rule out complete indifference. Probably using some strong monotonicity in money.

The authors see what their conditions mean for some models, primarily quasi-hyperbolic discounting.

In general, different indexes have different pros and cons, and which is most relevant depends on the particular decision situation. To illustrate an alternative index, consider Prelec's (2004 Scandinavian Journal of Economics). His index concerns time inconsistency. He considers the set of all future timepoints at which a decision is taken deviating from the present decision. The total duration of this set is Prelec's index. The authors, unfortunately, do not cite Prelec, probably because they consider time inconsistency to be different than naivity. But Prelec's index can readily be restricted to only naïve choice and, thus, can serve as an index alternative to the ones of this paper. It is also preference-based with no commitment to any model and in this sense precedes this paper. (Prelec, personal communication, explained to me that in the quasi-hyperbolic, also called beta-delta, model, then $\tau = \ln \beta / \ln \tau$ is the relevant index.) Imagine that someone can pay a controler for controlling the future agent and preventing her from time inconsistency, and imagine that this is imperative to be done. Further imagine that the controler is to be paid per time unit. Then Prelec's index is the relevant one, and not the indexes of this paper. In the same spirit, in some decisions under risk the relative index of risk aversion is the relevant one, and in others the absolute index is.

The writing of this paper is narrow in the sense that the authors consider alternative definitions, consider examples where those alternatives give different results than those of this paper, but then blame the alternatives for being counterintuitive (p. 2321, p. 2323) or erroneous (p. 2325), just because they deviate from the ones of this paper. Their own approach is called "most reasonable" (p. 2321). Similarly, someone using an absolute index of risk aversion could blame the relative index just for deviating. %}

Ahn, David S., Ryota Iijima, Yves Le Yaouanq, & Todd Sarver (2019) "Behavioral Characterizations of Naiveté for Time-Inconsistent Preferences," *Review of Economic Studies* 86, 2319–2355.
https://doi.org/10.1093/restud/rdy076

{% Good reference for Möbius function and Möbius transform %}
Aigner, Martin (1979) “Combinatorial Theory,” *Grundlehren der Math. Wiss*. 234, Springer, Berlin.

{% %}
Aimone, Jason A. & Daniel Houser (2012) “What You Don’t Know Won’t Hurt You: A Laboratory Analysis of Betrayal Aversion,” *Experimental Economics* 15, 571–588.

{% %}
Aimone, Jason A. & Daniel Houser (2013) “Harnessing the Benefits of Betrayal Aversion,” *Journal of Economic Behavior and Organization* 89, 1–8.

{% %}
Aimone, Jason A., Daniel Houser, & Bernd Weber (2013) “Neural Signatures of Betrayal Aversion: An fMRI Study of Trust,” *Proceedings of the Royal Society B* 3281: 2013.2127.

{% May have introduced hyperbolic discounting; or was it Chung & Herrnstein (1967)? %}
Ainslie, George (1975) “Specious Reward: A Behavioral Theory of Impulsiveness and Impulse Control,” *Psychological Bulletin* 82, 463–496.

{% %}
Ainslie, George (1986) “Beyond Microeconomics. Conflict among Interests in a Multiple Self as a Determinant of Value.” *In* John Elster (ed.) *The Multiple Self*, 133–175, Cambridge University Press, New York.

{% **dynamic consistency** %}
Ainslie, George W. (1992) “*Picoeconomics* ” Cambridge University Press, Cambridge.

{% Seems to argue that we are more insensitive with respect to the time dimension than to many other dimensions. %}

Ainslie, George W. (2001) “*Breakdown of Will.*” Cambridge University Press, Cambridge.

{% This paper should not have been published. Too much the author not even understands the most basic concepts. He erroneously claims in the abstract and elsewhere that hyperbolic discounting is behavioral and prospect theory is cognitive, and says that behavioral decision theory has two legs: one behavioral and one cognitive.

P. 262 2nd column erroneously claims that expected utility assumes constant discounting. %}

Ainslie, George (2016) “The Cardinal Anomalies that Led to Behavioral Economics: Cognitive or Motivational?,” *Managerial and Decision Economics* 37, 261–273.

{% **real incentives/hypothetical choice, for time preferences**: seems to be. %}

Ainslie, George W. & Vardim Haendel (1983) “The Motives of Will.” *In* Edward Gottheil, Keith A. Druley, Thomas E. Skolda & Howard M. Waxman (eds.) *Etiologic Aspects of Alcohol and Drug Abuse*. Charles C. Thomas, Springfield, IL.

{% **discounting normative**: p. 63, 2nd paragraph suggests that (steep) discounting would not be selected in evolution. %}

Ainslie, George W. & Nick Haslam (1992) “Hyperbolic Discounting.” *In* George F. Loewenstein & John Elster (1992) *Choice over Time*, 57–92, Russell Sage Foundation, New York.

{% P. 27: “It is well known that Constant Relative Risk Aversion (CRRA) preferences sustain the Black-Scholes model in equilibrium …” and then it gives many references. P. 38 points out that CRRA does not fit data well. %}

Aït-Sahalia, Yacine & Andrew W. Lo (2000) “Nonparametric Risk Management and Implied Risk Aversion,” *Journal of Econometrics* 94, 9–51.

{% Measure of fit is −2L*ln*L + 2k where L designates likelihood and k the number of parameters. %}

Akaike, Hirotugu (1973) "Information Theory and an Extension of the Maximum Likelihood Principle." *In* Boris Nikolaevich Petrov & Frigyes Csaki (eds.) *Second International Symposium on Information Theory*, 267–281, Akademiae Kiado, Budapest.
https://doi.org/10.1007/978-1-4612-1694-0_15

{% Use RIS.

Problem in data: Of the 92 farmers, 41 were maximally risk averse. The authors write that for them, essentially, no ambiguity aversion can be measured, and had to remove them from the sample, generating a bias. I would, by the way, prefer to think that these farmers cannot be ambiguity averse, and that dropping them has generated a bias towards ambiguity aversion.

Farmers in Ethiopia are more risk averse, and equally ambiguity averse, as Dutch students. Poor farmers are not more risk- and ambiguity averse (**decreasing ARA/increasing RRA**); poor-health people are. Ambiguity attitude is derived from comparing CE (certainty equivalent) with risk, taking normalized CE differences.

correlation risk & ambiguity attitude: There is a negative relation, but it is not written in the paper. Is pointed out in survey chapter by Trautmann & van de Kuilen (2015). %}

Akay, Alpaslan, Peter Martinsson, Haileselassie Medhin, & Stefan T. Trautmann (2012) "Attitudes toward Uncertainty among the Poor: An Experiment in Rural Ethiopia," *Theory and Decision* 73, 453–464.

{% %}

Akerlof, George A. (1970) "The Market for 'Lemons': Quality Uncertainty and the Market Mechanism," *Quarterly Journal of Economics* 84, 488–500.

{% Gives many examples of procrastination etc., phenomena where a small initial expense is used day after day to postpone something that on the long run brings way higher expenses. Obedience can be similar such as in Milgram's famous experiment. Reminds me of the "frog effect" (when heating water at a sufficiently slow speed a frog, supposedly, never jumps and gets boiled, so dies).

P. 2: "Individuals whose behavior reveals the various pathologies I shall model are not maximizing their 'true' utility."

§1 describes how salient information has more effect on decisions than equivalent nonsalient information.

Several places (e.g., §III.a p. 5) express disagreement with Becker et al's rational addiction, and disagreeing with Becker I take as a good sign. %}

Akerlof, George A. (1991) "Procrastination and Obedience," *American Economic Review, Papers and Proceedings* 81, 1–19.

{% %}

Akerlof, George A. (2002) "Behavioral Macroeconomics and Macroeconomic Behavior," *American Economic Review* 92, 411–433.

{% **crowding-out**: their model seems to imply that severe punishment of crime may increase crime, because of the crowding-out effect. %}

Akerlof, George A. & William T. Dickens (1982) "The Economic Consequences of Cognitive Dissonance," *American Economic Review* 72, 307–319.

{% In Amer. J. Agr. Econ. 91 p. 1175, Akerlof (2009) writes: "… Shiller and I … challenge the economic wisdom that got us into this mess …and put forward a bold new vision and policies that will transform economics and restore world prosperity." There is no limit or concession to nuances in the author's enthusiasm about his own work!

The authors argue, in this book written for popular reading, that animal spirits should get a bigger role in economics. They consider 5 psychological facts in particular: overconfidence, fairness, corruption and bad faith, money illusion, and stories (a catch-all category).

On p. 3 they cite Keynes (1921): "they are *not*, as rational economic theory would dictate, the outcome of a weighted average of quantitative benefits multiplied by quantitative probabilities." [Italics from original] %}

Akerlof, George A. & Robert J. Shiller (2009) "*Animal Spirits: How Human Psychology Drives the Economy, and why It Matters for Global Capitalism*." Princeton University Press, Princeton, NJ.

{% A theoretical study of present bias for costly long-run projects. Naïve agents should be given higher bonuses to prevent inefficient procrastination. %}

Akin, Zafer (2012) Intertemporal Decision Making with Present Biased Preferences," *Journal of Economic Psychology* 33, 30–47.

{% Russian, writes usually in Russian, about web theory. %}
Akivis, Maks A.

{% About web theory! %}
Akivis Maks A. & Vladislav V. Goldberg (2000) "Algebraic Aspects of Web Geometry," *Commentationes Mathematicae Universitatis Carolinae* 41, 205–236.

{% %}
Al-Awadhi, Shafeeqah A., & Paul H. Garthwaite (1998) "An Elicitation Method for Multivariate Normal Distributions," *Communications in Statistics—Theory Meth.* 27, 1123–1142.

{% §3.4 correctly cites de Finetti on his arguments against countable additivity. Unfortunately, it also suggests that Savage disliked countable additivity but Savage (1954, §3.4) did not have such an opinion. For Savage it was not central and only a pragmatic matter of convenience. He used all subsets of the state space and not a sigma-algebra only for expositional purposes, actually preferring sigma-algebra other than for exposition. Savage did express a slight preference for not committing to countable additivity but, again, not out of principle but only pragmatically, and not committing clearly. (Probably to quite some extent so as not to get in conflict with de Finetti who was in a less refined league than Savage.)

The paper considers to what extent infinitely many observations necessarily lead to unique probabilities of all events through the law of large numbers. If the set of events considered is complex and large, and way more so than the number of observations, and if probability is finitely additive, then probabilities may not get uniquely determined. This is of course a mathematical result in the sense that it really builds on finite additivity and complexity degrees of infinity.

§4: this paper derives a set of priors from learning, and only then derives decisions from that. %}

Al-Najjar, Nabil I. (2009) “Decision Makers as Statisticians: Diversity, Ambiguity, and Learning,” *Econometrica* 77, 1370–1401.

{% Establish a model of undescribable events where the best coinsurance is no coinsurance. Assume that any finite description can be given, but complete outcome-relevant description should be infinite. Although the basic point is technical, the authors eloquently give many nice examples. %}

Al-Najjar, Nabir I., Luca Andelini, & Leonardo Felli (2006) “Undescribable Events,” *Review of Economic Studies* 73, 849–869.

{% Something different than bounded rationality. Gives precise formal definitions from logic it seems. %}

Al-Najjar, Nabil I., Ramon Casadesus-Masanell, & Emre Ozdenoren (2003) “Probabilistic Representation of Complexity,” *Journal of Economic Theory* 111, 49–87.

{% Epstein-Zin but with parameter uncertainty, that the agent is averse to. Give a closed-form representation when discounting approaches 1. %}

Al-Najjar, Nabil I. & Eran Shmaya (2019) “Recursive Utility and Parameter Uncertainty,” *Journal of Economic Theory* 181, 274–288.

{% **proper scoring rules**; problem that calibration tests can be passed by charlatans disappears if there are more than one expert. %}

Al-Najjar, Nabil I., & Jonathan Weinstein (2008) “Comparative Testing of Experts,” *Econometrica* 76, 541–559.

{% **ambiguity attitude taken to be rational**: This paper criticizes the normatively motivated modern ambiguity aversion literature. I, as Bayesian, only and purely study ambiguity for descriptive reasons, and fully agree that the nonEU models (including ambiguity) are not rational. Empirically, though, there is considerable ambiguity seeking (**ambiguity seeking**). The paper, appropriately, writes on p. 252 2nd para that its arguments have been known before by specialists. The paper is written with enthusiasm of a kind that will especially appeal to young readers, but it is informal and not very sophisticated. I disagree with many nuances.

Central to the paper are the rationality problems of ambiguity models in dynamic decision making and **updating** (**dynamic consistency**). However, these are general problems of nonexpected utility and not particularly of ambiguity. Because the paper assumes expected utility for risk (and then can assume payment in utils so that it is risk neutrality), a debate of ambiguity (which is about *differences between* unknown and known probabilities) is the same as the debate about nonexpected utility. It has been widely known since Hammond (1988), and was explained more clearly before in the impressive Burks (1977, Ch. 5), that nonEU violates convincing principles in dynamic decision making. The best paper to start on this debate is Machina (1989). Ghirardato (2002) is also good. He appropriately used the term folk theorems for the results, because they were widely known. I wrote
Wakker (1999) http://personal.eur.nl/Wakker//pdf/alias.pdf.
The debates are often hard to pin down because the relevant assumptions discussed are so self-evident (surely I as Bayesian think so) that people often assume some of those critical conditions implicitly, and verbal descriptions often can equally well refer to one condition as to the other.

In the resolute choice approach one gives up what Machina (1989) called consequentialism so as to maintain dynamic consistency. Then one's decisions depend on risks borne in the past; i.e., on events that could have happened at some stage in the past but are now known to be counterfactual and nonexistent. In Wakker (1999) I described this as believing in ghosts. This was Machina's preferred way to go, and also McClennen's who coined the term resolute for it, and also Jaffray's.

In **sophisticated choice** one gives up dynamic consistency, so as to maintain consequentialism. Then prior and posterior preferences are not the same, and from a prior perspective one may violate dominance (one is willing to pay for precommitment). This was preferred by Karni & Safra and is the least unconvincing for nonEU in my opinion. In Wakker (1999) I called this split personality.

A third approach is to give up RCLA, which for uncertainty is something like event invariance. These are models about not being indifferent to the timing of the resolution of uncertainty. I will not discuss them further.

Footnote 1, p. 250 suggests that probabilistic sophistication (Machina &

Schmeidler's P4*) is a special case of the sure-thing principle but this is not so. P4* implies Savage's P4 which is logically and conceptually different from the sure-thing principle (Savage's P2).

P. 251 $\ell\ell$. 1-2: "The all-consuming concern of the ambiguity aversion literature is the Ellsberg "paradox."" expresses well my impression: the field is too much focused on the Ellsberg paradox.

P.254 4th para and elsewhere: It is not true that capacities (weighting functions) are interpreted as indexes of belief in nonEU. Some people, especially novices, do so, but experienced people know that this need not be. Abdellaoui et al. (2011 American Economic Review, p. 701 top) wrote, where source functions capture the nonadditivity of capacities/weighting functions: "Source functions reflect interactions between beliefs and tastes that are typical of nonexpected utility and that are deemed irrational in the Bayesian normative approach." They reference preceding contributions by Winkler (1991), Vernon Smith (1969), and others. Wakker (2004, Psychological Review) suggested that inverse S/source-sensitivity could be a belief component but pessimism/source-preference/ambiguity-aversion not so. Also in maxmin EU many are aware of the difference. It is explicit in contraction expected utility by Gajdos, Hayashi, Tallon, & Vergnaud (2008, JET), for instance. KMM's smooth model also has it explicitly.

The paper then assumes risk neutrality, or, in other words, EU plus payment in utils.

P. 259 discusses what the authors call irrelevance of sunk costs but what amounts to the additivity axiom (discussed in Wakker, 2010, Ch. 1) restricted to constant acts in combination with some updating. It is well known that nonEU can depend on counterfactual risks and costs (see above on resolute choice).

What the authors call fact-based on p. 261 is like **sophisticated choice**. The informal presentation does not allow for an exact pinning down.

P. 267, on dynamic inconsistency à la Strotz, takes it purely as externally-imposed (say ingrained in your genes) and not as decision based, thus ducking the central questions there. The dynamic inconsistency resulting under ambiguity is not taken that way in this paper. Hence the difference ...

P. 275 criticizes multiple priors for the concept of unknown true probability, with which I agree. They then go to self-references, referring to previous technical work by themselves with limiting theorems on identifying better-knowing experts versus pretending-phony-experts.

§5 (announced before on p. 255) argues that ambiguity aversion may be a mis-applied social instinct. In some places it is suggested that it then could be rational, but misapplications do not seem to be rational I would think. This instinct-misapplication-interpretation does not invalidate attempts to model things using ambiguity models. Note also that the considerable ambiguity seeking found empirically shows that more is going on. Another problem in this explanation is that most interactions with other human beings can be expected to be favorable rather than unfavorable, because human beings have more common interests than conflicting interests. So, I think that the misapplied social instincts should generate more ambiguity seeking than ambiguity aversion. In the conclusion section, pp. 280-281, the authors will argue that their mis-applied heuristics model is descriptively superior to existing models. Such a claim, with almost no knowledge of the empirical literature, based mostly on theoretical examples on updating (see their first problem there), is naïve. The second problem on p. 281 has a strange and incomprehensible mix of rational and descriptive requirements. The third problem seems to be unaware that descriptively working people know well that not only fit but also parsimony are important, a standard fact in statistics in all empirical fields. %}

Al-Najjar, Nabil I. & Jonathan Weinstein (2009) "The Ambiguity Aversion Literature: A Critical Assessment," *Economics and Philosophy* 25, 249–284. https://doi.org/10.1017/S026626710999023X

{% **DC = stationarity** on p. 100 top; Seems to correct a number of mathematical problems of Loewenstein-Prelec (1992). %}

Al-Nowaihi, Ali & Sanjit Dhami (2006) "A Note on the Loewenstein-Prelec Theory of Intertemporal Choice," *Mathematical Social Sciences* 52, 99–108.

{% Critical condition assumes multistage prospects with backward induction and then varies upon Luce's (2001) condition by taking only two outcomes but three stages. %}

Al-Nowaihi, Ali & Sanjit Dhami (2006) "A Simple Derivation of Prelec's Probability Weighting Function," *Journal of Mathematical Psychology* 50, 521–524.

{% P. 41: The authors cite Rode et al. (1999) on a finding that, if in the unknown urn subjects are told that all colors have the same probability, then they still prefer the known urn. However, they will not use this assumption in their analysis (Al-Nowaihi 27 March 2018, personal communication)."

§4 & §5 are the heart of the paper, explaining the theory of this paper. Before, they cite interesting literature on quantum probabilities to accommodate Ellsberg. Requires some knowledge of quntum theory. I was not able to understand. %}

Al-Nowaihi, Ali & Sanjit Dhami (2017) "The Ellsberg Paradox: A Challenge to Quantum Decision Theory?" *Journal of Mathematical Psychology* 78, 40–50.

{% **inverse S:** seems to provide counter-evidence.

Propose that w for choice between (p, x) and (q, y) should depend on both p and q. Can explain anomalies such as preference reversals but is hard to assess.

Some properties of weighting functions are derived from stylized choices from the literature. Only one nonzero outcome is considered, and, hence, the power is undetermined. %}

Alarie, Yves & Georges Dionne (2001) "Lottery Decisions and Probability Weighting Function," *Journal of Risk and Uncertainty* 22, 21–33.

{% Consider two-outcome prospects, and partition the probability-outcome combinations into subsets with particular "qualities," which are used to accommodate all kinds of empirical findings. %}

Alarie, Yves & Georges Dionne (2006) "Lottery Qualities," *Journal of Risk and Uncertainty* 32, 195–216.

{% Use the KMM smooth ambiguity model, and then give conditions under which ambiguity aversion raises demand for self-insurance and insurance coverage, but decreases demand for self-protection. The effects are different than from increased risk aversion, and are more like increased pessimism. %}

Alary, David, Christian Gollier, & Nicolas Treich (2013) "The Effect of Ambiguity Aversion on Insurance and Self-Protection," *Economic Journal* 123, 1188–1202.

{% %}

Albers, Wulf, Robin Pope, Reinhard Selten, & Bodo Vogt (2000) "Experimental Evidence for Attractions to Chance," *German Economic Review* 1, 113–130.

{% **real incentives/hypothetical choice, for time preferences**: delivered future payments in person. Fit data using quasi-hyperbolic discounting. %}

Albrecht, Konstanze, Kirsten Volz, Matthias Sutter, David Laibson, & Yves von Cramon (2011) "What Is for Me Is Not for You: Brain Correlates of Intertemporal Choice for Self and Other," *Social Cognitive and Affective Neuroscience* 6, 218–225.

{% Seems to present a theoretical foundation for the positive skewness of individual stocks and underdiversified portfolios. %}

Albuquerque, Rui (2012) "Skewness in Stock Returns: Reconciling the Evidence on Firm versus Aggregate Returns," *Review of Financial Studies* 25, 1630–1673.

{% **principle of complete ignorance**: Concerns approach with only set of outcomes, à la Pattanaik, but assumes ordinal info on likelihood. Is related to Jaffray's belief-function approach. %}

Alcalde-Unzu, Jorge, Ricardo Arlegi, & Miguel A. Ballester (2013) "Uncertainty with Ordinal Likelihood Information," *Social Choice and Welfare* 41, 397–425.

{% **revealed preference** %}

Alcantud, José C.R. (2002) "Revealed Indifference and Models of Choice Behavior," *Journal of Mathematical Psychology* 46, 418–430.

{% **revealed preference** %}

Alcantud, José Carlos R. (2008) "Mixed Choice Structures, with Applications to Binary and Non-Binary Optimization," *Journal of Mathematical Economics* 44, 242–250.

{% **ordering of subsets**: additive representations for finite subsets, with a simple set of sufficient conditions. %}

Alcantud, José C.R. & Ritxar Arlegi (2008) "Ranking Sets Additively in Decisional Contexts: An Axiomatic Characterization," *Theory and Decision* 64, 147–171.

{% Study an incomplete order that violates weak anonymity. %}

Alcantud, José C.R. & Ram Sewak Dubey (2014) "Ordering Infinite Utility Streams: Efficiency, Continuity, and no Impatience," *Mathematical Social Sciences* 72, 33–40.

{% **risky utility u = transform of strength of preference v, latter doesn't exist**: writes on p. 50: "In effect the utility whose measurement is discussed in this paper has literally nothing to do with individual, social or group welfare, whatever the latter may be supposed to mean."

Paper gives nice account, didactical with numerical examples etc., of the difference between ordinal utility and cardinal vNM utility. Nice for students with little mathematical background.

P. 31: "Whether or not utility is some kind of glow or warmth, or happiness, is here irrelevant;". Footnote 4 on that page is pessimistic about the step, called psychological, philosophical, of relating utility to satisfaction, happiness, etc.

P. 34 ℓℓ. 2-3 does the naive "expected utilitycism" of saying that all of life is decision under uncertainty.

independence/sure-thing principle due to mutually exclusive events: p. 37 2nd para gives the nice separability argument for vNM independence that goods contingent upon mutually exclusive events are never consumed jointly, which was first put forward by Marschak (see Moscati 2016).

P. 37 last para states that different ways of generating same probability distribution should be equivalent.

Paper makes clear that whether a function is ordinal/cardinal etc. depends on what we want the function to do, such as on p. 40 middle. P. 43 bottom states the **utility of gambling**.

P. 42 already has the **probability triangle**.

P. 44 clearly states the prospect theory/Markowitz idea that outcomes are taken as changes with respect to a reference point, and not as final wealth. He later refers to Markowitz for it.

P. 45 shows this weird past convention of calling convex what is nowadays (1980-2023) called concave.

P. 46: on difficult observability status of reference point theories in absence of theory about location of reference point: "Markowitz recognizes that until an unambiguous procedure is discovered for determining when and to what extent current income deviates from customary income, the hypothesis will remain essentially nonverifiable because it is not capable of denying any observable behavior." %}

Alchian, Armen A. (1953) "The Meaning of Utility Measurement," *American Economic Review* 43, 26–50.

{% %}

Alessie, Rob J. M., Stefan Hochguertel, & Arthur van Soest (2002) "Household Portfolios in the Netherlands." *In* Luigi Guiso, Michael Haliassos, & Tullio Jappelli (eds.) *Household Portfolios*, The MIT Press, Cambridge, MA.

{% Nice empirical study on asymmetric loss functions. The idea was central in Birnbaum, Coffey, Mellers, & Weiss (1992), p. 325 and Elke Weber (1994), two studies not cited. %}

Alexander, Marcus & Nicholas A. Christakis (2008) "Bias and Asymmetric Loss in Expert Forecasts: A Study of Physician Prognostic Behavior with Respect to Patient Survival," *Journal of Health Economics* 27, 1095–1108.

{% **inverse S** is found. Bettor's subjective probabilities are estimated from portion of money bet on a horse. Objective probabilities are estimated from percentage of times that some horse (say favorite, or no. 5-favorite, etc.) wins. Thus, bettors overestimate small probabilities of winning and understimate large probabilities of winning.

Uses power family to estimate utility and find that bettors are risk seeking (P.s.: no wonder, for horse race bettors! %}

Ali, Mukhtar M. (1977) "Probability and Utility Estimates for Racetrack Betting," *Journal of Political Economy* 85, 803–815.

{% %}

Ali, Iqbal, Wade D. Cook, & Moshe Kress (1986) "On the Minimum Violations Ranking of a Tournament," *Management Science* 32, 660–672.

{% **maths for econ students**. %}
Aliprantis, Charalambos D. & Kim C. Border (1999) "*Infinite Dimensional Analysis: A Hitchhiker's Guide.*" Springer, Berlin.

{% Hammond (1976): says that this book was the first to consider endogenously changing tastes: consumer regretting his earlier choice; explicitly restricted attention to the case where no changing or inconsistent choice occurs. %}
Allais, Maurice (1947) "*Economie et Interet.*" Imprimerie Nationale, Paris.

{% **dynamic consistency**: **favors abandoning time consistency, so, favors sophisticated choice**, through his distinction between ex ante and ex post choice.
Used **just noticeable difference** for cardinal utility.
biseparable utility: Eq. 19.1, p. 50 in English '79 translation.
utility elicitation: different EU methods give different curves: Moscati (2019) cites Allais on p. 247 (outside the page range given in the reference below; probably in comments that Allais gave later) for discussing two different methods under EU to measure utility, being the certainty equivalent method and the probability equivalent method, and predicting that these will give different results, thus falsifying expected utility.
Allais did not only provide his eye-opening paradox and make general empirical claims, but he also provided concrete models aiming at concrete quantitative predictions. Although some value may be ascribed to his chosen direction of nonlinear weighting of probability to capture the psychology of risk attitude, the quality of his models is too low otherwise to deserve further attention. Allais did not understand enough that models must be specific so as to have tractability, and not even that parameters should satisfy the minimal requirement of being identifiable. %}
Allais, Maurice (1953) "Fondements d'une Théorie Positive des Choix Comportant un Risque et Critique des Postulats et Axiomes de l'Ecole Américaine," *Colloques Internationaux du Centre National de la Recherche Scientifique (Econométrie)* 40, 257–332. Paris: Centre National de la Recherche Scientifique. Translated into English, with additions, as "The Foundations of a Positive Theory of Choice Involving Risk and a Criticism of the Postulates and Axioms of the

American School." *In* Maurice Allais & Ole Hagen (1979, eds.) *Expected Utility Hypotheses and the Allais Paradox*, 27–145, Reidel, Dordrecht.

{% **random incentive system**: seems to have used that.

P. 539 writes: N*otre psychologie est telle que nous préférons plus la sécurité au voisinage de la certitude qu'au voisinage de grands risques,* et nous ne pensons pas qu'elle puisse être regardée, en quoi que ce soit, comme irrationelle. [Italics from ortiginal] Translated into English, where the traditional plural we is replaced by the modern singular I: "My psychology makes me prefer safety more strongly in the neighbourhood of certainty than I do in the neighbourhood of high risk. I am absolutely convinced there is nothing about this view that could justify it as being regarded in any way as irrational." Allais is referring here to the certainty effect, as appears from the preceding text. %}

Allais, Maurice (1953) "Le Comportement de l'Homme Rationnel devant le Risque: Critique des Postulats et Axiomes de l'Ecole Américaine," *Econometrica* 21, 503–546.

{% **risky utility u = strength of preference v (or other riskless cardinal utility, often called value)** %}

Allais, Maurice (1953) "La Psychologie de l'Homme Rationnel devant le Risque: La Théorie et l'Expérience," *Journal de la Société de Statistique de Paris* (Janvier-Mars), 47–73.

{% P. 8: **risky utility u = strength of preference v (or other riskless cardinal utility, often called value)**; nonlinearity in probabilities

utility elicitation: different EU methods give different curves:

Pp. 533-536 on 1952 exchance with Savage on him violating his axioms at first in Allais paradox but him considering those violations to be irrational.

P. 535 writes, about Savage's reformulation of the Allais paradox, that it …"has no value at all, as it changes the nature of the problem completely, eliminating—as did Samuelson—the complementarity effect operating in the neighbourhood of certainty." This is a nice formulation of the certainty effect.

Pp. 612-613 predicts PE (probability equivalents) and CE (certainty equivalents) will give different curves, where for the first, PE, however, he suggests to get p's closer to 1 so has to have the certainty effect, whereas for CE one takes a fixed p far away from certainty. %}

Allais, Maurice (1979) "The So-Called Allais Paradox and Rational Decisions under Uncertainty." *In* Maurice Allais & Ole Hagen (eds.) *Expected Utility Hypotheses and the Allais Paradox*, 437–681, Reidel, Dordrecht.

{% P. 70 writes: "It cannot be too strongly emphasized *that there are no criteria for the rationality of ends as such other than the condition of consistency*. Ends are completely arbitrary." (**coherentism**) Before, Allais stated that weak ordering, stochastic dominance, and consideration of objective probabilities, are necessary and sufficient for being rational. This is too broad as regards phenomena incorporated, and too narrow intellectually, to be interesting.

P. 133 endnote 18: **risky utility u = transform of strength of preference v, latter doesn't exist**: %}

Allais, Maurice (1979) "The Foundations of a Positive Theory of Choice Involving Risk and a Criticism of the Postulates and Axioms of the American School." *In* Maurice Allais & Ole Hagen (eds.) *Expected Utility Hypotheses and the Allais Paradox*, 27–145, Reidel, Dordrecht.

{% **risky utility u = strength of preference v (or other riskless cardinal utility, often called value)**: seems to have written/said: "some, including myself even believe that it [cardinal utility] can be defined independently of any random choice by reference to the intensity of preferences." %}

Allais, Maurice (1984) citation. *In* Ole Hagen & Fred Wenstop (eds.) *Progress in Utility and Risk Theory*, 28, Reidel, Dordrecht.

{% **risky utility u = strength of preference v (or other riskless cardinal utility, often called value)**: according to Bouyssou/Vansnick this paper tries to prove that risky cardinal u = riskless cardinal v. %}

Allais, Maurice (1985) "Three Theorems on the Theory of Cardinal Utility and Random Choice," working paper C–4337.

{% %}

Allais, Maurice (1987) “The General Theory of Random Choices in Relation to the Invariant Cardinal Utility Function and the Specific Probability Function: The (U, q) Model—A General Overview,” Centre National de la Recherche Scientifique, Paris.

{% Three out of four subjects show **inverse S** probability weighting.

P. 243: “The variations of function θ(p) [the probability weighting function] of a given subject with respect to the magnitude of the sums at stake and the variations of this function from one subject to the other correspond to the *very great complexity* [italics from original] of the risk psychology, and, as I have constantly stated since 1952, the impossibility to represent by one and the same formulation this psychology over the whole field of random choices for a given subject as well as for all subjects.” %}

Allais, Maurice (1988) “The General Theory of Random Choices in Relation to the Invariant Cardinal Utility Function and the Specific Probability Function.” *In* Bertrand R. Munier (ed.) *Risk, Decision and Rationality*, 233–289, Reidel, Dordrecht.

{% **risky utility u = strength of preference v (or other riskless cardinal utility, often called value)**: seems to write, on p. 104: “Today, given the positions taken by some eminent economists which, with some rare exceptions, are as spectacular as they are dogmatic, an intolerant orthodoxy has banished, almost totally, cardinal utility, and, in general, any psychological introspection from economic science.” %}

Allais, Maurice (1991) “Cardinal Utility, History, Empirical Findings, and Applications,” *Theory and Decision* 31, 99–140.

{% %}

Allais, Maurice & Ole Hagen (1979, eds.) “*Expected Utility Hypotheses and the Allais Paradox.*” Reidel, Dordrecht.

{% %}

Allais, Maurice & Ole Hagen (1994, eds.) “*Cardinalism; A Fundamental Approach.*” Kluwer Academic Publishers, Dordrecht.

{% It is well known that nudging people into reducing energy use works well if social comparisons are brought in. This paper examines long-term effects. People

slowly react to the nudge, only slowly reducing energy use, but after a prolonged exposure the effect remains long after. %}

Allcott, Hunt & Todd Rogers (2014) "The Short-Run and Long-Run Effects of Behavioral Interventions: Experimental Evidence from Energy Conservation," *American Economic Review* 104, 3003–3037.

{% %}

Allen, Beth (1987) "Smooth Preferences and the Approximate Expected Utility Hypothesis," *Journal of Economic Theory* 41, 340–355.

{% Data from N = 9,789,093 (!) marathon runners shows that round numbers serve as reference points. %}

Allen, Eric J., Patricia M. Dechow, Devin G. Pope, & George Wu (2017) "Reference-Dependent Preferences: Evidence from Marathon Runners," *Management Science* 63, 1657–1672. https://doi.org/10.1287/mnsc.2015.2417

{% **Christiane, Veronika & I**: **probability elicitation**; compare Roth & Malouf (1979) %}

Allen, Franklin (1987) "Discovering Personal Probabilities when Utility Functions are Unknown," *Management Science* 33, 542–544.

{% **optimal scale levels**: seems to argue that for unipolar scales five answer levels is optimal, and for bipolar scales it is seven. %}

Allen, I. Elaine & Christopher A. Seaman (2007) "Likert Scales and Data Analyses," *Quality Progress* 40, 64–65.

{% %}

Allen, Roy G.D. (1934) "A Comparison between Different Definitions of Complementary and Competitive Goods," *Econometrica* 2, 168–175.

{% P. 155, about cardinal utility, writes: "cannot be expressed in terms of the individual's acts of choice; it can only be supported by introspection into one's own experience or by questioning others about their experiences" %}

Allen, Roy G.D. (1935) "A Note on the Determinateness of the Utility Function," *Review of Economic Studies* 2, 155–158.

{% **questionnaire versus choice utility & real incentives/hypothetical choice**: As I understand it, the paper is on that. It seems to argue for also using non-revealed-preference data, i.e. choiceless data, and hypothetical choice, in economics. Many people have argued for that, e.g. Kahneman. It is done in contingent evaluation in marketing, and in the field of happiness studies. I am also among the many who argued for it, e.g. in Kahneman, Wakker, & Sarin (1997) and Abdellaoui, Barrios, & Wakker (2007). However, the paper does not link to any such literatures. The abstract writes: "Most empirical work in economics has considered only a narrow set of measures … we argue that a more flexible and broader approach to measurement could be extremely useful". As I understand, the broader measures they have in mind are choiceless, but they do not say this explicitly in the abstract or first part of the intro. %}

Almås, Ingvild, Orazio Attanasio, & Pamela Jervis (2024) "Presidential Address: Economics and Measurement: New Measures to Model Decision Making," *Econometrica* 92, 947–978.
https://doi.org/10.3982/ECTA21528

{% **tradeoff method**: Uses a weak version of comonotonic tradeoff consistency and axiomatizes a generalization of biseparable utility that is local instead of global. It does give one cardinal utility function. %}

Alon, Shiri (2014) "Derivation of a Cardinal Utility through a Weak Tradeoff Consistency Requirement," *Mathematics of Operations Research* 39, 290–300.

{% **EU+a*sup+b*inf**: A special case of neo-additive RDU for uncertainty. The agent, for every act, adds an "unforeseen" state, which she endows with the worst outcome of the act. It means that the worst outcome is overweighted. The author uses tradeoff consistency and thus escapes from drawbacks of the Anscombe-Aumann framework. (**tradeoff method**) %}

Alon, Shiri (2015) "Worst-Case Expected Utility," *Journal of Mathematical Economics* 60, 43–48.

{% An important improvement of Alon & Schmeidler's (2014) axiomatization of maxmin EU. They had one problematic axiom, Axiom 7. This paper shows that it can be removed. Now a clean preference axiomatization of maxmin EU results, with simply all the natural analogs in terms of the, tractable, endogenous midpoint operation, of the mixture axioms used by Gilboa & Schmeidler (1989). Thus, Theorem 1 provides the most appealing preference axiomatization of maxmin EU existing today (2022). %}

Alon, Shiri (2022) "A Comment on the Axiomatics of the Maxmin Expected Utility Model," *Theory and Decision* 92, 445–453.
https://doi.org/10.1007/s11238-022-09879-8

{% Every individual in society satisfies Savage's axioms and does SEU, and society is assumed to do maxmin EU. Society's preferences are maxmin EU with utility an average of the individual utilities and the set of priors the convex hull of the individual priors (Theorem 2), or a subset of it (Theorem 1) if and only if the following two Pareto conditions: The authors impose Pareto only if there is agreement on the probabilities or on the utilities and, thus, avoid impossibility results by Mongin and others on aggregating SEU. Agreement on probabilities is only needed for exchangeable partitions where all agents agree on this exchangeability, so, it is observable (socially unambiguous partition). Note that these are not subject to source preference because agents do SEU.

They assume at least one such twofold partition to exist, referring to, say, a coin toss. Agreement on utility is ordinal in the sense of ordering the relevant outcomes the same way. P. 1182 middle para suggests that it makes sense that society more than individuals are not ambiguity neutral. My opinion is opposite: it is natural that aggregation at society planning level will be more rational. %}

Alon, Shiri & Gabrielle Gayer (2016) "Utilitarian Preferences with Multiple Priors," *Econometrica* 84, 1181–1201.

{% Do the Bewley (1986, 2002) model but now for qualitative probability. %}

Alon, Shiri & Ehud Lehrer (2014) "Subjective Multi-Prior Probability: A Representation of a Partial Likelihood Relation," *Journal of Economic Theory* 151, 476–492.

{% **tradeoff method**: Is used to obtain the first axiomatization of maxmin EU that I consider to be satisfactory, not needing Anscombe-Aumann. Thus, it does not need EU for risk, and, more importantly, does not need the dynamic backward induction assumption of the Anscombe-Aumann framework (p. 384 3rd para). Alon (2022) provided a significant improvement, showing that their most complex Axiom 7 is implied by the other axioms and can be removed. Thus, Alon (2022) provided the nicest axiomatization of maxmin EU that I know (April 2022).

I agree much with the discussion of axioms on pp. 385-386. P. 393 penultimate para explains that the axiomatization in Ghirardato et al. [12] uses an operation which implies that their axioms involve infinitely many variables and in this sense are intractable. This paper avoids this problem by only using, roughly, 50-50 subjective mitures.

P. 392 Axiom A0* suggests that for the biseparable approach topological separability would be needed. However, Köbberling & Wakker (2003, §7) provide several generalizations for this approach, obtained as corollaries of their results using the tradeoff technique. Their Observation 18 shows that topological separability can be dropped, as they point out on p. 407 last line. Hence Axiom A0* is redundant. %}

Alon, Shiri & David Schmeidler (2014) "Purely Subjective Maxmin Expected Utility," *Journal of Economic Theory* 152, 382–412.

{% **foundations of quantum mechanics** %}

Allori, Valia, Sheldon Goldstein, Roderich Tumulka & Nino Zanghì (2011) "Many Worlds and Schrödinger's First Quantum Theory," *British Journal for the Philosophy of Science* 62, 1–27.

{% %}

Alós-Ferrer, Carlos, Ernst Fehr, & Nick Netzer (2021) "Time Will Tell: Recovering Preferences When Choices Are Noisy," *Journal of Political Economy* 129, 1828–1877.

{% The authors react to McGranaghan, Nielsen, O'Donoghue, Somerville, & Sprenger (2024 AER). That paper argued that preceding evidence suggesting a common ratio effect can be explained by noisy choice and not common ratio. The present paper uses a technique, using repeated choices, by Alós-Ferrer, Fehr, & Netzer (2021), which can separate noise from core-preference in great generality. The authors use it in a new experiment showing clear evidence for common ratio. %}

Alós-Ferrer, Carlos, Ernst Fehr, Helga Fehr-Duda, & Michele Garagnani (2024) “Distinguishing Common Ratio Preferences from Common Ratio Effects Using Paired Valuation Tasks: Comment,” working paper.

{% They investigate how all kinds of candidates for strength-of-preference indexes (e.g., expected-utility difference which do better than expected value differences) impact choice probabilities. It has often been pointed out that other things matter, such as salient stochastic dominance. I did not read the paper enough to see how the authors handle this.

They seem to show that imposing a symmetric error structure and random choice can erroneously support particular decision models.

risky utility u = strength of preference v (or other riskless cardinal utility, often called value): the authors do not get into the classical cardinal/ordinal debate. %}

Alós-Ferrer, Carlos & Michele Garagnani (2022) “Strength of Preference and Decisions under Risk,” *Journal of Risk and Uncertainty* 64, 309–329. https://doi.org/10.1007/s11166-022-09381-0

{% Study updating experimentally. Paradoxically, increasing incentives increases reliance on reinforcement, rather than Bayesian updating, because the winlose cues become more salient. %}

Alós-Ferrer, Carlos & Michele Garagnani (2023) “Part-Time Bayesians: Incentives and Behavioral Heterogeneity in Belief Updating,” *Management Science* 69, 5523–5542. https://doi.org/10.1287/mnsc.2022.4584

{% “Mere choice effect”: merely that agent chose some object, makes her like it more. Assuming this comes AFTER the choice made, it does not affect correctness of revealed-preference info. But if it is followed up by a within-

subject prediction test, then it may distort future choices, overestimating predictive power, as a kind of status-quo effect or avoidance of cognitive dissonance. The authors set up a careful experiment to measure and test this with much statistical power, and do NOT find it. This nonfinding is intuitively puzzling to me. %}

Alós-Ferrer, Carlos & Georg D. Granic (2023) "Does Choice Change Preferences? An Incentivized Test of the Mere Choice Effect," *Experimental Economics* 26, 499–521.
https://doi.org/10.1007/s10683-021-09728-5

{% **updating: testing Bayes' formula**: Study updating, helped by pupil-dilation measurement. Paradoxically, increasing incentives sometimes leads to more over-focusing on gains versus losses and, hence, worse updating. %}

Alós-Ferrer, Carlos, Alexander Jaudas, & Alexander Ritschel (2021) "Effortful Bayesian Updating: A Pupil-Dilation Study," *Journal of Risk and Uncertainty* 63, 81–102.
https://doi.org/10.1007/s11166-021-09358-5

{% Repeated choice. %}

Aloysius, John (2002) "A Behavioral Model of Intertemporal Decision Making under Risk," University of Arkansas.

{% Discusses Samuelson's colleague, much literature about it, and the extent to which it entails a violation of expected utility. Presents the analysis of Tversky & Bar-Hillel, which shows that the behavior of Samuelson's colleague is precluded by the following three conditions:

A1 ($200_{0.5}(-100)$) is not liked under all levels of wealth possible for the 100 times repeated Samuelson game, i.e., [−10000, 20000]),

A2 ("dominance") if prospect X is not liked conditional on each outcome of prospect Y, then X should not be liked under Y), and

A3 (transitivity).

Axiom A2 is called dominance, which is misleading because A2 is pactically as strong as independence (especially in the version of standard gamble

consistency as I call it). The author argues that the behavior of Samuelson's colleague can be reconciled with expected utility more than thought before. If I understood well, he does so by taking what is sometimes called utility of income; i.e., at every choice of accepting or not accepting the prospect the reference point is the status quo of that moment, and probably abandoning axiom A1. I did not understand the role of Samuelson's citation on pp. 65-66. One can of course complicate by bringing in dynamic models such as distinguishing between conditional preference and preference if the event actually happens. %}

Aloysius, John (2007) "Decision Making in the Short and Long Run: Repeated Gambles and Rationality," *British Journal of Mathematical and Statistical Psychology* 60, 61–69.

{% People are overconfident. %}

Alpert, Mark & Howard Raiffa (1982) "A Progress Report on the Training of Probability Assessments." *In* Daniel Kahneman, Paul Slovic, & Amos Tversky (eds.) *Judgment under Uncertainty: Heuristics and Biases*, 294–305, Cambridge University Press, Cambridge.

{% Subjects can choose in which society their grandchild can live (no real incentives then). Two aspects are specified, being their absolute income and the average income. Subjects evaluate through a mix of absolute and relative income. The authors fit both arithmetic and geometric mix. %}

Alpizar, Francisco, Fredrik Carlsson, Olof Johansson-Stenman (2005) "How Much Do We Care about Absolute versus Relative Income and Consumption," *Journal of Economic Behavior and Organization* 56, 405–421.

{% **strength-of-preference representation**. Gives formal derivation of Ragnar Frisch's result, with continuity etc. analyzed explicitly. Says it is an open question whether strength of preferences can be observed, but expects a positive answer to come soon.

Is often credited as the first real preference axiomatization in the literature (e.g., by Moscati 2019, p. 107). To justify this priority assignment, we accept strength of preference as a kind of preference for this occasion, and we consider Ramsey (1931) as too incomplete to call a preference axiomatization. We must then also classify de Finetti (1931) (and de Finetti 1937) as too much different from that. Well, de Finetti axiomatized subjective probability and I prefer to give priority to him. Helmholtz (1887) and Hölder (1901) preceded with measurement theorems/representations of ordered structures and could also be given the priority, but they did not interpret their orderings as preferences.

Alt, a mathematician, wrote his paper in reaction to Lange (1934), whose analysis was not tight. %}

Alt, Franz (1936) "Über die Messbarkeit des Nutzens," *Zeitschrift für Nationalökonomie* 7, 161–169. Translated into English by Siegfried Schach (1971) "On the Measurability of Utility." *In* John S. Chipman, Leonid Hurwicz, Marcel K. Richter, & Hugo F. Sonnenschein (eds.) *Preferences, Utility, and Demand*, Ch. 20, Hartcourt Brace Jovanovich, New York.

{% BMJ is a popular weekly medical magazine. %}

Altman, David G. & J. Martin Bland (1995) "Absence of Evidence is not Evidence of Absence," *BMJ* 311(7003), 485.
https://doi.org/10.1136/bmj.311.7003.485

{% **preference for flexibility**: because relevant intermediate information regarding tastes is expected, but also desire for precommitment due to time inconsistency with lack of self-control. Determine optimal levels of flexibility/commitment. %}

Amador, Manuel, Iván Werning, & George-Marios Angeletos (2006) "Commitment vs. Flexibility," *Econometrica* 74, 365–396.

{% **Prospect theory not cited**. They seem to assume expected utility throughout, in particular in what they call "structural equations models," although they never seem to write explicitly what that is and they never state this.

cognitive ability related to risk/ambiguity aversion: They find no relation but this should come as no surprise because they only study risk aversion and its special case of loss aversion. It is more plausible that likelihood insensitivity is related to cognitive ability, but the authors do not know this concept. %}

Amador-Hidalgo, Luis, Pablo Brañas-Garza, Antonio M. Espín, Teresa García-Muñoz, & Ana Hernández-Román (2021) "Cognitive Abilities and Risk-Taking: Errors, not Preferences," *European Economic Review* 134, 103694.

{% A prospect is mapped into an affine function on a set of probability measures (similar to Möbius inverse I guess, where a capacity is transformed into an additive measure on a set of larger cardinality), and the representing functional over the prospects then turns into a Choquet integral over the affine functions under fairly weak conditions on that representing functional. Proposition 2: Two linear functions are comotonic iff they are isotonic. Isotonic means ordinally equivalent; well, a linear function is a nondecreasing nonconstant transformation of another iff it is a strictly increasing transformation, even linear transformation. §3.1 criticizes the separation of ambiguity and ambiguity attitude of Ghirardato, Maccheroni, Marinacci 2004) and says that it is impossible to assign a meaning to the separate components.

Special cases of the general functionals considered here can be interpreted in statistics, hence the title. %}

Amarante, Massimiliano (2009) "Foundations of Neo-Bayesian Statistics," *Journal of Economic Theory* 144, 2146–2173.

{% %}

Amarante, Massimiliano (2017) "Conditional Expected Utility," *Theory and Decision* 83, 175–193.
https://doi.org/10.1007/s11238-017-9597-9

{% Characterize concepts of ambiguity aversion such as of Epstein & Zhang for maxin EU, criticizing the latter. %}

Amarante, Massimiliano & Emel Filiz (2007) "Ambiguous Events and Maxmin Expected Utility," *Journal of Economic Theory* 134, 1–33.

{% Show how ambiguity, analyzed using Schmeidler's (1989) CEU, can shed new light on contract theory, and when still plausible things can follow. They assume that one of the two sides does SEU, and only one exhibits ambiguity nonneutrality. I conjecture that similar results hold if one side is more/less ambiguity averse than the other. For interesting cases, some ambiguity seeking is needed. The authors explain that this is more plausible than much of the literature believed until recently (p. 2243, §0.1; **ambiguity seeking**). The main result

extends a likelihood ratio result of SEU to ambiguity by a condition called vigilance. %}

Amarante, Massimiliano, Mario Ghossoub, & Edmund Phelps (2017) "Contracting on Ambiguous Prospects," *Economic Journal* 127, 2241–2246.

{% If two convex-ranged (For every A⊂C and P(A) ≤ β ≤ P(C) there exists A⊂ B⊂ C with P(B) = β) probability measures P and Q have a probability 0<p<1 such that $P^{-1}(p) = Q^{-1}(p)$ then they are the same, so, they are uniquely determined by it. This was shown, if the domain is a λ system (which includes algebras and σ algebras) under countable additivity by Marinacci (2000), and was later extended to finitely additive probability measures. This paper gives simpler proofs and alternative conditions. %}

Amarante, Massimiliano, Felix-Benedikt Liebrich, & Cosimo Munari (2025) "Range Convexity: Probabilities, Risk Measures, and Games," *Mathematics of Operations Research* 50, 743–763.
https://doi.org/10.1287/moor.2023.0015

{% Empirical study to see how subjects in an experiment, who have to play the role of social planner (so, no self interest and, by definition, no real incentives), aggregate ordinal preferences of a group. Condorcet-type rules that seek to ignore cardinal rules fare poorly. Borda rules that score ranks and in this sense seek cardinal info, fare way better. Can be taken as an argument for: **Arrow's voting paradox ==> ordinality does not work**
real incentives/hypothetical choice: this kind of work by definition has to use hypothetical choice. %}

Ambuehl, Sandro & B. Douglas Bernheim (2021) "Interpreting the Will of the People: A Positive Analysis of Ordinal Preference Aggregation," NBER working paper series, working paper 29389.

{% Seems to show that there are algebras on which one can define finitely additive probability measures but it is impossible to have them countably additive. This seems to be on so-called free algebras. It seems to be as follows. One takes a set of basic propositions, I guess denumerably many. One assumes that every

intersection and union is nontrivial, so, nothing nested. Then one takes the set of all finite intersections of the basic statements and then all finite unions. Then … I forgot. %}

Amer, Mohamed A. (1985) "Extension of Relatively σ-Additive Probabilities on Boolean Algebras of Logic," *Journal of Symbolic Logic* 50, 589–596. https://doi.org/10.2307/2274314

{% %}

American Psychological Association (1994) "*Publication Manual*; 4th edn." American Psychological Association, Washington DC.

{% %}

Ames, Daniel R. (2004) "Inside the Mind Reader's Tool Kit: Projection and Stereotyping in Mental State Inference," *Journal of Personality and Social Psychology* 87, 340–353.

{% **equity-versus-efficiency**: Seem to find that many prefer equity to efficiency

Seem to have written: "Any parent with two or more children needs no formal analysis to be persuaded of the importance of distributional justice." (p. 193) %}

Amiel, Yoram & Frank A. Cowell (1994) "Income Inequality and Social Welfare." *In* John Creedy (ed.) *Taxation, Poverty and Income Distribution*, 193–219, Edward Elgar, Cheltenham, Glos.

{% Do classical preference reversal of P bet versus $ bet, but let stimuli be distributions of welfare over population rather than prospects. %}

Amiel, Yoram, Frank A. Cowell, Liema Davidovitz, & Avraham Polovin (2008) "Preference Reversals and the Analysis of Income Distributions," *Social Choice and Welfare* 30, 305–330.

{% Meta-analysis on discounting in health. %}

Amlung, Michael, Emma Marsden, Katherine Holshausen, Vanessa Morris, Herry Patel, Lana Vedelago, Katherine R. Naish, Derek D.Reed, & Randi E. McCabe (2019), "Delay Discounting as a Transdiagnostic Process in Psychiatric Disorders: A Meta-Analysis," *JAMA Psychiatry* 76, 1176–1186.

https://doi.org/10.1001/jamapsychiatry.2019.2102

{% **foundations of statistics**

They seem to favor confidence intervals, and argue against thresholds. %}

Amrhein, Valentin, Sander Greenland, & Blake McShane (2019) “Comment: Scientists Rise up against Statistical Significance,” *Nature* 567, 305–307. https://doi.org/10.1038/d41586-019-00857-9

{% Field experiment in India with 1.5 million stock investors. People who received initial public offerings (IPO) of shares randomly allocated, were more likely to keep them than others (others receive equivalent money endowment). Is taken to support the endowment effect for reasons other than reference dependence/loss aversion. However, the authors only consider two very specific forms of reference dependence. In one (backward looking reference point), the difference between prior endowment or not is not just a matter of framing but involves real costs, so that it concerns simply different outcomes and not the framing-based endowment effect as commonly defined in the literature. The second (forward looking) is a very specific version of the Köszegi-Rabin model. But then, they formulate their conclusion carefully and modestly: “We do not find conclusive evidence that our results can be fully explained by leading theoretical explanations, such as reference-dependent preferences” (p. 1975).

The effect reduces considerably, but absolutely does not disappear, with experience. %}

Anagol, Santosh, Vimal Balasubramaniam, & Tarun Ramadorai (2018) “Endowment Effects in the Field: Evidence from India’s IPO Lotteries,” *Review of Economic Studies* 85, 1971–2004.

{% Uses the nice term contraction consistency

Contains the example of dice A, B, C, where $A > B > C > A$ with $>$ denoting higher probability of giving higher number. %}

Anand, Paul (1987) “Are the Preference Axioms Really Rational?,” *Theory and Decision* 23, 189–214.

{% Normative arguments against transitivity %}

Anand, Paul (1993) "The Philosophy of Intransitive Preference," *Economic Journal* 103, 337–346.

{% %}

Anand Paul, Prasanta K. Pattanaik & Clemens Puppe (2009, eds.) "*Handbook of Rational and Social Choice*." Oxford University Press, Oxford.

{% %}

Anand, Paul & Allan Wailoo (2000) "Utilities versus Rights to Publicly Provided Goods: Arguments and Evidence from Health Care Rationing," *Economica* 67, 543–577.

{% Comments for version of 29 Nov 2018.

This paper measures the ambiguity indexes of Baillon et al. (2018, ECMA) in a sample of almost 300 people in the Dutch population of the Dutch bank household survey. The sample is representative, however, with the restriction that subjects did financial investments. The paper also measures risk attitudes and has all kinds of demographic info. The indexes are measured for four sources: familiar individual stock (chosen by the subjects themselves), the local stock market index, a foreign stock market index, and the crypto-currency Bitcoinn. What Baillon et al. take as insensitivity index, these authors take as perception of ambiguity. I will continue to use the term insensitivity.

65% of subjects is ambiguity averse, 5% is ambiguity neutral, and 30% is ambiguity seeking. The four aversion indexes are highly correlated for the different sources, with 1 factor explaining 70% of their variance. The insensitivity indexes for the different sources are much less related to each other. It suggests that aversion for financial stocks is only person-dependent but source-independent, whereas insensitivity is also source dependent.

Insensitivity is lower for financial literacy and better education, supporting its cognitive interpretation. (**cognitive ability related to likelihood insensitivity**)

correlation risk & ambiguity attitude: ambiguity aversion is positively related to risk aversion.

Aversion and insensitivity are almost unrelated, supporting their orthogonality.

For a 0.50 gain probability, 65% of subjects is risk averse. For a 0.33

probability, 56% is risk seeking.

Many subjects are ambiguity seeking for domestic stocks (**ambiguity seeking**) but ambiguity averse for foreign stocks, showing the desirability of source dependence of ambiguity attitudes, as also shown by Tversky & Fox (1995). %}

Anantanasuwong, Kanin, Roy Kouwenberg, Olivia S. Mitchell, & Kim Peijnenburg (2024) "Ambiguity Attitudes for Real-World Sources: Field Evidence from a Large Sample of Investors," *Experimental Economics* 27, 548–581. https://doi.org/10.1007/s10683-024-09825-1

{% Uses Anscombe-Aumann framework for intertemporal choice, axiomatizing exponential and quasi-hyperbolic discounting. %}

Anchugina, Nina (2017) "A Simple Framework for the Axiomatization of Exponential and Quasi-Hyperbolic Discounting," *Theory and Decision* 82, 185–210.

{% %}

Anderberg, Dan & Frederik Andersson (2000) "Social Insurance with Risk-Reducing Investments," *Economica* 67, 37–56.

{% **common knowledge** %}

Anderlini, Luca (1990) "Some Notes on Church's Thesis and the Theory of Games," *Theory and Decision* 29, 19–52.

{% **small worlds** %}

Anderlini, Luca & Leonardo Felli (1994) "Incomplete Written Contracts: Undescribably States of Nature," *Quarterly Journal of Economics* 109, 1085–1124.

{% **real incentives/hypothetical choice, for time preferences**; They used an, apparently existing, system of Israelian cheques with deferred payment. They measured WTP and WTA for some prospects, all when received now, in 4 weeks, or in 8 weeks. They found significant correlation showing that more risk averse subjects discount more. No correlation between risk aversion and time inconsistency. They found time inconsistency (in fact, nonstationarity with consumption time changing but decision time kept fixed) but weakly so. They also found the usual discrepancy between WTP and WTA. %}

Anderhub, Vital, Werner Güth, Uri Gneezy, & Doron Sonsino (2001) "On the Interaction of Risk and Time Preferences: An Experimental Study," *German Economic Review* 2, 239–253.
https://doi.org/10.1111/1468-0475.00036

{% They present a model of the housing market and estimate it using a big unique data set in Denmark. They use Köszegi & Rabin's (2006) model of loss aversion and assume that utility is linear with a kink at the reference point. They find strong reference dependence and loss aversion of 2 or 2.5. %}

Andersen, Steffen, Cristian Badarinza, Lu Liu, Julie Marx, & Tarun Ramadorai (2022) "Reference Dependence in the Housing Market," *American Economic Review* 112, 3398–3440.
https://doi.org/10.1257/aer.20191766

{% Consider risky experimental choices from a large representative sample from the Danish population also used in other papers, with varying prior endowments in the lab. They here use a 2009 sample. They also have data on wealth of the subjects, which is possible in Denmark, which they now for the first time bring in and this is a novelty of this paper. This Danish data set is very valuable because it can have such information. Using it, the authors can investigate dependence of risk attitude on wealth. For wealth dependence, they assume homogenous preferences, i.e., a representative agent. Their (claimed) finding is between complete asset integration and none at all, i.e., partial asset integration. Unsurprisingly, they find asset integration for the prior endowment in the lab, but not for bank account.

With w denoting wealth and y denoting experimental money won, they take a two-variate utility function U(w,y), and do not assume asset integration (which would give U(w+y)) but use another 3 parameter family

$$U(w,y) = \left((\omega w^{\rho} + y^{\rho})^{1/\rho}\right)^{1-r}$$

where ρ is taken to reflect nonlinear asset integration, ω reflects importance of w, and r would be risk aversion if there were perfect asset integration (otherwise ρ

and ω also influence risk attitude). For $\omega = 0$ the functional has complete asset independence (“nonintegration”), depending only on y. For $\omega = 1$ and $\rho = 1$, it has perfect asset integration, depending on $w + y$. I find ρ, elasticity between w and y, hard to interpret behaviorally. Given that w will greatly exceed y, a large ρ means more weight to w and, hence, ω and ρ interact. ω and ρ will also interact with risk attitude.

The authors fit assuming RDU (with power weighting, unfortunately) or EU as they call it, with utility function U(w,y). As explained in §8.5 of my 2010 book, I regret this terminology because giving up asset integration is giving up EU. w plays a similar role as reference point in prospect theory. Thus, what they do theoretically is in fact prospect theory with a particular form of reference dependence. They find a bit of wealth dependence of the curvature of U, but weakly so.

The authors interpret dependence of U’s curvature on w (wealth dependence) as reference dependence. However, this cannot be inferred from the data, bit is only the interpretation of the authors. It could also be wealth dependence of a reference-independent (terminal-wealth) utility function. Their finding of weak reference dependence may also be weakly nonconstant absolute risk aversion. They should more carefully compare different pairs w,y with the same sum $w + y$, rather than brute-force data fitting with interacting parameters. In the terminology of Bleichrodt, Doctor, Gao, Li, & Meeker (2020 JRU), they should distinguish reference dependence and outcome dependence as in Figs. 1d1 and 1d2 of Bleichrodt et al., so, situations that are identical in terminal wealth but different in reference points/outcomes.

The authors suggest that their data shed new light on Rabin’s (2000) paradox. Well, Rabin himself already pointed out that loss aversion explains much of his paradox, which entails reference dependence, as (possibly) comprised by using U(w,y), and their claims are consistent with that.

They measure probability weighting but use the RIS, something strongly criticized by Harrison & Swarthout (2014). %}

Andersen, Steffen, James C. Cox, Glenn W. Harrison, Morten I. Lau, E. Elisabet Rutström, & Vjollca Sadiraj (2018) “Asset Integration and Attitudes toward Risk: Theory and Evidence,” *Review of Economics and Statistics* 100, 816–830.

{% Considers SEU, with, however, **second-order probabilities** (interpreted as ambiguity), with bingo cages. The introduction suggests that virtually all ambiguity models model it as second-order probabilities or at least sets of probabilities (multiple priors). Does not mention the other theories that use nonadditive measures. Uses meta-population assumptions about distributions and then fits this to data. Some extreme results are found. P. 179: For probability that experimenter knows to be 20%, the subjective probabilities are about 40%. Assume same utility for risk as for uncertainty. %}

Andersen, Steffen, John Fountain, Glenn W. Harrison, Arne Risa Hole, & E. Elisabet Rutström (2012) "Inferring Beliefs as Subjectively Imprecise Probabilities," *Theory and Decision* 73, 161–184.

{% **probability elicitation**; elicit choices between prospects with known probabilities, to elicit risk attitudes (probability weighting and utility), and then use those to infer subjective probabilities from **proper scoring rules** (do QSR, and also the nonproper linear scoring rule). Use error models and econometrically fit all parameters in one blow, with the usual technique of this team (that cannot handle indifferences and) that takes different choices of the same individual as stochastically independent (given individual characteristics), with subjects only distinguished by their characteristics. Thus, for each combination of characteristics they get a global agent. Restrictive is that they assume global probabilistic sophistication, so that they can´t handle ambiguity aversion and the Ellsberg paradox.

They claim repeatedly that with slight risk aversion already an interior solution will result for the linear scoring rule, but this is not so. It is only so for subjective probability 0.5 (and then 0.5 as interior solution). If subjective probability is 0.9, for instance, then under considerable risk aversion still $p = 1$ is optimal under linear scoring. Rather can the many interior solutions found be explained by the compromise effect.

decreasing ARA/increasing RRA: Find strongly increasing RRA. Strangely enough, they find optimistic concave probability weighting (they fitted power weighting and not inverse S).

Problem of this paper is that scoring rules serve to quickly get beliefs and to circumvent extensive measurements. If the whole uncertainty attitude including subjective probabilities is measured anyhow, then it is not belief measurement but entire uncertainty attitude measurement, and the typical feature of scoring rules is lost. It is interesting to study scoring rules and to also know about entire risk attitudes to know more about scoring rules, which makes this paper valuable, but it cannot go as an improved way to do proper scoring rules.

They measure probability weighting but use the RIS, something strongly criticized by Harrison & Swarthout (2014). %}

Andersen, Steffen, John Fountain, Glenn W. Harrison, & E. Elisabet Rutström (2014) "Estimating Subjective Probabilities," *Journal of Risk and Uncertainty* 48, 207–229.

{% **Prospect theory not cited**

Detailed study and references on what they call multiple price list but what I prefer to call choice list. §1 discussed the general phenomenon of interval responses.

gender differences in risk attitudes: no difference %}

Andersen, Steffen, Glenn W. Harrison, Morten I. Lau, & E. Elisabet Rutström (2006) "Elicitation Using Multiple Price List Formats," *Experimental Economics* 9, 383–405.

https://doi.org/10.1007/s10683-006-7055-6

{% **time preference**; **error theory for risky choice**; **risky utility u = strength of preference v (or other riskless cardinal utility, often called value)**

In discounted utility, there are two unknowns, being the subjective discount function and the subjective utility function. This is much like prospect theory that has subjective probability weighting and subjective utility (let us focus on gains, so, no loss aversion) as two unknowns. Estimating the two subjective functions jointly can be done but takes some work in both cases. In intertemporal choice, people have mostly simply assumed linear utility to simplify the task, but some studies sought to generalize and reckon with nonlinear utility.

A big controversial issue has been, since the ordinal revolution of the 1930s, what the status of cardinal utility is, and also if cardinal utility used within expected utility can be equated with that in intertemporal choice. The history is presented in Abdellaoui, Barrios, & Wakker (2007, §2-3). Early allusions to such differences of cardinal utility are in Samuelson (1937 last paragraph of paper, on p. 161) who from the beginning understood this issue, and Baumol (1958). There have been many debates on the issue using a risky-riskless utility distinction (I do not like here the lumping of all nonrisky versions of cardinal utility into one "riskless" class, something like non-elephant zoology). I favored equating all cardinal utilities in Wakker (1994, Theory and Decision), but not to be done naively. It may be done after work, such as handling differences between risk attitude and marginal utility using, for instance, prospect theory. Epper, Fehr-Duda, & Bruhin (2011) do this in a sophisticated manner.

This paper by Andersen et al. is unaware of the mentioned history. It assumes, without any discussion or justification, that cardinal utility is to be measured from risky choice only and take this as almost by definition (why not directly from intertemporal choice by many observations and data fitting, for instance; Abdellaoui, Attema, & Bleichrodt (2010) give a nonparametric method for deriving intertemporal utility from intertemporal preferences, and Bleichrodt, Rohde, & Wakker (2009) give yet another). It further assumes that cardinal utility then is to be used for intertemporal choice. Thus, it falls victim to a version of what Luce & Raiffa (1957, p. 32) called "Fallacy 3." Comes to it that this paper uses expected utility to measure risky utility, having utility distorted by the other components of risk attitude. Those other components have even less to do with intertemporal. The authors' position appears for instance from pp. 589-590, or from p. 603: "Although the basic insight that one *should* elicit risk and time preference jointly seems simple enough" [italics added]. P. 614: "Our results have direct implications for future efforts to elicit time preference. The obvious one is to jointly elicit risk and time preferences, or at least to elicit risk preferences from a sample drawn from the same population, so that inferences about time preferences can be conditioned appropriately."

In earlier separate papers the authors elicited time preference and risk attitudes separately, for time preference apparently assuming linear utility. In this paper they combine the two, using the risky-utility function that they estimated from risky choice, assuming expected utility (EU), to estimate time preference. This correction for nonlinearity of utility leads to less discounting (because the large late payment now is less valued because of concave utility rather than because of strong discounting) and less deviation from constant discounting. They use power utilities. Using risky choices and expected utility to measure discounting (or, equivalently, its integral, being utility of life duration), and then using this correction of linearity in intertemporal choice, has been done before in the health domain in QALY calculations. Two references are:

Redelmeier, Donald A. & Daniel N. Heller (1993) "Time Preference in Medical Decision Making and Cost Effectiveness Analysis," *Medical Decision Making* 13, 212–217.

Stiggelbout, Anne M., Gwendoline M. Kiebert, Job Kievit, Jan-Willem H. Leer, Gerrit Stoter, & Hanneke C.J.M. de Haes (1994) "Utility Assesment in Cancer Patients: Adjustment of Time Tradeoff Scores for the Utility of Life Years and Comparison with Standard Gamble Scores," *Medical Decision Making* 14, 82–90.

Utility functions for risk and time are not taken completely identical in this paper. Risky choice gives instant payments, which is taken to be emotional and driven by temptation. Long-term intertemporal choice is not subject to such emotions. Hence, the authors take power (= CRRA) utility, but with initial wealth terms added as extra utility parameters, which may be different for risky choice than for intertemporal (p. 584 3rd para; p. 592 2nd para). The power is taken the same for both. Why the initial-wealth parameter would be good to capture the difference is not clear to me. The authors argue that the difference between immediate emotional choosing or long-term lies in different ways of integrating payments with initial wealth, but I can imagine many other effects and consider it a question to be tested empirically. The difference between risky and intertemporal utility that they use here is that emotions can generate extra initial wealth for time, and not as it should be that these can be different concepts.

The various parameters are derived from fitting data over the whole group, taking all choices (both within and between subjects; p. 586 2nd para) as independent observations and assuming a representative agent. They later do regressions where demographic variables (gender (**gender differences in risk attitude**), age, and so on; p. 604) are added as regressors, which gives some individualization, but still within-subject choices are then taken as statistically independent within same subgroups. (**relation age-risk attitude**)

P. 585 footnote 4 on the history of the price list (the authors use the inefficient term multiple price list): Cohen, Jaffray, & Said (1987) preceded Holt & Laury (2002) by 15 years here, and still were not the first. (**Prospect theory not cited**) (**risky utility u = strength of preference v (or other riskless cardinal utility, often called value)**)

The paper takes a simple position regarding aggregation. The opening sentence says that there are [only?] three ways of aggregation for utility, being over goods, time, and uncertainty. The authors do not consider other types of aggregation such as over different persons as in welfare and utilitarianism, for instance, or over different locations, and so on. Different body locations to do radiotherapy, to mention yet one more.

real incentives/hypothetical choice, explicitly ignoring hypothetical literature: p. 585 top writes: "There are only a few studies that address the joint elicitation of risk and time preferences directly using monetary incentives and procedures familiar to experimental economists." (**Prospect theory not cited**) §4 cites two hypothetical-task studies but they are not as close as studies mentioned above.

random incentive system between-subjects (paying only some subjects): p. 586 bottom: one of 10 subjects was paid for real.

equate risk aversion with concave utility under nonEU: As do so many economists, the authors equate risk aversion with concave utility. Unlike most economists, they are aware of the problematic nature of this equating and mention it in footnote 11 (p. 589). Yet, the confusions continue in their writings. If one uses the term risk aversion for concave utility as they do, then what term to use for what others call risk aversion? P. 591 2nd para claims evidence for risk aversion, which is solid if risk aversion concerns the empirical phenomenon of preference for expected value but less clear (because rarely properly separated and, therefore, concavity of utility usually overestimated) if it concerns concave utility. The confusion is aggravated because the authors cite Holt & Laury (2002) for it, who do not separate risk aversion from concave utility, and then spend 10 lines on their own work, but not on the ocean of other literature reviewed for instance by Starmer (2000). The beginning of §C shows that the authors do need the evidence for the claim of concave utility because they contrast the above with arguments for linear utility for small stakes.

linear utility for small stakes: They state it on p. 591, beginning of §C. Selten, Sadrieh, & Abbink (1999) found that the deviations from expected utility are stronger than those from linear utility, which for this context suggests that the approach of this paper generates bigger new deviations than the original deviations that it avoids.

My opinion summarized: Assuming linear utility for measuring discounting is better than the utility correction of this paper because EU utility captures more nonEU risk factors than true utility curvature for risk, let be for intertemporal.

P. 602: more error in risky questions than in intertemporal. %}

Andersen, Steffen, Glenn W. Harrison, Morten I. Lau, & E. Elisabet Rutstrom (2008) "Eliciting Risk and Time Preferences," *Econometrica* 76, 583–618. https://doi.org/10.1111/j.1468-0262.2008.00848.x

{% Their famous Denmark data sets are used to test if risk attitudes change over 17 months. Don't find systematic changes. Use EU and power utility (CRRA) to fit. %}

Andersen, Steffen, Glenn W. Harrison, Morten I. Lau, & E. Elisabet Rutström (2008) "Lost in State Space: Are Preferences Stable?," *International Economic Review* 49, 1091–1112. https://doi.org/10.1111/j.1468-2354.2008.00507.x

{% Discussed measurements of risk attitude in a number of tv shows, in particular deal or no deal. Discuss data fitting only for EU, referring to a working paper for PT. %}

Andersen, Steffen, Glenn W. Harrison, Morten I. Lau, & E. Elisabet Rutstrom (2008) "Risk Aversion in Game Shows," *Experimental Economics* 12, 361–406.

{% Argue for more use in psychology of maximum likelihood fitting techniques of econometricians. Do so in the context of DUR with prospect theory. %}

Andersen, Steffen, Glenn W. Harrison, Morten I. Lau, & E. Elisabet Rutström (2010) "Behavioral Econometrics for Psychologists," *Journal of Economic Psychology* 31, 553–576.

{% Yet another analysis of a Denmark data set, which they continue to call field study. This sampling was done in 2009 (p. 685). This time they focus on the magnitude effect, whose estimation is the contribution of this paper, and they allow for individual heterogeneity.

The abstract writes: "If the magnitude effect is quantitatively significant, it is not appropriate to use one discount rate that is independent of the scale of the project for cost–benefit analysis and capital budgeting." I do not understand here why a descriptive finding can fully determine a prescriptive procedure.

real incentives/hypothetical choice, explicitly ignoring hypothetical literature: they explicitly ignore studies using hypothetical choice except some early ones, writing on pp. 671 bottom (& p. 678): "We concentrate our review on studies with real monetary rewards, but also discuss the earliest papers on magnitude effects that rely on hypothetical questions, and studies that allow for nonlinear utility functions." They explicitly use the words "statistically significant" for every result of that kind.

P. 671 writes: "We carefully review the most important contributions here, and every other paper in Appendix A (available from the authors on request)." From that appendix we can learn what are unimportant contributions!

Pp. 684-685 again equates risky utility with utility for discounted utility, as the authors do in other papers.

P. 685 writes: "This design does not assume that behaviour is better characterized by expected utility theory (EUT) or some other model." suggesting full generality for their utility measurement, independent of whatever decision model is used. However, they simply use EUT to derive utility on pp. 686-687. P. 689 reiterates the claim: "Nothing in this inferential procedure relies on the use of EUT, or the CRRA functional form."

P. 685 writes that there were 40 intertemporal choices and 40 risky choices, where each subject had a 1/10 probability to play one for real for each of these two 40 tuples.

They measure probability weighting but use the RIS, something strongly criticized by Harrison & Swarthout (2014). %}

Andersen, Steffen, Glenn W. Harrison, Morten I. Lau, & E. Elisabet Rutström (2013) "Discounting Behaviour and the Magnitude Effect: Evidence from a Field Experiment in Denmark," *Economica* 80, 670–679.

{% For N = 413 subjects, representative for Denmark, measure discounting, finding average of 9% annually. Find little evidence of nonconstant discounting. The introductory §2 assumes that the cardinal utility function for intertemporal choice must be the same as for risky choice, via EU or other risk models. Although footnote 6 cites some of the several papers that elicit utility, to be used in intertemporal choice, directly from intertemporal choice, the rest of the paper continues to assume that it must be derived from risky choice. P. 20 seems to take the issue up, writing: "We also assume that the same utility function that governs decisions over risky alternatives is the one that is used to evaluate time-discounted choices. This assumption has been criticized recently, and we take up those issues in Section 7." However, Section 7 does not discuss this issue. It does discuss risk and time, but not the issue of cardinal utility.

real incentives/hypothetical choice, explicitly ignoring hypothetical literature: p. 27 on hypothetical choice: "We ignored all hypothetical survey studies, on the grounds that the evidence is overwhelming that there can be huge and systematic hypothetical biases. It is simply inefficient to take the evidence from hypothetical survey studies seriously."

%}

Andersen, Steffen, Glenn W. Harrison, Morten I. Lau, & Elisabet Rutström (2014) "Discounting Behavior: A Reconsideration," *European Economic Review* 71, 15–33.

{% %}

Andersen, Steffen, Glenn W. Harrison, Morten I. Lau, & E. Elisabet Rutström (2018) "Multiattribute Utility Theory, Intertemporal Utility, and Correlation Aversion," *International Economic Review* 59, 537–555.

{% %}

Andersen, Steffen & Kasper Meisner Nielsen (2011) "Participation Constraints in the Stock Market: Evidence from Unexpected Inheritance Due to Sudden Death," *Review of Financial Studies* 24, 1667–1697.

{% Chess players on internet do more effort, and play better, if they are close below their personal best, or some round number times 100. They are more likely to quit playing if they just exceeded the mentioned thresholds. The authors model this through a utility function that jumps discontinuously up at the threshold, when of course it is natural that this happens. The phenomenon is typical of the particular context of these sports, and the salience and speial value of personal records. I would not call this loss aversion, for one reason because it involves a term rather than a factor, for another reason because I would call this basic utility. Also, it is not very representative of reference points in general. %}

Anderson, Ashton & Etan A. Green (2017) "Personal Bests as Reference Points," working paper.

{% Shows experimentally that ambiguity aversion leads to undervaluation of new observations but overpayment of getting info what true probability is. %}

Anderson, Christopher M. (2012) "Ambiguity Aversion in Multi-Armed Bandit Problems," *Theory and Decision* 72, 15–33.

{% Asset pricing with not only risk premium but also ambiguity premium. Ambiguity is modeled in two different ways: (1) In a theoretical analysis, the μ of a supposed (log?)normal distribution having a 2nd order distribution imposed and then its variance reflects ambiguity. (2) Empirically, discrepancies in published forecasts. %}

Anderson, Evan W., Eric Ghysels, & Jennifer L. Juergens (2009) "The Impact of Risk and Uncertainty on Expected Returns," *Journal of Financial Economics* 94, 233–263.

{% **utility elicitation** %}

Anderson, Jock R., John L. Dillon, & Brian Hardaker (1977) "*Agricultural Decision Analysis.*" Iowa State University Press, Ames.

{% **random incentive system between-subjects**: investigated.

Paying some subjects yields lower levels of risk aversion than paying everyone, but more risk aversion than paying all subjects lower stakes. Paying some subjects high stakes better approximates the condition of paying all subjects high stakes compared to paying everyone lower stakes.

Prospect theory not cited (p. 162): "The rise in the popularity of experimental methods in economics resulted in an alternative approach to hypothetical questions for measuring risk preferences. Holt and Laury (2002) *proposed* a relatively simple format, the multiple price list, to measure risk tolerance using incentive-compatible decisions for real financial stakes. A robust literature *followed* both the Barsky et al. (1997) and Holt and Laury (2002) papers, and measuring risk tolerance is now commonplace in the economics field." [italics added] Then they prominently cite Harrisson, and they cite Kahneman & Tversky (1979) only for an irrelevant small detail (violation of reduction of compound lotteries).

The abstract opens with a cliché-policy claim: "Measuring risk tolerance is of interest to policymakers given its importance in decision-making" %}

Anderson, Lisa R., Beth A. Freeborn, Patrick McAlvanah, & Andrew Turscak (2023) "Pay Every Subject or Pay only Some?," *Journal of Risk and Uncertainty* 66, 161–188.
https://doi.org/10.1007/s11166-022-09389-6

{% Measure risk attitudes as the low real-payment treatment of Holt & Laury (2002) (take three times higher payments). (**Prospect theory not cited**:
) N = 1094, nonstudent adults.

Find similar results. **questionnaire for measuring risk aversion**: Relate risk aversion to smoking and other things. Risk aversion is negatively related with smoking, heavy drinking, overweight, seat belt non-use, and likelihood of risky behaviors. %}

Anderson, Lisa R. & Jennifer M. Mellor (2008) "Predicting Health Behaviors with an Experimental Measure of Risk Preference," *Journal of Health Economics* 27, 1260–1274.
https://doi.org/10.1016/j.jhealeco.2008.05.011

{% N = 239 subjects. Use choice list to measure one certainty equivalent per subject and fit EU with power utility to measure risk aversion, as in Holt & Laury (2002). Use real incentives with random incentive system. **questionnaire for measuring risk aversion**: Use this also, and correlate it with the power of utility. Find some correlation but not much.

Prospect theory not cited: P. 138: "Holt and Laury (2002) lottery choice task, the "gold standard" in the experimental literature on risk aversion." %}

Anderson, Lisa R. & Jennifer M. Mellor (2009) "Are Risk Preferences Stable? Comparing an Experimental Measure with a Validated Survey-Based Measure," *Journal of Risk and Uncertainty* 39, 137–160.
https://doi.org/10.1007/s11166-009-9075-z

{% **real incentives/hypothetical choice, for time preferences**: professors sign promises.

Let subjects make simple risky choices, and intertemporal choices, taking 14, 28, or 56 days delay. They avoid immediacy effect: Every payment is in two weeks or more (p. 54 last para). They study interactions. People are less patient if there is risk, which is opposite to earlier findings, maybe because the earlier findings had immediacy effect but this paper doesn't. This can be taken as a violation of generalized stochastic dominance (**restrictiveness of monotonicity/weak separability**).

I did not find relations between risk attitude and intertemporal attitude reported. %}

Anderson, Lisa R. & Sarah L. Stafford (2009) "Individual Decision-Making Experiments with Risk and Intertemporal Choice," *Journal of Risk and Uncertainty* 38, 51–72.
https://doi.org/10.1007/s11166-008-9059-4

{% A statistical analysis of weight judgments of fisheries managers. Scale compatibility biases are estimated quantitatively, and are in agreement with qualitative predictions.

paternalism/Humean-view-of-preference: the authors argue for quantitative corrections based on estimations of scale compatibility biases. %}

Anderson, Richard M. & Benjamin F. Hobbs (2002) "Using a Bayesian Approach to Quantify Scale Compatibility Bias," *Management Science* 48, 1555–1568.

{% %}

Anderson, Robert M., Walter Trockel, & Lin Zhou (1997) "Nonconvergence of the Mas-Colell and Zhou Bargaining Sets," *Econometrica* 65, 1227–1239.

{% Try the Rawls/Harsanyi veil of ignorance out empirically. Some subjects receive information about probabilities of being each member of society, others don't get probabilistic information. Rawls minimax criterion could be explained as an extreme degree of uncertainty aversion. Empirically, the subjects with unknown probabilities are not more ambiguity averse than those with known, and rather it is the opposite (**ambiguity seeking**). So, this empirical finding could be contrary

to ambiguity aversion. Not very easy to interpret because equity etc. is also going on. %}

Andersson, Fredrik & Carl Hampus Lyttkens (1999) “Preferences for Equity in Health behind a Veil of Ignorance,” *Health Economics* 8, 369–378.

{% **cognitive ability related to risk/ambiguity aversion**: Cognitive ability is related to choice error. In stimuli where choice error, e.g. due to regression to the mean, increases risk aversion, this relation can generate a spurious relation between cognitive ability and risk aversion. This is what this paper shows experimentally.

P. 1132 3rd para: in a choice list with more risk-averse choices provided than risk-seeking, error of the kind of regression to the mean need not increase risk aversion if the mean is risk aversion. %}

Andersson, Ola, Håkan J. Holm, Jean-Robert Tyran, & Erik Wengström (2016) “Risk Aversion Relates to Cognitive Ability: Preferences or Noise?,” *Journal of the European Economic Association* 14, 1129–1154.

{% Hey, Lotito, & Maffioletti (2010) nicely introduced a bingo blower to generate ambiguity, where the ambiguity could be manipulated by increasing the number of balls and their speed. This paper introduces a binary version of the bingo blower. They use the ambiguity indexes of Baillon et al. (2018). They do it for a blower with 10 balls (A10), a blower with 60 balls (A60), and natural events (stock index movements). Their findings are all plausible: no ambiguity aversion but ambiguity indifference for all three sources of uncertainty (this is plausible!), insensitivity for all sources, most insensitivity for natural events and a bit more insensitivity for A60 than for A10. It confirms the validity of the binary bingo blower. %}

Andersson, Ola, Geoffrey Castillo, & Erik Wengström (2023) “Generating Ambiguity with a Virtual Bingo Blower,” working paper.

{% **cognitive ability related to risk/ambiguity aversion**: They suggest an improved way to correct for noise in risky choice data, by reckoning with heterogeneity of noise, although, as they write, the econometric technique is well known. Then cognitive ability is related to noise and not risk preference, similar for age and education (**relation age-risk attitude**). The big five correlate more with risk attitude and less with noise.

They use an old (2008) data set. They only consider 50-50 lotteries. Unfortunately, they assume EU (with logpower, CRRA, utility) and do not consider probability weighting. P. 202 erroneously writes: “By keeping probabilities fixed, we do not address potential effects from probability weighting (Quiggin 1982; Fehr-Duda and Epper 2012).” This would be true under 1979 OPT (at least for mixed prospects or for the separable variation of OPT, and as long as no degenerate prospects (certain outcomes) are involved), but certainly is not true under Quiggin’s RDU or 1992 PT. It also implies that they only consider risk aversion, and not insensitivity. %}

Andersson, Ola, Håkan J. Holm, Jean-Robert Tyran, & Erik Wengström (2020) “Robust Inference in Risk Elicitation Tasks,” *Journal of Risk and Uncertainty* 61, 195–209.
https://doi.org/10.1007/s11166-020-09341-6

{% Uses Siniscalchi’s (2009) vector EU to obtain optimality results. %}

André, Eric (2014) “Optimal Portfolio with Vector Expected Utility,” *Mathematical Social Sciences* 69, 50–62.

{% %}

André, Francisco J. (2009) “Indirect Elicitation of Non-Linear Multi-Attribute Utility Functions. A Dual Procedure Combined with DEA,” *Omega* 37, 883–895.

{% Survey among 10,000 economists what they think about their field. Most want more policy relevance and more interdisciplinary, for instance. A problem with this study, which cannot be avoided, is that such majority opinions are predictable and cheap talk and I learn nothing from it. But, as said, this cannot be avoided, and still good that the authors did this survey. May I add that claims of policy relevance are cliché in my field today (2022), maybe because referees and editors think (thought!?) that they should push them, and they usually lead to weak texts. %}

Andre, Peter & Armin Falk (2021) “What’s Worth Knowing? Economists’ Opinions about Economics,” working paper.

{% %}
Andreoni, James (1990) "Impure Altruism and Donation to Public Goods: A Theory of Warm Glow Giving," *Economic Journal* 100, 464–477.

{% They essentially test the Machina's mom example of Machina (1989) experimentally. Here an a priori fair lottery gives a prize to Abigail rather than Benjamin, but after that done Benjamin takes the ex post position and argues that it is unfair to just give to Abigail, and better that the lottery be repeated. %}
Andreoni, James, Deniz Aydin, Blake Barton, B. Douglas Bernheim, & Jeffrey Naecker (2020) "When Fair Isn't Fair: Understanding Choice Reversals Involving Social Preferences," *Journal of Political Economy* 128, 1673–1711.

{% They consider choice under time and risk. Seems that they find that conditioning on timepoints fits better than conditioning on states but that the evidence is thin. %}
Andreoni, James, Paul Feldman, & Charles Sprenger (2017) "A Stream of Prospects or a Prospect of Streams: On the Evaluation of Intertemporal Risks," NBER Working Paper,

{% The authors compare the convex-set method for measuring discounting of Andreoni & Sprenger (2012 American Economic Review) with the measurement of Andersen et al. (2008, *Econometrica*). The latter measured utility using risky choice and EU and then used this to measure discounting. That is, they used risky utility to serve as intertemporal utility. The former method fitted intertemporal utility to intertemporal choice, which is the more natural way to go, as in Abdellaoui, Attema, & Bleichrodt (2010, EJ) or Abdellaoui, Bleichrodt, & L'Haridon (2013 JRU), works not cited by the authors. They use power utility and quasi-hyperbolic discounting to fit. Unsurprisingly, the risky EU utility function is way more concave than the intertemporal utility function. The latter is close to linear. (**linear utility for small stakes**) As many studies on prospect theory have shown, the EU utility function is too concave because it also captures the risk aversion generated by probability weighting. The authors show no awareness of this literature, nor of the Nobel-awarded prospect theory, following a tradition in experimental economics as in Holt & Laury (2002) and others.

(**Prospect theory not cited**)

To define their intellectual position and level, the authors side with Andersen, Harrison, Lau, & Rutstrom (2008), as appears from many parts in their paper:

- P. 452: "However, in an important recent contribution, Andersen et al. (2008) …"
- P. 452: "This observation has reset the investigation of new elicitation tools. …"
- P. 452: "Andersen[,] et al. (2008) (henceforth AHLR) offer the clever use of …"
- P. 463, §4, 1st line describes the two methods as "two recent innovations"

P. 1 footnote 2 gives a nice discussion of the outside-market arbitrage problem in intertemporal experiments. (**time preference, fungibility problem**)

Nicely, this paper also does a predictive exercise, where their convex method fares better than the Andersen et al. method.

P. 459: Taking linear utility in binary choice, they estimate an annual discount rate of 102%. This is absurdly high of course. Bringing in the (overly) concave utility reduces it to 47%, which still is extreme. Their convex method instead, gives annual discounting of 74%, which again is very very high.

Section 3.2.3 explains why the authors used no probabilistic model: They considered Luce's error model but take it up on its weakest point: that it predicts violations of dominance (through irrational switchings), which are not found much in the data.

When justifying a new model by comparing with an existing model in a horse race, one of several difficulties usually is that there is no existing gold standard. So, whatever existing model one takes, many readers will think that it is not interesting because they think that the existing model chosen is not the best one. This happens with me reader here. %}

Andreoni, James, Michael A. Kuhn, & Charles Sprenger (2015) "On Measuring Time Preferences," *Journal of Economic Behavior and Organization* 16, 451–456.

{% Propose a model of deviation from EU only at certainty, which is enough to expain all kind of data. My difficulty is that I see nothing new in this paper, because these things have been well known and investigated before. My keyword **EU+a*sup+b*inf** gives references. %}

Andreoni, James & Charles Sprenger (2010) "Certain and Uncertain Utility: The Allais Paradox and Five Decision Theory Phenomena," Econ. Dept., University of California, San Diego.

{% %}

Andreoni, James & Charles Sprenger "Uncertainty Equivalents: Testing the Limits of the Independence Axiom," Econ. Dept., University of California, San Diego.

{% **real incentives/hypothetical choice, for time preferences**: Students get paid money in some hours and in some months. They use the RIS.

decreasing/increasing impatience: Find counter-evidence against the commonly assumed decreasing impatience and/or present effect. This may be because they have a front-end delay, as they point out. They give theoretical arguments (p. 3347) but cite no empirical evidence. Attema, Bleichrodt, Rohde, & Wakker (2010, Management Science) find it too and on p. 2026 cite a dozen other studies finding it. The above keyword (**decreasing/increasing impatience**) gives literature in this annotated bibliography.

SUMMARY

Subjects can do weighted allocations of tokens over one timepoint near (some hours) and one some months (1, 2, or 3) ahead. The authors assume time-separable discounted utility, and fit the discounted utility model with power utility with a time-dependent transfer parameter that may reflect background consumption (Stone-Geary utility functions). They find utility close to linear (power 0.921), but still significantly different from linear.

NOVELTIES

Until Jan. 2022 I thought that one novelty of this paper for intertemporal choice is that it simultaneously fits discounting and utility to data. January 2022 I realized that Abdellaoui, Attema, & Bleichrodt (2010) had done that before. (They give both parametric and nonparametric estimates.) So, then only remains as novelty that it has subjects choose from continua of stimuli.

Regarding the simultaneous measuring of discounting and utility, discounted utility, and prospect theory alike, face the difficulty that there are two subjective functions to be estimated, where to estimate one function one would like to know the other. Thus, nonparametric estimations are not so easy to conceive, but have still been found (Abdellaoui 2000 and others for risk; Abdellaoui, Attema, & Bleichrodt 2010 for time; Attema, Bleichrodt, Rohde, & Wakker (2010, Management Science), also for time, writing on p. 2016, on Method 2: “The latter approach is the first one available in the literature that measures the discount function in an entirely utility-free manner.”). Parametric econometric fitting in one blow is of course possible with no problem, and for risk and prospect theory this has often been done. Why it was for a long time not done before for intertemporal choice is puzzling. This paper does it. But Abdellaoui, Attema, & Bleichrodt (2010) did it also with parametric fitting, before.

As regards the only remaining novelty, not letting subjects choose from pairs but from multiple objects, even continua, has often been done in risky/uncertainty choice. Examples are proper scoring rules, and many experiments that ask subjects to divide money over different risky investments. Choi, Fisman, Gale, & Kariv (2007 American Economic Review) nicely did so with choices from budget sets. Again, this had not yet been done in intertemporal choice, and this paper may be the first to do it. A useful move. A drawback is that this approach has biases of its own, such as the compromise effect, of subjects, partly driven by experimenter demand, too much choosing middle answers and no corner solutions. Thus, I expect the number of corner solutions reported on p. 3344 to be an underestimation, and the curvature of utility an overestimation (even if it is already close to linear). I also conjecture that simulations with most models will show that for these stimuli it should nearly always be corner solution.

Thus, the paper is a routine contribution, extending an idea from risk to intertemporal, but it is useful. The implementation of real incentives (p. 3339) is careful, so much that the self-praising “unique steps” (p. 3337 middle) is justified.

PROBLEMS WITH INTERPRETING UTILITY

A difficulty in the writing is that the paper takes Andersen et al. (2008, Econometrica) as the state of the art, probably misled by the prominence of the journal Econometrica (p. 3334 ℓ. 10 ff. “An important step”), and guided by Andersen et al. being experimental economists as are the authors here. I conjectured this difficulty in my comments on this paper in versions of this annotated bibliography before 2015. A confirmation is available since 2015, from Andreoni & Sprenger (2015) "Risk Preferences Are not Time Preferences: Reply (#14)," *American Economic Review*, p. 2287 2nd para: "the work that we saw as the best and most impressive was that by Andersen et al. (2008)." Andersen et al. "solve" the problem of two unknown intertemporal functions (utility and discounting) by measuring utility from risky choices, assuming expected utility uncritically. This was an unfortunate move. Most people had not done this before because they knew it does not work. Thus, Cohen, Jaffray, & Said (1987, p. 11), preceding Holt & Laury (2002) by 15 years, wrote: "The reason why subjects' risk attitudes are not correctly conveyed by the conventional definitions may simply be that these definitions, despite their intrinsic character, take their origins in the EU [expected utility] model, and therefore share in its deficiencies." An advanced study separating out intertemporal utility by measuring, yes, intertemporal utility rather than risky utility, is Abdellaoui, Attema, & Bleichrodt (2010, EJ, not cited by Andreoni & Sprenger). See also Epper et al. (2011), cited below.

Utility from EU captures risk attitude (and does not do so very well) and therefore is not suited to be used in other contexts. A number of keywords in this annotated bibliography starting with "**risky utility u =**" give over 100 references on this topic, dating back to the 1950s. Sentences such as

"the two elicitation methodologies ostensibly measure the same utility concept" (p. 3353)

and

"require further research on the relationship between risk and time preferences. This work is *begun* in Andreoni & Sprenger (2012b)." [p. 3349 italics added here]

suggest that the authors are not really aware of these ideas (despite some literature added on p. 3335 end of 3rd para, with Allais 1953 not fitting there). Their conclusion

"These findings suggest that the *practice* of using HL risk experiments to identify and correct for curvature in discounting may be problematic" [p. 3353; italics added]

therefore will not surprise many people, and again shows their focus on Andersen et al. (2008). P. 3354 writes that there is no correlation between risky HL utility and intertemporal utility.

Epper, Fehr-Duda, & Bruhin (2011 JRU; not cited by Andreoni & Sprenger) use utility, inferred from risky decisions, to measure discounting, but use the better prospect theory instead of Andersen et al.'s (2008) expected utility to measure utility, and so as to have the separation of marginal utility and risk attitude more plausible.

They mostly use CRRA utility with time-dependent location shifts (Stone-Geary) as extra parameter. %}

Andreoni, James & Charles Sprenger (2012) "Estimating Time Preference from Convex Budgets," *American Economic Review* 102, 3333–3356. https://doi.org/10.1257/aer.102.7.3333

{% **time preference: comparing risky and intertemporal utility**. Earlier versions of this paper put central that a utility function measured for intertemporal choice can be different than a utility function measured for risky choice. The naïve title (and some cross references in the accompanying paper Andreoni & Sprenger 2012, *American Economic Review* 3333–3356) still refer to that idea, and it is reiterated by Andreoni & Sprenger (2015 "Risk Preferences Are not Time Preferences: Reply (#14)," *American Economic Review* p. 2292). However, this point has been too well known (see keywords with "**risky utility u =**" in this annotated bibliography, giving over 100 references). Fortunately, in this published version the authors removed such claims. Nevertheless, quite some novices to the field have been misled, probably by early versions of the paper, to cite Andreoni & Sprenger for the "discovery" that risky utility need not be the same as intertemporal utility. A mature paper with good empirical tests and mature interpretations of the relevant issues is Abdellaoui, Bleichrodt, L'Haridon, & Paraschiv (2013, Management Science).

The contribution that remains is as follows.

The authors use the same, impressive, design as Andreoni & Sprenger (2012, *American Economic Review* 3333–3356). Subjects invest part of money received in a, possibly risky, soon payment (in some hours) and the rest in a, possibly risky, late payment (in some months), with the late return per invested unit exceeding the soon return so as to make up for impatience/discounting. The risk is always resolved immediately, also for later payments. Subjects' choices are used to infer their risk/time attitude. The classical model for these risky intertemporal stimuli is discounted expected utility, with no interactions between risk and time attitude.

The authors focus on three phenomena in this paper. The first is the common ratio effect but with no riskless prospects involved. There they find no violations of classical discounted expected utility, in agreement with most of the literature.

The second phenomenon focused upon is the common ratio with one riskless prospect involved, as in the Allais paradox. For instance, for a sure outcome α and a risky prospect x, $\alpha \succ x$ but $(\alpha_{0.25}0) \prec (x_{0.25}0)$ is the common ratio paradox, violating expected utility. They find this for α an intertemporal outcome and x a lottery over intertemporal outcomes. This phenomenon has often been observed before. The authors point out that this, of course, need not entail a violation of prospect theory. It was one of the main motivations for developing prospect theory.

[Added July 2014: My analysis below follows the theoretical assumptions of this Andreoni & Sprenger paper. Cheung (2015), Epper & Fehr-Duda (2015), and Miao & Zhong (2015), all in AER, pointed out another problem: In the experiment, there was not one joint probability over early-late payments, but those probabilities were always independent. This invalidates the theoretical analysis of A&S. I nevertheless keep the analysis below, showing that there are more problems in A&S's analysis even if they had done the above right.]

restrictiveness of monotonicity/weak separability: The third phenomenon is interpreted as a special kind of common ratio by the authors, but I prefer to interpret it as a generalized stochastic dominance. Now there are two riskless outcomes. If, for two riskless outcomes, we have $\alpha \succ \beta$, then by generalized stochastic dominance we should have $\alpha_{0.25}0 \succ \beta_{0.25}0$. (More generally, in every lottery we should prefer replacing β by α under generalized stochastic dominance.) The authors call this common ratio with the two probabilities 1 in the first choice but both reduced by the same factor 0.25 for the second choice, and also group it under "direct preference for certainty." As said, I prefer to relate it to generalized stochastic dominance. The violation does not reflect direct preference for certainty, but instead a changed evaluation of outcomes under certainty than under risk. For monetary outcomes α,β, generalized stochastic dominance is regular stochastic dominance and is obvious and trivial. For general multiattribute outcomes, generalized stochastic dominance, even if rational, may easily be violated empirically. Diecidue, Schmidt, & Wakker (2004) use the term ordinal equivalence for what I called generalized stochastic dominance here, and describe the phenomenon as follows (their p. 248), giving references that find empirical violations of it:

> "For general outcomes, e.g. multiattribute outcomes or commodity bundles, ordinal equivalence is not self-evident because the tradeoffs made between commodities may be different under risk than under certainty. For example, chronic health states are two-dimensional outcomes, with one dimension specifying a health state and the other the duration of that health state. Subjects may prefer (blind, 25 years) to (full health, 20 years) but may prefer the riskless gamble (1/2: (full health, 20 years); 1/2: (full health, 20 years)) to the more complex gamble (1/2: (full health, 20 years); 1/2: (blind, 25 years)). Such discrepancies have often been found when measuring quality of life through the "time-tradeoff method," a method that uses riskless preferences of the former kind, and the "standard-gamble method," which uses risky preference of the latter kind (Miyamoto & Eraker, 1988, pp. 17–18; Lenert et al., 1997).
> Bleichrodt and Pinto (2002) observed a direct violation of ordinal equivalence. Participants preferred death to a severely impaired health state following stroke. However, if these outcomes resulted with probability .25 (.75 probability of full recovery), then the preferences reversed." [Death and stroke are not explicitly modeled as multiattribute here but are similar.]

I add here that Bleichrodt & Pinto (2009) found, with FH denoting full health and X some health state, $(FH_{0.75}\text{death}) > (FH_{0.75}X)$ but death < X, which can be taken as yet another violation of generalized stochastic dominance. A special case arises if multiattribute outcomes are intertemporal (streams of) money. It is well known that the presence of risk affects the present bias (also called immediacy effect), weakening it. For example,

(now, \$100) $\succ$ (delay, \$110)

but

(now, \$100)$_{0.25}$0 $\prec$ (delay, \$110)$_{0.25}$0

is a typical finding. Andreoni & Sprenger find this phenomenon also. They point out that it entails a violation of prospect theory. However, it entails a violation of all theories with generalized stochastic dominance, which is virtually all presently existing, and not just prospect theory. In its quantitative form (proportion of investment in presence versus future) it is a strict test of generalized stochastic dominance because any distorting factor affecting the tradeoff between time and outcome for

(now, \$100)$_{0.25}$0 versus (delay, \$110)$_{0.25}$0

differently than

(now, \$100) versus (delay, \$110)

will generate violations. That is, noise goes against the hypothesis here, and it would be statistically better to have a consistency check to assess noise and then do ANOVA type testing. Anyway, the only theory in the literature that can accommodate this finding, cited by the authors for this purpose, is the theory of the utility of gambling (**utility of gambling**), where riskless outcomes are evaluated by an entirely different utility function than risky outcomes, which is the topic of Diecidue, Schmidt, & Wakker (2004), and several other earlier and later papers.

The above violations of generalized stochastic dominance for the context of intertemporal choice have been known before. The earliest paper that I know, showing that the presence of risk moderates the present bias, is Keren & Roelofsma (1995; see my annotations there). Fudenberg & Levine (2011) predicted it in a theoretical model. Similarly, other papers have shown that delaying risks moderates the certainty effect. Anderson & Stafford (2009) find the opposite, with risk increasing impatience. Bommier (2006) presents a theoretical model on it.

If we let the multiattribute outcomes be lotteries themselves (why not?), then, with RCLA, generalized stochastic dominance becomes vNM independence, clearly showing the nontrivial nature of the condition, and that it is not surprising to have it violated for multiattribute outcomes.

Not the same phenomenon, but related, is that risk attitudes for future risks can be different than for present risks, with often less risk aversion for future risks. This was found in empirical studies by Abdellaoui, Diecidue, & Öncüler (2011), Baucells & Heukamp (2010), and Noussair & Wu (2006). Advanced theoretical models capturing interactions between risk and time are in Baucells & Heukamp (2012) and Halevy (2008).

Andreoni & Sprenger cite some of the above literature in the published version of their paper, but did not digest it enough to articulate the novelty of their contribution relative to it. For instance, the sentence in the intro (p. 3558) "The question for this research is whether the common ratio property holds both on and off this boundary of certainty in choices over time." suggests that they are just redoing the well-known tests of common ratio. Their contribution is, as I see it, not that they found new phenomena, because they only reconfirm preceding findings from behavioral economics on common ratios and generalized stochastic dominance known before. Their contribution is that they do so in a very good experiment with good stimuli (multiple choice) and a good implementation of real incentives, bringing in the bigger experimental rigor of experimental economics. For the attenuation of the present bias due to the presence of risk, their paper is probably the best demonstration presently (2013) available.

The authors conclude their paper enthusiastically: "This intuition … may help researchers to understand the origins of dynamic inconsistency, build sharper theoretical models, provide richer experimental tests, and form more careful policy prescriptions regarding intertemporal choice." %}

Andreoni, James & Charles Sprenger (2012) "Risk Preferences Are not Time Preferences," *American Economic Review* 102, 3357–3376.

{% P. 2287 2nd para: the authors reveal their intellectual level and position by writing: "the work that we saw as the best and most impressive was that by Andersen et al. (2008)." [Andersen, Harrison, Lau, & Rutstrom (2008) "Eliciting Risk and Time Preferences," *Econometrica*.]
Whereas the empirical contribution of the authors is valuable, p. 2292 shows once again that the authors did not yet properly digest that the difference between risky and intertemporal utility has been understood in the economic literature since Samuelson (1937), and has been discussed in 100s of papers (see my keyword "**risky utility u =** "), because they still put it forward as their "primary conclusion" when writing: "None of these challenges the primary conclusion of or study: that risk preferences and time preferences are not the same." %}

Andreoni, James & Charles Sprenger (2015) "Risk Preferences Are not Time Preferences: Reply (#14)" *American Economic Review* 105, 2287–2293.

{% Comments are on the working paper of Feb. 17, 2024. They interview 4,500 mothers in a rural area in India, on finding partners, grooms, for their daughters. They use hypothetical vignets, not about their own daughters but about hypothetical other daughters of other people (to avoid social desirability bias). They vary five attributes of daughters and grooms, such as level of education and whether or not job with government, and see how the mothers choose between different options of desirability of getting groom for daughter. In their sample, marriages are usually arranged, determined by parents. They first do “ex-post” questions, meaning choices between grooms, obtained with certainty. From this they derive utilities, I presume. (Note that this paper uses the term “preference”, or “taste”, for wat I would call utility, where subjective beliefs/probabilities are no part of it, differently than I use the term preference, where it comprises beliefs.) Then they ask “ex ante” questions, where the mothers choose between taking a groom now with certainty or waiting for, say, five years to get a better groom, so with uncertainty involved. Given that they have utilities, they can derive subjective probabilities from the latter questions of getting a good groom in, say, five years. I guess that this is what they did, although I did not do very detailed reading and did not find it easily explained in the paper. To get utilities from the ex post questions, they will have had to make many assumptions. One of them must address the issue that those ex post questions only give the ordinal level of utility, and it then is not clear which cardinal level to use as needed in SEU. They did the main study in 2017, but re-interviewed the subjects five years later, in 2022, finding that the real choices made corresponded well with the hypothetical preferences measured five years before. This is a good way to validate hypothetical questions.

The authors emphasize much their novelty claims on them introducing a new methodology for measuring subjective beliefs. However, I don’t see novelty. Using hypothetical vignets with variations of attributes is widely used in marketing, health, psychology, and other fields, often analyzed using multiattribute utility theory or conjoint analysis. Measuring subjective beliefs/probabilities, not by direct asking which may be difficult for people who don’t understand the concept of probability, but by revealing choices and using as-if models, was first done by de Finetti (1931) and Ramsey (1931), and has since been done in 1000s of papers. Ambiguity theories are popular today, to generalize SEU there and get better measurements of beliefs. The authors suggest to be new on doing the above things. Thus p. 3 writes, naively: “The identification approach is based on the *novel* insight that by varying the amount of information on future realizations of stochastic variables, discrete choice experiments can identify not only preferences, but also subjective beliefs." [italics added] **Prospect theory not cited:** the authors, without one word on it, implicitly assume expected utility. On their claimed novelty of deriving subjective beliefs from observed choices, Footnote 34 on p. 17 writes, strangely, that papers on learning are related. They then do a within-clan citation of Charness & Levin (2005), a paper that only investigates one paradoxical finding on updating that has little to do with learning and very little with measuring subjective beliefs from revealed preferences. Then, even more weirdly, they cite Nash (1951). That citation may look fancy to novices, but the paper has absolutely nothing to do with measuring subjective beliefs. Nash (1951) gives an improved proof, and applications, of his Nobel-awarded 1950 paper on the existence of equilibria.

Situations of once choosing a terminal outcome and deciding when to go for that, which is the marriage problem studied here, is often studied under the name secretary problem, a term not mentioned here.

The findings of this beautiful data set may speak to decisions to give more school education to daughters, and this may be relevant. I regret that the authors did not elaborate on this point. %}

Andrew, Alison & Abi Adams (2024) "Revealed Beliefs and the Marriage Market: Return to Education," working paper.

{% **PT, applications**: Dynamic risk preferences estimated from trading in sports-wagering market using prospect-theory. Find mild utility curvature, moderate loss aversion, and probability overweighting of extreme outcomes (inverse S). Conclude that prospect theory can better explain the prevalence of the disposition effect than previously thought. %}

Andrikogiannopoulou, Angie & Filippos Papakonstantinou (2020) "History-Dependent Risk Preferences: Evidence from Individual Choices and Implications for the Disposition Effect," *Review of Financial Studies* 33, 3674–3718. https://doi.org/10.1093/rfs/hhz127

{% **information aversion**: They consider an Epstein-Zin-Kreps-Porteus model, but with Gul's disappointment aversion model. Then aversion to information can result, and they have parameters for that. Basically, you may want to avoid info

so as to avoid disappointment. They apply it in all kinds of economic models, such as in consumption/saving. %}

Andries, Marianne & Valentin Haddad (2020) “Information Aversion,” *Journal of Political Economy* 128, 1901–1939.

{% Use a data set of betters on football games and fit PT (they write CPT). As objective probabities they take the betting odds of the bookmakers, which are well calibrated. They confirm all findings of PT, with concave utility for gains, convex utility for losses, probability weighting inverse S for gains and losses, and loss aversion, although less strong than traditionally thought. A restriction for these results is that they fit parametric families that do not really allow for different patterns. For instance, utility is logpower (CRRA) with the same power for gains and for losses and, hence concave utility for gains must be accompanied by convex utility for losses. Probability weighting for losses is taken the same as for gains. Thus, both utility and probability weighing do not permit deviations from reflection.

They consider mixture models where subjects can turn either of probability weighting or loss aversion on or off. 2/3 of subjects have loss aversion, but all have probability weighting. So, they conclude that probability weighting is more important than loss aversion. Their subjects are mostly risk averse. They are of course not a representative sample, but people attracted to gambling. The authors write that subjects are not risk seeking but skewness seeking, and this is why they gamble even though being risk averse. %}

Andrikogiannopoulou, Angie & Filippos Papakonstantinou (2016) “Heterogeneity in Risk Preferences: Evidence from a Real-World Betting Market,”

{% **revealed preference** %}

Andrikopoulos, Athanasios (2012) “On the Construction of Non-Empty Choice Sets,” *Social Choice and Welfare* 38, 305–323.

{% %}

Angeletos, George-Marios, David Laibson, Andrea Repetto, Jeremy Tobacman, & Stephen Weinberg (2001) “The Hyperbolic Consumption Model: Calibration, Simulation, and Empirical Evaluation," *Journal of Economic Perspectives* 15, 47–68.

{% %}

Angelopoulos, Angelos & Leonidas C. Koutsougeras (2015) "Value Allocation under Ambiguity," *Economic Theory* 59, 147–167.

{% %}

Anger, Bernd (1972) "Kapazitäten und Obere Einhüllende von Massen," *Mathematische Annalen* 199, 115–130.

{% Theorem 3 of this paper is, actually, more general than Schmeidler's (1986) characterization of the Choquet integral.

Theorem 3 as stated does not state the characterization of the Choquet integral explicitly. But the displayed equality in the proof shows that the functional is indeed identical to the Choquet integral, so that we have a characterization of the Choquet integal after all.

The topological assumptions of Anger may seem to be complex, but a simple way out is: If E (the state space) is finite, R is the collection of all subsets of E, and H is the set of functions from S to Re^+, then all topological assumptions of Anger (see, for instance, the top of p. 246) are satisfied, and readers not knowing these can restrict attention to the finite case as mentioned. Definition 2 gives a condition weaker than comonotonic additivity. It amounts to imposing additivity only for functions f, g such that g takes its minimal value whenever f is not maximal. The latter restriction implies comonotonicity of f and g. (The author only states the condition for normalized functions, and assumes positive homogeneity separately. Schmeidler (1986) stated his comonotonic additivity in general, in which case it, together with other natural conditions, implies positive homogeneity.) In Wakker (1990, *Fuzzy Sets and Systems*) I used the term minmax-relatedness for the condition for f and g mentioned above. Chateauneuf (1991, JME, Axiom 5) also used this weakening. Schmeidler's comonotonic additivity immediately implies Anger's Definition 2, and quickly implies positive homogeneity, after which Schmeidler's theorem follows from Anger's. %}

Anger, Bernd (1977) “Representations of Capacities,” *Mathematische Annalen* 229, 245–258.
https://doi.org/10.1007/BF01391470

{% %}
Anger, Bernd & Jörn Lembcke (1985) “Infinitely Subadditive Capacities as Upper Envelopes of Measures,” *Zeitschrift für Warscheinlichkeitstheorie und Verwandte Gebiete* 68, 403–414.

{% Textbook on behavioral economics.
Paul van Bruggen recommended this book to me 4-4-2019. %}
Angner, Erik (2012) “*Course in Behavioral Economics*.” Palgrave, the MacMillan Press, London.

{% Paper explains how behavioral economics arose, and explains how it came from the cognitive revolution in psychology, leading to behavioral decision research (BDR) in psychology, and then to behavioral psychology.
It nicely shows the analogy between developments in psychology such as behaviorism etc. and the ordinal revolution in economics.
They assume, as do Bruni & Sugden (2007), that behavioral economists do not accept the revealed-preference paradigm but want introspective psychological inputs. I think that the link is less strong. Virtually all papers by Kahneman & Tversky use only revealed preference inputs. I discuss it more at the Bruni & Sugden (2007) paper.
P. 27, on the cognitive revolution: “As a result, they were cautious not to commit the mistakes that were committed by early twentieth-century psychologists and which had been identified by behaviorists.”
§4.4 calls the function 1/(1+kt) simple hyperbolic. %}
Angner, Erik & George F. Loewenstein (2010) “Behavioral Economics.” *In* Uskali Mäki (2012, eds.) *Philosophy of Economics*, vol. 13, Dov Gabbay, Paul Thagard, & John Woods (eds.) *Handbook of the Philosophy of Science*, 67–101, Elsevier, Amsterdam.

{% Seems to show that if you can stop sampling when you want, but then to classical statistics hypothesis testing as if the sample size had been determined beforehand, then you can get to reject the null with probability 1, also if the null is true. %}

Anscombe, Frank J. (1954) "Fixed Sample Size Aanalysis of Sequential Observations," *Biometrics* 10, 89–100.
https://doi.org/10.2307/3001665

{% What is called the Anscombe-Aumann framework "these days" (1990-2022 etc.) is described in §13.1 of Fishburn (1970). It is two-stage with first horses and then roulette, and leaves out the first stage that Anscombe-Aumann have.

Results similar to this paper had been around and probably people knew this before, but no one stated it as nicely as Anscombe-Aumann. Arrow (1951, Econometrica, p. 431/432) describes a state-dependent version, citing unpublished papers by Rubin (1949) and Chernoff (1949), and oral contributions by Savage. The Chernoff paper was published in Econometrica in 1954, so, after Arrow's paper; see comments there.

What is usually called monotonicity in the Anscombe-Aumann framework (replacing a roulette-lottery conditional on a horse by a preferred roulette-lottery improves the act) would better be called (weak) separability. Monotonicity w.r.t. an objectively given predefined ordering such as the natural ordering on the reals can, indeed, be called monotonicity. Increasing a monetary payoff in a lottery, or one of the commodities in a commodity bundle, concerns monotonicity. In the Anscombe-Aumann framework, however, it concerns a subjective preference relation over lotteries to be derived from preferences, and then it is a kind of separability. Here it is more conceivable that the subjective ordering of lotteries conditional on one horse is affected by the lottery received conditional on another horse, entailing a violation of monotonicity or, rather, separability. It underlies the backward induction optimization of the Anscombe-Aumann framework. In the modern applications of the Anscombe-Aumann framework under nonEU such as ambiguity about the horse-events such violations are VERY conceivable, and almost by definition are what ambiguity entails. My book Wakker (2010 Figure 10.7.1) gives an example. This is a big drawback of the use of the Anscombe-Aumann framework to study ambiguity. Because of this reason, some people including me have argued that the order of events in the Anscombe-Aumann framework is unfortunate for studying nonEU for horse events and then better the roulette events PRECEDE the horse events (Wakker 2010 §10.7.3; Wakker 2011 Theory and Decision p. 19 penultimate para).

Anscombe-Aumann monotonicity can be called weak separability because it only concerns single horse states and not composite (overlapping) horse events. The theorem can be obtained as a corollary of Harsanyi (1955), as pointed out by De Meyer & Mongin (1995). %}

Anscombe, Frank J. & Robert J. Aumann (1963) "A Definition of Subjective Probability," *Annals of Mathematical Statistics* 34, 199–205. https://doi.org/10.1214/aoms/1177704255

{% Seems to discuss consequentialism. %}

Anscombe, G. Elizabeth M. (1958) "Modern Moral Philosophy," *Philosophy* 33, 1–19.

{% Portfolio selection/market equilibria with ambiguity, using α maxmin, explaining many findings. To my joy, the authors put central that there is also ambiguity seeking and that α-maxmin allows for it. They consider a special case of α maxmin where the set of priors is determined by two parameters: a focus probability distribution and an index of spread around it. They argue for the interest of non-differentiability with kinks, in deviation of the smooth model. %}

Anthropelos, Michail & Paul Schneider (2024) "Optimal Investment and Equilibrium Pricing under Ambiguity," *Review of Finance* 28, 1758–1805. https://doi.org/10.1093/rof/rfae032

{% **updating: testing Bayes' formula**: under EU and RDU. %}

Antoniou, Constantinos, Glenn W. Harrison, Morten I. Lau, & Daniel Read (2015) "Subjective Bayesian Beliefs," *Journal of Risk and Uncertainty* 50, 34–55.

{% Could have been a useful list of papers in utility theory dating before '71. But, unfortunately, there are so very many typos that the list is no use. %}

Aoki, Masahiko, John S. Chipman, & Peter C. Fishburn (1971) "A Selected Bibliography of Works Relating to the Theory of Preferences, Utility, and

Demand.” *In* John S. Chipman, Leonid Hurwicz, Marcel K. Richter, & Hugo F. Sonnenschein (eds.) *Preferences, Utility, and Demand*, 29–58, Hartcourt, New York.

{% Assume the usual Savage (1954) framework for uncertainty. This paper assumes that the outcome set is ℝ and, further, that utility is linear. This amounts mathematically to the same as the Anscombe-Aumann (AA) framework but avoids a number of drawbacks of AA.The paper assumes rank-dependent utility, i.e., Choquet expected utility, with v denoting the capacity/weighting function. I denotes the Choquet integral, i.e., the certainty equivalent. Two acts X,Y are anti-comonotonic if X, −Y are comonotonic. Anti-comonotonic superadditivity: if X,Y are anti-comonotonic, then I(X+Y) ≥ I(X) + I(Y). Theorem 1: Anti-comonotonic superadditivity if and only v is convex (pessimistic) both at the imposssible and universal event.

The paper also considers generalizations in the spirit of Anger (1977), Chateauneuf (1991), and Wakker (1990 Fuzzy Sets and Systems), where one does not consider comonotonic acts but only the more restrictive maxmin-relatedness: in every state of nature, either one act is maximal or the other is minimal. %}

Aouani, Zaier, Alain Chateauneuf, & Carolina Ventura (2021) “Propensity for Hedging and Ambiguity Aversion,” *Journal of Mathematical Economics* 97, 102543.

{% Measure beliefs in game theory by asking after games played, to avoid it impacting the game. Use, to my regret, the binarized scorig rule to measure beliefs. %}

Aoyagi, Masaki, Guillaume R. Fréchette, & Sevgi Yuksel (2024) “Beliefs in Repeated Games: An Experiment,” *American Economic Review* 2024, 3944–3975. https://doi.org/10.1257/aer.20220639

{% Adverse selection is well known. But sometimes the oposite happens: advantageous selection. This paper cites literature on it, and analyzes it using the expectation-based Köszegi-Rabin loss aversion. %}

Aperjis, Christina & Filippo Balestrieri (2017) "Loss Aversion Leading to Advantageous Selection," *Journal of Risk and Uncertainty* 55, 203–227.

{% **revealed preference**: Do revealed preference theory but with reference dependence included. Consider conditions for dependence on the reference point such as preference cycles generated by different reference points (*RD-chains*, p. 431), and status quo bias where x > y under reference point x and y > x under reference point y can be, but not the other way around, and an extension of Plott's path dependence where end results should not depend on initial reference points.

Focus on the case where, as in Bleichrodt (2007, 2009), the reference point is always assumed present in the choice set, so that there is incompleteness of preference below the reference point. %}

Apesteguia, Jose & Miguel A. Ballester (2009) "A Theory of Reference-Dependent Behavior," *Economic Theory* 40, 427–455.

{% The authors introduce the swaps index: The minimum number of preferences that should be reversed for the preferences to fit some model. They analyze it in the context of revealed preference. This field has the unfortunate tradition of using the term rational in a naive formal way to designate maximization of a weak order, and this paper follows this tradition. %}

Apesteguia, Jose & Miguel A. Ballester (2015) "A Measure of Rationality and Welfare," *Journal of Political Economy* 123, 1278–1310.

{% For many core theories combined with error models, choice probabilities are not monotone in parameters, which complicates analyses. Forinstance, increasing a paremeter may first increase but then decrease the probability of choosing a risky lottery. They propose models that do satisfy that monotonicity. The authors cite Wilcox (2011) for preceding results on this topic. %}

Apesteguia, Jose & Miguel A Ballester (2018) "Monotone Stochastic Choice Models: The Case of Risk and Time Preferences," *Journal of Political Economy* 126, 74–106.

https://doi.org/10.1086/695504

{% Do not find endowment effect with isolated tribes (Hazda), but do find it with tribes that have contact with much of mankind. All tribes are Hazda from Tanzania. Whereas List (2003) found no endowment effect for sports cards traders with much market experience, the authors here find it for the tribes with most market experience. %}

Apicella, Coren L., Eduardo M. Azevedo, Nicholas A. Christakis, & James H. Fowler (2014) "Evolutionary Origins of the Endowment Effect: Evidence from Hunter-Gatherers," *American Economic Review* 104, 1793–1805.
http://dx.doi.org/10.1257/aer.104.6.1793

{% Useful for master theses. Seems to have been written by Stefania Apostol. Identifies consumer attitudes towards mobile phone and gadget insurance, insurance claims, and competitive strategies in the UK. %}

Apostol, Stefania (2022) "UK Consumers and Gadget Insurance Marhet Report."

{% Abstract starts with: "People discount delayed gains (where the default is to receive a smaller gain sooner) more than accelerated gains (where the default is to receive a larger gain later). For losses, the pattern reverses—people discount delayed losses less than accelerated losses." The authors use a psychological Query Theory to analyze these points in hypothetical choices with big groups from internet. %}

Appelt, Kirstin C., David J. Hardisty, & Elke U. Weber (2011) "Asymmetric Discounting of Gains and Losses: A Query Theory Account," *Journal of Risk and Uncertainty* 43, 107–126.
https://doi.org/10.1007/s11166-011-9125-1

{% %}

Appleby, Lynda & Chris Starmer (1987) "Individual Choice under Uncertainty: A Review of Experimental Evidence, Past and Present." *In* John D. Hey & Peter J. Lambert (eds.) *Surveys in the Economics of Uncertainty*, 25–45, Basil Blackwell, Oxford.

{% Investigate precautionary savings and higher order risk attitudes, when decisions are made by pairs of individuals. For the first two moments, the pair inherits properties from the individuals, but for higher moments this is not so. %}

Apps, Patricia, Yuri Andrienko, & Ray Rees (2014) “Risk and Precautionary Saving in Two-Person Households,” *American Economic Review* 104, 1040–1046.

{% **updating under ambiguity with sampling**: An interesting point of this paper is that ambiguity is generated through missing information, with an incomplete data set.

The first part of the paper is theoretical, discussing a number of attempts to define ambiguity aversion endogenously (Epstein & Zhang 2001; Ghirardato & Marinacci 2002; Nehring 1999). The theoretical analysis considers only convex or concave weighting functions, with 1 – W(A) – W(A^c) type measures of ambiguity aversion. (**Ambiguity = amb.av = source.pref, ignoring insensitivity**)

The second part presents two experiments. Subjects could gamble on the color of a ball drawn from an urn with yellow and white balls. (Pity they did not take Ellsberg’s colors red and black; they also had signs O and X not discussed here.) Experiment 2 was the main one, discussed here first. It had two treatments. In the first (precise info), they told subjects that 8 drawings with replacement from the urn gave 3 yellow balls and 5 white balls. A difficulty in ambiguity experiments with real incentives is always how to generate the ambiguity. Here the authors did it using deception (**deception when implementing real incentives**): They told results of samples that had not really taken place (especially regarding the missing information). 3-5 was not the result of a real drawing, but instead was the real composition. In the second treatment (imprecise info) subjects were told that of 8 drawings, 4 were yellow, 2 white, and 2 unknown color. (Again, this drawing had not really taken place.) Some subjects were asked the CE (certainty equivalent) of gambling NIS 150 on yellow, and others were asked the CE of gambling NIS 150 on white. Because subjects did not know what was offered to the others, and could not choose the color, there was no control for suspicion (**suspicion under ambiguity**). (The authors assume that ambiguity neutral subjects with imprecise info will treat it as if 3-5, but I find 2-4 more plausible there.) The CE for imprecise info (average 50.9) is lower than for precise info (average 65.3), suggesting ambiguity aversion. Note that the CE of precise info is high, suggesting risk seeking (or subjective probability close to a prior 0.5 rather than observed relative frequency of 3-8). Experiment 1, reported below, will suggest risk seeking rather than subjective belief. They did a similar experiment with more unlikely events, and found the same ambiguity aversion.

For completeness, here is the first experiment, which served as a kind of control. Experiment 1 has two treatments. The first treatment did not consider the main research question but was preparatory, and considered no imprecise info. They told subjects that 8 drawings with replacement from an urn gave 3 yellow balls and 5 white balls (precise info). Again, this drawing had not really taken place, so, it is a form of deception. In the second, control, treatment, subjects were told the true composition 3-5. Then they were offered the gamble of winning NIS 150 (≈ $40) if a color drawn would be yellow, and a choicelist was used to measure the certainty equivalents (CE). Thus, there was again no control for suspicion. In the precise-drawing info subjects could conjecture that despite this drawing the number of yellow balls still was low. The average CEs were 67.37 and 69.52 for the two treatments, suggesting that they were the same, and suggesting that precise info is treated like objective probabilities. Btw., the CEs are remarkably high, with risk seeking. %}

Arad, Ayala & Gabrielle Gayer (2012) "Imprecise Data Sets as a Source of Ambiguity: A Model and Experimental Evidence," *Management Science* 58, 188–202.

{% They show that finding regressors in linear regression is hard (NP-complete). Give arguments that, similarly, for an economic agent it is hard to find relations between facts each of which the agent knows. The latter reflects fact-free learning, where we get new insights not by getting information from outside, but merely by rethinking. Further discussions of NP-completeness and its empirical meaning. %}

Aragones, Enriqueta, Itzhak Gilboa, Andrew Postlewaite, & David Schmeidler (2005) "Fact-Free Learning," *American Economic Review* 95, 1355–1368.

{% %}

Archimedes (287–212 B.C.) "*De Aequiponderantibus,*" Syracuse.

{% Archimedes wrote: "those who claim to dicover everything, but produce no proofs of the same, my be confuted as having pretended to discover the impossible." %}
Archimedes (–225) "On Spirals."
Reprinted in Thomas L. Heath (ed. 2009), "*The Works of Archimedes*", Cambridge University Press, Cambridge UK.

{% Seems to show that comparisons to others and especially to one's past determine the standard of satisfaction with income. %}
Argyle, Michael (1987) "*The Psychology of Happiness.*" Methuen, London

{% **proper scoring rules**: Investigate mathematically when one optimal choice from a continuum of acts reveals the subjective probabilities of an agent, assuming expected utility. %}
Arieli, Itai & Manuel Mueller-Frank (2017) "Inferring Beliefs from Actions," *Games and Economic Behavior* 102, 455–461.

{% Field study in India and the US, finding that paying much to workers has a detrimental effect on their performance. Maybe they then need no more money and work less? (That's how in 1980 my then 80-years old landlady Ms. Veenstra, who had been a rich colonist in Indonesia but lost all after the Indonesian liberation war second half of 1940s, justified to me that they gave low wages to the Indonesians.) %}
Ariely, Dan, Uri Gneezy, George F. Loewenstein, & Nina Mazar (2009) "Large Stakes and Big Mistakes," *Review of Economic Studies* 76, 451–469.

{% %}
Ariely, Dan, Emir Kamenica, & Drazen Prelec (2008) "Man's Search for Meaning: The case of Legos," *Journal of Economic Behavior and Organization* 67, 671–677.

{% Show that, maybe, we only measure stable response heuristics, and stability need not imply the existence of fundamental values, because of many framing effects.
They use the nice term "coherent arbitrariness" for coherent choices that are

coherent biases rather than coherent genuine preference. It is what Loomes, Starmer, & Sugden (2003 EJ) call the shaping hypothesis.

coherentism: although the authors do not really get into that, the term coherent arbitrariness nicely indicates disagreement with coherentism. %}

Ariely, Dan, George F. Loewenstein, & Drazen Prelec (2001) " 'Coherent Arbitrariness': Stable Demand Curves without Stable Preferences," *Quarterly Journal of Economics* 118, 73–106. https://doi.org/10.1162/00335530360535153

{% %}

Ariely, Dan, George F. Loewenstein, & Drazen Prelec (2006) "Tom Sawyer and the Construction of Value," *Journal of Economic Behavior and Organization* 60, 1–10.

{% %}

Ariely, Dan & Dan Zakay (2001) "A Timely Account of the Role of Duration in Decision Making," *Acta Psychologica* 108, 187–207.

{% Aristotel lived from –384 till –322. Seems to have argued that happiness agrees with satisfying rules for good life. Seems in spirit of Pareto who wrote that for the rational person ophelimity (= descriptive pleasure) coincides with utility.

conservation of influence: Seems to write, according to Georgescu--Roegen (1954, QJE, p. 510 footnote 3) on pp. 1133a-b: "all things that are exchanged must be somehow comparable … must therefore be measured by one thing … exchange if there were not equality, nor equality if there were not commensurability." And he also seems to write there: "in truth it is impossible that things differing by so much become commensurate, but with reference to demand they become so sufficiently."

Seems to have distinguished between nature and artifice. Scipion Depleix (1603) seems to have written: "According to the Aristotelian philosophy, nature behaves unnaturally under constructed, artificial circumstances. Experiments do not teach us anything about natural processes." %}

Aristoteles, Ethica Nicomachea.

{% Nice survey on the existence of gambling. %}

Ariyabuddhiphongs, Vanchai (2011) "Lottery Gambling: A Review," *Journal of Gambling Studies* 27, 15–33.

{% **paternalism/Humean-view-of-preference** ?

Considers three kinds of errors:

(1) Strategy-based errors occur when the cost of extra effort outweighs the potential benefit of additional accuracy.

(2) Association-based errors (semantic memory) are costs caused by wrong associations due to special words etc.

(3) Psychophysically based errors are due to nonlinear perception of linear things.

At first I found the division ad hoc. Ad (3) for instance, what about stimuli that do not constitute a continuum, or are not even numerical, or are nonlinear? Ad (2), is all our knowledge memory and/or association? Then I took them as the author's way of indicating broader categories: Maybe (3) concerns perception, (2) cognition, and (1) how we turn the other two into actions? As often with psychologists, each single example is not convincing and may have many other explanations, but together they do bring the picture. Weak is that the author confuses reflection and framing, as pointed out by Fagley (1993). (**loss aversion: erroneously thinking it is reflection**)

P. 492 ff. on debiasing is interesting. Giving examples of innate mistakes that are not reduced by incentives, but by clarifications. P. 494 1st para: "To diminish an association-based judgment error, neither the introduction of incentives nor entreaties to perform well will necessarily cause subjects to shift to a new judgment behavior. Instead, it will be more helpful to instruct the subjects in the use of a behavior that will add or alter associations." %}

Arkes, Hal R. (1991) "Costs and Benefits of Judgments Errors: Implications for Debiasing," *Psychological Bulletin* 110, 486–498.

{% Sunk Cost %}

Arkes, Hal R. & Catherine Blumer (1985) "The Psychology of Sunk Cost," *Organizational Behavior and Human Decision Processes* 35, 124–140.

{% Find that reference points are moved in direction of recent changes, but stronger so for gains than for losses. %}

Arkes, Hal R., David Hirshleifer, Danling Jiang, & Sonya Lim (2008) “Reference Point Adaptation: Tests in the Domain of Security Trading,” *Organizational Behavior and Human Decision Processes* 105, 67–81.

{% **ordering of subsets**: taken as **principle of complete ignorance** %}
Arlegi, Ricardo (2007) “Sequentially Consistent Rules of Choice under Complete Uncertainty,” *Journal of Economic Theory* 135, 131–143.

{% The authors seem to think that Fox & Tversky (1995) introduced ambiguity aversion.

This paper seeks to criticize Fox & Tversky (1995, QJE). They test the Ellsberg paradox, but do not let the subjects choose the color so that there can be reason for suspicion (**suspicion under ambiguity**). No real incentives are used. Their proposed theory with the ratio (“tradeoff measure”) at the bottom of p. 16 resembles α-maxmin, where the ratio is α, which in several papers in the literature can depend on the prospect in particular ways. %}
Arló-Costa, Horacio & Jeffrey Helzner (2009) “Ambiguity Aversion: The Explanatory Power of Indeterminate Probabilities,” *Synthese* 172, 37–55.

{% Subjects can choose between known (C) and unknown (B) Ellsberg urn, and also 2nd order probability Ellsberg urn (B*). The latter is between C and B in data. But then they also do decision from experience (subjects are told nothing and have to sample). This they do only for C and B*, not for B (in the latter Bayesian learning about the composition would happen). They do not control for suspicion (**suspicion under ambiguity**). In the experience treatment, C and B* just generate the same probability at a prize. The authors do not explain if in experience subjects only hear about the prize or also about the outcome of the random mechanisms. In the former case, C and B* would be just the same to the subjects. %}
Arlo-Costa, Horacio, Varun Dutt, Cleotilde Gonzalez, & Jeffrey Helzner (2011) “The Description/Experience Gap in the Case of Uncertainty.” In Frank Coolen, Gert de Cooman, Thomas Fetz, & Michael Oberguggenberger (eds.) *Proceedings of*

the Seventh International Symposium on Imprecise Probability: Theories and Applications, 31–40, Studia Universitätsverlag, Innsbruck.

{% **random incentive system between-subjects** (paying only some subjects): P. 406 $\ell\ell$. 4-8 below Eq. 1. In one treatment, for all subjects one decision was played for real ($D_i = 1$) (more precisely, some subjects knew this; but I skip details here). In another treatment, only 1/5 of the subjects played for real ($D_i = 0$) (see pp. 395-396). No difference was found. It suggests that not paying each subject at least one choice is doable. %}

Armantier, Olivier (2006) "Do Wealth Differences Affect Fairness Considerations," *International Economic Review* 47, 391–429.

{% **probability elicitation**: applied to experimental economics.

Measure beliefs through subjective probabilities in first-price auctions. Measure it by introspective judgment, quadratic scoring rule, and prediction (rewarding those whose probability estimates are closest to true objective probability). Argue that the third method is a good compromise between being incentive compatible (which it is only partly) and understandable.

inverse S: They find that subjects throughout underestimate their probability of winning, going some against inverse S. They find that probability weighting better explains data than utility curvature (which they call risk aversion: **equate risk aversion with concave utility under nonEU**), which supports the importance of probability weighting and prospect theory. %}

Armantier, Olivier & Nicolas Treich (2009) "Subjective Probabilities in Games: An Application to the Overbidding Puzzle," *International Economic Review* 50, 1013–1041.

{% Investigate **proper scoring rules**, assuming EU. They investigate, both theoretically and empirically, how proper scoring rules are distorted by risk aversion, and what the effect is of increasing stakes or adding event-contingent stakes, depending on risk attitudes.

In the instructions, they explain the payments using a table, but they do not give instructions on what is good or bad. They emphasize much that their instructions do not use the concept of belief or probability. %}

Armantier, Olivier & Nicolas Treich (2013) “Proper Scoring Rules: Incentives, Stakes and Hedging,” *European Economic Review* 62, 17–40.

{% P.1956: The paper nicely rewrites the parameters of the two-parameter family of Prelec (1998). The authors write

$w(p) = \exp\big(\ln(a)[\ln(p)/\ln(a)]^b\big).$ (*)

(The family is an affine transformation at the level $-\ln(-\ln(p))$.)

Prelec uses $\alpha = b$, $\beta = (-\mathit{ln}\,a)^{1-b}$.

Now a is the fixpoint, which may serve as an index of optimism, and b, the derivative of w at the fixpoint a, is an index of insensitivity. It has been pointed out in the literature, and also in my annotations below at Prelec’s (1998) paper, that his insensitivity parameter also impacts optimism/pressimism. This also happens with the parametrization in Eq. (*), be it to a lesser extent. Set the optimism parameter a at the neutral value $a = 0.50$. Set $b = 0.65$, say. The $1 - w(p) - w(1-p)$ is always negative for $p = j/1000$, with most extreme value 0.051 at $p = 0.018$, showing optimism.

They pay by RIS.

violation of risk/objective probability = one source: Show that the source of risk (known probabilities) is not always weighted the same, but one can generate negative emotions, e.g., by making the events complex. Such a finding had been obtained before, as can be found through my keyword above. For instance, Chew, Li, Chark, & Zhong (2008) had it.

I agree with the main message of the paper, that many things besides probabilities being unknown-versus-known or multi-stage-versus-single-stage play a role. The paper shows that complexity may be just as important. Uncertainty is a rich domain, and Ellsberg’s paradox has led most of the field—Ellsberg (2011) himself not included fortunately— to overfocus on probabilities being unknown, as much of the recent literature overfocuses on RCLA.

One thing I learn from this paper is that in the definition of ambiguity as uncertainty minus risk, one has to specify that risk is to be taken as neutral risk, without special emotions aroused. Fox, Rogers, & Tversky (1996) and Tversky & Fox (1995) also state this; see my related annotation there, added in 2022. I don’t end as negative as the authors do on p. 1960, end of §5.3: “Experimental measures of ambiguity aversion are thus contingent on the source of risk considered." Here pragmatism and parsimony should prevail. I still like to take risk as one source, adding "emotion-neutral." Tversky (personal communication) argued that risk ("chance" as he liked to call it) best be taken as one source.

Another limitation that I see is not that often there are more than one risk attitude, but rather that, let me say imprecisely first, there is less than one risk attitude. What I mean is that for uncertainty the thought experiment of all the same except that probabilities are known, is often too unrealistic to even consider. Then ambiguity attitude in the narrow sense of only difference between unknown-known probability is too uninteresting to consider. Then we should only look at an all encompassing uncertainty attitude. But for now the word "ambiguity" is the magic popular term in the field, so, for a decade or so to come (2017-2027) we will be dealing with this often meaningless concept.

This paper has nice ways of generating complexity other than through multistage. In Experiment 1, there are the known and unknown Ellsberg urns, but there is, in addition, a third treatment, a complex one, where draws from two known urns are combined but this is of course more complex than simply the one urn. They find that subjects treat the unknown and complex urns quite similarly, strongly correlated (p. 1958). I find this agreeing with my opinion that Ellsberg's unknown urn is not about unknown probability but about weird silly urns. In experiment 2, two dice are thrown, each giving one of 10 numbers, numbered 0 … 9. In one treatment, simple risk, they just compose two-digit nos. 00 … 99 and ask probabilities of number between 1 (included) and 25 (included), which has probability 1/4. In the other treatment, complex risk, they take the sum of the two throws. The event that the sum is between 2 (included) and 6 (included) also has probability 1/4 (the authors claim so and I trust them) but this is a complex risk. They find, in proper scoring rules, that people treat multistage and complex probabilities quite similarly, strongly correlated.

A difficulty is that the complex probabilities are simply too complex for subjects to get, so that for them it is not risk but ambiguity. The authors seem to discuss this somewhere but I don't know where.

source-dependent utility: Experiment 1 & 2 find the same utility for different sources (p. 1956 & 1959).

The authors take (their versions of) the parameters of the Prelec family as indexes of pessimism and insensitivity. Both pessimism and insensitivity are larger for unknown and complex than for known (so, ambiguity aversion) in Experiment 1 (p. 1957). In Experiment 2, insensitivity is larger for two-stage/complex than for simple, but pessimism is the same (p. 1959).

ambiguity seeking for unlikely: they confirm ambiguity seeking for unlikely and aversion for likely.

P. 1961, §5.5, is more pessimistic on the source method than I am. The following sentence is their sentence in §5.5 but with everywhere "the source method" replaced by "utility theory," "source function" by "utility function," and "source (of uncertainty)" by "commodity":

"Indeed, because it is context dependent, utility theory has an infinite number of degrees of freedom (i.e., a different utility function for each commodity). As a result, utility theory does not lend itself to out of sample prediction: knowing an agent's attitude toward one commodity does not provide guidance as to the attitudes of that agent toward a different commodity." Note that Abdellaoui et al. (2011) call the DOMAIN rich, not their model. Every ambiguity theory has to deal with source dependence. Multiple prior models will have to have different sets of priors for the Dow Jones index than for the Amsterdam index, and the smooth model will have to have different two-stage decompositions there. (And, what I empirically predict, deviating from KMM's views, also different φ functions.)

P. 1963, Appendix C, suggests improvements of the statistics of Abdellaoui et al. I agree with this appendix. The authors write: "First, the t-tests conducted in Step 3 to compare the distributions of $w_{it}(j/8)$ across treatments are valid if one treats the $w_{it}(j/8)$ as (recoded) data, but they are not valid if one treats the $w_{it}(j/8)$ as econometric estimates, i.e., random variables whose standard deviations depend on the sampling error from the estimation of …" This puts things exactly right. Outside econometrics, the first approach is common and we followed it.

The reason that Abdellaoui et al. used a two-step parametric approach, with an extra parameter w(1/2) estimated, is that such a procedure can be interesting for interactive decision analysis sessions where w(1/2) is a once-and-for-all correction factor. %}

Armantier, Olivier & Nicolas Treich (2016) "The Rich Domain of Risk," *Management Science* 62, 1954–1969.
https://doi.org/10.1287/mnsc.2015.2215

{% Model for calculation costs %}
Armel, K. Carrie & Antonio Rangel (2008) “Neuroecoomic Models of Computation Time and Experience on Decision Values,” *American Economic Review, Papers and Proceedings* 98, 163–168.

{% **probability communication**: Subjects are given probabilities in described (DFD) and experienced (DFE) format. The latter gives better understanding, with fewer biases. %}
Armstrong, Bonnie & Julia Spaniol (2017) “Experienced Probabilities Increase Understanding of Diagnostic Test Results in Younger and Older Adults,” *Medical Decision Making* 37, 670–679.

{% %}
Armstrong, J. Scott (2001) “Combining Forecasts.” *In* J. Scott Armstrong (ed.), *Principles of Forecasting: A Handbook for Researchers and Practitioners*.” Kluwer Academic Publishers, Norwell, MA, 417–439.

{% P. 39 gives many references on the relation between properties of Choquet integrals and properties of capacities. %}
Armstrong, Thomas E. (1990) “Comonotonicity, Simplicial Subdivision of Cubes and Non-Linear Expected Utility via Choquet Integrals,” Dept. of Mathematics and Statistics, University of Maryland, Baltimore, MD 21228.

{% conglomerability %}
Armstrong, Thomas E. (1990) “Conglomerability of Probability Measures on Boolean Algebras,” *Journal of Mathematical Analysis and Applications* 150, 335–358.

{% %}
Armstrong, Thomas E. & William D. Sudderth (1989) “Coherent Inference for Improper Priors and from Finitely Additive Priors,” *Annals of Statistics* 17, 907–919.

{% %}

Armstrong, Thomas E. & William D. Sudderth (1989) "Locally Coherent Rates of Exchange," *Annals of Statistics* 17, 1394–1408.

{% %}

Armstrong, Wallace E. (1948) "Uncertainty and the Utility Function," *Economic Journal* 58, 1–10.

{% Known as "The Port Royal Logic."

Citation of Keynes (1921, p. 308).

"In order to judge of what we ought to do in order to obtain a good and to avoid an evil, it is necessary to consider not only the good and evil in themselves, but also the probability of their happening and not happening, and to regard geometrically the proportion which all these things have, taken together."

Is this the first statement of the expectation principle, even more so in the context of the expected utility criterion to guide decisions, with also utility recognizable in the sense that the good and the evil are apparently assumed quantifiable because a geometric mean (I assume probability-weighted average) can be taken? %}

Arnauld, Antoine & Pierre Nicole (1662) "*La Logique ou l'Art de Penser: Contenant, outre les Règles Communes, Plusiers Observations Nouvelles, Propre à Former le Jugement*." Known as "Logique de Port-Royal." Translated into English by James Dickhoff & Patricia James (1964) "The Art of Thinking; Port-Royal Logic," Bobbs-Merrill, Indianapolis.

{% African scholar in third//fourth century. Primitive predecessor of Pascal's proof; discussed by Mellers et al. %}

Arnobius, (1949) "The Case Against the Pagans." Translated into English by A. Hamilton Bryce & Hugh Campbell, Newman Press, Winchester, MD, 116–117.

{% **probability communication**: 66 cancer patients received either visualized or nonvizualized info about risky probabilities. The vizualized patients remembered the info better. %}

Arrick, Bradley A., Katarzyna J. Bloch, Laura Stein Colello, Steven Woloshin, & Lisa M. Schwartz (2019) "Visual Representations of Risk Enhance Long-Term

Retention of Risk Information: A Randomized Trial," *Medical Decision Making* 39, 100–107.

{% Discusses welfare evaluations for variable population sizes, showing that average evaluations can give different rankings than additive by ignoring deads for instance. The paper is not theoretical/axiomatic as many papers by Blackorby et al., and also Kothiyal, Spinu, & Wakker (2015 OR), but it gives nice empirical and historical examples. %}

Arrighi, Yves, Mohammad Abu-Zaineh, & Bruno Ventelou (2015) "To Count or Not to Count Deaths: Reranking Effects in Health Distribution Evaluation," *Health Economics* 24, 193–205.

{% %}

Arrow, Kenneth J. (1948) "The Possibility of a Universal Social Welfare Function," Project RAND, RAD(L)-289, 26 October, Santa Monica, California, (hectographed).

{% **risky utility u = transform of strength of preference v, latter doesn't exist**: p. 529 writes (for welfare and not for risk): "and in any case, it is an assumption of a totally different logical order from that of utility maximization itself. The older discussions of diminishing marginal utility as arising trom the satisfaction of more intense wants first make more sense, although they are bound up with the untenable notion of measurable utility. However, their fundamental point seems well taken." %}

Arrow, Kenneth J. (1951) "An Extension of the Basic Theorems of Classical Welfare Economics." *In* Jerzy Neyman (ed.) "*Proceedings of the Second Berkeley Symposium on Mathematical Statistics and Probability,*" University of California Press.

{% %}

Arrow, Kenneth J. (1951) "*Social Choice and Individual Values.*" Wiley, New York. (9th edn. 1972, Yale University Press, New Haven.)

{% P. 404, opening para, writes that uncertainty is present in all our decisions and that uncertainty theory can answer all questions in life, but the author is not subject to

the ubiquity fallacy because he carefully lets others say this (not **ubiquity fallacy**). This paper immediately starts with a first signal of the depth and subtleness of the author! At least at the age he had then.

P. 405 in this preSavage (1954) paper writes "the distinction between the two will be carefully maintained." where "the two" means consequences versus acts. But he never clearly states how acts, consequences, and events are formally related.

P. 405/406 give some nice words on **free will/determinism**:

> I do not wish to face here the question whether or not there is any "objective" uncertainty in the economic universe, in the sense that a supremely intelligent mind knowing completely all the available data could know the future with certainty. The tangled web of the problem of human free will does not really have to be unraveled for our purposes; surely, in any case, our ignorance of the world is so much greater than the "true" limits to possible knowledge that we can disregard such metaphysical questions.

P. 406: "In view of the general tradition of economics, which tends to regard rational behavior as a first approximation to actual, I feel justified in lumping the two classes of theory together." That this was view in economics up to 1980s is stated also in opening para of McQuillin & Sugden (2012 p. 553). A nice accompanying citation is from Newton (1687): "I can calculate the motion of heavenly bodies, but not the madness of people."

P. 407, on coexistence of gambling and insurance, mentions, as a class of economic phenomena that by their definition are concerned with uncertainty, insurance and gambling. Then writes, "A theory of uncertainty must account for the presence of both."

P. 410 middle: statistical hypothesis are uncertainty but not risk (I mean, no probabilities)

Pp. 410-411 describes various views on probability

P. 411, footnote 4, describes the idea of matching probability.

End of §3.1.1 seems to criticize Lange incorrectly for assuming cardinal probabilities if only ordinal info. Ordinal info about probabilities easily gives cardinal info because of additivity, if A,B,C are three mutually exclusive and exhaustive events, then A ~ B ~ C immediately implies that their probabilities are 1/3.

P. 412: Jacob Bernoulli first formulated the principle of insufficient reason in the 17th century. P. 413 2nd para will discuss its problem.

P. 416: Keynes essentially abandons completeness of preference when handling subjective probabilities. (P.s.: Keynes likes logical interpretation of probability)

P. 418 etc. is on **foundations of statistics**, its early history, origin of Neyman-Pearson.

P. 419 defines, for potential surprise, the max and min operations for union and intersection, which will later underly fuzzy sets.

P. 421 writes "With the development of the utility theory of value in the 1870's, Bernoulli's proposal was found to fit in very well, especially in view of the common assumption of diminishing marginal utility of income." Arrow gives no references from that period, unfortunately.

P. 422 mentions nonEU models though it seems to be only models based on moments.

P. 423: **risky utility u = transform of strength of preference v, latter doesn't exist**: "This argument, however, was undermined by the rise of the indifference-curve view of utility, due to Pareto, where utility ceased to have any objective significance, and in particular diminishing marginal utility had lost its meaning." P. 425 repeats the point: "First, the utilities assigned are not in any sense to be interpreted as some intrinsic amount of good in the outcome (which is a meaningless concept in any case)."

P. 423 1st para mentions sign dependence.

P. 424: "Ramsey's work was none too clear."

P. 424 3rd para and further: R**CLA**

P. 424/425: **substitution-derivation of EU**: not really, but gives ingredients. P. 424 states weak ordering, p. 424/425 the standard gamble (SG)-assumption, and p. 425 the substitution principle; impressive is Footnote 22 on p. 425, a point that I had found before reading it here after considerable thinking, and showing that Arrow really understood how to prove the result.

P. 425: "If, as seems natural, we demand that all utilities be finite,"

Early mention of maxmin EU: p. 429 second para describes it, and refers to Wald (1950).

P 428 last para points out that the significance level of Neyman-Pearson is arbitrary.

P. 429 3rd para: Wald's maxmin criterion fully reflects the idea of complete ignorance. Note that he formulates Wald's principle in an Anscombe-Aumann setting. He criticizes it for nature not behaving like a zero-sum-game opponent.

P. 429/430 refers to Savage's maxmin regret, apparently stated in a 1948 course, and also to Chernoff's demonstration that IIA then is violated. So, Chernoff (1949, unpublished) already had an example of IIA.

P. 431: that de Finetti's bookmaking is not reasonable for high stakes.

Pp. 431-432 describes a state-dependent version of the theorem of Anscombe & Aumann (1963), referring to Rubin (1949, 1950) and Chernoff (1949, 1950) for it.

P. 432 ℓ. 1 describes the vNM independence axiom.

P. 432, sign-dependence (when discussing Shackle's work): "The exposition is greatly complicated by his insistence on differentiating between gains and losses. It is completely unclear to me what the meaning of the zero-point would be in a general theory; after all, costs are usually defined on an opportunity basis only."

Seems to mention early solutions to the St. Petersburg paradox that assumed nonlinear probability weighting.

criticizing Knight (1921) for low quality: Arrow is cynical and critical of Knight in many places. %}

Arrow, Kenneth J. (1951) "Alternative Approaches to the Theory of Choice in Risk-Taking Situations," *Econometrica* 19, 404–437. https://doi.org/10.2307/1907465

{% Seems to be among the first to use the state-preference approach where states of nature are like dimensions of commodity bundles.

Théorème 3: risk aversion under EU holds if and only if U is concave; only for 50-50 lotteries. (The risk aversion statement is discussed on p. 95, following the theorem. %}

Arrow, Kenneth J. (1953) "Le Rôle des Valeurs Boursières pour la Répartition la Meilleure des Risques." *Colloques Internationaux du Centre National de la Recherche Scientifique* (Econométrie) 40, 41–47. Translated into English as "The Role of Securities in the Optimal Allocation of Risk-Bearing," *Review of Economic Studies* 31 (1964), 91–96.

{% P. 7 gives, for decision making under risk with a continuum of utility range, the reasoning that, under EU and completeness, U must be bounded by a variation of the St. Petersburg paradox, and refers to Menger for this point. %}

Arrow, Kenneth J. (1958) "Bernoulli Utility Indicators for Distributions over Arbitrary Spaces," Technical Report 57, Dept. of Economics, Stanford University, Stanford, CA, USA.

{% Axiom C4 is IIA, not in the Arrow-social choice sense, but in the revealed-preference sense, for multivalued choice functions. This is the first published version of the condition it seems. Nash (1950, Axiom 3) had a special case of this condition (for single-valued choice functions, where it coincides with some other conditions). %}

Arrow, Kenneth J. (1959) "Rational Choice Functions and Ordering," *Economica*, N.S., 26, 121–127.

{% Moral hazard. Seems to show that under actuarially unfair coinsurance (loading factor in insurance premium) and EU with concave utility, no complete insurance is taken. %}

Arrow, Kenneth J. (1963) "Uncertainty and the Welfare Economics of Medical Care," *American Economic Review* 53, 941–969.

Reprinted in Kenneth J. Arrow (1971) "*Essays in the Theory of Risk Bearing.*"

{% Seems to prove that deductible is Pareto optimal relative to coinsurance etc. Seems to be a famous result.

An amusing pastime is to read justifications of axioms that authors give who don't have any serious argument to give. Here is a strong, often cited, bluff act by Arrow (1971 p. 48): "The assumption of Monotone Continuity seems, I believe correctly, to be the harmless simplification almost inevitable in the formalization of any real-life problem." (**criticizing the dangerous role of technical axioms such as continuity**)

1971, p. 52: probabilistic beliefs: If the probability distribution of consequences is the same for two acts, they are indifferent. Assumption 2.1.2 in Wakker (2010) calls it decision under risk.

1971, p. 64/65 shows that under his Monotone continuity axiom, utility function u of Savage's model must be bounded.

1971, p. 26/27: R**CLA** is rational (called utility boundedness theorem later (??))

1971, p. 35, seems to write: "the behavior of these measures as wealth varies is of the greatest importance for prediction of economic reactions in the presence of uncertainty."

1971, p. 90/91: funny citation, "Brethren, here there is a great difficulty; let us face it firmly and pass on."

1971, P. 96: on quadratic utility, "is unacceptable since it violates the principle of decreasing absolute risk aversion."

decreasing ARA/increasing RRA:

(1) 1971, p. 96, on decreasing ARA (absolute risk aversion), seems to write: "seems supported by everyday observation."

(2) 1971, p. 97, on decreasing ARA/increasing RRA, seems to write: "the hypothesis of increasing RRA [relative risk aversion] is not easily confrontable with intuitive evidence. The assertion is that if both wealth and size of bet are increased in the same proportion, the willingness to accept the bet (as measured by the odds demanded) should decrease. The hypotheses will be defended partly by its consistency with general theoretical principles and partly by its success in explaining economic behavior." It seems that Arrow's theoretical principle is based on the assumption that utility should be bounded from above and from below, which I find unconvincing as an argument.

decreasing ARA/increasing RRA: p. 103/104 seems to give an additional argument for increasing RRA.

Section 11.2 points out that government should not insure, because the stakes are (almost always) moderate given the budget of the government.

1965 in fact does DUR only. %}

Arrow, Kenneth J. (1965) "*Aspects of the Theory of Risk-Bearing.*" Academic Bookstore, Helsinki. Elaborated as Kenneth J. Arrow (1971) "*Essays in the Theory of Risk-Bearing.*" North-Holland, Amsterdam.

{% %}

Arrow, Kenneth J. (1968) "The Economics of Moral Hazard: Further Comment," *American Economic Review* 58, 537–539.

Reprinted in Kenneth J. Arrow (1971) "*Essays in the Theory of Risk Bearing,*" North-Holland, Amsterdam.

{% Elaboration of Arrow (1965). Comments see there. %}

Arrow, Kenneth J. (1971) "*Essays in the Theory of Risk Bearing.*" North-Holland, Amsterdam.

{% **dynamic consistency**: forgone-event independence: principle of conditional preference: "what might have happened under conditions that we know won't prevail should have no influence on our choice of actions" %}

Arrow, Kenneth J. (1972) "Exposition of the Theory of Choice under Conditions of Uncertainty." *In* Charles Bartlett McGuire & Roy Radner (eds.) *Decision and Organization*, North-Holland, Amsterdam.

{% **crowding-out**: seems that he cannot believe what Titmuss claimed on payment for blood. %}

Arrow, Kenneth J. (1972) "Gifts and Exchanges," *Philosophy and Public Affairs* 1, 343–362.

{% **Z&Z**? %}

Arrow, Kenneth J. (1973) "*Theoretical Issues in Health Insurance.*" University of Essex, Colchester, England.

{% %}

Arrow, Kenneth J. (1974) "The Use of Unbounded Utility Functions in Expected-Utility Maximization: Response," *Quarterly Journal of Economics* 88, 136–138. https://doi.org/10.2307/1881800

{% %}

Arrow, Kenneth J. (1974) "Optimal Insurance and Generalized Deductibles," *Scandinavian Actuarial Journal* 1, 1–42.

{% Irrationalities in intertemporal markets and relevance to that of psychologists' (K&T, etc.) findings. %}

Arrow, Kenneth J. (1982) "Risk Perception in Psychology and Economics," *Economic Inquiry* 20, 1–9.

{% **coherentism**: The paper takes, as a commonly accepted practice of those days, rationality as completeness and transitivity of preference. The beginning of §III, p. S390, points out that this deviates from everyday usage. It discusses rationality purely and only from the economic perspective, within economic markets and so on. It, therefore, is not relevant for current (2018) debates in behavioral economics. %}

Arrow, Kenneth J. (1986) "Rationality of Self and Others in an Economic System," *Journal of Business* 59, S385–S399.

{% %}

Arrow, Kenneth J., Enrico Colombatto, Mark Perlman, & Christian Schmidt (eds.) *The Rational Foundations of Economic Behavior: Proceedings of the IEA Conference Held in Turin, Italy*, 225–250, St. Martins Press, New York.

{% Give duality conditions for optimization with quasi-concave functions. %}

Arrow, Kenneth J. & Alain C. Enthoven (1961) "Quasi-Concave Programming," *Econometrica* 29, 779–800.

{% **principle of complete ignorance**: on this topic.

ambiguity seeking for unlikely and **inverse S:** The α-Hurwicz criterion is inverse S! It assigns $1-\alpha$ weight to the best outcome, no matter how unlikely. In an Ellsberg unknown urn with many colors a gamble on one color gives generates ambiguity seeking!

P. 2: "But how we describe the world is a matter of language, not of fact."

biseparable utility. %}

Arrow, Kenneth J. & Leonid Hurwicz (1972) "An Optimality Criterion for Decision Making under Ignorance." *In* Charles F. Carter & James L. Ford (1972) *Uncertainty and Expectations in Economics: Essays in Honour of G.L.S. Shackle*, 1–11, Basil Blackwell, Oxford.

{% **discounting normative**: seem to consider it OK normatively. Seem to write: "it is hard to see why the revealed preference of individuals should be disregarded in the realm of time, where it is accepted, broadly speaking, in evaluating current commodity flows" (p. 12). %}

Arrow, Kenneth J. & Mordecai Kurz (1970) "*Public Investment, the Rate of Return, and Optimal Fiscal Policy.*" Johns Hopkins University Press.

{% %}
Arrow, Kenneth J. & Robert C. Lind (1970) "Uncertainty and the Evaluation of Public Investment Decisions," *American Economic Review* 60, 364–378.

{% Argue that the utility function in expected utility better be bounded, as Arrow argued before. Although in many respects I admire Arrow, especially when he was young, I always found his views on unbounded utility narrow. %}
Arrow, Kenneth J. & Marcel Priebsch (2014) "Bliss, Catastrophe, and Rational Policy," *Environmental and Resource Economics* 58, 491–509.

{% %}
Arrow, Kenneth J. & Hervé R. Raynaud (1986) "*Social Choice and Multicriterion Decision Making.*" MIT, C idge, MA.

{% %}
Arrow, Kenneth J., Amartya K. Sen, & Kotaro Suzumura (2007) "*Handbook of Social Choice and Welfare, Vol. 2*" Elsevier, Amsterdam.

{% Report on WTP etc. They seem to acknowledge that subjects can have different discount rates for different time horizons, which also supports using different discount rates than the market rate. %}
Arrow, Kenneth J., Robert M. Solow, Paul R. Portney, Edward E. Leamer, Roy Radner, & Howard Schuman (1993) "Report of the NOAA Panel on Contingent Valuation," *Federal Register* 58, 4602–4614.

{% Seem to argue that the Safra & Segal (2008) account of Rabin's paradox will not hold if RCLA is violated and people, for instance, do recursive nonEU. %}
Artstein-Avidan, Shiri & David Dillenberger (2015) "Dynamic Disappointment Aversion: Don't Tell Me Anything until You Know for Sure." Working paper.

{% They do not consider binary preferences over acts (they call them "risks"), but a representing function called risk measure. More precisely, the risk measure is minus 1 times a representing function. Then they do two things.

(1) They provide mathematical results that are not new but have been known before, not only by Huber (1981, Ch. 1, Proposition 2.1, preceding their Proposition 4.1) which they cite but also by multiple prior papers Gilboa & Schmeidler (1989) and Chateauneuf (1991).

(2) They present a naïve interpretation of their axiomatization. If authors/readers did not see axiomatizations before, they can intimidate/get-intimidated by claiming that their axioms are criteria of rationality. Authors in that spirit often use broad uninformative terms such as rationality/consistency/coherence; this paper uses the term coherent. But if you have seen 100 axiomatizations before, you don't get impressed by yet one more, and you don't use such broad uninformative terms anymore.

It so happened that in the field of risk measures, axiomatizations had not been seen before. Hence, the average researcher in that field got impressed by the axiomatization in this paper and it became seminal. It is of course very useful that this paper introduced axiomatizations in the field of risk measures. %}

Artzner, Philippe, Freddy Delbaen, Jean-Marc Eber, & David Heath (1999) "Coherent Measures of Risk," *Mathematical Finance* 9, 203–228.
https://doi.org/10.1111/1467-9965.00068

{% The authors point to much empirical evidence for risk and ambiguity seeking (**ambiguity seeking**), citing a.o. Trautmann & van de Kuilen (2015) for empirical evidence on the fourfold pattern. They show that equilibria still exist if sufficiently many agents are risk- and ambiguity averse. %}

Araujo, Aloisio, Alain Chateauneuf, Juan Pablo Gama, & Rodrigo Novinski (2018) "General Equilibrium with Uncertainty Loving Preferences," *Econometrica* 86, 1859–1871.
https://doi.org/10.3982/ECTA14777

{% Consider incomplete markets and frictons that sometimes lead to nonEU pricing, such as through Choquet integrals or maxmin EU. %}

Araujo, Aloisio, Alain Chateauneuf, José Heleno Faro, & Bruno Holanda (2019) "Updating Pricing Rules," *Economic Theory* 68, 335–361.

{% They use the LISS panel, measure inconsistencies in choice lists through the money pump index, and relate it with demographic variables. It is negatively related with wealth, also if correcting for cognitive ability and other things. %}

Arts, Sara, Qiyan Ong, Jianying Qiu, & Jana Vyrastekova (2023) "Choice (In)Consistency and Real-Life Outcomes, in preparation.

{% **game theory for nonexpected utility**: do it for maxmin EU. %}

Aryal, Gaurab & Ronald Stauber (2014) "Trembles in Extensive Games with Ambiguity Averse Players," *Economic Theory* 57, 1–40.

{% Cominimum independence means that two acts take their minimal value at the same state s. $\mathcal{E}$-cominimum independence requires it for every event in the partition $\mathcal{E}$. It means that minimal values are over- or underweighted within every element of $\mathcal{E}$. It is a generalization of the special case of neo-additive capacities that only overweight minimal outcomes (Gilboa 1988 JMP; Jaffray 1988 Theory and Decision). (**EU+a*sup+b*inf**). It also generalizes Kajii, Kojima, & Uic (2007 JME), for one thing by allowing infinite state spaces. %}

Asano, Takao & Hiroyuki Kojima (2015) "An Axiomatization of Choquet Expected Utility with Cominimum Independence," *Theory and Decision* 78, 117–139.

{% **dynamic consistency. NonEU & dynamic principles by restricting domain of acts**; **updating: nonadditive measures**

The authors examine updating of a nonadditive measure, denoted v, in Choquet expected utility. I will discuss it from the perspective of §9 of

Sarin, Rakesh K. & Peter P. Wakker (1998) "Revealed Likelihood and Knightian Uncertainty," *Journal of Risk and Uncertainty* 16, 223–250,

SW henceforth, a paper not cited by the authors. For updating, v(S|A), three events play a role: $A \cap S$, A\S, and A^c. SW argue that the various updating methods in the literature differ in the rank-order assumptions that they make. For instance, the Bayesian rule, $v(S|A) = v(s \cap A)/v(A)$ assumes $s \cap A$ in the best ranking position, A\S 2nd best, and A^c worst. Dempster-Shafer and Fagin-Halpern assume two different rank-orderings. There are six ways to rank-order the three events, so, one can think of three more update rules in this spirit. For Baysian updating, one should assign the worst outcome to A^c. This paper shows that it can be captured by imposing a lower-constrained dynamic consistency, so, only if A^c has the worst outcome. Upper-constrained dynamic consistency captures Dempster-Shafer.

To have consequentialism w.r.t. a conditioning event A, we need to have Choquet-expected utility conditional on A, involving comonotonicity restricted to A. The authors capture this using conditional comonotonicity. %}

Asano, Takao & Hiroyuki Kojima (2019) "Consequentialism and Dynamic Consistency in Updating Ambiguous Beliefs," *Economic Theory* 68, 223–250.

{% **measure of similarity** %}

Ashby, F. Gregory & Daniel M. Ennis (2007) "Similarity Measures." *In* Eugene M. Izhikevich (ed.), *Scholarpedia*, 2(12): 4116.

{% **measure of similarity** %}

Ashby, F. Gregory & Nancy A. Perrin (1988) "Toward a Unified Theory of Similarity and Recognition," *Psychological Review* 95, 124–150.

{% Use TTO; abstract: "the most striking differences were found between women who had experienced breast cancer and those who had not." They later on explain that their group of patients was a relatively favorable group without recurrencies. Only 17 who had had breast cancer.

Discuss who is the appropriate valuer of health states for public policies, informed members from the general public (refer to Torrance for this viewpoint), people in the health state, or health professionals. %}

Ashby, Stephen J., Moira O'Hanlon, & Martin J. Buxton (1994) "The Time Trade-Off Technique: How Do the Valuations of Breast Cancer Patients Compare to Those of Other Groups?," *Quality of Life Research* 3, 257–265.

{% **real incentives/hypothetical choice, for time preferences**: they implement real incentives. %}

Ashby, Nathaniel J.S. & Tim Rakow (2017) "When Time is (not) Money: Preliminary Guidance on the Interchangeability of Time and Money in Laboratory-Based Risk Research, *Journal of Risk Research*, 21, 1036–1051. https://doi.org/10.1080/13669877.2017.1281334

{% Nice title!

If a riskless outcome is presented as an option to witness the outcome of a lottery without playing it, then subjects become more risk seeking. Also if the expected value is bad. %}

Ashby, Nathaniel J. S., Tim Rakow, & Eldad Yechiam (2017) "Tis Better to Choose and Lose than to never Choose at All," *Judgment and Decision Making* 12, 553–562.

{% **dynamic consistency**; Relates dynamic consistency to revision-proofness, unifying individual choice and a refinement of subgame-perfectness of game-theory. It refines Peleg & Yaari (1973) and Goldman (1980) by considering indifferences and infinite time horizons. %}

Asheim, Geir B. (1997) "Individual and Collective Time-Consistency," *Review of Economic Studies* 64, 427–443.

{% %}

Asheim, Geir B. (2010) "Intergenerational Equity," *Annual Review of Economics* 2, 197–222.

{% Discuss mathematical problems of evaluating infinite income streams. Propose not to require complete preference, but to consider only choice functions in limited choice sets and to impose conditions on this. %}

Asheim, Geir B., Walter Bossert, Yves Sprumont & Kotaro Suzumura (2010) "Infinite-Horizon Choice Functions," *Economic Theory* 43, 1–21.

{% %}

Asheim, Geir B., Kohei Kamaga, Stéphane Zuber (2022) "Infinite Population Utilitarian Criteria," (CESifo Working Paper No. 9576).

{% Introduce a new axiom, “Hammond equity for the future” that axiomatizes a family of general discounting. They show that the deviation from Koopmans’ discounted utility is primarily due to his assumption of separability of the first two periods. %}

Asheim, Geir B., Tapan Mitra, & Bertil Tungodden (2012) “Sustainable Recursive Social Welfare Functions,” *Economic Theory* 49, 267–292.

{% Extend Zuber & Asheim (2012) to variable population size. %}

Asheim, Geir B. & Stéphane Zuber (2014) “Escaping the Repugnant Conclusion: Rank-Discounted Utilitarianism with Variable Population,” *Theoretical Economics* 9, 629–650.

{% %}

Ashraf, Nava, Dean Karlan, & Wesley Yin (2006) “Tying Odysseus to the Mast: Evidence from a Commitments Savings Product in the Phillippines,” *Quarterly Journal of Economics* 121, 635–672.

{% %}

Ashworth, Mark, Susan I. Robinson, Emma Godfrey, Henk Parmentier, Melanie Shepherd, Jeremy Christey, Kevin Wright, & Veronica Matthews (2005) “The Experiences of Therapists Using a New Client-Centered Psychometric Instrument, PSYCHLOPS (Psychological Outcome Profiles),” *Counselling & Psychotherapy Research* 5, 37–42.

{% Used Roger Cooke’s 1991 expert aggregation method. %}

Aspinall, Willy (2010) “A Route to more Tractable Expert Advice,” *Nature* 463, 294–295.

{% Strict convexity means that attitudes become infinitely risk averse at the lower end. This becomes too much to be reconcilable with continuity. A funny paradox. %}

Assa, Hirbod & Alexander Zimper (2018) “Preferences over All Random Variables: Incompatibility of Convexity and Ccontinuity,” *Journal of Mathematical Economics* 75, 71–83.

{% This paper examines a nonadditive probability space (Ω,ℱ, ν) where ν can be nonadditive. A topology on the set of random variables satisfies BA if any open set containing X contains a set {Y: ν{|Y-X| ≥ c} ≤ ε for some positive c, ε, reminiscent of convergence in measure as in the weak LLN. If ν is atomless, then continuity and convexity imply monotonicity. One can't have continuty, convexity, and monotonicity over all loss variables (mainly because utility then has to be unbounded). The results remind me some of Wakker & Yang (2019, JET), which shows, roughly, that monotonicity and convexity imply continuity under RDU. %}

Assa, Hirbod & Alexander Zimper (2021) "When a Combination of Convexity and Continuity Forces Monotonicity of Preferences," *International Journal of Approximate Reasoning* 136, 86–109.

{% **losses from prior endowment mechanism;**

risk seeking for symmetric fifty-fifty gambles: They find risk neutrality there and, hence, conclude that no loss aversion. Have a design with 0.1, 0.5, and 0.9 probability at best outcomes, with mixed prospects, testing preferences for skewness. They find that utility does not explain much, but probability weighting and likelihood insensitivity do.

equate risk aversion with concave utility under nonEU: unfortunately, they use the term risk-loving and risk aversion for utility curvature even though nonEU, but they properly define so explicitly, so that it is not confusing. %}

Astebro, Thomas, José Mata, & Luis Santos-Pinto (2015) "Skewness Seeking: Risk Loving, Optimism or Overweighting of Small Probabilities," *Theory and Decision* 78, 189–208.

{% Reviews papers that study relation between entrepreneurship and, either, risk attitudes (from real-life actions; from hypothetical risky-choice questions; and from real incentive- risky-choice questions), or three kinds of overconfidence (p. 58: 1: overestimation: thinking one is too good absolutely (also called illusory superiority); (2) overplacement: thinking one is too good relative to others; (3) overprecision: one is overcertain about one's opinions. Distinguishes overconfidence from optimism. Often seeks to link with behavioral views. The evidence found in the literature is not very clear.

When analyzing effects of risk attitudes, a confound is that entrepreneurs will be in different risk situations than nonentrepreneurs, and that rather than different risk attitude could play a role. This is a general problem when relating risk attitude (or whatever) to demographics (or whatever). The longitudinal studies at the bottom of p. 56 can avoid this confound.

There is a paradox of many people starting business with high chance of failing, and low average returns. The paper gives references to document this.

The contribution of this paper appears best from the following sentence: p. 51: "… our reading of the literature suggests that even papers that find evidence consistent with one interpretation are often unable to rule out other mechanisms …."

Pp. 56-57: **Prospect theory not cited**.

P. 61 ff. discusses nonpecuniary benefits, but it is hard to say anything about those.

P. 64 ff. present new frontiers. %}

Astebro, Thomas, Holger Herz, Ramana Nanda, & Roberto A. Weber (2014) "Seeking the Roots of Entrepreneurship: Insights from Behavioral Economics," *Journal of Economic Perspectives* 28, 49–70. https://doi.org/10.1257/jep.28.3.49

{% On expert aggregation. A big (N = 2400) study of the big probability-elicitation competition that started in 2011. In 2011 the Intelligence Advanced Research Project Agency (IARPA), the research wing of the intelligence community, sponsored a multiyear forecasting tournament. Five university-based programs competed to develop the most innovative and accurate methods possible to predict a wide range of geopolitical events.

They find that simple polls with discussions ("converge") work best, then weighted averaging of simple polls (mix of "merge" and "purge"), then prediction markets, and, worst, unweighted averaging of simple polls ("merge"). In weighted averaging, the weights are not derived from the data set used to evaluate, in which case it would be just data fitting with the more parameters the better, but they were derived from other data in the past, so that it is proper prediction. Still no surprise that it does well because it is using more info (also

the past data). That converge works best is also not surprising, because experts can share info and learn. In the case of converge, at the end they still could all do individual judgment and they need not produce a consensus view. This avoids strategic behavior.

P. 694 2nd column ℓ. 4: "Prediction markets generally produce adequately calibrated prices, with the excepotion of the favorite long-shot bias." Restated, with references on top of p. 698. Following Rothschild (2009), they do recalibration for overconfidence, which seems to be good.

P. 701: in prediction markets, more than 50% of all orders were placed by the most active 5%.

P. 703 bottom of 1st column: maybe experts did not understand well how prediction markets work. Then there is a possibility for improvement. %}

Atanasov, Pavel, Phillip Rescober, Eric Stone, Samuel A. Swift, Emile Servan-Schreiber, Philip Tetlock, Lyle Ungar, & Barbara A. Mellers (2017) "Distilling the Wisdom of Crowds: Prediction Markets vs. Prediction Polls," *Management Science* 63, 691–706.

{% **decreasing ARA/increasing RRA**: seems to use power utility. %}

Atkinson, Anthony B. (1970) "On the Measurement of Inequality," *Journal of Economic Theory* 2, 244–263.

{% **utility depends on probability** %}

Atkinson, John W. (1957) "Motivational Determinants of Risk-Taking Behavior," *Psychological Review* 64, 359–372.

{% %}

Atkinson, Richard C., Richard J. Herrnstein, Gardner E. Lindzey, & R. Duncan Luce (1988, eds.) "*Stevens Handbook of Experimental Psychology*; 2nd edn." Wiley, New York.

{% Introduced overtaking criterion, simultaneously with von Weizsäcker (1965). %}

Atsumi, Hiroshi (1965) "Neoclassical Growth and the Efficient Program of Capital Accumulation," *Review of Economic Studies* 32, 127–136.

{% This review of my book captures both the general spirit and many details of the book very well. I was happy to see such good reading and understanding. My only objection is that the author uses the term RDEU rather than RDU.:)

Somer minor details:

Footnote 1: The book does not use the term subjective probability for transformed probabilities, and uses subjective probability only for additive probabilities as in Savage (1954). It warns against the former use on p. 49 preceding Exercise 2.3.1.

P. 241 Footnote 2 explains why my book does not consider the Köszegi & Rabin (2006) theory of endogenous reference points.

The "questionable assumption" (book review p. 539 ℓ. −6), assumed to be implicit and critical, that probabilities be weighted the same under risk and ambiguity, is vacuous. Ambiguity is BY DEFINITION whatever the difference is between unknown and known probability. And if probability is weighted differently under unknown probability than under known probability (I have difficulties in understanding what probabilities and their weighting may mean in the first case, but try to understand the author as much as can), then that difference is ambiguity BY DEFINITION. The point is discussed more by Abdellaoui et al. (2011, American Economic Review), p. 719, under "Ambiguity or Different Risk Attitudes?—A Terminological Issue.—". %}

Attanasi, Giuseppe (2011) Book Review of: Peter P. Wakker (2010) "Prospect Theory: For Risk and Ambiguity, Cambridge University Press, Cambridge, UK," *Journal of Economic Psychology* 32, 538–540.

{% The authors present *exogenous* two-stage uncertainties to subjects and fit the smooth ambiguity model.

correlation risk & ambiguity attitude: seem to find negative relation %}

Attanasi, Giuseppe, Christian Gollier, Aldo Montesano, & Noemi Pace (2014) "Eliciting Ambiguity Aversion in Unknown and in Compound Lotteries: A Smooth Ambiguity Model Experimental Study," *Theory and Decision* 77, 485–530.

{% Consider how much an agent in ambiguity would pay to get to know the (objective) probabilities, and propose this, normalized by utility spread of outcomes, as ambiguity premium. Do this essentially if only one prospect is faced, so, no different ambiguous prospects to choose from, which is kind of preference for info. The nice title of Section 2.1 “Buying information without using it” expresses it nicely. (They later also consider cases in which decisions do follow.) Their definition captures all nonadditivity of the weighting function, including nonadditive weighting of probabilities. Hence, they propose their definition only when EU holds for risk. They derive many comparative static results on ambiguity premiums with and without decisions to be taken.

Pp. 128-129 explain that the authors rather use RDU (they write CEU, abbreviating Choquet expected utility) than the smooth model, for one reason because in the latter it will be harder to disentangle things from the utility functions.

A problem is what objective probability is, and how much ambiguity there is about what that true probability is. Eq. 1.a (p. 132) assumes one objective probability $Pr(s_g)$ but the problem is that this does not occur in any decision situation. They next use a symmetry argument to get rid of that probability, but the symmetry argument can be seen to imply $Pr(s_g) = 0.5$ (because then $v(s_g) = v(s_b)$, implying that Eq. 1.a is the same as that equation with $1 - Pr(s_g)$).

Section 3.2 on Abdellaoui et al. (2011): Note that the latter do not take risk as a source with some ambiguity, but instead DEFINE it as unambiguous. Further, the difficulty to disentangle the authors’ definition from probability weighting is as much a problem for the authors themselves, which they avoid only by simply assuming EU (so, no probability weighting).

P. 127, strangely, writes that Andersen et al. (2010) were the first to note that risk and ambiguity attitudes can be different, and that risk aversion can go together with ambiguity seeking (p. 127). The keyword **correlation risk & ambiguity attitude** in this annotated bibliography, for instance, gives many other references on this point, many preceding. %}

Attanasi, Giuseppe & Aldo Montesano (2012) “The Price for Information about Probabilities and its Relation with Risk and Ambiguity,” *Theory and Decision* 73, 125–160.

{% Well-focused survey on empirical intertemporal studies.

Focused survey on intertemporal choice, with special attention for its relevance for health.

decreasing/increasing impatience: p. 1391 (§3.1) discusses reasons why some find increasing impatience and others find it decreasing.

§3 concisely discusses the main findings from the economic literature with monetary choices. §3.2 discusses sign effects, §3.3 discusses sequence effects (**intertemporal separability criticized**), and §3.4 the magnitude effect. §4 discusses these same things for the health domain with health outcomes, and §5 discusses studies that related them. %}

Attema, Arthur E. (2012) "Developments in Time Preference and Their Implications for Medical Decision Making," *Journal of the Operational Research Society* 63, 1388–1399.

https://doi.org/10.1057/jors.2011.137

{% %}

Attema, Arthur E., Han Bleichrodt, & Olivier L'Haridon (2018) "Ambiguity Preferences for Health," *Health Economics* 27, 1699–1716.

{% %}

Attema, Arthur E., Han Bleichrodt, Olivier L'Haridon, O., Patrick Peretti-Watel, & Valérie Seror (2018) "Discounting Health and Money: New Evidence Using a More Robust Method," *Journal of Risk and Uncertainty* 56, 117–140.

{% **decreasing/increasing impatience**: find no presence effect.

P. 2016, on Method 2: "The latter approach is the first one available in the literature that measures the discount function in an entirely utility-free manner." %}

Attema, Arthur E., Han Bleichrodt, Kirsten I.M. Rohde, & Peter P. Wakker (2010) "Time-Tradeoff Sequences for Analyzing Discounting and Time Inconsistency," *Management Science* 56, 2015–2030.

https://doi.org/10.1287/mnsc.1100.1219

Direct link to paper

{% %}

Attema, Arthur E., Han Bleichrodt, Yu Gao, Zhenxing Huang, & Peter P. Wakker (2016) "Measuring Discounting without Measuring Utility," *American Economic Review* 106, 1476–1494.
http://dx.doi.org/10.1257/aer.20150208
Direct link to paper

{% %}

Attema, Arthur E., Han Bleichrodt, & Peter P. Wakker (2012) "A Direct Method for Measuring Discounting and QALYs more Easily and Reliably," *Medical Decision Making* 32, 583–593.
https://doi.org/10.1177/0272989X12451654
Direct link to paper

{% %}

Attema, Arthur E. & Werner B.F. Brouwer (2008) "Can we Fix it? Yes We Can! But What? A New Test of Procedural Invariance in TTO-Measurement," *Health Economics* 17, 877–885.

{% %}

Attema, Arthur E. & Werner B.F. Brouwer (2009) "The Correction of TTO-Scores for Utility Curvature Using a Risk-Free Utility Elicitation Method," *Journal of Health Economics* 28, 234–243.

{% **decreasing/increasing impatience**: seem to find that utility of life duration has increasing risk aversion, which indirectly implies increasing impatience. %}

Attema, Arthur E. & Werner B.F. Brouwer (2012) "Constantly Proving the Opposite? A Test of CPTO Using a Broad Time Horizon and Correcting for Discounting," *Quality of Life Research* 21, 25–34.

{% Use the direct method of Attema et al. (MDM) to measure utility of life duration, and test whether it is independent of health state. Do it on a large representative sample (N = 1448). Find independence for two health states better than death, but more concave utility for a health state worse than death. %}

Attema, Arthur E. & Werner B.F. Brouwer (2012) "A Test of Independence of Discounting from Quality of Life," *Journal of Health Economics* 31, 22–34.

{% Study preference reversals for, obviously hypothetical, chronic health states. Find that matching fares worse in having more inconsistency (internal preference reversals as the authors nicely call it). Cite many papers finding the same. They find only bit of support for scale compatibility, and several violations. %}

Attema, Arthur E. & Werner B.F. Brouwer (2013) "In Search of a Preferred Preference Elicitation Method: A Test of the Internal Consistency of Choice and Matching Tasks," *Journal of Economic Psychology* 39, 126–140.

{% N = 80 students. For health, obviously no real incentives.

reflection at individual level for risk: although they have the data, they do not report this.

They test PT (I prefer this to their notation CPT for the 92 version of prospect theory) with life duration as outcomes. They use framing to let 30 years life duration be reference point (p. 1060 §3.3 1st para), so, then there are both gains and losses. They only use fifty-fifty prospects, so, only probability 0.5.

P. 1058 3rd para: location of reference point is problem in health.

P. 1059 para −3: under exponential (= CARA) utility, location of reference point is not important for curvature (apart from loss aversion).

P. 1059 para −2: when the authors say exponential utility, they mean that it can be different for gains than for losses.

P. 1061, §4.2 1st para: risk aversion both for gains and losses. P. 1061, §4.2 last para: much risk aversion for mixed prospects.

P. 1061, §4.3 1st para: just a little bit of loss aversion: $\lambda = 1.18$. Much individual variation.

P. 1062 §4.6, nicely redid the analysis assuming EU and then, obviously, found way more concave utility. Data fitting suggests that RDU is better than EU, and PT's sign dependence is yet better, but it is not clear how the authors corrected for extra parameters.

P. 1063 2nd column 1st para: Not at all clear that for life duration U should be convex for losses. Here it is concave for both gains and losses. (**concave utility**

for gains, convex utility for losses).

The results in this paper (almost no loss aversion, and no real sign-dependence of utility) suggest to me that sign- and reference-dependence play no role for life duration. For life duration there is no clear reference point. The authors end the main text (p. 1064 §6) with this opinion, although they go less into the direction of no reference point: "Third, the location of the RP in the health domain deserves further exploration. This location is less obvious for health outcomes than for monetary outcomes, and plays a crucial role in PT. Finally, an extension of this study to a more representative sample of thegeneral population would be worthwhile." %}

Attema, Arthur E., Werner B.F. Brouwer, & Olivier l'Haridon (2013) "Prospect Theory in the Health Domain: A Quantitative Assessment," *Journal of Health Economics* 32, 1057–1065.

{% %}

Attema, Arthur E., Werner B.F. Brouwer, Olivier l'Haridon, & José Luis Pinto (2015) "Estimating Sign-Dependent Societal Preferences for Quality of Life," *Journal of Health Economics* 43, 229–243.

{% **reflection at individual level for risk**: they find a positive correlation between risk aversion for gains and losses.

Their pilot shows that it is better to ask gain questions before loss questions.
%}

Attema, Arthur E., Werner B.F. Brouwer, Olivier l'Haridon, & José Luis Pinto (2016) "An Elicitation of Utility for Quality of Life under Prospect Theory," *Journal of Health Economics* 48, 121–134.

{% %}

Attema, Arthur E., Olivier L'Haridon, & Gijs van de Kuilen (2019) "Measuring Multivariate Risk Preferences in the Health Domain, *Journal of Health Economics* 64, 15–24.
https://doi.org/10.1016/j.jhealeco.2018.12.004

{% Study higher order risk preferences. Find aversion towards social health losses and exante-inequality aversion, unrelated to risk aversion which falsifies simple forms of utilitarianism. %}

Attema, Arthur E., Olivier L'Haridon, & Gijs van de Kuilen (2023) "An Experimental Investigation of Social Risk Preferences for Health," *Theory and Decision* 95, 379–403.
https://doi.org/10.1007/s11238-023-09928-w

{% Consider risk about monetary outcomes, as usual, but also about the time when something is received. Introduce reference dependence also for the latter. They measure probability weighting. Find the fourfold pattern with inverse S probability weightig for both gains and losses for both types of outcomes. Find usual loss aversion for monetary outcomes, but the opposite, gain seeking, for risky time of receipt. %}

Attema, Arthur E. & Zhihua Li (2024) "Reference-Dependent Discounting," *Journal of Risk and Uncertainty* 69, 57–83.
https://doi.org/10.1007/s11166-024-09432-8

{% **measure of similarity** %}

Attneave, Fred (1950) "Dimensions of Similarity," *American Journal of Psychology* 63, 516–556.

{% Asked people to judge the frequencies of letters in English text, compared that to real frequencies; on average, it overestimated frequencies below .04, underestimated the higher frequencies; so, looks like **inverse S** but only overestimation of very small probabilities; there are violations of monotonicity (e.g., D occurring more often but judged lower) showing that judgments depend on more than just (transformations) of real frequencies; this finding can serve as a nice example to explain that not **SEU = SEU** to psychologists.

Guessing games reveal nonlinear probability weights. %}

Attneave, Fred (1953) "Psychological Probability as a Function of Experienced Frequency," *Journal of Experimental Psychology* 46, 81–86.

{% **inverse S:** Cites literature that find inverse S shape. Does a first experiment in which subjects' behavior confirms that they relatively overvalue longshot lotteries (so, small probability for gain). Payments was in "points" (not explained more). Unfortunately, the gambles always seem to deal with both gains and losses, so loss aversion plays a role. Then comes the second experiment. Subjects are first asked for estimations of probability and it seems that they !under!estimate small probabilities and they !over!estimate bigger ones. However, not much explanation is given about experimental details there seem to be many complicating factors. For instance, probabilities are measured by having subjects indicate percentages of occurrences of events when repeated 100 times. They first are asked to calculate the mathematical answer, then they are asked what they think will really be the percentage. They also choose between gambles but it is repeated choices and they seem to play for totals of points. In this second experiment, no clear relation between gambling behavior and estimated probabilities was found. It could be argued that the second experiment deals some with ambiguity, but I don't think really. It is too close to known probability I think. %}

Attneave, Fred (1959) "A Priori Probabilities in Gambling," *Nature* 183, 842–843.

{% **calculating RDU**: An R computer program that helps to calculate, test, and visualize prospect theory and other nonexpected utility theories, and see which is best. Other similar programs are cited. Useful! %}

Au, Gary (2019) "pt: An R package for Prospect Theory," Melbourne School of Psychological Sciences, Faculty of Medicine, Dentistry and Health Sciences, The University of Melbourne, Australia.

{% %}

Aue, Hermann (1938) "n+1 Hyperflächengewebe des n-Dimensionalen Raum," *Mitt. Math. Ges. Hamburg* 7, 367–399.

{% Recommended to me by Harald Uhlig in January 1997 %}

Auerbach, Alan J., Jagadeesh Gokhale, & Laurence J. Kotlikoff (1994) "Generational Accounting," *Journal of Economic Perspectives* 8 no. 1, 73–94.

{% They throughout do the RIS for real incentives.

A careful experiment considers intertemporal choice for monetary outcomes and for slightly unpleasant jobs to be done. The delays considered are 3 and 6 weeks. Because real incentives, they can only consider such short periods. They fit data with the β-δ model and Stone-Geary utility of money and parametric utility of work similarly. They find close to linear utility of money. Small present bias for money, much bigger for effort. Their first pages discuss the fungibility problem (utility of money vs. utility of consumption) that intertemporal experiments with money always have, which is why they also did the job experiment, especially in footnote 4. (**time preference, fungibility problem**) They find a positive relation between present bias and desire to precommit, and enthusiastically write on this in the last sentence of the abstract: "Therefore our findings validate a key implication of models of dynamic inconsistency, with corresponding policy implications." P. 1071 describes it as key validation. It is common, and cliché, in theoretical papers nowadays (2016) to refer to policy implications. The positive correlation found is plausible because for dynamically consistent people there is nothing to precommitment for, them always choosing the same anyhow.

One difficulty can be that the job is a negative outcome, and for negative outcomes it is not so clear to what extent people are at all impatient or have present bias. Well, in this paper they do. %}

Augenblick, Ned, Muriel Niederle, & Charles Sprenger (2015) "Working over Time: Dynamic Inconsistency in Real Effort Tasks," *Quarterly Journal of Economics* 130, 1067–1115.

{% The authors measure time preference for subjects who have to do a number of unpleasant tasks at some future timepoints in the next seven weeks. The paper emphasizes that they do not consider monetary outcomes so as to avoid fungibility problems (**time preference, fungibility problem**), a fashionable point in 2022. Subjects could freely choose tasks in future timepoints, but could make predictions beforehand. How much the prediction is off, speaks to sophistication. Confounds here can be that prediction can be (mis)used for self-commitment, and can impact future decisions through the incentives for the prediction being right. The authors go at great length to avoid/reduce these confounds. For me outsider it is not easy to see many other differences with Augenblick, Niederle, & Sprenger (2015). %}

Augenblick, Ned & Matthew Rabin (2019) "An Experiment on Time Preference and Misprediction in Unpleasant Tasks," *Review of Economic Studies* 86, 941–975. https://doi.org/doi:10.1093/restud/rdy019

{% **updating: discussing conditional probability and/or updating**: Consider an agent who repeatedly updates beliefs regarding an event E. Usually, the uncertainty should reduce over time (dilation, a term not mentioned by the authors, should be the exception) and the confidence should increase. The authors define the uncertainty at time t as $\pi_t(1-\pi_t)$ where π_t is the subjective probability of E at time t, and movements as $(\pi_{t+1}-\pi_t)^2$ and discuss many phenomena, simulations, and data fitting. I expect that there are advanced related results in the statistics literature.

Very unfortunately, QJE publishes proofs only in online appendixes, meaning that maths published in this journal is unreliable. For a good view on this point, see Spiegler (2023). %}

Augenblick, Ned & Matthew Rabin (2021) "Belief Movement, Uncertainty Reduction, and Rational Updating," *Quarterly Journal of Economics* 136, 933–985.
https://doi.org/10.1093/qje/qjaa043

{% %}

Augustin, Patrick & Yehuda Izhakian (2020) "Ambiguity, Volatility, and Credit Risk," *Review of Financial Studies* 33, 1618–1672.

{% %}

Aujard, Henry (2001) "The 'Allais Effect' Is Real," *21st Century Science and Technology* 14, 70–75.

{% **completeness criticisms**; The author considers preferences that satisfy the usual vNM preference conditions, except the weakest one, being completeness. Theorem A (p. 450) characterizes existence of at least one utility u. "Utility" means the analog of the EU functional, implying linearity in (probabilistic) mixing. Further, denoting prospects by x, y, and so on, $x > y \Rightarrow u(x) > u(y)$ and $x \sim y \Rightarrow u(x) = u(y)$. Note that this way we cannot recover preference from utility because prospects can be incomparable, irrespective of their utility value ordering. So, the result is not really a representation. §7 turns to the representation question; i.e., the extent to which the set of all utilities can determine the order. Unfortunately, the writing on formal results is not explicit and often ambiguous. The verbal claims that preference can be recovered from utility (made not only in §7 but also elsewhere in the paper, such as on p. 448 end of 3rd para) seem to be incorrect. So, I think that Aumann cannot be credited for such results, and Baucells & Shapley (2008) and Dubra, Maccheroni, & Ok (2004), two papers written independently and simultaneously, share the priority.

In his §7, Aumann never specifies whether "preference" and "order" refer to the weak or the strict part. By the terminology of the paper, it should maybe be the weak part. However, this cannot be. We consider the preference cone for a binary relation R: There are finitely many prizes, say n; $(p_1,\ldots,p_n)$ in Re^n designates the prospects in the obvious manner. The preference cone is the cone generated by all differences $(p_1,\ldots,p_n) - (q_1,\ldots,q_n)$ with the former prospect R-preferred to the latter. Aumann does not state if the preference cone takes weak or strict preference for R. It cannot be weak because that would not satisfy his regularity condition, containing 0. So, it has to be strict. A function on the prizes can be defined as $(u_1,\ldots,u_n)$ in the obvious manner. It is a utility function if and only if its inner product with everything in the preference cone is strictly positive (another reason why his preference cone can only refer to strict preference; cf. last para of Aumann's §7). So, the set of utility functions is exactly the dual of the preference cone. If then the preference cone is the dual of that, then the preference cone can be uniquely recovered from the set of all utility functions in the usual Bewley (1986, 2002)-unanimous-EU-incomplete-preference representation way. However, this only concerns recovery of strict preference. So, now the million $ question is: does strict preference uniquely determine indifference, in view of independence and continuity? This is not so, as an example by Dubra (2009, personal communication) explained to me. For example, take any preference satisfying Aumann's axioms 1.1 and 1.2 on p. 449;

can even be a complete one. Replace all indifferences by incomparability, only leaving reflexivity intact. Then the relation still satisfies all of Aumann's axioms, has the same strict part as the original one, but is different regarding indifference/incomparability. This shows that Aumann's continuity axiom 1.2 is too weak, not sufficiently distinguishing between indifference and incomparability (his 4.1 on p. 452 could do better). So, his results of §7 cannot be added to Theorem A to give a representation theorem.

Aumann's casual style and way of representation in §7 could be accepted if the mathematics was trivial to him, and impeccable. However, now that it is not and he has mistakes in continuity, one cannot know exactly what his sentences mean, and they accordingly cannot be credited.

Aumann's (1964) addendum corrects Theorems B and C in §5, for which his continuity is also too weak, but it does not address the problems of Theorem D in §7, which is the topic relevant for us here. %}

Aumann, Robert J. (1962) "Utility Theory without the Completeness Axiom," *Econometrica* 30, 445–462. (Addendum in vol. 32, 1964, 210–212.)

{% **criticisms of Savage's basic framework** %}

Aumann, Robert J. (1971, January 8) "Letter from Robert Aumann to Leonard Savage." Published as Appendix A to Ch. 2 of Jacques H. Drèze (1987), *Essays on Economic Decision under Uncertainty*. Cambridge University Press, Cambridge.

{% %}

Aumann, Robert J. (1976) "Agreeing to Disagree," *Annals of Statistics* 4, 1236–1239.

{% %}

Aumann, Robert J. (1977) "The St. Petersburg Paradox: A Discussion of Some Recent Comments," *Journal of Economic Theory* 14, 443–445.

{% Seems to say that it is possible "to [do] away with the dichotomy usually perceived between the 'Bayesian' and the 'game-theoretic' view of the world."

Presents it as criticism of Nash equililbrium, but it is simply changing the rules of the game: the players have something that they can correlate on, say sunspots.

An implicit assumption then is that they cannot correlate on other things. I disagree witih many claims in the paper. %}

Aumann, Robert J. (1987) "Correlated Equilibrium as an Expression of Bayesian Rationality," *Econometrica* 55, 1–18.

{% Derive expected utility for game theory with subjective probabilities over opponent's strategy choices. Use thought experiments such as: If you could choose between strategies 1 and 2 in this game, whereas your opponent were erroneously thinking that you could choose between strategies 1, …, 10, then what would you prefer?

The paper in fact gives a nice generalization of Anscome & Aumann's (1963) theorem to subdomains of acts (in the spirit of Harsanyi 1955), which can be used independently of whether it is interpreted for game theory or otherwise. This paper is related to Gilboa & Schmeidler (2003 GEB), and Kadane & Larkey (1982, 1983) and the ensuing discussions, which also model game theory as a special case of decision under uncertainty. (**game theory can/cannot be viewed as decision under uncertainty**) %}

Aumann, Robert J. & Jacques H. Drèze (2008) "Rational Expectations in Games," *American Economic Review* 98, 72–86.

{% The authors recognize that the usual revealed-preference approach of changing choice sets in game theory changes the whole game, so, does not satisfy ceteris paribus. Some restricted choices can be observed and they give data so poor that subjective probabilities and EU are not falsified. This paper is related to Gilboa & Schmeidler (2003 GEB), and Kadane & Larkey (1982, 1983) and the ensuing discussions, which also model game theory as a special case of decision under uncertainty. (**game theory can/cannot be viewed as decision under uncertainty. %**}

Aumann, Robert J. & Jacques H. Drèze (2009) "Assessing Strategic Risk," *American Economic Journal: Microeconomics* 1, 1–16.

{% %}

Aumann, Robert J. & Michael Maschler (1985) "Game Theoretic Analysis of a Bankruptcy Problem from the Talmud," *Journal of Economic Theory* 36, 195–213.

{% Propose a variation of risk tolerance as global index of riskiness of a prospect, where riskiness, as in much literature, should concern something like variance or downside and should be an ingredient in evaluation of prospect besides something like expected value or benefits or so. They give necessary and sufficient conditions, not in terms of preferences but directly using quantitative inputs.

Their measure is as follows. For a lottery and a level of wealth, the risk factor is the risk tolerance (reciprocal of the Pratt-Arrow index of risk aversion) for which the lottery, at that level of wealth, is equivalent to not gambling. It is real-valued for prospects with both positive and negative outcomes. %}

Aumann Robert J. & Roberto Serrano (2008) "An Economic Index of Riskiness," *Journal of Political Economy* 116, 810–836.

{% Sequential updating under ambiguity and optimal stopping of exploration, with maxmin EU and prior-by-prior updating. Does sophisticated choice, giving up dynamic consistency, and calls that rational. Too much exploration under low uncertainty and too much under high (then random stopping.

The paper opens up with the usual ubiquity claim: "The problem of making a decision on an action after deliberating on its merits is ubiquitous in many situations of life…. The pervasiveness of such a problem makes the framework of central importance" %}

Auster, Sarah, Yeon-Koo Che, & Konrad Mierendorff (2024) "Prolonged Learning and Hasty Stopping: The Wald Problem with Ambiguity," *American Economic Review* 114, 426–461.
https://doi.org/10.1257/aer.20221149

{% **foundations of statistics**; **foundations of probability** %}

Austin, James T. (1988) Book Review of: Lorenz Krüger, Lorraine J. Daston & Michael Heidelberg (1987, eds.) "The Probabilistic Revolution: Vol. 1, Ideas in History," MIT Press, Cambridge, MA; *in* Lorenz Kruger, Gerd Gigerenzer, &

Mary S. Morgan (1987, eds.) "*The Probabilistic Revolution: Vol. 2, Ideas in the Sciences.*" MIT Press, Cambridge, MA.

{% http://dx.doi.org/10.1111/risa.12067
Deep uncertainty means that probabilities are not known and there is uncertainty about a model. Discusses a Walker et al. (2010) table (p. 2083) to classify kinds of uncertainty. This paper provides a qualitative discussion of general managers' attitudes towards it. Typical of the paper is: The author argues that it is not just a matter of improving decision analysis techniques, and that those just provide decision support, but there is a need to see beyond. What this "beyond" is, there is no consensus on it, the author argues. %}

Aven, Terje (2013) "On How to Deal with Deep Uncertainties in a Risk: Assessment and Management Context," *Risk Analysis* 33, 2082–2091.

{% %}

Averbakh, Yuri (1985) "*Comprehensive Chess Endings, Vol. 2: Bishop against Knight Endings; Rook against Minor Piece Endings*." Pergamon, Oxford. Translated from Russian into English by Kenneth P. Neat.

{% %}

Averill, Edward W. (1990) "Are Physical Properties Dispositions?," *Philosophy of Science* 57, 118–132.

{% Find loss aversion and reference dependence for traveling times as outcomes.
loss aversion: erroneously thinking it is reflection: p. 411 2nd para. %}

Avineri, Erel (2006) "The Effect of Reference Point on Stochastic Network Equilibrium," *Transportation Research* 40, 409–420.

{% They find Allais paradox and overestimation of small probabilities, as predicted by prospect theory, when outcomes are travel time. %}

Avineri, Erel & Joseph N. Prashker (2004) "Violations of Expected Utility Theory in Route-Choice Stated Preferences: Certainty Effect and Inflation of Small Probabilities," *Transportation Research Record* No. 1894, 222–229.

{% If situations of repeated choice ("learning") are analyzed as single situations, then there are violations of PT. Things are different when they are analyzed as repetitions. %}

Avineri, Erel & Joseph N. Prashker (2005) "Sensitivity to Travel Time Variability: Travelers' Learning Perspective," *Transportation Research Part C* 13, 157–183.

{% %}

Awwad, Tamara, Sandra de Jong, & Peter P. Wakker (2017) "De Zin en Onzin van Reisverzekeringen," *NU.NL* 19 May 2017, Sanomia Media. (NU.NL is a Dutch newswebsite (http://www.nu.nl/). It opened 1999 and then was the first Dutch website with continuously updated news.)

{% %}

Aydogan, Ilke (2017) "Decisions from Experience and from Description: Beliefs and Probability Weighting," Ph.D. thesis.

{% **updating: testing Bayes' formula**; **updating under ambiguity with sampling** This paper does data fitting for existing data of decision from experience (DFE). However, its novelty is that it incorporates a parameter for the prior probability of the subjects, and a parameter of how they update during sampling, in particular, how much they weigh their prior belief versus the observed relative frequency. It uses Carnap's updating rule to do so, which is equivalent to Bayesian updating with beta priors. Then it assumes a probability transformation function there as in the soure method, capturing ambiguity attitudes. For instance, for an option that gives an outcome with certainty, subjects cannot be sure about this and may assign subjective probability 0.95 to it. The paper sometimes seems to find higher insensitivity under DFE than under risk, and sometimes lower. (**DFE-DFD gap but no reversal**) %}

Aydogan, Ilke (2021) "The Role of Prior Beliefs and Their Updating in Decisions under Experienced Ambiguity," *Management Science* 67, 6934–6945. https://doi.org/10.1287/mnsc.2020.3841

{% **updating: mistakes in using Bayes' formula**: The authors propose a tractable model of updating, adding two parameters to Bayes' formula. One is for the extent to which people are conservative (overweighing prior beliefs and underweighting signals) or the opposite. The other is for confirmatory bias: how they overweigh signals supporting their ideas and underweigh opposite signals. In an experiment, there is confirmatory bias by 19% misreading of signals contradicting priors and conservatism by seeming to miss 28% of the signals. %}

Aydogan, Ilke, Aurélien Baillon, Emmanuel Kemel, & Chen Li (2025) "How Much Do We Learn? Measuring Symmetric and Asymmetric Deviations from Bayesian Updating through Choices," *Quantitative Economics* 16, 329–365. https://doi.org/10.3982/QE2094

{% The authors take the three-layer model of Marinacci (2015). The first layer describes an objective probability distribution over states of nature. For (simple) decision under risk, no more to say. Following Marinacci, they call it probability model instead of probability measure. They consider ambiguity, where there is uncertainty about the first layer, captured through an exogenously given set of priors, and a 2nd order distribution on it. It is called model uncertainty. But then there is a 3rd layer of uncertainty, model misspecifiation, reflecting that the true prior may be outside the set of priors considered. It may be related to what is called unforeseen contingencies elsewhere.

This paper provides new insights into the relation between RCLA and ambiguity attitude. Although, in principle, model misspecification cannot be implemented, at least not without deception, the authors have a good proxy for it.

Their experiment has four treatments:, with some 0 < p < 1 fixed:

(1) Risk

(2) Common Ellsberg

(3) Compound risk (P(Red) = p or P(Red) = 1-p, each with 2nd order probability 0.5)

(4) Model uncertainty: P(Red) = p or P(Red) = 1-p but now unknown, ambiguous, 2nd order probability

(5) Model misspecification: like (4), but subjects are told that there is a small possibility that P(Red) is different than p or 1-p.

The authors consider Wald's (1950) maxmin EU model with the set of priors {p, 1-p} as above, Gilboa & Schmeidler's (1989) maxmin EU which I take to be the same as Wald but they model in a deviating manner, imposing a set of priors at a 3rd level, over the set of priors at the 2nd level, two smooth models, KMM and also Seo (2009) which they take as a particular assumption on nonreduction of higher-order risks, recursive RDU, and recursive disappointment aversion. They find less relation between violations of RCLA and ambiguity aversion than preceding studies. Their findings suggest that violation of RCLA is mostly due to complexity. %}

Aydogan, Ilke, Loïc Berger, Valentina Bosetti, & Ning Liu (2023) "Three Layers of Uncertainty: An Experiment," *Journal of the European Economic Association* 21, 2209–2236.
https://doi.org/10.1093/jeea/jvad008

{% Sample of students and one of financial experts. Stimuli: decks of cards. They measure CEs using choice lists and derive ambiguity premiums from that. They only consider ambiguity aversion, not insensitivity.

Findings: (1) ambiguity aversion is robust to sophistication. (2) relation between ambiguity aversion and violation of RCLA for students, but not one-to-one and, rather, complexity aversion seems to be relevant. Complexity concerns number of stages. (3) no relation between ambiguity aversion and violation of RCLA for financial experts.

They conclude that ambiguity aversion is mostly something on its own, not related to many other things. %}

Aydogan, Ilke, Loïc Berger, & Valentina Bosetti (2024) "Unraveling Ambiguity Aversion," *Review of Economics and Statistics*, forthcoming.
https://doi.org/10.1162/rest_a_01358

{% Consider Ellsberg urns with varying info about the unknown urn, in particular with varying total nr. of balls, and multiple prior models. They take the size of the set of priors as index of complexity. Relate it to existing theories and data. Filiz-Ozbay et al. (2021) found a preference for large urns, so, complexity seeking, a special case of the ratio bias. The findings here are less clear. %}

Aydogan, Ilke, Loic Berger, & Vincent Theroude (2022) "More Ambiguous or More Complex? An Investigation of Individual Preferences under Model Uncertainty," working paper.

{% **random incentive system between-subjects**: finds that it works well also for measuring ambiguity attitudes. %}

Aydogan, Ilke, Loic Berger, & Vincent Theroude (2024) "Pay All Subjects or Pay only Some? An Experiment on Decision-Making under Risk and Ambiguity," *Journal of Economic Psychology* 104, 102757. https://doi.org/10.1016/j.joep.2024.102757

{% **RCLA**: Luce (2011) provided a (claimed) simplification of Prelec's (1998) preference axiomatization of Prelec's most popular weighting functions, the compound invariance family. But Luce could get this done only because he assumed compound gambles PLUS backward induction. This paper tests Luce's condition empirically and finds it well satisfied. The special case that corresponds with power weighting is rejected. %}

Aydogan, Ilke, Han Bleichrodt, & Yu Gao (2016) "An Experimental Test of Reduction Invariance," *Journal of Mathematical Psychology* 75, 170–182.

{% %}

Aydogan, Ilke, Nahed Eddai, James Tremewan, & Uyanga Turmunkh (2025) "Ambiguity Attitudes in Climate Context and Willingness to Pay to Reduce CO2 Emissions," in preparation.

{% This paper investigates the decision from experience (DFE) versus decision from description (DFD) gap. The original studies, which claimed a reversal of inverse S, had many problems. Thus, subjects did not know the probabilities and in fact faced ambiguity, and there was utility curvature. This paper corrects for those. Then it finds a bit of the gap in the sense that inverse S is attenuated for DFD, but it is not reversed. (**DFE-DFD gap but no reversal**) %}

Aydogan, Ilke & Yu Gao (2020) "Experience and Rationality under Risk: Re-Examining the Impact of Sampling Experience," *Experimental Economics* 23, 1100–1128. https://doi.org/10.1007/s10683-019-09641-y

{% **dynamic consistency**: in individual decisions, extracting optimal amounts of fish from a lake each year under boundary conditions, backward induction is verified. %}

Aymard, Stephane & Daniel Serra (2001) "Do Individuals Use Backward Induction in Dynamic Optimization Problems? An Experimental Investigation," *Economics Letters* 73, 287–292.

{% %}

Ayton, Peter (1997) "How to Be Incoherent and Seductive: Bookmakers' Odds and Support Theory," *Organizational Behavior and Human Decision Processes* 72, 99–115.

{% %}

Azar, Ofer H. (2005) "Do Consumers Make too Much Effort to Save on Cheap Items and too Little to Save on Expensive Items? Experimental Results and Implications of Relative Thinking." Department of Business Administration, School of Management, Ben-Gurion University of the Negev, Beer Sheva, Israel.

{% %}

Azar, Ofer H. (2007) "Relative Thinking Theory," *Journal of Socio-Economics* 36, 1–14.

{% %}

Azevedo, Eduardo M. & Eric Budish (2019) "Strategy-Proofness in the Large," *Review of Economic Studies* 86, 81–116.

{% **DC = stationarity**; seems to think that this if no randomness.

time preference; if uncertainty about discounting, then the average may look like nonconstant discounting even if deterministic would be constant discounting. %}

Azfar, Omar (1999) "Rationalizing Hyperbolic Discounting," *Journal of Economic Behavior and Organization* 38, 245–252.

{% The authors argue that the random incentive system (RIS), which they call random problem selection (RPS), is incentive compatible as soon as what they call monotonicity is satisfied, where it roughly is if and only if. They give formal statements. However, what they call montonicity is rather separability, or, more precisely, not RCLA, but the rest of independence, which Machina (1989) decomposed into consequentialism and dynamic consistency. Their condition does not refer to an externally given objective relation over outcomes (then monotonicity is a common term) but to a subjective relation over outcomes. This is better called (weak) separability. It is what has often been called isolation in the context of RIS. That separability can be interpreted as monotonicity, was pointed out by Zimper (2008), Marschak (1987), and LaValle (1992). (**restrictiveness of monotonicity/weak separability**)

To avoid misunderstanding, the result of this paper means

UNIVERSAL (for all experiments) incentive compatibility of RSI

$\Leftrightarrow$

UNIVERSAL (their) monotonicity.

In experiments, one does not need universal incentive compatibility of RSI, but only for the particular questions asked, which can be helped by careful framing of the particular stimuli used. Hence, the result of this paper does not apply to applications as commonly done in experiments. %}

Azrieli, Yaron, Christopher P. Chambers, & Paul J. Healy (2018) "Incentives in Experiments: A Theoretical Analysis," *Journal of Political Economy* 126, 1472–1503.
https://doi.org/10.1086/698136

{% %}

Azrieli, Yaron, Christopher P. Chambers, & Paul J. Healy (2020) "Incentives in Experiments with Objective Lotteries," *Experimental Economics* 23, 1–29.
https://doi.org/10.1007/s10683-019-09607-0

{% They consider not eliciting entire preference relation, but only type of agent. So, one parameter. Is elicitable if and only if each type is defined by what the agent would choose from some list of menus. %}

Azrieli, Yaron, Christopher P. Chambers, & Paul J. Healy (2021) "Constrained Preference Elicitation," *Theoretical Economics* 16, 507–538.
https://doi.org/10.3982/TE4208

{% **survey on nonEU**: in game theory.
Show that quasi-convexity of preference is necessary and sufficient for equilibria to always exist. %}
Azrieli, Yaron & Roee Teper (2011) "Uncertainty Aversion and Equilibrium Existence in Games with Incomplete Information," *Games and Economic Behavior* 73, 310–317.

{% Referaat van Wenny Kiebert van 3 Feb. 1993. Two fictitious papers, one analyzes data badly, the other does it properly. %}
Baar, Joseph & Ian Tannock (1989) "Analyzing the Same Data in Two Ways: A Demonstration Model to Illustrate the Reporting and Misreporting of Clinical Trials," *Journal of Clinical Oncology* 7, 969–978.

{% wishful thinking %}
Babad, Elisha (1995) "Can Accurate Knowledge Reduce Wishful Thinking in Voters' Predictions of Election Outcomes?," *Journal of Psychology* 129, 285–300.

{% **PT, applications**: in agriculture. %}
Babcock, Bruce A. (2015) "Using Cumulative Prospect Theory to Explain Anomalous Crop Insurance Coverage Choice," *American Journal of Agricultural Economics* 97, 1371–1384.

{% %}
Babcock, Linda, Maria P. Recalde, Lise Vesterlund, & Laurie Weingart (2017) "Gender Differences in Accepting and Receiving Requests for Tasks with Low Promotability," *American Economic Review* 107, 714–747.
https://doi.org/10.1257/aer.20141734

{% %}

Babul, Riyana, Shelin Adam, Berry Kremer, Suzanne Dufrasne, Sandi Wiggins, Marlene Huggins, Jane Theilmann, Maurice Bloch, & Michael R. Hayden (Canadian Collaborative Group on Predictive Testing for Huntington Disease) (1993) "Attitudes toward Direct Predictive Testing for the Huntington Disease Gene: Relevance for Other Adult-Onset Disorders," *Journal of the American Medical Association* 270, 2321–2325.

{% On defining beliefs under state-dependent utility, that then info beyond preferences is needed. %}

Baccelli, Jean (2017) "Do Bets Reveal Beliefs? A Unified Perspective on State-Dependent Utility Issues," *Synthese* 194, 3393–3419.

{% Argues that preference axiomatizations of general decision models are neutral as regards what risk attitudes are. (P. 67 §3 1st sentence: "On the face of it, the axiomatic analysis of decision-making under risk does not rely on the risk attitude concepts introduced in the previous section." P. 71 §3 last para: "The neutrality of the decision models between the various risk attitudes is one thread in the history of decision theory at large.") I see it somewhat differently: Those models want to allow for as many interesting risk attitudes as possible, and as few uninteresting ones as possible. I use this distinction in my risk-history lectures. In intertemporal choice the situation is (too) different. The general models popular today (quasi-hyperbolic and hyperbolic) are too much committing to decreasing impatience. As another example, cautious utility (Cerreia-Vioglio, Dillenberger, & Ortoleva 2015) is, I think, too much committing to only risk aversion.

The paper considers three forms of risk aversion, points out that they are equivalent under EU, and puts up the research question under what other models they could be equivalent.

The author repeatedly claims that RDU is very general, probably misled by Cerreia-Vioglio, Dillenberger, & Ortoleva (2015). In reality, it uses lower-dimensional parameters than betweenness expected utility or cautious expected utility.

The paper throughout focuses on risk aversion, and does not consider insensitivity. %}

Baccelli, Jean (2018) “Risk Attitudes in Axiomatic Decision Theory—A Conceptual Perspective,” *Theory and Decision* 84, 61–82.

{% Under EU, if we do allow for state dependence, then we can multiply utility by state-dependent positive constants, divide the corresponding probabilities, and renormalize, which makes probabilities unidentifiable apart from being nonzero. This does not work as easily for nonEU models that can be taken as having act-dependent probabilities, such as RDU (where probabilities depend on the act via the ranking of states) or moral hazard, because then the probability proportions between states vary imposing extra restrictions. The paper shows that if the set of act-dependent probabilities {P_f: f an act} has linear dimension n and there are n states of nature, then in fact U and the probabilities are uniquely determined even if one allows for state dependence, which reinterprets a mathematical result by Drèze. Whereas the common thinking was that this result is typical of moral hazard this paper shows that it holds more generally under act-dependent probabilities. %}

Baccelli, Jean (2018) “Moral Hazard, the Savage Framework, and State-Dependent Utility” working paper.

{% **risky utility u = strength of preference v (or other riskless cardinal utility, often called value)**: Paper discusses Suppes’ ideas on it, arguing that Suppes favors one cardinal concept of utility, and pointing out that this is their *interpretation* of Suppes’ work (p. 269 end of 1st para), because for him as a non-economist it was not a very central issue.

Abstract: “We identify Suppes’ doctrine with the major deviation from ordinalism that conceives of utility functions as representing preference differences, while being nonetheless empirically related to choices.” They cite Köbberling (2006) as a good paper on axiomatization of preference difference representation. Baccelli (personal communication) told me that Suppes mentions a number of known attempts to reveal preference intensity from choice (e.g., by monetary side payments) but does not clearly advocate one. They all have their well-known problems.

P. 273: The authors distinguish between absolutely cardinal and relatively cardinal, where the latter depends on the desired functional representation of preference. However, I think that cardinal and ordinal are always relative. %}

Baccelli, Jean & Philippe Mongin (2016) "Choice-Based Cardinal Utility. A Tribute to Patrick Suppes," *Journal of Economic Methodology* 23, 268–288.

{% Peters & Wakker (1987) analyzed Yaari's (1969) comparative risk aversion (lower certainty equivalents) for general outcome domains, that may be nonconvex, nonnumerical, and/or finite. They showed that, under expected utility (EU), more risk averse is still equivalent to utility being more concave. In particular, they thus greatly generalized the weak Kihlstrom & Mirman (1974) showing in particular that the assumption of same ordering of riskless outcomes, emphasized so much by K&M, can be dropped because it is essentially implied by the other assumptions. Thus, under EU comparative risk aversion works similarly on finite and infinite domains.

This paper shows that, under RDU (rank-dependent utility), comparative risk aversion works differently on finite than on convex (so numerical and infinite) domains. They show the same for strong risk aversion. They show, a new result also, that under EU comparative weak and strong risk aversion work the same for finite and convex domains.

For general outcomes, a spread of a lottery means that some outcome is chosen as center, and then probability mass is moved to extremes in both directions. It does not require same expected values, those not even being defined for nonquantitative outcomes. That is, the distribution functions single-cross. This is used in definitions of strong risk aversion.

Pp. 383-395 discuss that a characterization of risk aversion (which means weak risk aversion) or its comparative version is open under RDU.

The abstract is enthusiastic when writing, on some results being different under EU than under RDU: "Thus, considering comparative risk aversion over finite domains leads to a better understanding of *the divide* between expected and non-expected utility, more generally, the structural properties of the main models of decision-making under risk." [italics added] %}

Baccelli, Jean, Georg Schollmeyer, & Christoph Jansen (2022) "Risk Aversion over Finite Domains," *Theory and Decision* 93, 371–397. https://doi.org/10.1007/s11238-021-09847-8

{% Use of probabilities in AI. %}

Bacchus, Fahiem (1990) "*Representing and Reasoning with Probabilistic Knowledge*, A Logical Approach to Probabilities," MIT Press, London.

{% Shows ways to test separabilities and discusses literature. %}
Baccouche, Rafiq & Francois Laisney (1991) "Describing the Separability Properties of Empirical Demand Systems," *Journal of Applied Econometrics* 6, 181–206.

{% Investigates 2nd order probabilities. It concerns losses, because subjects gambled on getting one or three electric shocks. (In return, they received a fixed payment for the experiment.) This is a nice way to have real incentives for losses!

The authors get same overall probabilities through different 1st- versus 2nd stage probabilities, using entropy at 2nd stage as index of ambiguity. Thus, (0.5:(1: 3 shocks), 0.5:(0 shocks)) is taken as maximally ambiguous, and (1: (0.5: 3 shocks, 0.5: 0 shocks)) as completely unambiguous. Big problem is that they describe the different ambiguity theories used vaguely verbally, in Table 1 (p. 4815), referring to a web appendix for formulas. Information that crucial should not be put in such an unreliable place. Their lumping Segal (1987) and Klibanoff, Marinacci, & Mukerji (2005) into one category makes me doubt their formulas. KMM is not put in the category that models ambiguity through using different utility for risk than for ambiguity (KMM can also vary 2nd-order probabilities). %}
Bach, Dominik R., Oliver Hulme, William D. Penny, & Raymond J. Dolan (2011) "The Known Unknowns: Neural Representation of Second-Order Uncertainty, and Ambiguity," *Journal of Neuroscience* 30, 4811–4820.

{% Ambiguity presented but without decisions, so, perception is most they measure, and it is related to brain activities. %}
Bach, Dominik R., Ben Seymour, & Raymond J. Dolan (2009) "Neural Activity Associated with the Passive Prediction of Ambiguity and Risk for Aversive Events," *Journal of Neuroscience* 29, 1684–1656.

{% **Nash equilibrium discussion**: seems to argue that Nash equilibria need not be rational. %}

Bacharach, Michael (1987) “A Theory of Rational Decision in Games,” *Erkenntnis* 27, 17–55.

{% %}

Bacharach, Michael (1990) “Commodities, Language, and Desire,” *Journal of Philosophy* 87, 346–368.

{% %}

Bacidore, Jeffrey, Robert H. Battalio, & Robert H. Jennings (2003) “Order Submission Strategies, Liquidity Supply, and Trading in Pennies on the New York Stock Exchange,” *Journal of Financial Markets* 6, 337–362.

{% First discusses value of axiomatizations. Then explains that formalized theories may lose contact with reality, then that researchers should recognize the problem of “translation” between the proof-generating meaning of theoretical concepts and the meaning of the real-world concepts to which these relate. %}

Backhouse, Roger E. (1998) “If Mathematics Is Informal, then perhaps We Should Accept that Economics Must Be Informal too,” *Economic Journal* 108, 1848–1858.

{% %}

Backhouse, Roger E. (2015) “Revisiting Samuelson’s Foundations of Economic Analysis,” *Journal of Economic Literature* 53, 326–350. http://dx.doi.org/10.1257/jel.53.2.326

{% **confirmatory bias**: “The human understanding when it has once adopted an opinion draws all things else to support and agree with it. And though there be a greater number and weight of instances to be found on the other side, yet these it either neglects and despises, or else by some distinction sets aside and rejects, in order that by this great and pernicious predetermination the authority of its former conclusion may remain inviolate.” %}

Bacon, Francis (1620) “*The New Organon and Related Writings.*” (Later edn. 1960, Liberal Art Press, New York.)

{% %}

Bacon, Francis (1960) "*The New Organon and Related Writings.*" Liberal Art Press, New York. (First publication 1620)

{% Seems to have written: "Read not to contradict and confute; nor to believe and take for granted; nor to find talk and discourse; but to weigh and consider." %}

Bacon, Francis (1625) "*The Essays or Counsels Civil and Moral.*" Edited by Brian Vickers. Oxford University Press, New York.

{% Shows that the RIS does not work for ambiguity averse agents because the agents then can use RIS through Schmeidler's uncertainty aversion to hedge. This result crucially assumes (the dynamic structure -including backward- of) the Anscombe-Aumann framework.

criticism of monotonicity in Anscombe-Aumann (1963) for ambiguity: can be interpreted this way, although the paper does not relate to it. %}

Bade, Sophie (2015) "Randomization Devices and the Elicitation of Ambiguity-Averse Preferences," *Journal of Economic Theory* 159, 221–235. https://doi.org/10.1016/j.jet.2015.05.017

{% u**pdating under ambiguity**: only violation of dynamic consistency: Agents do not update for independent randomization outcomes (such as used by Raiffa 1961). Then info is generally valid but still ambiguity nonneutrality. %}

Bade, Sophie (2022) "Dynamic Semi-Consistency," *Games and Economic Behavior* 134, 117–126.

{% The paper does what its title says. Unfortunately, they never explain what "risk preference measure" means. I assume it is an index of risk aversion, and that the authors do not consider insensitivity. But they hardly give any other info on what is measured how and I, therefore, do not know what to infer from it. They are negative on validities of the measures. The study reminds me of the impressive Pedroni et al. (2017 Nature Human Behaviour). %}

Bagaïni, Alexandra, Yunrui Liu, Madlaina Kapoor, Gayoung Son, Paul-Christian Bürkner, Loreen Tisdall, & Rui Mata (2025) "A Systematic Review and Meta-Analyses of the Temporal Stability and Convergent Validity of Risk Preference Measures," *Nature Human Behaviour* 9,

https://doi.org/10.1038/s41562-024-02085-2

{% Apply PT in Akerlof lemons market. %}
Baharad, Eyal & Doron Kliger (2013) "Market Failure in Light of Non-Expected Utility," *Theory and Decision* 75, 599–619.

{% **risky utility u = strength of preference v (or other riskless cardinal utility, often called value)**
risky utility u = transform of strength of preference v?;
intertemporal separability criticized: seem to argue that intertemporal separability is more realistic than is usually thought. %}
Bailey, Martin J., Mancur Olson, & Paul Wonnacott (1980) "The Marginal Utility of Income does not Increase: Borrowing, Lending, and Friedman-Savage Gambles," *American Economic Review* 70, 372–379.

{% **measure of similarity** %}
Bailey, Tod M. & Ulrike Hahn (2001) "Determinants of Wordlikeness: Phonoactic or Lexical Neighborhoods?," *Journal of Memory and Language* 44, 568–591.

{% **probability elicitation**; **natural sources of ambiguity;**
Tests probabilistic sophistication using exchangeability, and tests source dependence. %}
Baillon, Aurélien (2008) "Eliciting Subjective Probabilities through Exchangeable Events: An Advantage and a Limitation," *Decision Analysis* 5, 76–87.

{% Eeckhoudt and Schlesinger (2006) proposed preference conditions that axiomatize prudence and higher-order risk attitudes for decision under risk with expected utility. Prudence means you rather have a risk added to a good outcome than to a bad outcome in a lottery you are facing. The present paper uses the Anscombe-Aumann framework, where probabilities in lotteries can serve as utility units, lets those play the role of outcomes in DUR. Ambiguity prudence means a preference for probability loss in an unambiguous event rather than ambiguous, doing it for several events in a partition to control for unknown beliefs. The paper shows that this definition of ambiguity prudence has theoretical implications analogous to

risk in the smooth ambiguity model and recursive expected utility (Theorem 1 p. 1739). Under α-maxmin, prudence holds quite generally (Theorem 3, p. 1741). It holds generally under multiplier preferences (Theorem 4 p. 1742). It holds for CEU under likelihood insensitive weighting function W (under a nonnullness condition), once more underscoring that prudence is like likelihood insensitivity (Theorem 5 p. 1742). In particular, it holds for neo-additive W (Theorem 6 p. 1743) given proper nonnullness. %}

Baillon, Aurélien (2017) "Prudence with Respect to Ambiguity," *Economic Journal* 127, 1731–1755.
https://doi.org/10.1111/ecoj.12358

{% %}

Baillon, Aurélien (2017) "Bayesian Markets to Elicit Private Information," *Proceedings of the National Academy of Sciences* 114, 7958–7962.

{% **losses from prior endowment mechanism**: they used the random incentive system (p. 85 top) but a priori gave subjects €15 endowment so that never net losses (p. 83 top).

natural sources of ambiguity;

suspicion under ambiguity: they told subjects that for each event they also play the complementary event (p. 87).

Take three disjoint events referring to performance of Dutch AEX stock index in two experiments. (Do the same with Indian SENSEX stock index in experiment 1 and the South African TOP40 in experiment 2. They will always find the same results for different sources: p. 92.) Measure matching probabilities and then derive implications for ambiguity attitudes using pessimism and insensitivity indexes. Do it both for gains and for losses. It is nice that they do it for natural events rather than the over-studied Ellsberg urns.

ambiguity seeking for losses: they find it,

ambiguity seeking for unlikely: they find it.

They find the fourfold pattern of ambiguity attitude, as does virtually every empirical study. End of intro writes (p. 78): "Models that can account for this pattern include prospect theory and α-maxmin expected utility. Models that assume uniform [over different likelihood levels of events] ambiguity aversion or ambiguity seeking, by contrast, are incompatible with most of the patterns that we observed.” **(event/outcome driven ambiguity model: event driven)**

I here denote by m(E) the matching probability of an event, where I do not express the outcome used or its sign and default is that it is about gains.

As index of lower subadditivity (capturing optimism for low likelihoods) they take, for disjoint events E_i, E_j with E_{ij} their union:

$LA(E_i,E_j) = m(E_i) + m(E_j) - m(E_{ij})$.

So, it is the difference between how much each event in isolation adds to the empty set and how much they add jointly.

As index of upper subadditivity (capturing pessimism for high likelihoods) one can take, as natural dual:

$UA(E_i,E_j) = 1-m(E_i^c) + 1-m(E_j^c) - (1 - m(E_{ij}^c)) =$

$1-m(E_i^c) - m(E_j^c) + m(E_{ij}^c) =$

So, it is the difference between how much each event in isolation subtracts from the universal event and how much they subtract jointly.

P. 80: The authors do not use this dual notation $UA(E_i,E_j)$ but write $UA(E_k)$ instead, which has the drawback that the notation does not express how E_k^c is partitioned into E_i and E_j.

I agree with p. 81 bottom: “A limitation of both maxmin EU and α-maxmin is their dichotomous nature: probability measures are either fully included or fully excluded from the set of priors C. A more realistic case is modeled by the variational model”

I disagree with p.82 bottom: “Choquet EU predicts that violations of binary complementarity are the same for gains and losses.” Choquet EU predicts that they are opposite, not the same. Note here that matching probabilities for gains x are measured by $(x_E0 \sim x_p0)$, so, the event and probabilities are attached to the best outcome, but that matching probabilities for losses z are measured by $(z_E0 \sim z_p0)$, so, the event and probabilities are attached to the worst outcome. This is why Choquet EU predicts opposite violations for gains than for losses. Another way to see this is that maxmin EU, α-maxmin EU, and Choquet EU are all biseparable utility, so, should give the same predictions. Hence, I also disagree with the claimed violation of Choquet EU on p. 95 penultimate para.

P. 96 ℓℓ. 4-5: “The only theory that can explain the choices of most subjects is prospect theory”

EXPERIMENT 1:

P. 77: They assume that if matching probabilities were to measure beliefs, they would have to be additive. So, they take subjective belief as additive. One can also argue for nonadditivity of beliefs. They put this view, which I like, forward on p. 97 3rd para. But they automatically connect it with the assumption of sign-dependence and that is something I would not follow.

. 87 bottom: a bit strange that more a-seeking for losses than a-aversion for gains.

P. 88: binary complementarity holds for gains but not for losses.

P. 89 bottom: They find more ambiguity seeking for losses than ambiguity aversion for gains, which is unusual. Hence, while binary complementarity is satisfied for gains, it is not for losses (pp. 88-89), where we find a deviation in the ambiguity-seeking direction.

P. 89 3rd para: They find lower SA *always* confirmed.

EXPERIMENT 2:

Now binary complementarity is also violated for gains (p. 92).

P. 93: more a-generated insensitivity for losses than for gains.

P. 95: they again find the fourfold pattern of ambiguity attitude.

P. 95 2nd para: all models except Choquet EU, α-maxmin, and prospect theory are widely violated.

P. 96: "The superior performance of prospect theory illustrates the importance of allowing for sign-dependence in modeling ambiguity attitudes."

P. 97: "Some recent ambiguity models are too general to generate predictions …"

P. 97: "Moreover, intuitively, it is not immediately obvious why beliefs should differ between gains and losses."

I reproduce the conclusion:

"This paper sheds light on patterns of violations of probabilistic sophistication. We measured matching probabilities for gains and losses in two experiments, using natural (non-Ellsberg-like) uncertainties. Matching probabilities were sign-dependent, additivity was violated, and the violations of additivity were stronger for losses than for gains. Together these violations imply a fourfold pattern of ambiguity attitudes: ambiguity aversion for likely gains and unlikely losses and ambiguity seeking for unlikely gains and likely losses. Our results were most consistent with prospect theory and, to a lesser extent, Choquet EU and -maxmin. Models with uniform ambiguity attitudes could not explain our results.” %}

Baillon, Aurélien & Han Bleichrodt (2015) “Testing Ambiguity Models through the Measurement of Probabilities for Gains and Losses,” *American Economic Journal: Microeconomics* 7, 77–100. https://doi.org/10.1257/mic.20130196

{% The authors calibrate regret theory per subject, and then test intransitivities predicted by regret theory and Loomes’ (2010) PRAM and Rubinstein’s (1988) similarity, subject-specific. Few such violations are found, and prospect theory better predicts choice. %}

Baillon, Aurélien, Han Bleichrodt, & Alessandro Cillo (2015) “A Tailor-Made Test of Intransitive Choice,” *Operations Research* 63, 198–211.

{% This paper analyzes in detail, and shows, how inverse-S probability weighting leads to underprevention against health risks. It shows how ambiguity reinforces it. (**uncertainty amplifies risk**) %}

Baillon, Aurélien, Han Bleichrodt, Aysil Emirmahmutoglu, Johannes G. Jaspersen, & Richad Peter (2022) “When Risk Perception Gets in the Way: Probability Weighting and Underprevention,” *Operations Research* 70, 1371–1392. https://doi.org/10.1287/opre.2019.1910

{% The paper in its opering sentences points out the disconnect between empirical and theoretical work in ambiguity. Then, it sets a good example of connecting those. First, it provides a desirable generalization of the multiplier preferences model, by adding an ambiguity seeking part (**ambiguity seeking**). This is desirable for empirical purposes because there is much ambiguity seeking. It gives a preference foundation. Then, it shows that it can be used empirically by fitting it to two big data sets of samples representative of the Dutch, and then the American, population, where matching probabilities were measured. In the Netherlands, 23% of the subjects is ambiguity seeking, and in the US it is 36%. %}

Baillon, Aurélien, Han Bleichrodt, Zhenxing Huang, & Rogier Potter van Loon (2017) “Measuring Ambiguity Attitude: (Extended) Multiplier Preferences for the

American and the Dutch Population," *Journal of Risk and Uncertainty* 54, 269–281.
https://doi.org/10.1007/s11166-017-9260-4

{% **natural sources of ambiguity; updating under ambiguity with sampling**: Measure pessimism and likelihood-insensitivity using the indexes of Abdellaoui et al. (2011). Consider ask prices of IPO stocks, so, natural events. Consider learning, with info about past performance gradually provided. They find little pessimism, but substantial insensitivity. Learning moves towards expected utility, reducing insensitivity, but clearly insensitivity does not disappear and deviation from EU remains. They also derived a-neutral probabilities and those were close to historical frequencies.

This paper was the first to relate the indexes of the source method of Abdellaoui et al. (2011) to indexes used under multiple priors. Multiple priors assumes expected utility for risk, and then pessimism = ambiguity aversion and likelihood insensitivity = a(mbiguity-generated) insensitivity (p. 2184 penultimate para). The paper shows that the insensitivity index of the source method of Abdelloui et al. (2011) is the ambiguity perception index of the epsilon-contamination subfamily of the multiple prior family, and that the ambiguity aversion index of epsilon-contamination is the aversion index of the source method per perceived ambiguity unit. They first did so in the working paper version of 13 August, 2013, downloadable here: link to 2013 version

pp. 10-11, where epsilon-contamination is exactly the neo-additive model of Chateauneuf, Grant, & Eichberger (2007) in multiple priors, as CGE show. Baillon et al. sent their 2013 paper to Dimmock & Kouwenberg who used it in Dimmock, Kouwenberg, Mitchell, & Peijnenburg (2015, JRU).

P. 2184 2nd para of 2nd column 2nd para points out that the value of the aversion parameter b depends on the value of the insensitivity parameter a. This does not mean that they are not different components. An example to explain: If a person is maximally risk averse, then the person can't be ambiguity averse. This does not mean that risk aversion and ambiguity aversion would not be different components.

P. 2185 2nd column 2nd para writes: "On the other hand, alpha$_t$ is a relative measure of ambiguity aversion, which is defined per unit of perceived ambiguity and, *therefore*, does not depend on the amount of perceived ambiguity. This explains why b_t is bounded by $-a_t$ and a_t and thus depends to some extent on likelihood insensitivity, and *alpha*$_t$ is bounded by by 0 and 1 and does not depend on ambiguity perception." [italics added]

P. 2185 penultimate para: "The multiple prior interpretation requires that a_t is positive. As several of our subjects had negative a_t, we could only use the multiple prior interpretation in the aggregate analyses and did not use it in the individual analyses."

Pp. 2187-2188: the authors measure certainty equivalents and fit utility, and do not measure matching probabilities. P. 2188: exponential, power, and expopower utility gave equally good fit. %}

Baillon, Aurélien, Han Bleichrodt, Umut Keskin, Olivier L'Haridon, & Chen Li (2018) "The Effect of Learning on Ambiguity Attitudes," *Management Science* 64, 2181–2198.
https://doi.org/10.1287/mnsc.2016.2700

{% A first draft of this paper was entitled: "Balanced Design: The Key to Measuring Ambiguity Attitudes when Beliefs Are Unknown."

The paper puts central that the ambiguity indexes can be identified. In fact, the a-neutral probabilities can also be. Eq. 29 gives enough equalities, where all $\sigma p_i = p_i$ result and where σ is also identified. Li, Turmunkh, & Wakker (2019, Eq. 3.3) gives a formula for three events.

P. 5 Footnote 4 mentions the idea of Bayesian twin for the a-neutral probabilities. %}

Baillon, Aurélien, Han Bleichrodt, Chen Li, & Peter P. Wakker (2021) "Belief Hedges: Measuring Ambiguity for All Events and All Models," *Journal of Economic Theory* 198, 105353.
https://doi.org/10.1016/j.jet.2021.105353
Direct link to paper

{% %}

Baillon, Aurélien, Han Bleichrodt, Chen Li, & Peter P. Wakker (2025) "Source Theory: A Tractable and Positive Ambiguity Theory," *Management Science*, forthcoming.
https://doi.org/10.1287/mnsc.2023.03307
Direct link to the paper

{% **violation of certainty effect**: In their common consequence task, strangely enough, only 5% of the subjects violate independence in the usual direction of the certainty effect, and 45% does it in the opposite direction. %}

Baillon, Aurélien, Han Bleichrodt, Ning Liu, & Peter P. Wakker (2016) "Group Decision Rules and Group Rationality under Risk," *Journal of Risk and Uncertainty* 52, 99–116.
https://doi.org/10.1007/s11166-016-9237-8
Direct link to paper

{% This paper examines what reference points are, about the most central question in decision under risk. It is entirely revealed-preference based, using no other data. It starts from a general model in Eq. 6, which contains six of the most popular models of reference points, displayed in Table 12 (p. 96). It uses a data set (N = 139) obtained in Moldavia, where the average payoff per subject was about a day's salary. It uses advanced Hierarchical Bayesian data fitting. The status quo and the security level (maxmin: The maximum of all minima of available prospects) did best. Koszegi-Rabin type expectation-based reference points do not perform well. This is stated explicitly on p. 105.

The authors distinguish between prospect-specific (depending on the prospect and different for each of the prospects available for choice and choice specific, determined by the choice situation. They cite many studies into the location of reference points, and cite papers equating the Koszegi-Rabin approach with disappointment-theory approaches.

The reference points do not depend much on absolute wealth level (p. 104), and probability weighting is too important to be ignored (p. 104); consumption utility can be ignored. Prospect-specific models often violate stochastic dominance (p. 104). %}

Baillon, Aurélien, Han Bleichrodt, & Vitalie Spinu (2020) "Searching for the Reference Point," *Management Science* 66, 93–112.
https://doi.org/10.1287/mnsc.2018.3224

{% %}

Baillon, Aurélien, Laure Cabantous, & Peter P. Wakker (2012) "Aggregating Imprecise or Conflicting Beliefs: An Experimental Investigation Using Modern Ambiguity Theories," *Journal of Risk and Uncertainty* 44, 115–147.
https://doi.org/10.1007/s11166-012-9140-x
Direct link to paper

{% **source-dependent utility** is criticized here.
endogenous midpoints; this paper uses an endogenous utility-midpoint operation to give theorems on concave utility in great generality, e.g. doing the Yaari (1969) comparative risk aversion without requiring identical beliefs, and doing ambiguity aversion in the smooth model without requiring the unobservable subjective probabilities as input or requiring same risk attitudes. Section 3.4 gives an intuitive interpretation criticizing the smooth model and many other models:

"An objection can be raised when our preference condition in terms of utility midpoints is not just used to analyze utility, but is also interpreted as a condition for risk or ambiguity aversion. Our midpoint condition does not speak to the empirical nature of risk, timing (as in Kreps and Porteus' model), or ambiguity, unlike the conditions that other authors have used. However, (and this is our message) if a theory such as EU or recursive EU implies that our condition is still equivalent to the others, then this implication of the theory cannot be empirically appropriate, which raises doubts about the theory itself." %}

Baillon, Aurélien, Bram Driesen, & Peter P. Wakker (2012) "Relative Concave Utility for Risk and Ambiguity," *Games and Economic Behavior* 75, 481–489.
https://doi.org/10.1016/j.geb.2012.01.006
Direct link to paper

{% **ambiguity seeking for unlikely**: They use matching probabilities to measure ambiguity attitudes, and do it for unlikely events (smallest has a-neutral probability 0.005), where they find overweighting, giving ambiguity seeking for gains and ambiguity aversion for losses, all confirming the fourfold pattern of ambiguity. The also find lower and upper sub/superadditivity in agreement with a-insensitivity.

They use the Prince incentive system. %}

Baillon, Aurélien & Aysil Emirmahmutoglu (2018) "Zooming in on Ambiguity Attitudes," *International Economic Review* 59, 2107–2131. https://doi.org/10.1111/iere.12331

{% The authors test the random incentive system (RIS) for measuring ambiguity aversion. Treatments are between-subjects. The control treatment is one single choice only, the standard two-urn Ellsberg test, with proper control for suspicion by letting subjects choose winning color. Then there are two treatments where subjects make two choices. For each of the two colors, subjects must choose between the known (K) and unknown (U) urn. The unknown urn has a somewhat higher prize, so that observed ambiguity aversion is strict. In the control treatment, 50% was ambiguity averse. In the treatments, averaged, KK (27%), KU (23%), UK (9.5%), UU (41.5%) (Figure 2.4). Remarkable is the small number of UK choices. That is, the deviation from random choice is that subjects in the treatment groups who at first chose U, often also did so the second time. It is a clear spillover effect, confounding the RIS measurement. It means that the RIS deviates from the control treatment, giving some less ambiguity aversion.

As the authors point out, they chose a framing of the stimuli that enhances integration effects and violations of RIS. In this sense, the finding is not very surprising. The more critical question is how RIS performs in best framing, not in worst framing. But this paper shows the principled point that the RIS can bring distortions, and that one has to watch out.

The paper did some other experiments to check. For instance, determining the real choice situation beforehand (but unknown to subjects) or after did not matter. It cites much literature. %}

Baillon, Aurélien, Yoram Halevy, & Chen Li (2022) "Randomize at Your Own Risk: On the Observability of Ambiguity Aversion," *Econometrica* 90, 1085–1107. https://doi.org/10.3982/ECTA18137

{% Hedging can occur in ambiguity measurements using the random incentive system if the implemented choice randomization is taken ex post, but not if taken ex ante. This paper derives this theoretically by embedding it in ambiguity theories and then theoretically resolving in those ambiguity theories. %}

Baillon, Aurélien, Yoram Halevy, & Chen Li (2022) "Experimental Elicitation of Ambiguity Attitude Using the Random Incentive System," *Experimental Economics* 25, 1002–1023.
https://doi.org/10.1007/s10683-021-09739-2

{% **cognitive ability related to likelihood insensitivity (= inverse S)**: They (well, "we") show that time pressure reduces the cognitive a(mbiguity generated) insensitivity, but find a H_0 of unaffected ambiguity aversion, which is motivational rather than cognitive. %}
Baillon, Aurélien, Zhenxing Huang, Asli Selim, & Peter P. Wakker (2018) "Measuring Ambiguity Attitudes for All (Natural) Events," *Econometrica* 86, 1839–1858.
http://dx.doi.org/10.3982/ecta14370
Direct link to paper

{% Sadness moves people to ambiguity neutrality, unlike joy, fear, and control group. Abmiguity aversion was measured as 0.5–p where p is the matching probability of the unknown two-color Ellsberg urn. (Study 2 has a-neutral probabilities 1/3 and 2/3.) Emotions are induced by movies. %}
Baillon, Aurélien, Philipp D. Koellinger, & Theresa Treffers (2016) "Sadder but Wiser: The Effects of Emotional States on Ambiguity Attitudes," *Journal of Economic Psychology* 67, 67–82.

{% An exemplary study of WTP and risk attitudes for health insurance of a valuable sample of Philipino households, using the tools of prospect theory, with clear applied relevance. The authors split up the risk premium into (1) belief premium: due to misperception of probabilities (2) weighting premium: due to nonlinear weighting of probabilities (3) utility premium: due to nonlinear utility (4) residual. It is somewhat reminiscent of the cited Hilton (1988). A typical finding here is that people take too little insurance, even if it is subsidized and actuarially fair, and have too low WTP. The authors investigate which factors contribute how and what to do about that. It is well-known that biases push WTP down, and I did not read the paper close enough to see how it handles this. Maybe it is

considered part of the residual premium, which captures about half as much as the risk attitude premiums.

P. 49 discusses the order of calculating the premiums.

Pp. 48-50, end of intro, summarizes the findings. The median belief premium is about 0. Utility and probability premiums are negative, as with prospect theory's risk seeking for losses, and explaining part of the overly low WTPs. But median utility and probability premiums seem to e close to 0. %}

Baillon, Aurélien, Aleli Kraft, Owen O'Donnell, & Kim van Wilgenburg (2022) "A Behavioral Decomposition of Willingness to Pay for Health Insurance," *Journal of Risk and Uncertainty* 64, 43–87. https://doi.org/10.1007/s11166-022-09371-2

{% A difficulty of working with the Pratt-Arrow index of absolute risk aversion is that it cannot be readily derived from a (small) finite number of observed indifferences, but that it requires parametric fitting. This paper provides a discrete approximation. Let $\alpha_E\mu$ denote an act assigning outcome α to event E and μ to event E^c. The paper uses indifferences $\alpha_E\mu \sim \beta_E\nu$ and $\beta_E\mu \sim \gamma_E\nu$ to define β as the endogenous midpoint of α and γ. Under EU, also with subjective probabilities, it implies that β indeed is the U midpoint between α and γ. We write $m(\alpha,\gamma) = \beta$. Assume $\gamma \succcurlyeq \alpha$. The index $A(\alpha,\gamma)$ is defined as $\frac{1}{m-\alpha} - \frac{1}{\gamma-m}$. It can be seen that it is a discrete approximation of the Pratt-Arrow index. The index can be used for many purposes.

Many authors use ad hoc indexes of risk aversion, such as normalized risk premiums, but this normalization is, in a way, not at the right order of magnitude, where the index for instance tends to risk neutrality simply if the interval $[\alpha,\gamma]$ gets small. The index of this paper does not suffer from that and is at a good order of magnitude. (See p. 1385, end of §3.)

Theorem 1 shows that, under common assumptions, for two states of nature, subjective expected utility holds if and only if the index satisfies a consistency condition. Theorem 2 shows that a comonotonic consistency condition holds if and only if biseparable utility holds. Theorem 3 and Table 1 list many conditions that can be characterized using the index, such as risk aversion and comparative risk aversion. %}

Baillon, Aurélien & Olivier L'Haridon (2021) "Discrete Arrow–Pratt Indexes for Risk and Uncertainty," *Economic Theory* 72, 1375–1393.
https://doi.org/10.1007/s00199-020-01315-8

{% Whereas Machina (2009) devised a paradox only for rank-dependent utility (also called CEU = Choquet expected utility), this paper shows that it is a paradox for virtually every ambiguity theory existing today in the Anscombe-Aumann framework. As an aside, if we abandon the Anscombe-Aumann framework, then Machina's paradox is only for RDU and no more for the other models. %}

Baillon, Aurélien, Olivier l'Haridon, & Laetitia Placido (2011) "Ambiguity Models and the Machina Paradoxes," *American Economic Review* 101, 1547–1560.

{% Show a generalization of Yaari's acceptance condition for more concave utility that also works under different beliefs and different state spaces for the two agents. In particular, it can be used for within-subject between-source comparisons of utility. Thus, it can characterize ambiguity aversion for KMM's smooth ambiguity model. The condition works as follows:

Let $\{E_1,\ldots,E_n\}$ be a partition for agent A, and

$\{F_1,\ldots,F_n\}$ a partition for agent B. $x_1,\ldots,x_n$ denote outcomes. Π is generic for a permutation of $1,\ldots,n$. f is an act depending on $E_1,\ldots,E_n$. g is an act depending on $F_1,\ldots,F_n$. $\Pi(f)$ is the act with $x_1,\ldots,x_n$ assigned to the Π permuted events and $\Pi(g)$ is similar. For instance, if Π does nothing but interchange 1 and 2, then $\Pi(g) = (F_1{:}x_2, F_2{:}x_1, F_3{:}x_3, \ldots F_n{:}x_n)$.

z is generic notation of a constant act, and >= denotes preference. If events $E_1, .., E_n$ are exchangeable, i.e., preference-symmetric, then $f \sim \Pi(f)$ for every Π. We assume SEU for both agents. Imagine that we have

$z \succcurlyeq_A \Pi(f)$ for all Π $\Rightarrow$ $z \prec_B \Pi'(g)$ for all Π'. Then, even for the most risk-favoring Π and the least risk-favoring Π', $\succcurlyeq_A$ seeks more certainty than $\succcurlyeq_B$. It cannot be that $\succcurlyeq_B$ is more risk averse than $\succcurlyeq_A$. It turns out that excluding this case is not only necessary, but also sufficient, for u_B to be more concave than u_A, whenever there exist uniform partitions $\{E_1, \ldots, E_n\}$ and $\{F_1, \ldots, F_n\}$. The result is easier to state for n = 2, and such versions can also be invoked for general state spaces.

The above condition is alternative to Yaari (1969), allowing for different beliefs and even state spaces. Baillon, Driesen, & Wakker (2012) achieve this in a different manner, using endogenous utility midpopints. The result can also be used to axiomatize ambiguity aversion in KMM's smooth ambiguity model, or in source-dependent SEU of Chew et al. (2008). Or for Kreps-Porteus (1978). %}

Baillon, Aurélien, Ning Liu, & Dennie van Dolder (2017) "Comparing Uncertainty Aversion toward Different Sources," *Theory and Decision* 83, 1–18.

{% This paper tests constant absolute and constant relative ambiguity aversion w.r.t. utility changes. It does so in the Anscombe-Aumann framework, relying on expected utility. The stimuli did not involve two-stage acts (which are hard to process for subjects), but single-stage Ellsberg urn bets where for instance a constant increase in utility was induced by adding to the ambiguous winning event an unambiguous event (color with known proportion). %}

Baillon, Aurélien & Laetitia Placido (2019) "Testing Constant Absolute and Relative Ambiguity Aversion," *Journal of Economic Theory* 181, 309–332.

{% The authors empirically test the preference conditions of Baillon (2017 EJ), based on the Anscombe-Aumann framework. They find majority ambiguity aversion, prudence, and temperance.

They use the Prince incentive system. %}

Baillon, Aurélien, Harris Schlesinger, & Gijs van de Kuilen (2018) "Measuring Higher Order Ambiguity Preferences," *Experimental Economics* 21, 233–256.

{% %}

Baillon, Aurélien, Asli Selim, & Dennie van Dolder (2012) "On the Social Nature of Eyes: The Effect of Social Cues in Interaction and Individual Choice Tasks," *Evolution and Human Behavior* 34, 146–154.

{% Develop a theoretical model, and experimental data (hypothetical choice) for insurance decisions (so, losses), that people want more insurance, but less of precautionary measures, if ambiguity increases. They do not discuss a-

insensitivity, but that fits perfectly well with these results. (**inverse S negatively related to prevention**) %}

Bajtelsmit, Vickie, Jennifer C. Coats, & Paul Thistle (2015) "The Effect of Ambiguity on Risk Management Choices: An Experimental Study," *Journal of Risk and Uncertainty* 50, 249–280.

{% The authors are incompetent and have no clue what prospect theory is about. A big success of PT, explaining the co-existence of gambling and insurance by overweighting of small probabilities is completely missed by the authors, who think that these things violate PT. There is worse, but let me stop here. %}

Baker, Ardith, Teresa Bittner, Christos Makrigeorgis, Gloria Johnson & Joseph Haefner (2010) "Teaching Prospect Theory with the Deal or No Deal Game Show," *Teaching Statistics* 32, 81–87.

{% Consider expert aggregation of composite probabilities, and compare aggregations of averages with averages of aggregations, by theoretical analysis, simulation, and real data. The former has smaller errors and mostly is larger. The authors suggest the former as gold standard. But this may depend much on the error theory and particular aggregation considered. %}

Baker, Erin & Olaitan Olaleye (2012) "Combining Experts: Decomposition and Aggregation Order,"

{% Measured monetary discounting from hypothetical choice, and related it to smoking. %}

Baker, Forest, Matthew W. Johnson, Warren K. Bickel (2003) "Delay Discounting in Current and Never-before Cigarette Smokers: Similarities and Differences across Commodity, Sign, and Magnitude," *Journal of Abnormal Psychology* 112, 382–92.

{% %}

Baker, Frank B. & Lawrence Hubert (1977) "Applications of Combinatorial Programming to Data Analysis: Seriation Using Asymmetric Proximity Measures," *British Journal of Mathematical and Statistical Psychology* 30, 154–164.

{% Nice description of the meaning of the value of a statistical life %}
Baker, Rachel, Susan Chilton, Michael Jones-Lee, & Hugh Metcalf (2008) "Valuing Lives Equally: Defensible Premise or Unwarranted Compromise?," *Journal of Risk and Uncertainty* 36, 125–138.

{% %}
Baker, Scott R., Nicholas Bloom, & Steven J. Davis (2016) "Measuring Economic Policy Uncertainty," *Quarterly Journal of Economics* 131, 1593–1636.

{% Propose to do statistical testing with true positive, true negative, false positive, false negative, assigning utilities to these outcomes and then using expected utility. Give medical application. %}
Baker, Stuart G., Nancy R. Cook, Andrew Vickers, & Barnett S. Kramer (2009) "Using Relative Utility Curves to Evaluate Risk Prediction," *Journal of the Royal Statistical Society: Series A (Statistics in Society)* 172, 729–748.

{% **Z&Z** %}
Bakker, Frank M. (1997) "Effecten van Eigen Betalingen op Premies voor Ziektekostenverzekeringen," Ph.D. dissertation, Erasmus University, Rotterdam.

{% **proper scoring rules**: They test scoring rules for multiple choice questions where not just right answers get score 1 and wrong answers and nonresponses all get score 0, which encourages random answering if not knowing, but scoring systems where wrong answering is punished by getting a lower score than nonresponse. Their novelty is that they distinguish gain- versus loss framing and that they do it in the field, with scores on exams with university students—I wonder if ethical commitees can approve of such experiments with something as serious as student grading.

Given that, according to loss aversion, losses are perceived more strongly than gains, one may expect improved performance and less nonresponse (random answering was better than not answering), the more so as studies by Yechiam and co-authors (e.g., Yechiam, Retzer, Telpaz, & Hochman 2015) suggest better motivation and performances under losses. The reduction of nonresponse is confirmed, but for the former there is even a nonsignificant tendency to the opposite. The authors, at the end, only cite studies that suggest that losses impair performance, contrary to findings by Yechiam, and cite Yechiam only for another point.

I expect that there is much related work in psychological literature on education, as for instance in Kaernbach (2001). Related, in probably relevant journals, are Budescu & Bar-Hillel (1993), and Echternacht (1972). %}

Balart, Pau, Lara Ezquerra, & Iñigo Hernandez-Arenaz (2022) "Framing Effects on Risk-Taking Behavior: Evidence from a Field Experiment in Multiple-Choice Tests," *Experimental Economics* 25, 1268–1297. https://doi.org/10.1007/s10683-022-09748-9

{% Seems to present in incorrect proof making the mistakes that Wakker (1993 JME) warned against. %}

Balasubramanian, Anirudha (2015) "On Weighted Utilitarianism and an Application," *Social Choice and Welfare* 44, 745–763.

{% %}

Balch, Michael & Peter C. Fishburn (1974) "Subjective Expected Utility for Conditional Primitives." *In* Michael S. Balch, Daniel L. McFadden, & Shih-Yen Wu (eds.) *Essays on Economic Behaviour under Uncertainty*, 57–69, North-Holland, Amsterdam.

{% In general, power (CRRA) utility fits data better than exponential (CARA) utility. However, power utility has analytical problems when defining loss aversion under prospect theory in the usual way (unless same power for gains and losses). See, e.g., Wakker (2010 p. 338-342, §9.6). This usual way is to take one normalization outcome $\alpha > 0$ with assumed $u(\alpha) = 1$, $u(-\alpha) = -1$, and set $\lambda = -U(-\alpha)/U(\alpha)$. Then λ can depend entirely on the α chosen with power utility. This paper proposes to take a weighted average over many α, where the αs range over a domain relevant for the applications considered, weighted according to importance/relevance. This is a nice idea. Data come from Ghanaian farmers. Data fitting shows that α can still be very volatile, e.g., w.r.t. power. The authors

argue that one should not sacrifice fit (by giving up power utility) to get a stable loss aversion parameter.

Utility is concave for gains and convex for losses, but is closer to linear for losses than for gains. (**concave utility for gains, convex utility for losses**)

They strongly confirm inverse S probability weighting but, because they fit Prelec two-parameter CI family, there is not much space for other shapes. (**inverse S**). They also find that parameters interact, with the estimation of loss aversion and also of probability weighting depending on the utility family used. %}

Balcombe, Kelvin, Nick Bardsley, Sam Dadzie, & Iain Fraser (2019) "Estimating Parametric Loss Aversion with Prospect Theory: Recognising and Dealing with Size Dependence," *Journal of Economic Behavior and Organization* 162, 106–119.

{% Re-analyze the data of Stott (2006) using Bayesian techniques, with a prior distribution chosen. His stimuli are not fully representative because they always concern a choice between two two-outcome prospects where one of the two has one outcome equal to 0 (p. 112 3rd para). Consider only gains. Fit PT (referring to the new 1992 version that is sometimes called CPT, but that Tversky and I prefer to call PT), which now agrees with RDU, but also Birnbaum's RAM and TAX models and the priority heuristic. Use more sophisticated error theories and Bayesian fitting techniques than Stott did.

They find that PT fits best. Power utility by far best fits rather than exponential or Saha's powerexpo (**decreasing ARA/increasing RRA**). Utility is concave, as is to be expected. For representative agent, probability weighting is more concave (optimistic) than inverse S (**inverse S**; **risk seeking for small-probability gains**). At the individual level, there is much heterogeneity in probability weighting. Much heterogeneity is confirmed by representative agent being firmly rejected. P. 184 writes that probability weighting is less stable than utility.

For error theory, Wilcox's (2011) contextual utility works best.

For a minority of subjects, linear probability weighting (so, EU) fits best, but for majority probability weighting is better.

Whereas Stott's analysis gave Prelec's one-parameter family as best, the alternative analysis of this paper gets two-parameter families as better. %}

Balcombe, Kelvin & Iain Fraser (2015) "Parametric Preference Functionals under Risk in the Gain Domain: A Bayesian Analysis," *Journal of Risk and Uncertainty* 50, 161–187.

{% %}

Baldassi, Carlo, Simone Cerreia-Vioglio, Fabio Maccheroni, Massimo Marinacci, & Marco Pirazzini (2020) "A Behavioral Characterization of the Drift Diffusion Model and its Multi-Alternative Extension for Choice under Time Pressure," *Management Science* 66, 5075–5093.

{% Study polarization, showing it cannot happen under the Bayesian model, but it can through hedging effects in the smooth model. Crucial for the result is that it refers to the 2nd order probability of the smooth model as capturing beliefs. Hence, it is not easily extendable to other ambiguity models, as the authors point out on p. 3083. %}

Baliga, Sandeep, Eran Hanany, & Peter Klibanoff (2013) "Polarization and Ambiguity," *American Economic Review* 103, 3071–3083. http://dx.doi.org/10.1257/aer.103.7.3071

{% Moulin showed this paper to me on September 17, 1990, as nice and simple access to rounding methods in voting theory.

Simple rounding methods, may be of use for my integer-fair/proportional division method. %}

Balinsky, Michel L. & H. Peyton Young (1980) "The Webster Method of Apportionment," *Proceedings of the National Academy of Sciences USA, Applied Mathematical Sciences* 77, 1–4.

{% %}

Balinsky, Michel L. & H. Peyton Young (1982) "*Fair Representation.*" Yale University Press, New Haven.

{% %}

Balk, Bert M. (1995) “Axiomatic Price Index Theory: A Survey,” *International Statistical Review* 63, 1, 69–93.

{% **ambiguous outcomes vs. ambiguous probabilities**: Consider vague descriptions not only of probabilities but also of outcomes. Find no support for the loss aversion/endowment explanation of preference reversals. In the matching measurements, the sure outcome is less likely to serve as a reference point than it is for choice lists. %}

Ball, Linden J., Nicholas Bardsley, & Tom Ormerod (2012) “Do Preference Reversals Generalise? Results on Ambiguity and Loss Aversion,” *Journal of Economic Psychology* 33, 48–57.

{% People are asked to predict the risk attitudes of others. Attractive, tall, and male (**gender differences in risk attitudes**) people are predicted to be more risk seeking, but the predictions overestimate those effects. %}

Ball, Sheryl, Catherine C. Eckel, & Maria Heracleous (2010) “Risk Aversion and Physical Prowess: Prediction, Choice and Bias,” *Journal of Risk and Uncertainty* 41, 167–193.

{% %}

Balla, John I., Arthur S. Elstein, & Caryn Christensen (1988) “Obstacles to Acceptance of Clinical Decision Analysis,” *British Medical Journal* 4, 579–539.

{% Seems to be a good text on differences between within- and between-subject designs. %}

Ballinger, T. Parker & Nathaniel T. Wilcox (1997) “Decisions, Error and Heterogeneity,” *Economic Journal* 107, 1090–1105.

{% Use certainty equivalent method of fifty-fifty prospects to measure risk aversion of highschool adolescents (fit EU with power utility). No real incentives. It finds strong peer effects for men, where risk attitude is affected much by peers, but not for women. %}

Balsa, Ana I., Néstor Gandelman, & Nicolás González (2015) “Peer Effects in Risk Aversion,” *Risk Analysis* 35, 27–43.

{% random incentive system; **random incentive system between-subjects** (paying only some subjects) %}

Baltussen, Guido, Thierry Post, Martijn J. van den Assem, & Peter P. Wakker (2012) "Random Incentive Systems in a Dynamic Choice Experiment," *Experimental Economics* 15, 418–443.

https://doi.org/10.1007/s10683-011-9306-4

Direct link to paper

{% **PT falsified**: This paper shows that a majority prefers, with probabilities 1/4 not written, the prospect

(–1000, –800, 1200, 1600) to the prospect (–1000, –800, 800, 2000). The choice is a nice combination of choices considered in several revent papers by Levy & Levy (2002 Management Science) but, contrary to the latter, the authors analyze the choice correctly, and establish a clear violation of PT. %}

Baltussen, Guido, Thierry Post, & Pim van Vliet (2006) "Violations of CPT in Mixed Gambles," *Management Science* 52, 1288–1290.

{% Seem to measure loss aversion under both risk and ambiguity. Find difference in the limelight, and not outside the limelight. %}

Baltussen, Guido, Martijn J. van den Assem, & Dennie van den Dolder (2016) "Risky Choice in the Limelight," *Review of Economics and Statistics* 98, 318–332.

{% **foundations of probability** %}

Bamber, Donald (2003) "What is Probability," Book Review of: Donald Gillies (2000) Philosophical Theories of Probability, Routledge, London; *Journal of Mathematical Psychology* 47, 377–382.

{% %}

Banach, Stefan & Kazimierz Kuratowski (1929) "Sur une Généralisation du Problème de la Mesure," *Fundamentà Mathematicae* 14, 127–131.

{% **Prospect theory not cited**;

An extensive study. Risk attitudes were measured once, and then again 12 weeks later. Here, as often, I regret that the authors did not also measure insensitivity, which is so easy to do and gives so many more insights. %}

Bandyopadhyay, Anwesha, Lutfunnahar Begum, & Philip J. Grossman (2021) “Gender Differences in the Stability of Risk Attitudes,” *Journal of Risk and Uncertainty*,” (2021) 63, 169–201.
https://doi.org/10.1007/s11166-021-09361-w

{% **revealed preference** %}

Bandyopadhyay, Taradas (1988) “Revealed Preference Theory, Ordering and the Axiom of Sequential Path Independence,” *Review of Economic Studies* 55, 343–351.

{% **revealed preference** %}

Bandyopadhyay, Taradas (1990) “Revealed Preference and the Axiomatic Foundations of Intransitive Indifference: The Case of Asymmetric Subrelations,” *Journal of Mathematical Psychology* 34, 419–434.

{% **revealed preference** %}

Bandyopadhyay, Taradas & Kunal Sengupta (1989) “The Strong Axiom of Revealed Preference and Path Independent Choice,” Graduate School of Management, University of California, Riverside, CA 92521.

{% **revealed preference** %}

Bandyopadhyay, Taradas & Kunal Sengupta (1991) “Semiorders and Revealed Preference,” Graduate School of Management, University of California, Riverside, CA 92521.

{% Consider preference relations on Re^M for $M \in \mathbb{N}$. Necessary and sufficient conditions for representation by a general function. %}

Banerjee, Kuntal (2014) “Choice in Ordered-Tree-Based Decision Problems,” *Social Choice and Welfare* 43, 497–506.

{% Corrects Theorem 1 in Gerasimou (2021); Gerasimou (2022) provides further comments. Characterizes preference intensity through weak ordering, reversal and lateral consistency. Note that Gerasimou and, accordingly, this paper do not consider a function-difference representation $((x_1,x) \mapsto (U(x_1) - U(x_2))$, but more general representations. %}

Banerjee, Kuntal (2022) "Corrigendum to 'Simple Preference Intensity Comparisons,' [J. Econ. Theory 192 (2021) 105199]," *Journal of Economic Theory* 204, 105519. https://doi.org/10.1016/j.jet.2022.105519

{% Consider preference relations on Re^{Na} that satisfy continuity and exchangeability ("anonymity;" zero discounting), and characterize the weakest continuity conditions that can apply. %}

Banerjee, Kuntal & Tapan Mitra (2007) "On the Continuity of Ethical Social Welfare Orders on Infinite Utility Streams," *Social Choice and Welfare* 30, 1–12.

{% **revealed preference**: test generalized axiom of revealed preference. %}

Banerjee, Samiran & James H. Murphy (2006) "A Simplified Test for Preference Rationality of Two-Commodity Choice," *Experimental Economics* 9, 67–75.

{% This paper criticizes Oprea (2024 AER). It argues that his experiment has much noise, with most subjects not even understanding the stimuli. Further, that there are more differences between the lottery preferences and the mirror preferences than suggested by Oprea. In particular so for the subgroup of subjects who understood the stimuli. %}

Banki, Daniel, Uri Simonsohn, Robert Walatka, & George Wu (2025) Decisions under Risk Are Decisions under Complexity: Comment, working paper. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=5127515

{% In hypothetical experiment inform patients about uncertainty about probability estimates (ambiguity), and see how this impacts patients' decisions, where it increases aversion. Qualitative descriptions of vagueness are better understood than quantitative. %}

Bansback, Nick, Mark Harrison, & Carlo Marra (2016) "Does Introducing Imprecision around Probabilities for Benefit and Harm Influence the Way People Value Treatments," *Medical Decision Making* 36, 490–502.

{% %}
Banzhaf, H. Spencer (2014) "The Cold-War Origins of the Value of Statistical Life," *Journal of Economic Perspectives* 28, 213–226.

{% They measure ambiguity aversion/neutrality/seeking through matching probabilities for unknown Ellsberg urn. Find great majority ambiguity aversion. Experiment shows that market prices overreact to bad news and underreact to good news, most so in prediction markets. Ambiguity-averse subjects overestimate variance of favorable signal relative to unfavorable signal. %}
Bao, Te, John Duffy, & Jiahua Zhu (2024) "Information Ambiguity, Market Institutions, and Asset Prices: Experimental Evidence," *Management Science*, forthcoming.
https://doi.org/10.1287/mnsc.2022.01223

{% **RCLA**: violated; conjunctive and disjunctive probability bias %}
Bar-Hillel, Maya (1973) "On the Subjective Probability of Compound Events," *Organizational Behavior and Human Performance* 9, 396–406.

{% %}
Bar-Hillel, Maya & David V. Budescu (1995) "The Elusive Wishful Thinking Effect," *Thinking and Reasoning* 1, 71–104.

{% **producing random numbers** %}
Bar-Hillel, Maya & Willem A. Wagenaar (1991) "The Perception of Happiness," *Advances in Applied Mathematics* 12, 428–454.

{% Analyse prognostics using belief functions. %}
Baraldi, Piero, Francesca Mangili, Enrico Zio (2015) "A Belief Function Theory Based Approach to Combining Different Representation of Uncertainty in Prognostics," *Information Sciences* 303, 134–149.

{% Consider cases of experts giving different judgments. Calculate through a Bayesian analysis, and then an analysis based on Dempster-Shafer belief functions. Are positive about the latter. %}

Baraldi, Piero & Enrico Zio (2010) “A Comparison between Probabilistic and Dempster-Shafer Theory Approaches to Model Uncertainty Analysis in the Performance Assessment of Radioactive Waste Repositories,” *Risk Analysis* 30, 1139–1156.

{% Test updating in two tasks with children and young adults. Optimal behavior in the two tasks is very simple though. In Task 1, one should gamble on the color observed most. In Task 2, one color is clearly superior no matter what is observed. Yet, young children often deviate from the optimal strategies and the authors analyze several alternative strategies, such as gambling on the last color observed. They use the term “evolutionary” in a strange manner. As I see it, everything comes from evolution and everything can be called evolutionary. However, they use it for the silly heuristic of gambling on the last color observed. They put up a strawman hypothesis: that we are born as Bayesians but at growing older more and more learn to do irrational heuristics. They, of course, find the opposite: the older the more Bayesian/rational. At least from child to young adult.

The authors often refer to which grade school children in the US in 2018 have and (almost) never to age, making it hard for readers from other places or times what that means.

The primary heuristic that I expect to be going on here is never mentioned, i.e., probability matching (Bitterman 1965): not doing the rational thing of always choosing highest probability of winning, but instead randomizing and choosing the highest probability of winning only with that same probability.

Nice for me, Bayesian, to read on p. 305 that the authors consider Bayesianism to be normative. %}

Barash, Jori, Isabelle Brocas, Juan D. Carrillo, & Niree Kodaverdian (2019) “Heuristic to Bayesian: The Evolution of Reasoning from Childhood to Adulthood,” *Journal of Economic Behavior and Organization* 159, 305–322.

{% **ordering of subsets**; **principle of complete ignorance** %}

Barberà, Salvador, Walter Bossert, & Prasanta K. Pattanaik (2004) "Ranking Sets of Objects." *In* Salvador Barberà, Peter J. Hammond, & Christian Seidl (eds.) *Handbook of Utility Theory, Vol. 2, Extensions*," 893–977, Kluwer Academic Publishers, Dordrecht.

{% %}

Barberà, Salvador, Peter J. Hammond, & Christian Seidl (1998, eds.) *Handbook of Utility Theory, Vol. 1, Principles*. Kluwer Academic Publishers, Dordrecht.

{% %}

Barberà, Salvador, Peter J. Hammond, & Christian Seidl (2004, eds.) *Handbook of Utility Theory, Vol. 2, Extensions*. Kluwer Academic Publishers, Dordrecht.

{% **principle of complete ignorance** %}

Barberà, Salvador & Mathew O. Jackson (1988) "Maximin, Leximin and the Protective Criterion," *Journal of Economic Theory* 46, 34–44.

{% **ordering of subsets**; add to the result of Kannai & Peleg (1984). %}

Barberà, Salvador & Prasanta K. Pattanaik (1984) "Extending an Order on a Set to the Power Set: Some Remarks on Kannai and Peleg's Approach," *Journal of Economic Theory* 32, 185–191.

{% %}

Barberà, Salvador, Hugo F. Sonnenschein, & Lin Zhou (1991) "Voting by Commitees," *Econometrica* 59, 595–609.

{% **dynamic consistency**; In PT person will prefer long-shot gamble as soon as w´(0) > λ; i.e., probability weighting at 0 can dominate loss aversion. Thus, betting on one number in roulette may already be preferred. Even if only 50-50 bets, the topic of this paper, PT people may prefer it by repeating them, say, 5 times, generating a small (1/32) probability that generates the overweighting. However, this is if prior perspective. If such people involve in playing some rounds then after 3 rounds of winning they face a probability of only ¼ of winning in the next

two rounds, and may decide to drop out, violating dynamic consistency. The mix of prior evaluation, dynamic inconsistency, and naivity can lead people to all kinds of irrationalities such as continuing playing after losing but stopping after gaining, all opposite to prior plans. The author, like me, uses the term prospect theory instead of cumulative prospect theory (footnote 1).

P. 39 end of §2: the author interprets transformed probabilities not as misperceptions, but as deliberate weighting.

Final sentence of paper is very positive about probability weighting:

"Taken together with this prior research, then, our paper suggests that casino gambling is not an isolated phenomenon requiring its own unique explanation, but rather that it is one of a family of empirical facts, all of which are driven by the same underlying mechanism: probability weighting." %}

Barberis, Nicholas C. (2012) "A Model of Casino Gambling," *Management Science* 58, 35–51.

{% **PT, applications**: lucid survey of PT accessible to a wide audience.

Abstract, p. 173: "More than 30 years later, prospect theory is still widely viewed as the best available description of how people evaluate risk in experimental settings." (**PT/RDU most popular**)

Abstract: "I am optimistic that some insights of prospect theory will eventually find a permanent and significant place in mainstream economic analysis." (**PT/RDU most popular**)

Abstract: "The fundamental difficulty in applying prospect theory in economics is that, even if we accept that the carriers of utility are gains and losses, it is often unclear what a gain or loss represents in any given situation."

P. 173 last para, and some other places p. 178 3rd para), write that PT hasn't been applied as much as one might expect mostly because it is not very clear how to apply it, mostly because of the difficulty of what the reference point is.

P. 174 middle prefers the new 1992 PT (better notation than the author's, and common, CPT) to the OPT of 1979.

P. 174: the author only describes PT for risk, with no mention that it was extended to uncertainty/ambiguity. P. 180 2nd para repeats it.

P. 174 bottom takes PT as depending only on changes w.r.t. reference point, and as if independent from initial wealth. This deviates from PT of Tversky &

Kahneman (1992), who allowed value and probability weighting to be different for different reference points. P. 179 end of 3rd para correctly retraces here.

P. 175 last para incorrectly writes as if diminishing sensitivity refer only to the value function, whereas Tversky & Kahneman apply it also to probability weighting.

utility concave near ruin: p. 175 footnote 2.

The paper puts the model of Köszegi & Rabin very central.

P. 177 bottom claims that Kahneman and Tversky emphasize that transformed probabilities do not represent erroneous beliefs but this is not correct because K&T do not commit to one or the other.

P. 179 end of 2nd para (also 192 1st para) do not follow Köszegi & Rabin on expectation as reference point: "in financial settings, a reference point such as the risk-free rate may be at least as plausible as one based on expectations." P. 192 1st para repeats the point, suggesting that in finance people may take some natural levels as reference points, rather than expectations.

P. 180 writes that PT has been most applied to finance; p. 190 writes that not much in health economics; p. 191 writes that to finance and insurance.

P. 183 writes on disposition effect, and studies looking into reflection but, apparently, not into probability weighting.

P. 190 gives some references that negative incentives have more effect than positive ones.

P. 191 bottom suggests that diminishing sensitivity, which in the author's terminology only refers to utility curvature, is less important than the other components reference dependence, loss aversion, and probability weighting. One thing that is important about it is that it is the only rational component!

P. 192 explicitly leaves open that PT may be rational: "because we do not, as yet, have a full understanding of whether loss aversion or probability weighting should be thought of as mistakes." I Bayesian see these things differently!

P. 192 footnote 13 claims that narrow framing is widely viewed as a mistake. Note that Tversky & Kahneman (1981) discusses discrepancies such as between narrow and wide framing and that the, subtle, underlying message is that what is really wrong is that we deviate too much from expected value.

A few things that I would present differently:

(1) This paper exclusively focuses on risk with given probabilities. P. 180:

"Prospect theory is, first and foremost, a model of decision-making under risk." An important innovation of the 1992 paper, expressed in its title (using the term uncertainty rather than risk as in 1979) is the extension to uncertainty/ambiguity. But, indeed, there have hardly been applications of the latter yet, it yet requiring further theoretical work–which is my main research interest today. (2015)

(2) P. 174 uses the unfortunate notation with negative indexes as T&K'92 did, and as Tversky regretted after (personal communication). Although T&K indeed ordered outcomes from low to high, the prevailing and recommended ordering is from high to low, with $x_1 \geq \cdots \geq x_n$, and $x_k \geq 0 \geq x_{k+1}$.

(3) P. 174 bottom claims that PT evaluates outcomes merely as changes wrt the reference point, independently of final wealth, so, independently of what the reference point is. This is not correct, but it is a widespread misunderstanding. Kahneman & Tversky (1979) write about this on p. 277, for instance: "The emphasis on changes as the carriers of value should not be taken to imply that the value of a particular change is independent of initial position."

(4) P. 175 last para, & p. 191 last para: The author erroneously has the term diminishing sensitivity refer exclusively to the utility/value of outcomes, as it is also commonly taken in the decision-from-experience (DFE) literature. It is a general phenomenon on numerical perception that as much concerns probability weighting. (T&K'92 p. 303 2nd para: "The principle of diminishing sensitivity applies to the weighting functions as well.")

(5) P. 177 ℓ. −2 writes: "Kahneman and Tversky emphasize that the transformed probabilities π_i do not represent erroneous beliefs; rather, they are decision weights." There is one sentence, if I remember right, where K&T make such a suggestion, but it is not really the belief of Tversky. He thought that it could be both misperceived probabilities and weighting for other reasons, and several parts in the K&T paper write this. %}

Barberis, Nicholas C. (2013) "Thirty Years of Prospect Theory in Economics: A Review and Assessment," *Journal of Economic Perspectives* 27, 173–195. https://doi.org/10.1257/jep.27.1.173

{% A short and very accessible version of Barberis (2013 JEP), pleaing for the importance of probability weighting. P. 611 2nd para mentions the two-stage model by Fox & Tversky. P. 621 penultimate para claims that the probability weighting function transforms subjective probabilities, but in common terminologies it is objective probabilities. Abdellaoui et al. (2011 American Economic Review) have what they call source function, which transforms choice-based probabilities (which will usually not reflect beliefs). Fox & Tversky tried to use the risk-probability-weighting function to transform introspective subjective probability estimates, but this is a strong empirical hypothesis to be tested, rather than standard terminology.

P. 611 footnote 1 states, in my terminology, that the 1979 OPT is outdated and we should use the modern 1992 PT (what many people call CPT).

P. 612 2nd para end claims that there is more evidence for probability weighting than for loss aversion, but I see this differently. It is true, as explained in footnote 2, that loss aversion is more volatile and, hence, it may be argued (although debatable) that it is less suited to make predictions.

P. 613 §II discusses overweighting versus underweighting of rare events.

P. 614 footnote 5 argues that probability weighting does not concern beliefs. People discuss this point, even for objective probabilities. Probability weighting may reflect numerical misperception, and this can concern belief. %}

Barberis, Nicholas C. (2013) "The Psychology of Tail Events: Progress and Challenges," *American Economic Review, Papers and Proceedings* 103, 611–616.

{% Paper on Thaler's Nobel prize. P. 662 mentions four factors. I disagree from the author in that I think that only the third factor "they found ways of helping people to make better economic decisions" is where Thaler is exceptional. But then, so exceptional and valuable, that I think it was enough for the Nobel prize. P. 668 writes: "It is here that Thaler had his single most influential insight. In the 1970s, after discovering that, unbeknownst to economists, psychologists –most notably Kahneman and Tversky – had been cataloguing the ways in which people depart from full rationality, Thaler recognized that this research was the key to progress in behavioral economics." Again, I disagree. Many people had this understanding. Just following Kahneman & Tversky is too small to call it Thaler's greatest contribution.

The author presents behavioral economics as a reaction to the rational expectations revolution, as the author calls it. Rational expectations was of course

a big idea in macro-economics and finance, but not wide enough to call it a revolution. Behavioral economics is better positioned as a reaction to the ordinal revolution. %}

Barberis, Nicholas C. (2018) "Richard Thaler and the Rise of Behavioral Economics," *Scandinavian Journal of Economics* 120, 661–684.

{% %}

Barberis, Nicholas C. (2018) "Psychology-Based Models of Asset Prices and Trading Volume." Ch. 2 *in* B. Douglas Bernheim, Stefano DellaVigna, & David Laibson (eds.) *Handbook of Behavioral Economics; Volume 1*, 79–176, North-Holland, Amsterdam.

{% This paper analyzes the implications of probability weighting of prospect theory in finance. It shows how it can explain a number of things not explainable by EU.

Seems to show that individual stocks and underdiversified portfolios have positive skewedness.

p. 2066: "In an effort to capture the experimental data more accurately, researchers have developed a number of so-called nonexpected utility models. Perhaps the most prominent of these is Amos Tversky and Daniel Kahneman's (1992) "cumulative prospect theory." (**Prospect theory/Rank-Dependent Utility most popular for risk**)

p. 2068: "Cumulative prospect theory is arguably the most prominent of all nonexpected utility theories." (**Prospect theory/Rank-Dependent Utility most popular for risk**)

p. 2088 §F dicusses nonarbitrage for nonEU. %}

Barberis, Nicholas C. & Ming Huang (2008) "Stocks as Lotteries: The Implications of Probability Weighting for Security Prices," *American Economic Review* 98, 2066–2100.

{% %}

Barberis, Nicholas C. & Ming Huang (2009) "Preferences with Frames: A New Utility Specification That Allows for the Framing of Risks," *Journal of Economic Dynamics and Control* 33, 1555–1576.

{% Let consumer derive direct utility from changes in income. Define loss aversion in such terms.

P. 17: loss aversion is more important than utility curvature and, hence, they let utility be linear for gains and losses!

P. 18 explains how the house money effect of Thaler & Johnson (1990) can be reconciled with the fourfold pattern of prospect theory: in Thaler & Johnson subjects do not integrate prior losses, but instead shift the reference point and at the same time become more loss averse. %}

Barberis, Nicholas C., Ming Huang, & Tano Santos (2001) "Prospect Theory and Asset Prices," *Quarterly Journal of Economics* 116, 1–53.

{% P. 1069 footnote 1: loss aversion generates first-order risk aversion.

Point out that nonEU without loss aversion can also explain the Rabin calibration paradox as per first-order risk aversion. Then they consider what they call "delayed gambles." What it means is that then background risks are incorporated. I think that background risks can almost as much play a role with immediate payment as with delayed. At any rate, what they call delayed gamble is with background risks involved. Then nonEU models with first-order risk aversion lose most of that first-order risk aversion. Let me explain for rank-dependent utility. With background risk, the rank of any outcome of a gamble now considered is mostly determined by the background risk, and it is similar for all outcomes of the gamble now considered. Thus, the rank-dependence in the gamble now considered mostly disappears. Hence, rank-dependence can only work in "isolated" analyses, without considering the background risks. A preliminary version of this idea, only for linear utility, had been pointed out before by Quiggin (2003). The isolated analyses is what the authors call narrow framing and what others call narrow bracketing.

P. 1072, bottom of 1st column, suggests that recursive is the "typical" implementation of nonEU in dynamic situations, apparently ignoring the several other ways such as propagated by Machina (1989). %}

Barberis, Nicholas C., Ming Huang, & Richard H. Thaler (2006) "Individual Preferences, Monetary Gambles, and Stock Market Participation: A Case for Narrow Framing," *American Economic Review* 96, 1069–1090.

{% %}

Barberis, Nicholas C., Lawrence J. Jin, & Baolian Wang (2021) "Prospect Theory and Stock Market Anomalies," Working Paper 27155 http://www.nber.org/papers/w27155

{% Seems that they consider returns to stocks, assume historical probability distribution, and then assume that investors use 1992 prospect theory to evaluate stocks. That they then find a negative correlation between past and future returns. So, opposite to the momentum returns claims. That they find that probability weighting explains most. %}
Barberis, Nicholas C., Abhiroop Mukherjee, & BaolianWang (2016) "Prospect Theory and Stock Returns: An Empirical Test," *Review of Financial Studies* 29, 3068–3107.

{% Consider over- and underreaction of stock prices. Assume that intrinsic value of stocks is a random walk but there is one representative agent who either thinks that trends continue in the future (overreaction) or that they return to the mean (underreaction). With this model, simulations of course do give over- and underreaction. The authors mention that the attitudes of such agents are similar in spirit to biases and heuristics in the psychological literature. However, in their calculations of updating they use the Bayesian way of updating. %}
Barberis, Nicholas C., Andrei Shleifer, & Robert Visny (1998) "A Model of Investor Sentiment," *Journal of Financial Economics* 49, 307–343.

{% %}
Barberis, Nicholas C. & Richard H. Thaler (2003) "A Survey of Behavioral Finance." *In* George M. Constantinides, Milton Harris, & René M. Stulz (eds) *Handbook of the Economics of Finance* (Ch. 18), 1051–1121.

{% %}
Barberis, Nicholas C. & Wei Xiong (2009) "What Drives the Disposition Effect? An Analysis of a Long-Standing Preference-Based Explanation," *Journal of Finance* 64, 751–784.

{% **foundations of statistics**; **foundations of probability**;
Organizes "Séminaire d'Histoire du Calcul des Probabilités et de la Statistique" %}

Barbut, Marc (1997),

{% **inverse S**, confirmed, although the families used assume it.

Test probability weighting families. Their own exponential odds family, introduced by these authors in 2013, performs best. Prelec's compound invariance is second best. They test for gains and for losses, finding very similar shapes only less overweighting of small probabilities for losses than for gains.

A central tool in their analysis is w´(p)/w(p), the derivative of ln(w(p)).

P. 195 Eq. 1 defines biseparable utility but does not specify the ranking of outcomes. For gains the examples in the paper always have $V_1 > V_2$ and for losses always $V_2 < V_1$, so, what is convention these days. For losses I did not check, so, I am not sure if they reflected for losses.

P. 195 2nd column middle suggests that methods such as Abdellaoui (2000) could not accommodate the Allais paradox, but this is not correct because they can.

P. 198 1st column middle takes utility is a concrete entity: "We may assume that there is no utility in earning no points."

P. 198: "This experiment expanded upon the novel gamble-matching paradigm used in Chechile and Barch (2013)." They get indifferences from choices between binary prospects, where they avoid degenerate sure prospects. All the binary prospects in fact have one zero outcome, so, they have only one nonzero outcome. This gives identifiability problems for the power of the weighting function, which will depend on conventions assumed for utility. %}

Barch, Daniel H. & Richard A. Chechile (2016) "Assessing Risky Weighting Functions for Positive and Negative Binary Gambles Using the Logarithmic Derivative Function," *Journal of Mathematical Psychology* 75, 194–204.

{% Present a general version of regret theory that will never violate stochastic dominance. Superadditivity accommodates Allais' paradox. They also have a novelty on multistage uncertainty that I did not study.%}

Bardakhchyan, Vardan G. & Armen E. Allahverdyan (2023) "Regret Theory, Allais' Paradox, and Savage's Omelet," *Journal of Mathematical Psychology* 117, 102807.
https://doi.org/10.1016/j.jmp.2023.102807

{% %}
Bardslay, Peter (1991) "Global Measures of Risk Aversion," *Journal of Economic Theory* 55, 145–160.

{% Ask subjects what they would do in three scenarios, one of which is true, the others are only hypothetical. The experimenters don't tell to subjects that each would have probability 1/3 (then the experimenters would be lying because they know which has probability 1) but tell them that !they! (the subjects) do not know which is the true scenario. In this manner, they get subjects to play artificial nonreal situations without lying to them. The data were re-analyzed by Bardsley & Moffat (2007).

P. 224 penultimae para: what is the real choice task is unknown in the beginning, because it depends on choices that other subjects will make.

Bardsley's method is sometimes called the conditional information lottery. %}
Bardsley, Nicholas (2000) "Control without Deception: Individual Behaviour in Free-Riding Experiments Revisited," *Experimental Economics* 3, 215–240.
https://doi.org/10.1023/A:1011420500828

{% A very useful standard text on methodological questions for experimental economics. Now not every author has to discuss all the issues about the random incentive system, and dozens of other questions, in each paper and with each referee again, but can refer to this book for all those issues. As it so happens, in virtually every issue of subjective opinion I agree with the authors.

Pp 26 (§1.4) & 96 (§3.2) discuss the Duhem-Quine problem: result of experiments can always have been distorted because of confounds due to other assumptions presupposed.

P. 32 (§1.4), about real incentives and stochastic choice theory: "We suggest that experimental economists have been too prone to lapse, in the first case [incentives], into unreflective conformism, and, in the second case [stochastic variation], into unreflective

diversity." More extensive to come in Ch. 6.

Ch. 2 is about internal and external validity, the discovered preference hypothesis, with two or three different kinds of domains in which experiments can be thought to be relevant.

Ch. 3 Experimental Testing in Practice

§3.5 discusses that economists, despite empirical evidence of violations of transitivity for instance, nevertheless maintain the transitivity assumption in their thinking (called hard-core commitment).

Ch. 4 experiments and inductive generalization.

§4.9.2 on confounds.

P. 181, §4.9.4, criticizes Plott & Zeiler (2005).

Ch. 5: external validity. §5.4.1 is about ceteris paribus.

§5.7 (p. 240) is on field studies. Write, in the context of the sports-cards experiment of List: "The use of a nonconvenience sample does not make the sample representative of the population of interest. ... Thus, the external-validity inference drawn (albeit tentatively) from this experiment by Harrison and List (2004, pp. 1027-28, 2008, pp. 823-24) that certain lab anomalies might be absent in the wild, and that corresponding naturally occurring markets [be] efficient, seems not to follow."

Ch. 6 is on real incentives. P. 249 §6.3 points out that in individual choice the differences between experimental economics and psychology is sharpest.

P. 249: experimental economists may use real incentives as marketing device. P. 250: or as barrier to entry.

P. 255, §6.4.1 discusses a study by Moffat (2005) who measured decision time and took this as index of effort. He found that for choices between (almost) indifferent options the decision time was about twice as much as between options with a clear preference. This is counterevidence against the flat-maximum problem discussed by Harrison (1989) and others. §6.4.2 is on crowding out, relating it also to cognitive dissonance.

§6.5, p. 265, distinguishes between theoretical incentive compatibility and behavioral incentive compatibility. See also their p. 285.

P. 268 takes single individual choice as gold standard.

P. 269 explains that RIS (RLI in authors' terminology) can remain valid under nonEU. 2nd para: "It is easy to see, however, that the RLI [RIS] could be unbiased in the presence of any form of NonEU preferences given different assumptions about how agents mentally process tasks." Bottom: "the RLI [RIS] scheme can be justified even given the knowledge that subjects violate independence."

§6.5, p. 270, discusses the binary lottery incentive scheme, which means paying in probability of gaining something. Pp. 271-274 discusses the BDM (Becker-DeGroot-Marschak) mechanism and its difficulties.

P. 280 writes that it is probably impossible to incentivize plans (unless assuming **dynamic consistency**).

P. 281 argues against a dogmatic requirement of real incentives: "If, as we have argued, there are certain types of tasks that it is inherently difficult, if not impossible, to incentivize, then insistence on task-related incentives for all tasks puts certain research topics off-limits. ... In view of this, we suggest that a more permissive attitude to the role that incentives should play in experiments would be both defensible from a scientific point of view and consonant with more general attitudes to data that prevail in the broader academic community of economists."

Pp. 283-284 discusses deception. Footnote 39 explains that not giving (all) information is not deception.

P. 285: "There may be trade-offs between the pursuit of theoretical incentive compatibility and intelligibility of incentive mechanisms that should enter as considerations in experimental design." See also their p. 265.

Ch. 7: probabilistic choice theories.

Pp. 287-289, §7.1, explain why techniques used in econometrics may be less suited to analyze experimental data. It is because econometrics is for field data where there is much out of control and, hence, much noise that overwhelms any within- or between-subject errors. In experiments there is much control and the stochastic nature of errors is of a different nature.

P. 299 explains how an asymmetry of a bigger number of risky choices for one prospect pair than for another may not indicate violations of a preference condition (such as independence) claiming that same choices may purely be generated by bigger errors in one prospect pair than in another. It can, then, not explain that majority choices are conflicting, but only that choices are closer to 50-50 in one situation than in another. P. 300 explains in words, without using the term, that a symmetric error theory is underlying the above reasoning.

P. 302 explains that error theories will predict more violations of stochastic dominance than observed.

P. 305 prefers random preference model to Fechnerian models

P. 309, §7.3.1, is on quantal response equilibrium.

Boxes:

2.1 (p. 52): internal and external validity.

2.2 (p. 54): blame-the-theory argument (experiment to test theory cannot be blamed for being artificially simple if the theory is so)

2.3 (p. 58): the voluntary-contribution mechanism.

2.4 (p. 61): instrumentalism and Friedman's methodology of positive economics

2.5 (p. 72): expected utility theory: transitivity and independence

2.6 (p. 74): the common ratio effect

2.7 (p. 77): the discovered preference hypothesis

2.8 (p. 88): partners and strangers designs

3.1 (p. 99): a classic market experiment "inducing" supply and demand in a double auction.

3.2 (p. 108): Popper and the methodology of falsification

3.3 (p. 116): the ultimatum game

3.4 (p. 131): preference reversals

3.5 (p. 135): regret theory and the new prediction of choice cycles

4.1 (p. 152): Chamberlin's [1948] experimental market

4.2 (p. 154): the Ellsberg paradox [3-color]

4.3 (p. 157): the endowment effect and the willingness-to-accept/willingness-to-pay disparity.

4.4 (p. 158): the trust game

4.5 (p. 158): focal points

5.1-5.3 (pp. 200-204): present three papers

5.4 (p. 223): the winner's curse

6.1 (p. 266): the random-lottery incentive scheme (a better name is random incentive scheme, RIS) and its variants. Discusses two ways to incentivize adaptive experiments, one based on Bardsley (2000) and the other by Johnson et al. (2007).

6.2 (p. 271): mechanisms for incentivizing valuation tasks. Explains BDM (Becker-DeGroot-Marschak) and Vickrey auction

6.3 (p. 274): the strategy method

6.4 (p. 282): deception: a case of negative externality %}

Bardsley, Nicholas, Robin P. Cubitt, Graham Loomes, Peter Moffat, Chris Starmer, & Robert Sugden (2010) "*Experimental Economics; Rethinking the Rules*." Princeton University Press, Princeton, NJ.

{% %}

Bardsley, Nicholas & Peter G. Moffat (2007) "The Experimetrics of Public Goods: Inferring Motivations from Contributions," *Theory and Decision* 62, 161–193.

{% Seems to say **bisection > matching**; %}

Bardsley, Nicholas & Peter G. Moffat (2009) "A Meta-Analysis of the Preference Reversal Phenomenon," in preparation.

{% %}

Bardsley, Nicholas & Chris Starmer (2005) "Exploring the Error in Experimental Economics; Guest-editorial," *Experimental Economics* 8, 295–299.

Bargh, John A. & Melissa J. Ferguson (2000) "Beyond Behaviorism: On the Automaticity of Higher Mental Processes," *Psychological Bulletin* 126, 925–945.

{% %}

Bargiacchi, Rossella (2006) "Modeling and Testing Behavior in Applications to Climate Change." Ph.D. dissertation, CentERfor Economic Research, Dissertation series 164, Tilburg University, Tilburg, the Netherlands.

{% **dynamic consistency** %}

Barkan, Rachel & Jeromy R. Busemeyer (1999) "Changing Plans: Dynamic Inconsistency and the Effect of Experience on the Reference Point," *Psychonomic Bulletin and Review* 6, 547–554.

{% **dynamic consistency** %}

Barkan, Rachel, Guy Ben-Bashat, & Jeromy R. Busemeyer (2003) "Planned and Actual Choices: Isolation, Integration and Dynamic Inconsistency,"

{% **dynamic consistency** %}

Barkan, Rachel & Jeromy R. Busemeyer (2003) "Modeling Dynamic Inconsistency with a Dynamic Reference Point," *Journal of Behavioral Decision Making* 16, 235–256.

{% **dynamic consistency** %}
Barkan, Rachel, Shai Danziger, Guy Ben-Bashat, & Jeromy R. Busemeyer (2005) "Framing Reference Points: The Effect of Integration and Segregation on Dynamic Inconsistency," *Journal of Behavioral Decision Making* 18, 213–226.

{% **foundations of statistics**; seems to have been first to emphasize likelihood principle (according to, for instance, von Winterfeldt & Edwards 1986 p. 144).
I'm not sure about it, most people say Barnard '49 was first; This 47 paper may be the first to introduce the Stopping Rule Principle? %}
Barnard, George A. (1947) "The Meaning of a Significance Level," *Biometrika* 34, 179–182.

{% According to virtually all references, this paper introduced the likelihood principle. %}
Barnard, George A. (1949) "Statistical Inference" (with discussion), *Journal of the Royal Statistical Society* 11, 115–149 (with discussion).

{% **foundations of statistics** %}
Barnard, George A. (1988) "R.A. Fisher—a True Bayesian?," *International Statistical Review* 56, 63–74.

{% **foundations of statistics** %}
Barnard, George A. & Vidyadhar P. Godambe (1982) "Allan Birnbaum 1923-1976," (memorial article), *Annals of Statistics* 10, 1033–1039.

{% **foundations of statistics**; discussion of the several approaches to statistics and how they are rooted in different notions of probability. §6.8.2 defines the likelihood principle. Ch. 8 discusses fiducial statistics and Edwards' likelihood approach. Seems to consider the fiducial approach to be incorrect. %}

Barnett, Vic (1982) "*Comparative Statistical Inference.*" Wiley, New York. (3rd edn. 1999.)

{% **second-order probabilities to model ambiguity** %}
Baron, Jonathan (1987) "Second-Order Probabilities and Belief Functions," *Theory and Decision* 23, 25–36.

{% **tradeoff method**: in Ch. 10 in 3rd and 4th edn. %}
Baron, Jonathan (1988) "*Thinking and Deciding*; 1st edn." Cambridge University Press, Cambridge. (2nd edn. 1994, 3rd edn. 2000, 4th edn. 2008.)

{% People don't want to vaccinate their child even if that decreases the total probability of death of the child, only so as to avoid perceived responsibility. %}
Baron, Jonathan (1992) "The Effect of Normative Beliefs on Anticipated Emotions," *Journal of Personality and Social Psychology* 63, 320–330.

{% %}
Baron, Jonathan (1994) "Nonconsequentialist Decisions," *Behavioral and Brain Sciences* 17, 1–10.

{% All references hereafter are to second edn.

reflective equilibrium: Ch. 17 introduction (p. 332), says that, if your intuitive choice deviates from decision analysis recommendation, it is not at all clear which is wrong. Says to consider decision analysis as a second opinion.

§17.1.4 presents the basic decision analysis for Down's syndrom. Final sentence in §17.1.4, on discrepancy between CE (certainty equivalent) and PE utility measurement method: "The difference method of measuring utility, when it can be used, is probably more accurate." (**PE doesn't do well**)

tradeoff method: §17.1.5 presents tradeoff reasoning in additive conjoint measurement.

time preference; **discounting normative**: an argument for zero discounting: §24.4.4 (p. 516): "Despite Parfit's reservations, many of us feel a strong pull toward an attitude of impartiality toward all parts of our future lives." %}

Baron, Jonathan (1994) “*Thinking and Deciding*; 2nd edn.” Cambridge University Press, Cambridge. 4th edn. 2008.

{% %}
Baron, Jonathan (1996) “When Expected Utility Theory Is Normative, but not Prescriptive,” *Medical Decision Making* 16, 7–9.

{% **ratio-difference principle** and **decreasing ARA/increasing RRA**: illustration that people usually do something between differences and proportions. %}
Baron, Jonathan (1997) “Confusion of Relative and Absolute Risk in Valuation,” *Journal of Risk and Uncertainty* 14, 301–309.

{% P. 49: **conservation of influence**: §2.2.3, on incentives: “Outcome bias: this bias could cause us to hold people responsible for events they could not control.”

§2.3: author considers EU and utilitarianism to be normative.

Potential energy to preserve the law of conservation of energy: Baron gives another example, on 1+1 = 2: “We say it isn’t fair because drops falling on top of each other do not count as “addition.” We do not apply the framework this way. But why not? The answer is that, once we have adopted the framework, we force the world into it.”

real incentives/hypothetical choice: §7.2.2 gives an example where real incentives may have the negative effect of reducing other incentives. “The reward may be effective in encouraging the work in question, but it may reduce the commitment to other valuable goals.”

§10.3 casually suggests that people have been asked their willingness to pay for the St. Petersburg paradox and did not want to pay much more than $3 or $4.

§11.4.4 discusses the rationality of regret, and that regret depends on whether we can control our emotions regarding upward and downward counterfactuals.

§13.1.2: points out that if the decision analysis solution deviates from the intuitive solution, then it is not clear which solution is best and the case should be reconsidered.

§14.0.14 explains conjoint measurement and standard sequences in an intuitive manner.

§15.3 explains why everything always takes longer than planned.

§16.2.1 describes the naturalistic fallacy, of people who base normative judgments on empirical facts ("what is natural").

DC = stationarity; §19.4.2 properly defines DC (dynamic consistency), and then defines delay independence as the combination of DC and stationarity. %}

Baron, Jonathan (2008) "*Thinking and Deciding*; 4th edn." Cambridge University Press, Cambridge.

{% That people take tests even if not relevant to decisions. %}

Baron, Jonathan, Jane Beattie, & John C. Hershey (1988) "Heuristics and Biases in Diagnostic Reasoning: II. Congruence, Information, and Certainty," *Organizational Behavior and Human Decision Processes* 42, 88–110.

{% Outcome bias: people judge decision only by the outcome. %}

Baron, Jonathan & John C. Hershey (1988) "Outcome Bias in Decision Evaluation," *Journal of Personality and Social Psychology* 54, 569–579.

{% %}

Baron, Jonathan & Ilana Ritov (1994) "Reference Points and Omission Bias," *Organizational Behavior and Human Decision Processes* 59, 475–498.

{% **paternalism/Humean-view-of-preference**; whole paper is on this. P. 26, end of 2nd para: "We might expect such convergence if the subject has an internal scale of disutility, which obeys the consistency requirement, but the subject distorts this scale when expressing it through certain kinds of questions. When the distortions are removed, different kinds of questions will tap the same underlying scale. This is the theoretical claim made by the idea of scale convergence in psychophysics (Birnbaum, 1978)." P. 31 ℓ. −2 cautions that the limiting scale need not necessarily be a true utility. This is the same point as what Loomes, Starmer, & Sugden (2003 EJ) call the shaping hypothesis.

Let subjects do person-tradeoff (what is better, 10 people blind or 8 healthy and 2 death), and two visual analog scale measurements, AS (scale being blind between being healthy and being both blind and deaf) and ME (how much worse is being blind *and d*eaf relative to being only blind, all versus being healthy). In second experiment, the subjects are confronted with inconsistencies (e.g., if for H

> A > B > D, B is exactly mid between H and D, and A is so between H and B, then inconsistency results if not A is 1/4 away from H), and are asked to resolve them. (Bit like Slovic & Tversky 1974) Leads to more internal consistency, and also more consistency between different methods. %}

Baron, Jonathan, Zhijun Wu, Dallas J. Brennan, Christine Weeks, & Peter A. Ubel (2001) “Analog Scale, Magnitude Estimation, and Person Trade-Off as Measures of Health Utility: Biases and Their Correction,” *Journal of Behavioral Decision Making* 14, 17–34.

{% **dynamic consistency**: Foregone opportunities (so, not foregone events but past decisions) impact present decisions, as experiments show. The corresponding emotions are close to regret theory. It is difficult to develop tractable models that have this. The authors cite much literature on counterfactual thinking. %}

Barreda-Tarrazona, Ivan, Ainhoa Jaramillo-Gutierrez, Daniel Navarro-Martinez, & Gerardo Sabater-Grande (2014) “The Role of Forgone Opportunities in Decision Making under Risk,” *Journal of Risk and Uncertainty* 49, 167–188.

{% **real incentives/hypothetical choice**: seem to find difference. %}

Barreda-Tarrazona, Ivan, Ainhoa Jaramillo-Gutierrez, Daniel Navarro-Martinez, & Gerardo Sabater-Grande (2011) “Risk Attitude Elicitation Using a Multi-Lottery Choice Task: Real vs. Hypothetical Incentives,” *Journal of Finance and Accounting* 40, 609–624.

{% **principle of complete ignorance** %}

Barret, C. Richard & Prasanta K. Pattanaik (1994) “Decision Making under Complete Ignorance.” *In* David G. Dickinson, Michael J. Driscoll & Somnath Sen (ed.) *Risk and Uncertainty in Economics*, 20–36, Edward Elgar, Vermont.

{% %}

Barrieu, Pauline & Barnard Sinclair-Desgagné (2011) “Economic Policy when Modes Disagree.”

{% %}

Barrios, Carolina (2003) “Une Réconciliation de la Mesure de l’Utilité à l’Aide de la “Prospect Theory”: Une Approche Experimentale,” Ph.D. dissertation, ENSAM, Paris, France.

{% %}

Barro, Robert J. (1999) “Ramsey Meets Laibson in the Neoclassical Growth Model,” *Quarterly Journal of Economics* 114, 1125–1152.

{% %}

Barro, Robert J. (2006) “Rare Disasters and Asset Markets in the Twentieth Century,” *Quarterly Journal of Economics* 121, 823–866.

{% %}

Barro, Robert J. & Xavier Sala-i-Martin (2004) “*Economic Growth*” (2nd ed.). McGraw-Hill, New York.

{% **risk averse for gains, risk seeking for losses**: In Experiment 1, they find more risk seeking for losses than for gains in one-shot. No real incentives here it seems.

real incentives/hypothetical choice: Experiment 2 had real incentives but loss-amounts were simply not implied but kept at zero.

It is remarkable how much the subjects keep on deviating from expected value maximization in repeated choices with the sum of payments received. Experiment 5 has 400 repetitions! %}

Barron, Greg & Ido Erev (2000) “On the Relationship between Decisions in One-Shot and Repeated Tasks: Experimental Results and the Possibility of General Models,” Technion, Haifa, Israel.

{% **PT falsified**: Subjects have to do common-ratio choices, and others, not once, but repeatedly, say 200 times. They don’t get any info about probabilities etc., only can push one of two buttons and from experience find out what probability distribution can be. They don’t even know that it is one fixed probability distribution. Real incentives: they are paid in points, and in end sum total of points is converted to money. Loss aversion is confirmed. Other than that, all phenomena are opposite to prospect theory, with underweighting of small

probabilities (**(very) small probabilities)**, anti-certainty effect, more risk seeking with gains than with losses, etc. A remarkable and original finding. The authors' explanation is that the subjects in their experiment experience the gambles rather than get descriptions of the gambles. It is surprising to me that subjects do not get close to expected value maximization.

My explanation (ex post indeed) (added Jan. 2023: = Fox & Hadar 2006): The subjects put the question "which button would give the best outcome" central, and not "which button would give the best probability distribution over outcomes." They get to see which button gave best outcomes in most of the cases, with recency effect reinforcing it. Thus, subjects experience only the likelihood aspect, whether or not events with good/better outcomes obtain or not. The subjects do not experience the outcomes, because these are just abstract numbers to be experienced only after the experiment. This procedure leads to likelihood-oversensitivity, and S-shaped rather than **inverse S**-shaped nonlinear measures. Example of recency effect: If subjects, for instance, remember only which option gave the best result on the last trial, then they choose the event that with highest probability gives the best outcome (a heuristic advanced by Blavatskyy). Outcomes will be perceived as ordinal more than as cardinal. The authors themselves may have alluded to this explanation on p. 221 just above Experiments 3a and 3b, when they refer to MacDonald, Kagel, & Battalio (1991, EJ) who found the opposite of what they found in an experiment with animals:

"For example, MacDonald et al. used a within-subject design and allowed the decision makers to immediately consume their rewards." %}

Barron, Greg & Ido Erev (2003) "Small Feedback-Based Decisions and Their Limited Correspondence to Description-Based Decisions," *Journal of Behavioral Decision Making* 16, 215–233.

{% P. 281 penultimate para: they have a nice treatment that is intermediate between experience (DFE) and description (DFD): An urn contains 100 balls with a particular proportion of winning balls. Subjects have to sample without replacement, but they have to sample the whole urn, so that they can exactly know the distribution. So, it is experience, but also equivalent to description (if subjects count properly). Yet the authors find underweighting of rare events. (**DFE-DFD gap but no reversal**: they find reversal) Also, it is not ambiguity, but risk. P. 280 cites other studies on DFE that yet have known probabilities, so, it is risk and not ambiguity. They also correct for preferences by first measuring indifferences and then (adaptively) using those stimuli.

Real incentives: they use random incentive system. %}

Barron, Greg & Giovanni Ursino (2013) "Underweighting Rare Events in Experience Based Decisions: Beyond Sample Error," *Journal of Economic Psychology* 39, 278–286.

{% %}

Barschak, Erna (1951) "A Study of Happiness and Unhappiness in the Childhood and Adolescense of Girls in Different Cultures," *Journal of Psychology* 32, 173–215.

{% This paper argues for the importance of probability weighting.

inverse S: 400,000 household insurance choices are analyzed. The authors find that likelihood insensitive (inverse S) probability weighting is an important factor to explain the data. Strangely enough, they denote probability weighting by capital omega, Ω; I will use the common w. Do both representative-agent analysis, and estimations at the individual level.

P. 2500: "we then demonstrate that neither KR loss aversion alone nor Gul disappointment aversion alone can explain our estimated probability distortions, signifying a crucial role for probability weighting."

P. 2501: The probability weighting functions that they find deviate from what Gul's (1991) disappointment aversion and Köszegi & Rabin's (2006) model (K&R) would imply, detailed on pp. 2015-2016. As explained on p. 2015 bottom, the web appendix seems to analyze how K&R loss aversion can be remodeled as probability weighting; for Gul it is well known (Wakker 2010). For K&R loss aversion it is central in Masatlioglu & Raymond (2016 American Economic Review).

§IV, starting p.2018, explains that they take quadratic distance approximation of w for individual estimates.

equate risk aversion with concave utility under nonEU: p. 2501 and else: they, unfortunately, use the term risk aversion to designate concavity of utility.

They simultaneously fit utility and probability weighting.

§ I.C, p. 2505 describes how they estimate the probabilities of claims/hazards of subjects.

Utility they approximate 2nd order, which means taking it quadratic.

P. 2511 2nd para explains that the data is rich enough to estimate both U and w.

They do regress wrt a vector Z of demographics and the like.

Section III estimates w. The authors call it parameter-free, but what they do is fit a 20th-order polynomial and then on the basic of BIC choose w quadratic.

§II.A: They find inverse S w. Most of their insurance data concern probabilities below 0.16 (p. 2527). They do not speak to other probabilities.

P. 2512: They, nicely, point out that utility is closer to linear if we incorporate probability weighting. (**utility measurement**: **correct for probability distortion**) They now find relative indexes of relative risk aversion (I regret this term for concavity of U) of 0.00064, 0.00063, and 0.00049 in Models 1a, 1b, and 1c, respectively.

P. 2514: w alone explains data better than U alone.

P. 2515 argues, in my terminology, that most probability transformation takes place for very small probabilities (say $p < 0.01$), with w approximately linear with slope 1 after (?), so that the usual inverse S-shapes do not fit well. It suggests neo-additive w (although then slope of linear has to be < 1). Note that they only consider the range [0, 0.16].

P. 2526 advocates probability weighting: "Perhaps the main takeaway of the article is that economists should pay greater attention to the question of how people evaluate risk. Prospect theory incorporates two key features: a value function that describes how people evaluate outcomes and a probability weighting function that describes how people evaluate risk. The behavioral literature, however, has focused primarily on the value function, and there has been relatively little focus on probability weighting. In light of our work, as well as other recent work that reaches similar conclusions using different data and methods, it seems clear that future research on decision making under uncertainty should focus more attention on probability weighting."

P. 2527 top discusses Rabin's paradox but is confused. For instance, their sentence "This suggests that it may be possible-contrary to what some have argued-to resolve Rabin's anomaly without moving to models that impose zero standard risk aversion and use a nonstandard value function to explain aversion to risk." I first (until 2016) misread the sentence to erroneously think that "use a nonstandard …" was part of the "without" part. However, it is part of the "possible .. to resolve …" So, it says that a nonstandard value function CAN explain.

P. 2527 and many other places: The authors cannot distinguish between probability weighting or probability misperception (but their AERPP 2013 paper is on it). I would say that the authors in fact are studying ambiguity attitudes, where their w's are source functions. They allude to ambiguity in Footnote 57, and pity they are not aware that the source method does exactly what they describe there. %}

Barseghyan, Levon, Francesca Molinari, Ted O'Donoghue, & Joshua C. Teitelbaum (2013) "The Nature of Risk Preferences: Evidence from Insurance Choices," *American Economic Review* 103, 2499–2529.
https://doi.org/10.1257/aer.103.6.2499

{% A mostly theoretical paper, with an application to a data set. They assume a large population with every individual making one choice from a choice set with finitely many risky lotteries. The risk attitudes and choice sets are not known to the researcher, but are parametrized by one parameter, which is estimated. I did not read enough to know to what extent they allow for individual differences. They assume a single crossing-over property. That is, choices only once change if some parameters grow. It reminds me of the same condition in Bell (1988, MS), a work not cited. They suggest that the condition is not very restrictive, claiming in Footnote 2: "The EUT framework satisfies the SCP, which requires that if a DM with a certain degree of risk aversion prefers a safer lottery to a riskier one, then all DMs with higher risk aversion also prefer the safer lottery." I am not aware of such a property of expected utility. It will depend on how one defines being more risky. For instance, Wakker (2010 Assignment 3.3.5) mentions an example of two lotteries with the same expected value but still a risk averse decision maker prefers the one with the higher variance (whereas a less risk averse, risk neutral, decision maker is indifferent). So, higher variance will not do. %}

Barseghyan, Levon, Francesca Molinari, & Matthew Thirkettle (2021) "Discrete Choice under Risk with Limited Consideration," *American Economic Review* 111, 1972–2006.
https://doi.org/10.1257/aer.20190253

{% Explain that one can distinguish between rank-dependent probability weighting and just using wrong probabilities if one has rich enough data, because the latter will exhibit no rank dependence, illustrating it with simulations. %}

Barseghyan, Levon, Francesca Molinari, Ted O'Donoghue, & Joshua C. Teitelbaum (2013) "Distinguishing Probability Weighting from Risk Misperceptions in Field Data," *American Economic Review, Papers and Proceedings* 103, 580–585.

{% They work on risk attitude and probability weighting much like I do, but have a different background with more econometrics working with big field data sets. It is interesting for me to see how this leads to differences. Although the paper presents itself as a survey, in reality it is more a long methodological intro followed by a discussion of relatively few studies, where each is discussed thoroughly.

P. 501: "Most of the literature uses expected utility (EU) theory to model risk preferences. Under EU theory, there are two potential sources of variation in attitudes toward risk: people might differ in (i) their degree of diminishing marginal utility for wealth (their utility curvature), or (ii) their subjective beliefs." The authors do not distinguish as clearly between risk (objective probabilities) and ambiguity or, at least, subjective probabilities, as is common in economic decision theory. For instance, p. 507 writes: "Models of risk preferences describe how a person chooses among lotteries of this form, where we often use X to denote a choice set. Throughout, we express lottery outcomes in terms of increments added to (or subtracted from) the person's prior wealth w. In other words, if outcome x_n is realized, then the person will have final wealth $w + x_n$. The probabilities should be taken to be a person's subjective beliefs. In particular, the models below describe how a person's subjective beliefs impact his or her choices." Here w denotes initial wealth and NOT reference point. The authors also use the HARA parametric utility family.

P. 509: What the authors call approximative approach means taking quadratic approximation and using it only locally. It reminds me of their 2013 American Economic Review paper where, in §III, what they called parameter-free meant first fitting a 20th-order polynomial and then on the basic of BIC choosing a quadratic approximation.

Pp. 509-510, §3.1 end, discusses Rabin's paradox. Whereas in the beginning they point out that when working with EU one wants one fixed utility function to be able to have predictions, they nevertheless propose as their "solution" to Rabin's paradox that one take different utility functions for different choice situations.

As in their other papers, the authors have the unconventional habit of denoting probability weighting by capital Omega, Ω.

§3.2, p. 510 bottom: Very regrettably, when defining RDU, the authors do not use top-down integration as is common today, but bottom-up. So, they are using weighting functions dually, where convex and concave should be interchanged everywhere, and so on. Also, the parametric families (e.g., their Table 1) get different meanings. Oh well. I discuss these things in my 2010 book, §7.6.

§3.2, p. 512, for prospect theory the authors, fortunately, take weighting functions as is common today.

P. 520: for RDU, the authors call utility "standard risk aversion."

§4.4, p. 521, points out the well-known point that for two-outcome lotteries most theories agree. It is explained by Wakker (2010, §7.11).

P 521 again points out that Köszegi-Rabin CPE and Bell-disappointment aversion cannot be distinguished, a central point in Masatlioglu & Raymond (2016 American Economic Review) (not cited here, but mentioned in Footnote 28 on p. 522).

P. 522: "A frequent assumption in the literature is that subjective beliefs μ coincide with objective expectations (e.g., "objective" claim probabilities), which in turn the econometrician can estimate. However, this assumption may fail in a given application. In that case, when μ is assumed to equal objective expectations, the estimated Ω(μ) function captures a mapping Ψ from the estimated objective probabilities to subjective beliefs, thereby yielding another possible source of probability distortions." The weighting function Ω(μ) is applied to goodnews probabilities to give decisions, and just equating this (why not its dual?) with beliefs is too unnuanced.

P. 524: "In most field contexts, however, objective probabilities either do not exist or are very hard to assess." Further text: "For such situations, an ideal approach would be to simultaneously estimate both the agents' beliefs and preferences. As we shall see in section 7.3, however, this presents a fundamental identification problem. Hence, the most common approach to date has been to assume "rational expectations," in the sense that agents' subjective beliefs correspond to objective probabilities (often, but not always, as reflected in past or future outcomes). The researcher then either posits a carefully thought-out model of rational expectations formation, or posits a "reduced-form" model, and estimates probabilities over outcomes conditional on the chosen covariates based on realized outcomes and observed covariates. These estimated probabilities are then typically taken as "data," in the sense that they are treated as an observed input when estimating preferences."

P. 525 bottom: describes two-stage probabilities if probabilities are heterogenous.

P. 527 briefly and factually states the basic revealed preference approach, that Gilboa & Schmeidler's CBDT deviates from: "In particular, risk preferences are estimated by investigating how agents react to changes in choice sets,"

P. 533: "Moreover, while there also is statistically significant curvature in u, economically the lion's share of households' observed aversion to risk is attributed to probability distortions."

(**Prospect theory/Rank-Dependent Utility most popular for risk**: they don't say that but it helps well.) %}

Barseghyan, Levon, Francesca Molinari, Ted O'Donoghue, & Joshua C. Teitelbaum (2018) "Estimating Risk Preferences in the Field," *Journal of Economic Literature* 56, 501–564.

{% **violation of risk/objective probability = one source**:

They assume expected utility with CARA (constant absolute risk aversion) utility. They find, using market data, that many households exhibit greater risk aversion in their home deductible choices than their auto deductible choices. P. 616 reports some PT analyses but the data seem to be too poor to identify much. %}

Barseghyan, Levon, Jeffrey Prince, & Joshua C. Teitelbaum (2011) "Are Risk Preferences Stable across Contexts? Evidence from Insurance Data," *American Economic Review* 101, 591–631.

{% **Z&Z**; P. 538 compares the survey approach to econometrics. Econometric estimations may be inappropriate if heterogeneity of the population is important. (I'm not sure if I understand this.)

For N = 11,707 subjects, aged 51-61, they measure risk attitude through gambles where you either receive a fixed outcome for the rest of your life, or a .5 prob of having X times income and a .5 probability of having x times income, where X = 2, x = 2/3, and then, depending on answer, either X = 2 and x = 1/2 or X = 2 and x = 4/5. This procedure classifies subjects into four risk aversion categories. The most risk averse class I was highly modal: 64.6% in class I, 11.6% in class II, 10.9% in class III, and 12.8% in class IV (Table IIA p. 548).

P. 550: Males somewhat more risk seeking than women (**gender differences in risk attitudes**). Asians and Hispanics are the most risk seeking, blacks and natives less, whites the least. Remarkable because intercultural studies suggest (if I remember well) that Asians are less risk seeking. Then, Asians in US ≠ Asians in Asia? Jews are most risk seeking, then Catholics, then protestants. Western US-ers are more risk seeking than others.

P. 551: Risk seeking index predicts actual behavior regarding health insurance, smoking, drinking, choosing risky (i.e., self-) employments, and investments (p. 560). The latter is not enough to explain the equity premium puzzle in their data (p. 561). However, the variance explained is small.

For n = 198 subjects, they measure intertemporal preference index by asking for future consumption while specifying the interest rate, and varying the latter; 116 useful observations could be used (p. 565). No statistical relation between intertemporal preference and risk aversion (p. 564).

dominance violation by pref. for increasing income: p. 567: people prefer increasing income to decreasing, even if interest rate is zero.

decreasing ARA/increasing RRA: first RRA is increasing, but then decreasing (p. 557). %}

Barsky, Robert B., F. Thomas Juster, Miles S. Kimball, & Matthew D. Shapiro (1997) “Preference Parameters and Behavioral Heterogeneity: An Experimental Approach in the Health and Retirement Study,” *Quarterly Journal of Economics* 112, 537–579.

{% %}

Barten, Anton P. & Volker Böhm (1982) “Consumer Theory.” *In* Kenneth J. Arrow & Michael D. Intriligator (eds.) *Handbook of Mathematical Economics* II, Ch. 9, 381–429, North-Holland, Amsterdam.

{% Philosophical debate about what is essentially only a technical point. %}

Bartha, Paul (2004) “Countable Additivity and the de Finetti Lottery,” *British Journal for the Philosophy of Science* 55, 301–321.

{% Discusses Pascal's wager, which involves an outcome with infinite utility (going to heaven with God), citing preceding discussions in the literature. Proposes ways to have sensible preferences still if there are outcomes with infinite utility. May be useful in discussions of de Finetti's **Dutch book**. %}

Bartha, Paul (2007) "Taking Stock of Infinite value: Pascal's Wager and Relative Utilities," *Synthese* 154, 5–52. https://doi.org/10.1007/s11229-005-8006-z

{% Paradoxes with infinity involved. %}

Bartha, Paul, John Barker, & Alan Hájek (2014) "Satan, Saint Peter and Saint Petersburg: Decision Theory and Discontinuity at Infinity," *Synthese* 191, 629–660.

{% %}

Barthélemy, Jean -Pierre (1990) "Intransitivities of Preferences, Lexicographic Shifts and the Transitive Dimension of Oriented Graphs," *British Journal of Mathematical and Statistical Psychology* 43, 29–37.

{% **measure of similarity** %}

Barthélemy, Jean-Pierre & Etienne Mullet (1996) "Information Processing in Similarity Judgements," *British Journal of Mathematical and Statistical Psychology* 49, 225–240.

{% %}

Bartling, Björn & Klaus M. Schmidt (2015) "Reference Points, Social Norms, and Fairness in Contract Renegotiations," *Journal of the European Economic Association* 13, 98–129.

{% Mathematical Review 13 (1952), No. 8, p. 775. %}

Bartsch, Helmut (1951) "Hyperflächengewebe des n-Dimensionalen Raumes," *Annali di Matematica* 4, Fasc. 32, 249–269.

{% Mathematical Review 13 (1952) No. 3, p. 227; Mathematical Review 14 (1953), No. 11, p. 1119. %}

Bartsch, Helmut

{% This paper generalizes Yaari's (1987) dual theory to multidimensional distributions, using generalized quantile functions, also extending Yaari (1986) and Galichon & Henry (2012). %}

Bas, Sinem, Philippe Bich, & Alain Chateauneuf (2021) "Multidimensional Inequalities and Generalized Quantile Functions," *Economic Theory* 71, 375–409.

{% **EU+a*sup+b*inf**; considers different regions with different kinds of (reference) outcomes, more than the two (gains and losses) of prospect theory. %}

Basili, Marcello (1997) "A Rational Decision Rule with Extreme Events," *Risk Analysis* 26, 1721–1728.

{% PT considers $CEU^+(f^+) + CEU^-(f^-)$, where f is a prospect, f^+ is its positive part where all outcomes worse than 0 have been replaced by zero, and f^- its negative part where all outcomes better than 0 have been replaced by 0. Then CEU^+ is a PT functional; i.e., the Choquet integral of utility of outcomes, and CEU^- is a PT functional too. PT generalizes Choquet expected utility by allowing CEU^+ to be different than CEU^-. This paper considers a generalization that considers three, instead of two, regions: $CEU^m(f^m) + CEU^{m,M}(f^{m,M}) + CEU^M(f^M)$. Here each CEU is a, possibly different, Choquet expected utility form, m < M, f^m replaces all outcomes better than m by m, $f^{m,M}$ replaces all outcomes worse than m by m and all outcomes better than M by M, and f^M replaces all outcomes worse than M by M. Note that, if all CEU forms are equal to some fixed CEU form, then what I just said amounts to CEU(f) + U(m) + U(M). The authors interpret outcomes below m and above M as unusual, because of which they are processed differently. Optimism for the lower part means that $CEU^m(f^m) > CEU^{m,M}(f^m)$; i.e., the different treatment of outcomes below m make the prospect better. It holds iff the capacity of $CEU^{m,M}$ dominates that of CEU^m. Similar things are given for pessimism for the upper part. %}

Basili, Marcello, Alain Chateauneuf, & Fulvio Fontini (2005) "Choices under Ambiguity with Familiar and Unfamiliar Outcomes," *Theory and Decision* 58, 195–207.

{% **updating: nonadditive measures**: study ε-contamination with updating. %}
Basili, Marcello, Alain Chateauneuf, & Giuseppe Scianna (2018) "Coherent and Consistent Representation of Keynes's Long-Term Expectation," Working paper.

{% **value of information**; give conditions on games in which all benefit from extra information. %}
Bassan, Bruno, Olivier Gossner, Marco Scarsini, & Shmuel Zamir (2003) "Positive Value of Information in Games," *International Journal of Game Theory* 32, 17–31.

{% This paper follows up on Cerreia-Vioglio, Maccheroni, & Marinacci (2015 JET). The two papers put a put-call parity condition, a restricted additivity condition, central, which axiomatizes that the market price is a Choquet integral. The put-call parity condition is equivalent to the maxmin relatedness condition of Anger (1977), who also used it to characterize the Choquet integral. This paper generalizes some conditions, and adds conditions that imply that the capacity is symmetric, so that the integral is also a Sipos integral. It requires invariance under multiplication by –1 $(V(x) = -V(-x))$, i.e., the absence of bid-ask spreads in finance. It considers limited arbitrage opportunities and roles of cores. %}
Bastianello, Lorenzo, Alain Chateauneuf, & Bernard Cornet (2024) "Put-Call Parities, Absence of Arbitrage Opportunities, and Nonlinear Pricing Rules," *Mathematical Finance* 34, 1242–1262.
https://doi.org/10.1111/mafi.12433

{% **Prospect theory/Rank-Dependent Utility most popular for risk**: P. 40: "One of the most prominent and most successful alternatives to expected utility theory is cumulative prospect theory (CPT) of Tversky and Kahneman (1992)."
This paper extensively cites axiomatizations of the Choquet integral, Choquet expected utility, and prospect theory (I use this term for the new 1992 version,

often called prospect theory). It would then have been nice to add Luce & Fishburn (1991), who axiomatized 1992 prospect theory independently of others.

This paper characterizes the Choquet integral when the functional is the primitive, and Choquet expected utility to represent preferences when those are primitive, assuming monetary outcomes with linear utility. It then does the same for prospect theory (linear basic utility but piecewise linear global utility, allowing a kink at 0). Although the paper writes that it is not using the Anscombe-Aumann (AA) framework and this claim can be defended, it can also be argued that it is a special case of the AA framework with $\mathbb{R}$ as a mixture space and, indeed, linear so affine utility. Unlike most others, I find the latter case a more satisfactory special case of the AA framework than when the outcome space, a mixture space, concerns a set of lotteries and we have EU there.

The Choquet integral is axiomatized in known manners, using comonotonic additivity of the functional or the preference relation. For prospect theory, first, comonotonic additivity is weakened to what I call sign-comonotonic additivity (their A3). Then an axiom, their $A4^{\lambda}$, is added to combine gain- and loss-parts, related to double matching of Tversky & Kahneman (1992), but explicitly assuming existence of a loss-aversion parameter λ which can be done behaviorally with linear utility but is strong. From Wakker & Tversky (1993 §8.1) it can be seen that Axiom $A4^{\lambda}$ is virtually always redundant.

This paper adds nice interpretations of $A4^{\lambda}$, showing that gain-acts can give special, extra, hedging against loss acts because of sign-dependence even for comonotonic acts. %}

Bastianello, Lorenzo, Alain Chateauneuf, & Bernard Cornet (2024) “Gain–Loss Hedging and Cumulative Prospect Theory,” *Mathematical Social Sciences* 131, 40–47.
https://doi.org/10.1016/j.mathsocsci.2024.07.003

{% Modify Kochov (2015) by replacing his intertemporal hedging & path stationarity by comonotonic stationarity, leading to Choquet discounted expected utility, which maintains weak separability of events. The authors’ purpose of having the comonotonic restriction of stationarity is to allow for a role for intertemporal correlations. Li, Rohde, & Wakker (2023) show that there is not only the

possibility of interactions between different timepoints, but even weak separability of timepoints must be violated. %}

Bastianello, Lorenzo & José Heleno Faro (2023) "Choquet Expected Discounted Utility," *Economic Theory* 75, 1071–1098. https://doi.org/10.1007/s00199-022-01438-0

{% A new characterization of rectangular sets of priors in expert aggregation under ambiguity: to avoid dynamic inconsistencies the experts should expand sets of priors. %}

Bastianello, Lorenzo, José Heleno Faro, & Ana Santos (2022) "Dynamically Consistent Objective and Subjective Rationality," *Economic Theory* 74, 477–504. https://doi.org/10.1007/s00199-022-01437-1

{% %}

Bastianello, Lorenzo & Marco Licalzi (2019) "The Probability to Reach an Agreement as a Foundation for Axiomatic Bargaining," *Econometrica* 87, 837–865.

{% %}

Basu, Kaushik (1980) "*Revealed Preference of Government.*" Cambridge University Press, Cambridge.

{% **strength-of-preference representation**; shows that utility-difference representation is unique up to level and unit if range of utility is an interval, without using any continuity. This theorem follows as a corollary of Theorem 4.2 of Krantz et al. (1971), in particular because their restricted solvability is more general than continuity. %}

Basu, Kaushik (1982) "Determinateness of the Utility Function: Revisiting a Controversy of the Thirties," *Review of Economic Studies* 49, 307–311.

{% Consider infinite streams of outcomes. Diamond (1965) first showed that fairness/anonymity then cannot be reconciled with strong Pareto, but did so only under restrictive assumptions including continuity. This paper shows it in almost complete generality. %}

Basu, Kaushik & Tapan Mitra (2003) "Aggregating Infinite Utility Streams with Inter-Generational Equity: The Impossibility of Being Paretian," *Econometrica* 71, 1557–1563.

{% Consider infinite streams of outcomes, and consider preference orders that are anonymous (which is not so easy for infinite streams), Pareto, and some more. Their criterion is, I think, that x is preferred to y if there is $N \in \mathbb{N}$ such that $x_1 + \cdots + x_N \geq y_1 + \cdots + y_N$ and from coordinate N+1 onwards x Pareto dominates y. %}

Basu, Kaushik & Tapan Mitra (2007) "Utilitarianism for Infinite Utility Streams: A New Welfare Criterion and Its Axiomatic Characterization," *Journal of Economic Theory* 133, 350–373.

{% The VC (Vapnik-Chervonenkis) dimension of a theory is calculated as follows, where the theory has some free parameters. Imagine a game between a falsifier F, who likes to see a particular theory violated, and a Theorist, who does not want the theory violated. First, a theorist chooses a natural number k. Second, the theorist moves again, choosing k binary choice situations. Third, the falsifier can choose, at will, what the observations in these choice situations are. Then, if the theory is not violated, T wins, and receives k from F. If the theory is violated, F wins, and nothing happens. The largest k that T can win is called the VC dimension. For example, if the theory only imposes weak ordering, and the preference domain is infinite, then the VC dimension is infinite. If the theory is single-peak preference and the preference domain $\mathbb{R}$, then the VC dimension is 1. The paper considers, for a finite state space with n states, EU, CEU (what I would call RDU), and maxmin EU (MEU), always assuming linear utility, which is reasonable for comparing these theories.

P. 1280: "In response, decision theorists have sought to generalize the theory of subjective expected utility to allow for ambiguity aversion. The two best known alternatives are the models of max–min expected utility and Choquet expected utility."

P. 1281 (on EU, CEU, MEU): "The three models we have described are arguably the most important models of decision-making under uncertainty."

P. 1281: Unfortunately, the authors make the widespread mistake of equating risk attitude with utillity curvature and write (where it is clear that they refer to linear utility): "In all three cases, we assume an agent who is risk-neutral. If we were to include the utility function as an additional parameter of the theory." (**equate risk aversion with concave utility under nonEU**)

P. 1282 goes wrong when writing: "Overfitting as a concern seems to be new in decision theory and behavioral economics." Such a claim cannot be. Every student doing empirical work is familiar with the elementary statistical phenomenon of overfitting, and so have I been since my youth. Mangelsdorff & Weber (1994) is an early example in my area of expertise. The authors cite that paper elsewhere, but do not recognize the point of overfitting there. Erev and his team organized several prediction competitions, e.g.

Erev, Ido, Eyal Ert, Alvin E. Roth, Ernan Haruvy, Stefan M. Herzog, Robin Hau, Ralph Hertwig, Terrence Stewart, Robert West, & Christian Lebiere (2010) "A Choice Prediction Competition: Choices from Experience and from Description," *Journal of Behavioral Decision Making* 23, 15–47,

and

Erev, Ido, Eyal Ert, Ori Plonsky, Doron Cohen, & Oded Cohen (2017) "From Anomalies to Forecasts: Toward a Descriptive Model of Decisions under Risk, under Ambiguity, and from Experience," *Psychological Review* 124, 369–409,

where overfitting of course iws central. I co-authored

Kothiyal, Spinu, & Wakker (2014) "An Experimental Test of Prospect Theory for Predicting Choice under Ambiguity," *Journal of Risk and Uncertainty* 48, 1–17,

where we discuss overfitting on p. 9. People often use the terms parsimony and fit to discuss these issues, e.g., Harless & Camerer (1994).

The bottom of p. 1283 cites some papers on estimating ambiguity aversion but is very limited. The survey Trautmann & van de Kuilen (2015) could have helped them considerably.

P. 1287 claims that axioms 1 and 3-5 axiomatize EU with linear utility, but give no reference. Chateauneuf (1991) is one reference giving these and related results, although he used additive rather than mixture axioms, but those are readily related to each other. It also follows from Schmeidler (1989) if we take money with linear utility as a mixture space in the Anscombe-Aumann framework.

P. 1288 Theorem 1. Let the state space have n elements, and utility is linear. Then VC(EU) = n.

VC(CEU) is between $\binom{n}{n/2}$ and $(n!)^2(2n+1)$.

If n=2, then VC(MEU) = VC(CEU)=2. If $n \geq 3$, then VC(MEU) $= \infty$.

nonadditive measures are too general: It means that VC(EU) grows linearly in the state space and VC(CEU) exponentially. MEU is worse. Oner can roughly understand these results as follows: With linear utility, every preference gives a linear inequality. For n states, EU has n−1 free parameters, being probabilities. Then n+1 potential inequalities can always be led into contradiction. CEU has $2^n - 2$ inequalities, concerning all nontrivial subsets (trivial are the state space and the empty set), with montonicity restricting it.

P. 1289 2nd para points out that we can add proper restrictions to theories, such as assuming functional families, and then VC can become much smaller, and this is to be done for theories that are too general.

Section 3 is on learnability. This term means that you can with arbitrary high probability get predictions arbitrarily close if enough observations. It should not be confused with learning in the sense of digesting new information. Theorem 2 says, unsurprisingly, that a theory is learnable iff VC dimension is finite. The theorem assumes that the true deterministic theory is chosen randomly, but does not consider probabilistic choice or choice error. %}

Basu, Pathikrit & Federico Echenique (2020) "On the Falsifiability and Learnability of Decision Theories," *Theoretical Economics* 15, 1279–1305. https://doi.org/1555-7561/20201279

{% %}

Batchelder, William H. (1999) "Contemporary Mathematical Psychology," Book Review of: Anthony A.J. Marley (ed. 1997) Choice, Decision, and Measurement: Essays in Honor of R. Duncan Luce, Lawrence Erlbaum Associates, Mahwah, N.J.; *Journal of Mathematical Psychology* 43, 172–187.

{% %}

Bateman, Bradley W. (1987) "Keynes's Changing Conception of Probability," *Economics and Philosophy* 3, 97–120.

{% %}

Bateman, Ian J., Brett Day, Graham Loomes, & Robert Sugden (2007) "Can Ranking Techniques Elicit Robust Values?" *Journal of Risk and Uncertainty* 34, 49–66.

{% §3 gives nice survey of differences between WTP, WTA, etc., as in Bateman et al. (1997, QJE). The paper tests whether money paid is perceived as a loss (the British prediction), or if subjects are prepared for the payment and do not perceive it as a loss (Kahneman's prediction). They find the first hypothesis confirmed.

The paper also explains adversarial collaboration, where people with different hypotheses come together and jointly test who is right. A drawback is that usually such studies don't give clear results.

Footnote 9 of version of May 16, 2001: "Whether or not loss aversion should be interpreted as a bias in the context of valuation is an interesting question. We view this as an open question which we do not attempt to address here." This text was dropped, unfortunately, in the working paper of 2003 and also in the published version. %}

Bateman, Ian J., Daniel Kahneman, Alistair Munro, Chris Starmer, & Robert Sugden (2005) "Testing Competing Models of Loss Aversion: An Adversarial Collaboration," *Journal of Public Economics* 89, 1561–1580.

{% Hicksian means: according to classical economic paradigm. %}

Bateman, Ian J., Ian H. Langford, Alistair Munro, Chris Starmer, & Robert Sugden (2000) "Estimating Four Hicksian Welfare Measures for a Public Good: A Contingent Valuation Investigation," *Land Economics* 76, 355–373.

{% Couples are more subject to common ratio when doing decisions jointly than when doing individual choice. %}

Bateman, Ian J. & Alistair Munro (2005) "An Experiment on Risky Choice amongst Households," *Economic Journal* 115, C176–C189.

{% **PT, applications**, loss aversion: WTP versus WTA;

WTP versus WTA; loss aversion; etc. §I gives a careful discussion of WTP-WTA where it is precisely specified whether goods are received, given up, what the assumed prior endowment is, etc. Buyer's point of view, seller's point of views, neutral point of view, etc., are terms that psychologists including as

Michael Birnaum, Barbara Mellers, and Elke Weber have used here.

They find that loss aversion explains most, and argue that, given loss aversion, no other fundamental principles of classical preference theory need to be violated here. End of paper suggests that the equivalent-gain method (the neutral point of view) is the least biased. %}

Bateman, Ian J., Alistair Munro, Bruce Rhodes, Chris Starmer, & Robert Sugden (1997) "A Test of the Theory of Reference-Dependent Preferences," *Quarterly Journal of Economics* 112, 479–505.

{% **part-whole bias**: a nice name for the attribute-splitting effect: Splitting up something into more components usually leads to greater weight being attached to it. It is useful to know this term and concept.

P. 322 (PHB = part-whole bias): "Some have interpreted PHB as evidence that respondents react to the symbolic value of the public good in question. …. warm glow of 'moral' satisfaction …"

WTP versus WTA; loss aversion; etc.; point out similarity between attribute splitting and event splitting (each of these leads to increased total weight, violating additivity). Refer to Martin Weber et al. 1988 for attribute splitting. %}

Bateman, Ian J., Alistair Munro, Bruce Rhodes, Chris Starmer, & Robert Sugden (1997) "Does Part-Whole Bias Exist? An Experimental Investigation," *Economic Journal* 107, 322–332.
https://doi.org/10.1111/j.0013-0133.1997.160.x

{% **risk seeking for losses**: seem to find that. %}

Bateman, Thomas S. & Carl T. Zeithaml (1989) "The Psychological Context of Strategic Decisions: A Model and Convergent Experimental Findings," *Strategic Management Journal* 10, 59–74.

{% **equity-versus-efficiency** %}

Battaglini, Marco, Rebecca B. Morton, & Thomas R. Palfrey (2007) "Efficiency, Equity, and Timing on Voting Mechanisms," *American Political Science Review* 101, 409–424.

{% experimental testing of, a.o., Ido & I.;

real incentives/hypothetical choice: P. 45 shows that there is a quantitative difference (more risk aversion for real incentives, both for gains and for losses) but the qualitative phenomena are the same. P. 28 also states this.

losses from prior endowment mechanism: Seem to do this. Their Table 3 seems to find significant deviation from integration.

risk averse for gains, risk seeking for losses: find what they call qualified support.

reference dependence test: test and find it confirmed in §3.1 (p. 31). That is, they find asset integration falsified.

P. 32: less risk seeking for losses than risk aversion for gains.

PT falsified: p. 35: **risk seeking for symmetric fifty-fifty gambles**: they find it for (0.5, 20; 0.5, –20). %}

Battalio, Raymond C., John H. Kagel, & Komain Jiranyakul (1990) "Testing between Alternative Models of Choice under Uncertainty: Some Initial Results," *Journal of Risk and Uncertainty* 3, 25–50.

{% Rat's choices satisfy stochastic dominance and exhibit the common ratio effect. Obviously, real incentives were used.

decreasing ARA/increasing RRA: they find nonincreasing ARA (absolute risk aversion).

risk averse for gains, risk seeking for losses: find no risk seeking for unfavorable-outcome lotteries, unlike Caraco (1981). %}

Battalio, Raymond C., John H. Kagel, & Don N. MacDonald (1985) "Animal's Choices over Uncertain Outcomes: Some Initial Experimental Evidence," *American Economic Review* 75, 597–613.

{% **utility families parametric**: variation on power utility %}

Battermann, Harald L., Udo Broll & Jack E. Wahl (2008) "Utility Functions of Equivalent Form and the Effect of Parameter Changes on Optimum Decision," *Economic Theory* 34, 401–414.

{% A follow-up on Battigalli, Cerreia-Vioglio, Maccheroni, & Marinacci (2015 American Economic Review). They assume the smooth model of ambiguity. They show that for self-confirming equilibrium (SCE) sequential and strategic form are not equivalent. Derive monotonicity results for sequential. %}

Battigalli, Pierpaolo, Emiliano Catonini, Giacomo Lanzani, Massimo Marinacci (2019) "Ambiguity Attitudes and Self-Confirming Equilibrium in Sequential Games," *Games and Economic Behavior* 115, 1–29.

{% Study self-confirming equilibrium (SCE). Players face ambiguity about opponents' moves. For the equilibrium they play, they collect more and more information and hence it turns into known probabilities, going away from ambiguity aversion. For agents who play myopically, at every round only optimizing the profits of that round (exploiting) without concern of learning (exploring), ambiguity aversion then increases status quo bias. Hence, more SCE exist under ambiguity aversion than under ambiguity neutrality. A restriction of this result is of course that the agents are assumed to play myopically, so, they are not very rational, and do not behave as rational agents for instance in multi-armed bandit problems.

A problem I have with much of the modern literature on ambiguity is the extent to which it is normative or descriptive. The myopic behavior of the agents means that it is not normative. But it also is not very descriptive because ambiguity aversion and the smooth model assumed here do not fit data well, for instance the fourfold pattern of ambiguity attitude (Trautmann & van de Kuilen 2015). The myopic behavior of agents can be made normative in a different interpretation: In each round, agent i is a new person who only plays that one round. But he does have the info of the preceding agents i. As this happens in information cascades. So, this deviates from Nash's mass action interpretation.

Loss aversion can similarly introduce a status quo bias.

In this paper, when the authors analyze Figure 1 on p. 649, in the second game say, they condition on H^2 and T^2. Both conditional on H^2 and T^2, the agents face ambiguity about the opponent's moves and ambiguity aversion leads to lower evaluations of H^2 and T^2 and, hence, the whole second game. If the agent were randomizing at the individual level, he might as well condition on h^2 and t^2, getting an Anscombe-Aumann framework. If he then playes fifty-fifty, then both under h^2 and t^2 he has (expected) payoff 2. So, then the value of the game is 2 (the same as with ambiguity aversion). However, agents are not randomizing at the individual level. This is Nash's mass action interpretation, where the randomness is only at the population level. Every individual player plays deterministally. Therefore, the conditioning on H^2 and T^2 as assumed here is natural.

Why do the authors choose the conditioning they choose, and not the other one? In the theoretical analysis on p. 652, Eq. 1, they evaluate each strategy of a player separately, which means that they use the same conditioning as in Figure 1, first conditioning on own strategy choice and not first on opponents' strategy choice. %}

Battigalli, Pierpaolo, Simone Cerreia-Vioglio, Fabio Maccheroni, & Massimo Marinacci (2015) "Self-Confirming Equilibrium and Model Uncertainty," *American Economic Review* 105, 646–677.

{% Consider smooth model of ambiguity. Consider set of justifiable choices (optimal w.r.t. some 2nd order belief over probabilistic models, i.e., some 2nd order distribution. They here take utilities u and φ as given and consider existence of 2nd order distribution mu. The set of justifiable choices grows as ambiguity aversion or risk aversion grow. An intuition for the ambiguity result can be that increasing ambiguity aversion is like increasing the set of possible priors, giving more options there. It is like making a surface more concave, giving more tangents. An opposite intuition would be that increasing ambiguity worsens every nonsure act.

They relate the result to the Bayesian analog, Wald (1949), which was famous a generation ago but seems to have been forgotten now (2016). They generalize Wald in the appendix. %}

Battigalli, Pierpaolo, Simone Cerreia-Vioglio, Fabio Maccheroni, & Massimo Marinacci (2016) "A Note on Comparative Ambiguity Aversion and Justifiability," *Econometrica* 84, 1903–1916.

{% **criticisms of Savage's basic framework**: Not exactly that, but the authors do consider alternative frameworks, such as Luce & Raiffa's (1957) that takes states and acts as primitive and lets the outcome set be the product set of the outcome set. Even yet one more deviation: The outcome set can yet be different, and there is a function ρ mapping the mentioned product set into what really are outcomes. This framework becomes equivalent to Savage's (1954) framework if (a) the ρ images of different states are the same (state-independence in the sense that the same outcomes can appear for different states); (b) two different acts that induce the same (or even just that modulo equivalence classes of outcomes) function from states to outcomes are equivalent (called consequentialism by the authors on p. 833); (c) enough richness.

The authors also consider probabilistic mixtures of acts. This is mixing in a prior sense, so that correlations between different states can play a role. It then becomes equivalent to the current version of Anscombe-Aumann (1963) if and only if we have a consequentialism-type condition: All that matters for the prior mixing is what mixing results conditional upon each state, and correlations between these do not matter. This is very similar to an assumption in the original Anscombe-Aumann (1963) paper, who had mixing both a priori and "a posteriori" (i.e., conditional on an act), but then assumed that prior mixing is equivalent/can be reduced to posterior mixing, after which their framework becomes equivalent to the modern version of the Anscombe-Aumann framework, explained by the authors on p. 851. The condition is even more similar, in fact equivalent, to Fishburn's (1966) marginal independence; for that, see for instance §6.5, p. 295, Theorem 6.4 of Keeney & Raiffa (1976). (**restrictiveness of monotonicity/weak separability**) The multiattribute utility of Keeney & Raiffa (1976) is very relevant to this paper because it exactly does prior mixing and provides an ocean of theorems on that. May I also add that I learned from Jaffray that in ambiguity we should do prior mixing and not posterior as in the modern version of Anscombe-Aumann because their monotonicity then implies an undesirable separability of states of nature.
P. 828 properly cites Fishburn (1970) for proposing the modern version of the Anscombe-Aumann framework.

In the 2nd half, the paper presents several revealed preference conditions and ambiguity models fitting into their framework. %}

Battigalli, Pierpaolo, Simone Cerreia-Vioglio, Fabio Maccheroni, & Massimo Marinacci (2017) "Mixed Extensions of Decision Problems under Uncertainty," *Economic Theory* 63, 827–866.

{% On macro-economics, and self-confirming policies, which can be based on incorrect beliefs that maintain themselves. There is uncertainty about the true data generating model. The authors use classical EU theory to model the uncertainty, only in end briefly mention ambiguity models, which is their expertise. %}
Battigalli, Pierpaolo, Simone Cerreia-Vioglio, Fabio Maccheroni, & Massimo Marinacci, & Thomas J. Sargent (2022) "A Framework for the Analysis of Self-Confirming Policies," *Theory and Decision* 92, 455–512.
https://doi.org/10.1007/s11238-021-09862-9

{% A survey on psychological game theory. %}
Battigalli, Pierpaolo & Martin Dufwenberg (2022) "Belief-Dependent Motivations and Psychological Game Theory," *Journal of Economic Literature* 60, 833–882.
https://doi.org/10.1257/jel.20201378

{% **normal/extensive form**; decision trees; A continuation on the Kohlberg & Mertens (1986) approach. They show that two games in extensive form are behaviorally equivalent (isomorphic map of strategy profiles to terminal nodes) if and only if one results from the other by collapsing/reversing consecutive moves. %}
Battigalli, Pierpaolo, Paolo Leonetti, & Fabio Maccheroni (2020) "Behavioral Equivalence of Extensive Game Structures," *Games and Economic Behavior* 121, 533–547.
https://doi.org/10.1016/j.geb.2019.11.009

{% Seems to be Mertens & Zamir (1985) with more epistemic refinements. %}
Battigalli, Pierpaolo, & Marciano Siniscalchi (1999) "Hierarchies of Conditional Beliefs and Interactive Epistemology in Dynamic Games," *Journal of Economic Theory* 88, 188–230.

{% Sophisticated work on Kohlberg & Mertens (1986). %}

Battigalli, Pierpaolo & Marciano Siniscalchi (2002) “Strong Belief and Forward Induction Reasoning,” *Journal of Economic Theory* 106, 356–391.

{% %}

Battle, Carolyn C., Stanley D. Imber, Rudolph Hoehn-Saric, Antony R. Stone, Earl H. Nash, & Jeromy D. Frank (1966) “Target Complaints as Criteria of Improvement,” *American Journal of Psychotherapy* 20, 184–192.

{% This paper provides formalizations of anticipated utility, experienced utility, and remembered utility, in total utility. The model is called AER (anticipation, experience, remembering). It assumes functional relations and derives implications. It is tested experimentally by asking subjects “Imagine so and so. How would you feel about it?” Psychological distance of Baucells & Heukamp is one factor.

P. 730: “The model is also predictive of choices, but only to the extent that individuals accurately predict future total utility and use such criteria to guide their decisions. In the framework of Kahneman et al. (1997), Read (2007), and Morewedge (2016), where a rational decision maker maximizes the time integral of instant utility, our model provides prescriptions for someone willing to “engineer” his or her own happiness.”

P. 731 and many places: anticipating utility reduces surprise and experienced and remembered utility.

P. 752: “In other words, conceptual consumption must take values that are realistically possible. Formally, the level of conceptual consumption at any point in time during anticipation and recall is a decision variable constrained to take values …”

P. 752: There is a central role for a reference point, always taken deterministically, endogenous during anticipation and recall, exogenous during experience. A value function is applied to the difference between consumption and the reference point.

P. 733: The authors can speak to habit formation. They capture magnitude effects. This, in combination with loss aversion, gives smaller discounting for losses than for gains (p. 734).

P. 741: “The AER model predicts a trade-off between anticipation and memory: the longer the duration of anticipation, the more adaptation, the lower the surprise,”

P. 742: “The extension of the AER model to conditions of uncertainty, together with the

assumption that conceptual consumption is driven by images of upcoming events, would naturally capturre the observation that people react more to the possibility of good or bad outcomes rather than to the probability of those good or bad outcomes (Kahneman and Tversky 1979)."

P. 742: "In conclusion, the anticipation-event-recall model is a step toward providing a more articulated, yet tractable, model of total event utility that captures the psychological elements of adaptation, time distance, and conceptual consumption." %}

Baucells, Manel & Silvia Bellezza (2017) "Temporal Profiles of Instant Utility During Anticipation, Event, and Recall," *Management Science* 63, 729–748. https://doi.org/10.1287/mnsc.2015.2362

{% An ordinal distance measure between probability distributions is used to obtain sensitivity analyses that, for one, are robust to utility transformations. %}

Baucells, Manel & Emanuele Borgonovo (2014) "Invariant Probabilistic Sensitivity Analysis," *Management Science* 59, 2536–2549.

{% %}

Baucells, Manel, Juan A. Carrasco, & Robin M. Hogarth (2008) "Cumulative Dominance and Heuristic Performance in Binary Multiattribute Choice," *Operations Research* 56, 1289–1304.

{% %}

Baucells, Manel & Franz H. Heukamp (2004) "Reevaluation of the Results by Levy and Levy (2002a)," *Organizational Behavior and Human Decision Processes* 94, 15–21.

{% Examine second-order etc. stochastic dominance for prospect theory. A remarkable point of this study, and new, is that all three factors (utility curvature, probability weighting, and loss aversion), can operate and interact. The results are based on crude but clever and pragmatic heuristic assumptions and estimations. %}

Baucells, Manel & Franz H. Heukamp (2006) "Stochastic Dominance and Cumulative Prospect Theory," *Management Science* 52, 1409–1423.

{% **real incentives/hypothetical choice**; risky payments get 6 months delayed, with real incentives. No explanation on how they implemented and guaranteed this (although end of §2 says it is during year of education, so no doubt about payment). Common ratio immediately and after 6 months, analyzed using their PTT model. Adding delay behaves like adding risk. Their value function exhibits increasing relative risk aversion (**decreasing ARA/increasing RRA**), and probability weighting is **inverse S**-shaped (they call this S-shaped). However, they only fitted Prelec's one-parameter family and they did not investigate other forms. %}

Baucells, Manel & Franz H. Heukamp (2010) "Common Ratio Using Delay," *Theory and Decision* 68, 149–158.

{% **nonconstant discount = nonlinear time perception**;

In most decisions, both time and risk play a role, and we should know about their interactions. Hence, there is a need for such models. This paper brings an advanced model (PTT: probability-time trade-off) to capture such interactions, with a unifying psychological distance.

Table 1 nicely puts together stylized empirical phenomena that motivate the model of this paper.

The authors consider triples (x,p,t), meaning one receives $x with probability p at timepoint t. The main general axioms are A3 (p. 833) and A5 (p. 834). To prepare for Theorem 1 (p. 834): The classical rational evaluation is $p \times e^{-rt} \times U(x)$, where p and t are aggregated multiplicatively as $p \times e^{-rt}$. Taking ln gives $\mathit{ln}p - rt$ as an additive aggregation. Theorem 1 captures this through axiom A3 (and some other things), for each fixed x and, hence dependence of r on x, as

$$\mathit{ln}p - r_x t.$$

So, the exchange rate r_x between $\mathit{ln}p$ and t depends on x. We can also write this representation multiplicatively by taking exponent, as

$$pe^{-r_x t}.$$

This leads to a representation

$$V(x,p,t) = V(x,pe^{-r_x t},0) = V(x, e^{-(-\mathit{ln}p + r_x t)},0) \qquad (*)$$

(their Theorem 1).

Then A5 is added, which is additive decomposability (through Thomsen condition) of x and p at t = 0. Given the presence of a null element, the additive decomposition must in fact be multiplicative, giving

$$V(x,p,0) = w(p)v(x) = f(-\mathit{ln}p)v(x). \qquad (**)$$

For general t, we combine (*) and (**), to get

$$V(x,p,t) = V(x,pe^{-r_x t},0) = w(pe^{-r_x t})v(x) = f(-\mathit{ln}p + r_x t)v(x)$$

(their Theorem 2, p. 834).

They add qualitative conditions to capture the magnitude effect and other phenomena, and a parameter-free elicitation procedure.

The paper gives a nice rewriting of the Prelec-Loewenstein (2012) hyperbolic discounting: rewrite $D(t) = 1/(1+at)^{b/a}$ as $e^{-(b/a)\ln(1+at)}$. Write $\gamma = a/b$ and concave time distance function $f(t) = (1/\gamma)\ln(1+\gamma t)$. Then, $D(t) = e^{-f(bt)}$. The slope of f(t) at 0 is always 1; and as $\gamma \to 0$, $f(t) \to t$ (exponential discounting). The discount rate is $-D'/D = rf'(rt) = r/(1+\gamma\, r\, t)$, decreases with time. Thus, γ is a purely behavioral parameter capturing the degree of diminishing impatience; and r is the discount rate for the immediate future. %}

Baucells, Manel & Franz H. Heukamp (2012) “Probability and Time Tradeoff,” *Management Science* 58, 831–842.

{% Introduce range utility theory, combining expected utility with Parducci’s range principle: risk attitudes depend on the range of outcomes in a context. With context fixed, they get four-fold pattern without violating expected utility (linear in probabilities). Wth varying context, all kinds of preference reversals. %}

Baucells, Manel, Michał Lewandowski, & Krzysztof Kontek (2024) “A Contextual Range-Dependent Model for Choice under Risk,” *Journal of Mathematical Psychology* 118, 102821.
https://doi.org/10.1016/j.jmp.2023.102821

{% They ask three groups, undergraduates, MBA students, and executives (N = 261), about recent real-life risky decisions, and the role of reference points and so on. Losses increase risk seeking. There are no differences between the groups or different outcomes.

Last sentence of abstract: “We confirm that reference-dependence, and not the default alternative, is the driver of risk-taking behavior.” %}

Baucells, Manel & Cristina Rata (2006) "A Survey of Factors Influencing Risk-Taking Behavior in Real-World Decisions under Uncertainty," *Decision Analysis* 3, 163–176.

{% %}
Baucells, Manel & Rakesh K. Sarin (2003) "Group Decisions with Multiple Criteria," *Management Science* 49, 1105–1118.

{% Consider three ways to evaluate a stream of income: (1) just discounted utility à la Samuelson-Koopmans. (2) Take utility of present value of each future payment. (3) Take utility of net present value. Give some analytical advantages of power utility. %}
Baucells, Manel & Rakesh K. Sarin (2007) "Evaluating Time Streams of Income: Discounting What?," *Theory and Decision* 63, 95–120.

{% **intertemporal separability criticized**: Explicitly model violation of separability in intertemporal choice by having utility of consumption at time t depend on previous consumption through a retention parameter, with the dependence becoming weaker as the time interval is bigger. There may be some sort of violation of dominance if the increase of consumption today decreases the utilities of future consumption much.

The interesting property of local substitution says that (t:x, s:y) becomes equivalent to (t:x+y) as s tends to t, is very natural, but cannot be satisfied by discounted utility. %}
Baucells, Manel & Rakesh K. Sarin (2007) "Satiation in Discounted Utility," *Operations Research* 55, 170–181.

{% Propose a variation of discounted utility, extending their 2007 model. At a timepoint t a reference point is chosen that is a convex combination of past consumptions (also indirectly through past satiation). Habit formation means that past consumption of some good amplifies its present utility, and satiation means the opposite. One has a different sign of some parameters than the other. The interesting property of local substitution of their 2007 paper is also used here. It

says that (t:x, s:y) becomes equivalent to (t:x+y) as s tends to t, is very natural, but cannot be satisfied by discounted utility. %}

Baucells, Manel & Rakesh K. Sarin (2010) "Predicting Utility under Satiation and Habit Formation," *Management Science* 56, 286–301.

{% Book has many good advices for people who do not manage their emotions and expectations wisely, with many nice anecdotes where Sarin's origin from India and Buddhism delivers a delicious mix with Baucell's Christean background.

P. x and other places: happiness = reality – expectation. P. 66 adds nuances, that increase in welfare gives partial adaptation, with partly happiness only because of change but partly extra happiness everlasting. I wish that this nuance had been put more central because, as is, it seems that one can get happier simply by reducing expectation.

P. 6: the authors identify themselves as decision analysts and management scientists.

P. 31, happiness seismograph is like Edgeworth's hedonimeter. The authors put forward what Kahneman, Wakker, & Sarin (1997) called total utility, being the time-integrated instant/experienced utility.

P. 159: "Let's explore some ways to influence expectation so that our lives can be happier within the same reality." P. 163 writes about karma.

Pp. 164-165: anxiety of choice. %}

Baucells, Manel & Rakesh K. Sarin (2012) "*Engineering Happiness*." University of California Press, Berkeley.

{% Gives **completeness criticisms**:

risky utility u = strength of preference v (or other riskless cardinal utility, often called value): intro points out that vNM do not justify transferable utility, used in 2/3 of their book.

§2, called a Review, in fact gives a beautiful new extension of vNM EU to the case of incompleteness in Theorem 1, however, quasi-covering it up with an unappealing mathematical formulation in terms of cones. %}

Baucells, Manel & Lloyd S. Shapley (2008) "Multiperson Utility," *Games and Economic Behavior* 62, 329–347.

{% N = 141. Two sessions 3 months apart. Hypothetical choice, with questions and answers by email.

Each subject had to answer only two choice questions:

(0.10: €3,000, 0.40: €2,000, 0.40: €1,000, 0.10: €0) versus €3000$_{0.50}$€0

(0.10:0, 0.40: –€1,000, 0.40: –€2,000, 0.10: –€3,000) versus €0$_{0.50}$(–€3,000).

So, they consider gain- and loss prospects, and not mixed ones. In this sense, limited data (they argue that they do it deliberately, to get inconsistencies). The prospects were all nondegenerate (no certainty), and risk aversion meant going for the highest variance (in every choice pair the two options had the same EV).

risk averse for gains, risk seeking for losses: They confirm usual findings of risk aversion for gains and risk seeking for losses. Find confirmation of reflection, because violations can be explained as noise: 72% of the subjects satisfy reflection, and 28% satisfy risk aversion for gains and losses. 63% of the subjects change preferences over 3 months (P. 204; 37% gave the same answers to all questions in the two sessions).

equate risk aversion with concave utility under nonEU: P. 196 3rd para explains that risk aversion (preference for EV over prospect) can be driven by probability weighting rather than by utility curvature. But then, unfortunately, it is going to use the term risk aversion for concave utility. Why they call concave utility what it isn't (risk aversion) rather than what it is (concave utility!) is a puzzle to me. If sometimes their term risk aversion still refers to the usual definition is not clear, especially when they discuss literature.

reflection at individual level for risk: Supported although not much data. Table 3, p. 203 the row of average over two sessions shows that (I exclude indifferences) of 72 risk averters for gains, 46 were risk seeking for losses and 26 were risk averse for losses. Of 12 risk seekers for gains, 7 were risk averse for losses and 5 were risk seeking.

P. 209 2nd para: "The existence of two types has important implications in the area of elicitation of risk preferences. For instance, in measuring the value function, rather than taking a grand average of a "representative value function," our results suggest to first classify subjects as either reflective or averse, and then calculate two separate representative value functions." %}

Baucells, Manel & Antonio Villasis (2010) "Stability of Risk Preferences and the Reflection Effect of Prospect Theory," *Theory and Decision* 63, 193–211. https://doi.org/10.1007/s11238-009-9153-3

{% Propose to modify classical utility measurements under EU, primarily CE and PE, to nonEU by adding tail probabilities t with common best and worst outcome, in the spirit of Mccord & de Neufville's (1986) lottery equivalent method, formalizing it. They assume PT with interior additivity which is empirically reasonable and justifies their method. They extensively test it, comparing it to more laborious methods such as the tradeoff method (**tradeoff method**) and find that it performs well. (**Probability weighting linear in interior**) The result is not surprising theoretically, but it is a convenient tool directly applicable to nonquantitative outcomes under nonEU and this is useful for applications. It is a sort of McCord & de Neufville method updated to the modern literature. %}

Baucells, Manel & Antonio Villasís (2015) "Equal Tails: A Simple Method to Elicit Utility under Violations of Expected Utility," *Decision Analysis* 12, 190–204.

{% Study how reference points evolve over time. It is mostly determined by the first and the last price in a series, where the intermediate prices have less impact. %}

Baucells, Manel, Martin Weber, & Frank Welfens (2011) "Reference-Point Formation and Updating," *Management Science* 57, 506–519.

{% Uses Gilboa & Schmeidler (1995) as point of departure. Does something with products of Möbius inverses. %}

Bauer, Christian (2012) "Products of Non-Additive Measures: A Fubini-Like Theorem," *Theory and Decision* 73, 621–647.

{% Adaptive designs were used in medicin long ago, as in this paper. See also the review Bauer et al. (2016). %}

Bauer, Peter (1989) "Multistage Testing with Adaptive Designs," *Biometrie und Informatik in Medizin und Biologie* 20, 130–148.

{% Surveys adaptive designs in medicine. %}

Bauer, Peter., Frank Bretz, Vladimir Dragalin, Franz König, & Gernot Wassmer (2016) "Twenty-Five Years of Confirmatory Adaptive Designs: Opportunities and Pitfalls," *Statistics in Medicine* 35, 325–347.

{% **three-doors problem**; argues that in single play it cannot be claimed that switching is better because, as he writes in the closing sentence: "If the best argument so far for switching in an isolated individual case (not in a series of cases) fails, then one might wonder whether probabilistic arguments say anything at all about isolated individual cases." In middle of paper there is some kind of argument such as (I do not understand it but try to reproduce) if switching is better, then in a concrete situation this need not apply because in a concrete situation where you chose door 1 initially switching means more, being it means going away from door 1, whereas in general it might also be going away from door 2. There also seems to be an argument about probabilities having to be the same even if conditioned on different events!? %}

Baumann, Peter (2005) "Three Doors, Two Players, and Single-Case Probabilities," *American Philosophical Quarterly* 42, 71–79.

{% **three-doors problem** %}

Baumann, Peter (2008) "Single-Case Probabilities and the Case of Monty Hall: Levy's View," *Synthese* 162, 265–273.

{% Ratio bias:use physical, textual, and graphical depiction, accounting for different levels of exposure to probabilities. Higher exposure to probabilities, higher levels of statistical numeracy, and risk literacy reduce ratio bias. %}

Baumeister, Jochen, Bernhard Streicher, Eva & Lermer (2025) "Ratio Bias Across Cultures and Disciplines: How Academic Background Shapes Statistical Decision-Making," *Journal of Behavioral Decision Making* 38, e70010. https://doi.org/10.1002/bdm.70010

{% On psychological background of loss aversion (and many other things), a comprehensive review, often cited, similar to Peeters & Czapinski (1990). Frankly, I like Peeters & Czapinski (1990) more than this paper. %}

Baumeister, Roy F., Ellen Bratslavsky, Catrin Finkenauer, & Kathleen D. Vohs (2001) “Bad Is Stronger than Good,” *Review of General Psychology* 5, 323–370.

{% **intuitive versus analytical decisions; free will/determinism**; Review the literature and conclude that conscious thinking does affect decisions. (May sound amazingly trivial to the uninitiated.) Is evidence in favor of free will. %}

Baumeister, Roy F., E. J. Masicampo, & Kathleen D. Vohs (2011) “Do Conscious Thoughts Cause Behavior?,” *Annual Review of Psychology* 62, 331–361.

{% **risky utility u = transform of strength of preference v, latter doesn’t exist**. Says that vNM utility is not riskless cardinal utility. P. 61 bottom of 2nd column points out that measurement of vNM utility is not appropriate if individual violates EU.

P. 64 argues that, with utils as unit of payment, $600_{1/6}420 \succ 600_{5/6}60$ is a reasonable preference because of the security of 420, but it violates EU because the EUs are 450 and 510, respectively. Here he makes the mistake that I criticize in Comment 2.6.5 of my 2010 book (p. 63), of not realizing that the utility unit already comprises risk attitude, and that speculating on risk attitudes w.r.t. util units is double counting. In his 1958 paper Baumol seems to dissociate himself from this confusion. %}

Baumol, William J. (1951) “The von Neumann-Morgenstern Utility Index—An Ordinalist View,” *Journal of Political Economy* 59, 61–66.

{% **substitution-derivation of EU**: in appendix.

risky utility u = transform of strength of preference v, latter doesn’t exist: p. 665: “… the mistaken view that the utility index is, or is intended to be, just another device for measuring neoclassical introspective utility, … As one who once fell into this trap, I am perhaps oversensitive to this matter.”

P. 666 nicely explains the different meanings of cardinal, first as merely unique up to level and unit, second with all the connotations attached of neoclassical utility. %}

Baumol, William J. (1958) “The Cardinal Utility Which Is Ordinal,” *Economic Journal* 68, 665–672.

{% According to Olson (1993) this paper is a classic. Social discount rate should be between the social opportunity cost of capital (reflecting marginal rate of return in the private sector, adjusted by risk premium) and the, lower, **time preference** rate. Baumol provided no definite conclusion in favor of either one. %}

Baumol, William J. (1968) "On the Social Rate of Discount," *American Economic Review* 58, 788–802.

{% P. 431: **risky utility u = transform of strength of preference v, latter doesn't exist. %**}

Baumol, William J. (1977) "*Economic Theory and Operations Analysis*; 4th edn." Prentice-Hall, London.

{% %}

Baumol, William J. (2000) "What Marshall *Didn't* Know: On the Twentieth Century's Contributions," *Quarterly Journal of Economics* 115, 1–44.

{% %}

Baumol, William J. & Stephen M. Goldfeld (1968, eds.) "*Precursors in Mathematical Economics: An Anthology*." Clowes and Sons, London.

{% %}

Bawa, Vijay S. (1982) "Stochastic Dominance: A Research Bibliography," *Management Science* 28, 698–712.

{% Equilibria under ambiguity %}

Bayer, Peter & Ani Guerdjikova (2024) "Optimism Leads to Optimality: Ambiguity in Network Formation," *Journal of Economic Dynamics & Control* 168, 104994. https://doi.org/10.1016/j.jedc.2024.104944

{% Introduced updating formula. %}

Bayes, Thomas (1763) "An Essay toward Solving a Problem in the Doctrine of Chances," *Philosophical Transactions of the Royal Society of London* 53, 370–418.

Communicated by Mr. Richard Price, in a letter to John Canton.

Reprinted in W Edwards Deming (1940, ed.) “*Facsimiles of Two Papers by Bayes*,” The Graduate School, Department of Agriculture, Washington D.C. https://doi.org/10.1098/rstl.1763.0053

{% %}
Bayoumi, Ahmed & Donald A. Redelmeier (2000) “Decision Analysis with Cumulative Prospect Theory,” *Medical Decision Making* 20, 404–412.

{% Examples of cognitive biases. Suited for nonmathematical students. %}
Bazerman, Max H. (1990) “*Judgement in Managerial Decision Making*.” Wiley, New York.

{% **real incentives/hypothetical choice**: seem to find, for estimating probabilities, that real rewards through quadratic scoring rule versus no reward do not affect the results much (**proper scoring rules**).
inverse S: seem to find it, with overestimation of low probabilities and underestimation of high. %}
Beach, Lee R. & Lawrence D. Phillips (1967) “Subjective Probabilities Inferred from Estimates and Bets,” *Journal of Experimental Psychology* 75, 354–359.

{% This paper shows that the compromise effect (always choosing the middle of the scale) exists, and biases prospect theory estimations. They then introduce an extra parameter reckoning with the compromise effect, which indeed neutralizes it. %}
Beauchamp, Jonathan P., Daniel J. Benjamin, David I. Laibson, & Christopher F. Chabris (2020) “Measuring and Controlling for the Compromise Effect,” *Experimental Economics* 23, 1069–1099.
https://doi.org/10.1007/s10683-019-09640-z

{% Consider a number of introspective risk attitude measures, and investigate them. The authors also have two choice-based questions, asking hypothetical choices between SEK 24,000 for sure or a chance of 0.25 of receiving SEK 100,000, and the same for the amounts multiplied by –1. But the authors give results on those only in the online appendix, which I did not read. %}

Beauchamp, Jonathan P., David Cesarini, & Magnus Johannesson (2017) "The Psychometric and Empirical Properties of Measures of Risk Preferences," *Journal of Risk and Uncertainty* 54, 203–237.

{% **finite additivity**: some example that anomalies for finite additivity can, in certain ways, be adapted to countably additivity. %}
Beam, John (2007) "Unfair Gambles in Probability," *Statistics and Probability Letters* 77, 681–686.

{% %}
Beardon, Alan F. & Ghanshyam B. Mehta (1994) "The Utility Theorems of Wold, Debreu, and Arrow-Hahn," *Econometrica* 62, 181–186.

{% **error theory for risky choice**: shows, with data, theoretical analysis, and simulation, that **inverse S** probability estimates can be generated by errors. %}
Bearden, J. Neil, Thomas S. Wallsten, & Craig R. Fox (2007) "Contrasting Stochastic and Support Theory Accounts of Subadditivity," *Journal of Mathematical Psychology* 51, 229–241.

{% %}
Beattie, Jane & Jonathan Baron (1991) "Investigating the Effect of Stimulus Range on Attribute Weight," *Journal of Experimental Psychology: Human Perception and Performance* 17, 571–585.

{% %}
Beattie, Jane, Jonathan Baron, John C. Hershey, & Mark D. Spranca (1994) "Psychological Determinants of Decision Attitude," *Journal of Behavioral Decision Making* 7, 129–144.

{% Presented at FUR-Oslo %}
Beattie, Jane, Judith Covey, Paul Dolan, Lorraine Hopkins, Michael Jones-Lee, Graham Loomes, Nick Pidgeon, Angela Robinson, & Anne Spencer (1998) "On the Contingent Valuation of Safety and the Safety of Contingent Valuation: Part 1—Caveat Investigation," *Journal of Risk and Uncertainty* 17, 5–25.

{% **real incentives/hypothetical choice**; many refs are given; do common-ratio HYPO (hypothetical), RPSP (random problem selection procedure). Find that these scenarios all give same results. In another choice involving dynamic sequential aspects, real payment did matter: G: £4 for sure, £10 if one toss gives heads up, £25 if two tosses give heads up, and £62.50 if three tosses give heads up. They didn't do it sequentially but as one-shot decision and only the resolution of uncertainty was sequential.

P. 165/166: "The results reported in this article suggest that in simple pairwise choices, incentives appear to make very little difference to performance." Then they indicate a more complex multistage task ("RPSP") in which real incentives did matter.

Seem to find isolation satisfied for three simple choices, but violated for a complex compound choice. %}

Beattie, Jane & Graham Loomes (1997) "The Impact of Incentives upon Risky Choice Experiments," *Journal of Risk and Uncertainty* 14, 155–168.

{% %}

Beatty, Jain & Daniel Kahneman (1966) "Pupillary Changes in Two Memory Tasks," *Psychonomic Science* 5, 371–372.

{% **equity-versus-efficiency** %}

Beblo, Miriam, Denis Beninger, François Cochard, Hélène Couprie, & Astrid Hopfensitz (2015) "Efficiency-Equality Trade-Off within French and German Couples: A Comparative Experimental Study," *Annals of Economics and Statistics* 117–118, 233–252.

{% Seems to show that gains and losses are processed in different parts of the brains. %}

Bechara, Antoine, Hanna Damasio, Daniel Tranel, & Antonio R. Damasio (1997) "Deciding Advantageously before Knowing the Advantageous Strategy," *Science* 275, 1293–1295.

{% **coherentism**: Considers preference purification from the structural interpretation of rationality (the coherence view? I did not check) versus the structural notion

(assuming inner rational agent? I did not check). Author seems to favor structural interpretation. I favor inner rational agent. %}

Beck, Lukas (2023) "The Econ within or the Econ above? On the Plausibility of Preference Purification," *Economics & Philosophy* 39, 423–443. https://doi.org/doi:10.1017/S0266267122000141

{% This paper does not discuss the normative status of models, but instead is a methodological analysis of normativeness in general. Normative models, like all models, make simplifying empirical assumptions that only approximate reality. P. 124 writes: "Thus, the puzzling question arises how models involving such false descriptions of agents can provide normative guidance to them." I did not fully understand this objection. P. 128: The authors (mis)use the term independence of irrelevant alternatives for what is mixture indepencence, the main condition axiomatizing expected utility in VNM's theorem (although vNM, as a mistake, did not write the condition but used it implicitly). P. 128 bottom takes transitivity as normative but the other conditions not, somewhat to my surprise.

I was glad to see that my paper Li, Li, & Wakker (2014), giving a litmus test on paternalism stances, is cited.

P. 130 bottom: I agree with the authors that my paper Bleichrodt, Pinto, & Wakker(2001) does not provide justifications for the claim that expected utility is normative. But I do not understand "let alone a discussion of how such models can offer guidance despite involving false descriptive statements, that is, descriptive idealizations." It is a methodological point of the paper that I miss anyhow.

P. 131 has the funny kind of footnote of a reviewer being thanked where one feels that the authors do it reluctantly and the referee insisted too much.

P. 134 bottom probably captures an essential point in the paper that I am missing: "Thus, descriptive idealizations seem to play a different role in normative models than descriptive premises in normative arguments." %}

Beck, Lukas & Marcel Jahn (2021) "Normative Models and Their Success," *Philosophy of the Social Sciences* 51, 123–150.

{% **updating: testing Bayes' formula**: unforeseen contingencies. An experiment is done with it, using the Karni & Vierø (2013) model. Subjects exhibit some common violations of updating, but the reversed nature of Bayesianism here does

not generate new ones.

A great difficulty with unforeseen event experiments is how to implement it without using deception. It is basically impossible. At best, one can do something similar. In this experiment, first subjects gamble on an urn with balls of only two colors, and only two prizes possible. But later content of another different urn with balls of a different color giving a different prize is added to the original urn and subjects are informed about that. This is not unforeseen event about the original urn but, rather, just, change of urn. However, we can never do better than such approximations of unforeseen events. %}

Becker, Christoph K., Tigran Melkonyan, Eugenio Proto, Andis Sofianos, & Stefan T. Trautmann (2021) "Reverse Bayesianism: Revising Beliefs in Light of Unforeseen Events," working paper.

{% P. 7 seems to acknowledge circularity in the concept of utility. Compares it with potential energy that is introduced only to preserve the law of conservation of energy. %}

Becker, Gary S. (1976) "*The Economic Approach to Human Behavior.*" Prentice-Hall, Englewood Cliffs, NJ.

{% **intertemporal separability criticized**: habit formation %}

Becker, Gary S. (1996) "*Accounting for Tastes.*" Harvard University Press, Cambridge, MA.

{% %}

Becker, Gary S. & Casey B. Mulligan (1997) "The Endogenous Determination of Time Preference," *Quarterly Journal of Economics* 112, 729–758.

{% This paper presents a rationalization for addiction. End of §I describes as one of the novelties of this work, "We appear to be the first to ... relate even temporary stressful events to permanent addictions." If one is not addicted, one does not have the stock of consumption capital S needed to make utility of non-heroin negative. So, how can nonaddicted ever become addicted? The question is answered on p. 690/691, in particular Eq. (22). I find it easier to state the point in words than in symbols as in Eq. (22): It is simply !assumed! for a person who never used heroin but is, for example, in marital breakup, that this marital breakup generates the same heroin consumption capital as for a person who had used heroin in the past! Voilà the miracle. Hence, nonaddicted can turn into addicted by marital breakup. (Eq. 22 does it by letting stock of consumption capital depend on sum c(t) + Z(t) where c refers to previously consumed heroin and Z to stressful event. So, Z can simply substitute for c.) %}

Becker, Gary S. & Kevin M. Murphy (1988) "A Theory of Rational Addiction," *Journal of Political Economy* 96, 675–700.

{% **error theory for risky choice** %}

Becker, Gordon M., Morris H. de Groot, & Jacob Marschak (1963) "Stochastic Models of Choice Behavior," *Behavioral Science* 8, 41–55.

{% **random incentive system**: Seem to use it so as to avoid "wealth effects." However, use it in an adaptive setup and this is not incentive compatible, as demonstrated by Harrison (1986).

Introduce the BDM (Becker-DeGroot-Marschak) mechanism. %}

Becker, Gordon M., Morris H. de Groot, & Jacob Marschak (1964) "Measuring Utility by a Single-Response Sequential Method," *Behavioral Science* 9, 226–232.

{% Expected utility where the utility function can depend on the lottery. This in itself is too general, and can accommodate any Archimedean weak order. %}

Becker, Joao L. & Rakesh K. Sarin (1987) "Lottery Dependent Utility," *Management Science* 33, 1367–1382.

{% %}

Becker, Joao L. & Rakesh K. Sarin (1989) "Economics of Ambiguity," Duke University, Fuqua School of Business, Durham NC, USA.

{% P. 67 (§3.2) has a clear discussion of the overtaking criterion, in combination with a "golden rule." **DC = stationarity**; P. 72, §3.3.1: "The time inconsistency problem raised by Strotz (1955) does not arise when preferences are stationary." They claim that stationarity refers to postponing decisions, whereas it is postponing consumption. They actually use the term calendar time, though not the term stopwatch time. %}

Becker, Robert A. & John H. Boyd III (1997) "*Capital Theory; Equilibrium Analysis and Recursive Utility*." Blackwell, Oxford.

{% This may be the first experimental test of Ellsberg's ambiguity claims. Chipman (1960) did not really test it.

second-order probabilities to model ambiguity: Not really. It is how they claim to model ambiguity (e.g., p. 64 middle of last para, pp. 64-65, and p. 65 Hypothesis II). They may have been the first to do so. In the experiment, however, they only give probability intervals and no 2nd order probabilities. P. 64: ambiguity is a "distribution of probabilities other than a point estimate". The typical multiple prior thinking.

Subjects choose from known fifty-fifty urn versus unknown fifty-fifty urn where unknown has varying degrees of ambiguity. Greater range of second-order probability then greater ambiguity. However, too few subjects to do statistics.

Pp. 63-64, footnote 4, has the famous reference to a conversation with Ellsberg, where Ellsberg suggests **ambiguity seeking for unlikely** events. He proposes an urn with 1000 numbered balls in unknown proportion. You get prize if randomly drawn ball has number from a subset of n numbers between 1 and 1000. Ellsberg predicts ambiguity seeking for small n, turning to ambiguity aversion as n increases.

P. 72: "there is some reason to believe that preferences for level of knowledge and for variance of outcome distribution are closely related and may, in fact, be perceived by the subjects to be the same or similar phenomenon." Inverse S can be interpreted as increasing variance and, hence, the second part of the sentence can be related to it (**inverse S**).

P. 73 suggests competence effect of Heath & Tversky (1991) (being "second-guessed" by other observers) %}

Becker, Selwyn W. & Fred O. Brownson (1964) "What Price Ambiguity? Or the Role of Ambiguity in Decision Making," *Journal of Political Economy* 72, 62–73. https://doi.org/10.1086/258854

{% **equity-versus-efficiency**, gives many refs; Paper presented at SSCW Vancouver 1998 %}

Beckman, Steven R., John P. Formby, W. James Smith, & Buhong Zheng (2002) “Envy, Malice and Pareto Efficiency: An Experimental Examination,” *Social Choice and Welfare* 19, 349–367.

{% **(very) small probabilities**: The paper discussed very high gains with a very small probability, and very high losses with a very small probability, reminding me of discussions of Parfit’s repugnant solution (not cited).

P. 431 opens with a nice story: “On your deathbed, God brings good news. Although, as you already knew, there's no afterlife in store, he'll give you a ticket that can be handed to the reaper, good for an additional year of happy life on Earth. As you celebrate, the devil appears and asks, “Won't you accept a small risk to get something vastly better?” %}

Beckstead, Nick & Teruji Thomas (2024) “A Paradox for Tiny Probabilities and Enormous Values,” *Nous* 58, 431–455. https://doi.org/10.1111/nous.12462

{% Use choices from LINGO tv show to estimate risk aversion; **marginal utility is diminishing**; **utility elicitation**

decreasing ARA/increasing RRA: use exponential and power utility; find high risk aversion;

They also consider probability transformation, but not as in prospect theory where most probabilities are underweighted. Instead, they assume that all probabilities are overweighted. Such overweighting is plausible if there is overconfidence about own performance. This explains why their corrections for probability weighting lead to even more concave utilities. %}

Beetsma, Roel M.W.J. & Peter C. Schotman (2001) “Measuring Risk Attitudes in a Natural Experiment: An Empirical Analysis of the Television Game Show LINGO,” *Economic Journal* 111, 821–848.

{% %}

Behavioural Insights Team (2012) “Annual Update 2011-2012,” Cabinet Office, 70 Whitehall, London, UK.

{% Various nonsmooth ambiguity models work best empirically, but are analytically difficult regarding 1st order optimality. This paper provides generalizations of derivatives that can conveniently be used there. In particular, they allow for nonconvexity and nonconcavity, as with likelihood insensitivity.

P. 1006 defines inverse S-shape as cavexity. I argued on several occasions that this is not a very good definition. Proposition 3 on p. 1008 shows that every cavex weighting function is a convex combination of a concave and a convex weighting function and, hence, of a generalized α-maxmin model where the generalization is that the set of priors can be different for the inf part than for the sup part. %}

Beissner, Patrick & Jan Werner (2023) "Optimal Allocations with α-MaxMin Utilities, Choquet Expected Utilities, and Prospect Theory," *Theoretical Economics* 18, 993–1022.
https://doi.org/10.3982/TE5060

{% %}

Beja, Avraham & Itzhak Gilboa (1992) "Numerical Representations of Imp *etical Economics* 18, 993–1022.
https://doi.org/10.3982/TE5060

erfectly Ordered Preferences (A Unified Geometric Exposition)," *Journal of Mathematical Psychology* 36, 426–449.

{% %}

Bell, David E. (1974) "Evaluating Time Streams of Income," *Omega* 2, 691–699.

{% **risky utility u = transform of strength of preference v, latter doesn't exist**? Haven't checked it;

Abstract suggests that EU is normatively questionable.

Suggests that regret may be included in a decision analysis as an extra attribute of outcomes. This is a case of what Broome (1990) calls individuation.

P. 979: "The next step is to determine, with the decision maker, whether a regret term is an appropriate component of the analysis. Even if the decision maker agrees that regret avoidance is a goal to be traded off against final assets, he may wish to consider whether the tradeoffs he is implicitly using are appropriate. A constructive analysis might then be undertaken. Of course the decision maker may wish to eliminate the regret component entirely. Just as weather forecasters accept training to improve their probability calibration so perhaps decision makers may accept training to eliminate, as appropriate, the practice of comparing uncertain alternatives by a weighted function of value differences …" %}

Bell, David E. (1982) "Regret in Decision Making under Uncertainty," *Operations Research* 30, 961–981.

{% %}

Bell, David E. (1983) "Risk Premiums for Decision Regret," *Management Science* 29, 1156–1166.

{% **inverse S** & **EU+a*sup+b*inf**: Proposed weighting function that is linear in the middle but discontinuous at 0 and 1. The same formula, for a different context, is in Eq. 3 of Birnbaum & Stegner (1981).

risk seeking for small-probability gains: p. 15 and Theorem 2 explicitly consider risk seeking for small probability gains to be plausible.

biseparable utility: yes for the special case where their disappointment function is 0-kinked linear. %}

Bell, David E. (1985) "Disappointment in Decision Making under Uncertainty," *Operations Research* 33, 1–27.

{% **utility families parametric**; Remarkably, the same family as in Farquhar & Nakamura (1987) is axiomatized through a different axiom. The only one-switch family that is nice (increasing, concave, decreasing absolute risk aversion) is the sumex $a \times \exp(cw) + b \times \exp(dw)$ with all parameters negative. c or d may be zero meaning a linear function is to be taken, as usual. %}

Bell, David E. (1988) "One-Switch Utility Functions and a Measure of Risk," *Management Science* 34, 1416–1424.
https://doi.org/10.1287/mnsc.34.12.1416

{% %}

Bell, David E. (1995) "Contextual Uncertainty Conditions for Utility Functions," *Management Science* 41, 1145–1150.

{% **risky utility u = transform of strength of preference v, latter doesn't exist**; **utility families parametric**; Adapt axiomatizations of parametric families (lin./exp., sums of exp., one-switch) of utility, well-known under SEU, to some nonEU models (rank-dependent, weighted utility, regret/SSBU). Log-power (CRRA) is not included.

P. 5 ℓ. 5 ff. and many other places claim that von Neumann-Morgenstern eschewed the early intensity interpretations of their vNM utility, as had been done in other writings by Fishburn (and possibly by Bell too but I have no concrete reference here). As I explained in a conversation with Fishburn somewhere in the 1990s, I disagree, and think that instead vNM did not commit to anything, neither to accepting nor to eschewing this interpretation.

P. 7 ℓ. 3–2 before Eq. (3) misuses the reputation of Savage (who can no more defend) in a commercial for Bell's work. This writing is of bad taste. %}

Bell, David E. & Peter C. Fishburn (2000) "Utility Functions for Wealth," *Journal of Risk and Uncertainty* 20, 5–44.

{% This paper proposes a simple preference condition, shows how this implies a functional equation for the ptf, and analyzes the latter. This general approach and technique are mathematically interesting. It is nice that they consider **inverse S.** However, the equation introduced is neither empirically nor normatively realistic. Examples and arguments to suggest the latter are not convincing.

Restricted independence brings in a touch of betweenness (which is nice). In its defense in Example 1, the authors simply refer to the appeal of independence in general.

Example 2: In the first choice, Paula prefers the certainty because the .02 chance of getting nothing is risky. In the second choice, the chance has reduced to .0001. Therefore, the multiplier of 0.005 that carried one probability to the other is too small to maintain indifference. However, less extreme but similar examples can be developed with the multiplier .5 as assumed in the axiom of this paper. Somewhere along the line, an x chance of getting nothing is risky but an x/2 chance is importantly less risky. The effect by a factor 2 will be less extreme, but basically the same as by a factor .0001; i.e., it will destroy the indifference for the same intuition. In short, the intuition put forward for the .005 multiplication seems to exist, less extreme but still just as convincing, for the .5 multiplication assumed in their axiom. The example thereby makes me doubt about the axiom.

P. 248 2nd para before Lemma 2: The condition $f(2p) \leq 2f(p)$, imposed locally, is strictly weaker than local subadditivity, which is strictly weaker than local convexity. Therefore, the terminology is not correct.

P. 248, ℓ. –4: “only to π’s extremes”: Those are the most important and most pronounced! This lemma shows that the axiom is not empirically realistic. Note also that empirical evidence suggests subproportionality, with $\pi(p/2)/\pi(p)$ increasing, maybe even tending to 1, as p approaches zero. The model of this paper has this constant and equal to $\pi(1/2)$ in the limit. Similar dual things hold near $p = 1$ instead of $p = 0$.

Contrary to what the authors suggest on p. 247, next-to-last para, Quiggin (1993) does not have RDU representations for arbitrary outcome sets, but he does need continuity of outcomes. %}

Bell, David E. & Peter C. Fishburn (2003) “Probability Weights in Rank-Dependent Utility with Binary Even-Chance Independence,” *Journal of Mathematical Psychology* 47, 244–258.

{% %}

Bell, David E. & Howard Raiffa (1982) “Marginal Value and Intrinsic Risk Aversion.” *In* Howard C. Kunreuther (ed.) *Risk: A Seminar Series*, Laxenberg, Austria: International Institute for Applied Systems Analysis, 325–350. Reprinted in David E. Bell, Howard Raiffa, & Amos Tversky (1988, eds.) “*Decision Making, Descriptive, Normative, and Prescriptive Interactions*,” Cambridge University Press, Cambridge.

{% %}

Bell, David E., Howard Raiffa, & Amos Tversky (1988) “*Decision Making, Descriptive, Normative, and Prescriptive Interactions*.” Cambridge University Press, Cambridge.

{% %}

Bell, David E., Howard Raiffa, & Amos Tversky (1988) "Descriptive, Normative, and Prescriptive Interactions in Decision Making." *In* David E. Bell, Howard Raiffa, & Amos Tversky (eds.) *Decision Making, Descriptive, Normative, and Prescriptive Interactions*, 9–30, Cambridge University Press, Cambridge.

{% **foundations of quantum mechanics** %}
Bell, John S. (1964) "On the Einstein-Podolsky-Rosen Paradox," *Physics* 1, 195–200.

{% **foundations of quantum mechanics** %}
Bell, John S. (1964) "On the Problem of Hidden Variables in Quantum Mechanics," Review*s of Modern Physics* 38, 447–452.

{% **proper scoring rules**; This paper consider the case where subjects have expressed a number of quantiles of their subjective probability distribution. How to interpolate? The authors consider cubic splins (using 3rd order polynomials that best fit between each adjacent pair of observed points), which works better than lower- or higher-order splins. The case of censored data (positive subjective probability outside the interval considered) is more complex, but the authors suggest ways to handle it. Cubic splin can lead to violations of monotonicity, for which the authors use Hyman's (1983) fix. It applies the technique to a data set on income expectations. %}
Bellemare, Charles, Luc Bissonnette, & Sabine Kröger (2012) "Flexible Approximation of Subjective Expectations Using Probability Questions," *Journal of Business and Economic Statistics* 30, 125–131.

{% %}
Bellemare, Charles & Sabine Kröger (2007) "On Representative Social Capital," *European Economic Review* 51, 183–202.

{% Use term "preference" also to designate just utility (capturing inequity aversion). It is sometimes hard to know if "preference" refers just to utility or to preference in general.

They study ultimatum games and inequality aversion à la Fehr-Schmidt. Subjects are students but also a representative sample from the Dutch population.

They measure subjective beliefs only through direct judgment, not incentivized. Find that subjective probabilities (of other rejecting offer and so on) better predict decisions than the true objective probabilities (percentage of others in sample that rejected offer). Also find a strange aversion to self-interest-serving inequity, with people rejecting to receive money if it makes them richer than the others.

Nicely refer to rational expectations regarding difference between subjective and objective probabilities (e.g., p. 829). They ask for both introspective probabilities of accepting offer and of the complementary event of rejecting offer. Those do not add to 1, but usually to less, violating binary additivity. They then take midpoints as estimates. In regressions for probability they use two-limit probit models, censoring at 0 and 1. Young and highly educated subjects are most selfish.

Nice sentence on p. 836: "These results suggested that subjective probability data, although suffering from the problem of a substantial framing bias, can be useful to better predict and understand behavior in simple games of proposal and response." %}

Bellemare, Charles, Sabine Kroger, & Arthur van Soest (2008) "Measuring Inequity Aversion in a Heterogeneous Population Using Experimental Decisions and Subjective Probabilities," *Econometrica* 76, 815–839.

{% **updating: testing Bayes' formula**: Hypothetical choice is used. Subjects are informed that a true distribution over a state space has randomly been chosen from one of three true distributions. Then they sample repeatedly. After every few samples, they are asked to state their 2nd- and 1st order distributions. Their 2nd order distributions are not sufficiently updated (conservatism), which, I add, fits well with a-insensitivity. Some let their 1st order distributions properly be averaged mixes via their 2nd order distributions, others go for the most likely of the three possible ones, and some just do random. The authors interpret the situation as ambiguity. Whether 2nd order probability can be taken as ambiguity has often been debated. (**second-order probabilities to model ambiguity**). %}

Bellemare, Charles, Sabine Kröger, & Kouamé Marius Sossou (2018) "Reporting Probabilistic Expectations with Dynamic Uncertainty about Possible Distributions," *Journal of Risk and Uncertainty* 57, 153–176.

{% This paper defines a degree of orness of a Choquet integral, only for positive acts. Orness is an acronym used before in some math. branches. It depends on the comonotonic set considered. In this case, for the special case where the nonadditive measure is lawinvariant (= probabilistic sophistication), the orness index is approximately the area under the curve of the transformation function. More precisely, for n states of nature, it is the usual rectangular-n-rectangle-area sum lower (or is it upper?) bound of the integral. So, it is an index of optimism. The paper cites other indexes proposed in the literature. It takes this as a global measure of risk seeking. For a probability transformation function w, it proposes w(p)/p as a local index of risk seeking. It verbally discussed some properties of these indexes. In the beginning of the paper it points out that some common risk measures are special cases of Choquet integrals, probably to fit with the journal. %}

Belles-Sampera, Jaume, Montserrat Guillen, & Miguel Santolino (2016) “What Attitudes to Risk Underlie Distortion Risk Measure Choices?,” *Insurance: Mathematics and Economics* 68, 101–109.

{% %}

Bellhouse, David R. (1988) “Probability in the Sixteenth and Seventeenth Centuries: An Analysis of Puritan Casuistry,” *International Statistical Review* 56, 63–74.

{% **Dutch book**: “Collapse to the mean” in the title means it becomes expected value maximization. The paper derives it from the usual additivity plus translation invariance, but considers many variations in domain, continuity, and so on, with presupposed functionals such as Choquet integrals and more general functionals, and also a true objective probability measure available.

The paper also shows, for convex law-invariant functionals, that if in one dimension one shows that the convexity is in fact linearity, then this is enough to give entire linearity and, hence, subjective expected value maximization. %}

Bellini, Fabio, Pablo Koch-Medina, Cosimo Munari, & Gregor Svindland (2021) “Law-Invariant Functionals That Collapse to the Mean,” *Insurance: Mathematics and Economics* 98, 83–91.
https://doi.org/10.1016/j.insmatheco.2021.03.002

{% %}
Bellini, Fabio, Pablo Koch-Medina, Cosimo Munari, & Gregor Svindland (2021) “Law-Invariant Functionals That Collapse to the Mean,” *Insurance: Mathematics and Economics* 98, 83–91.

{% **dynamic consistency**; p. 504: principle of Optimality: Seems like forgone-branch independence (often called consequentialism; both past decisions and past randomness are present), where dynamic consistency/sophistication seems to be assumed implicitly

Nowadays (1980-2023) it’s sometimes called “Bellman’s optimality principle” %}
Bellman, Richard (1954) “The Theory of Dynamic Programming,” *Bulletin of the American Mathematical Society* 60, 503–515.

{% Was probably the first to define the associativity condition for functionals, used by Kolmogorov (1930) and Nagumo (1930) to axiomatize generalized means (CEs (certainty equivalents) of EU). %}
Bemporad, Giulio (1926) “Sul Principio della Media Aritmetica,” *Rendiconti della Academia Nazionale dei Lincei* 3, 87–91.

{% %}
Ben Zur, Hasida & Shlomo J. Breznitz (1981) “The Effect of Time Pressure on Risky Choice Behavior,” *Acta Psychologica* 47, 89–104.

{% %}
Ben-Porath, Elchanan & Itzhak Gilboa (1994) “Linear Measures, the Gini Index, and the Income-Equality Tradeoff,” *Journal of Economic Theory* 64, 443–467.

{% twofold aggregation: over uncertainty and individuals (“inequality”), then min-of-means functional %}
Ben-Porath, Elchanan, Itzhak Gilboa, & David Schmeidler (1997) “On the Measurement of Inequality under Uncertainty,” *Journal of Economic Theory* 75, 194–204.

{% %}
Ben-Rephael, Azi & Yehuda Izhakian (2020) "Should I Stay or Should I Go? Trading Behavior under Ambiguity," *Management Science* 68, 4090–4111.

{% Prospect of upwards mobility: Poor do not want redistribution of income because they expect to become richer. Paper presents assumptions about risk aversion etc. that can rationalize it, and consider it in a simple data set. %}
Bénabou, Roland & Efe A. Ok (2001) "Social Mobility and the Demand for Redistribution: The Poum Hypothesis," *Quarterly Journal of Economics* 116, 447–487.

{% **real incentives/hypothetical choice**, & **crowding-out**: Present theoretical principal-agent model where incentives bring crowding-in and crowding-out effects. They posit all kinds of effects from the psychological literature, psychology-style, and then incorporate those into all kinds of utility functions with properly chosen derivatives, economists-style, where the latter involves deriving equilibria theorems. %}
Bénabou, Roland & Jean Tirole (2001) "Intrinsic and Extrinsic Motivation," *Review of Economic Studies* 70, 489–520.

{% %}
Bénabou, Roland & Jean Tirole (2002) "Self-Confidence and Personal Motivation," *Quarterly Journal of Economics* 117, 871–915.

{% Theoretical models for factors influencing self-control. %}
Bénabou, Roland & Jean Tirole (2004) "Willpower and Personal Rules," *Journal of Political Economy* 112, 848–886.

{% **crowding-out**: reward or punishment can lead to crowding out. %}
Bénabou, Roland & Jean Tirole (2006) "Incentives and Prosocial Behavior," *American Economic Review* 96, 1652–1678.

{% P. 141 2nd para writes that beliefs are motivated. However, everything we ever do is motivated (say by evolutionary procedures), including rational beliefs we seek

to have objectively. Probably the field means: beliefs that deviate from the info we have because we feel interests in believing different things than what is the truth.

P. 149, heading “memory and other neural processes”: isn’t everything a neural process?

In economics, precise meanings are given to many concepts, which may deviate some from natural language. For instance, risk refers to an uncertainty entirely outside the agent’s control and, further, with probabilities given. In natural language this is not so and risk may refer to uncertainties partly under control, and without probabilities known. Psychologists, of course, often do not follow the economic conventions.

In economics, following a Savagean tradition, beliefs are taken to refer to states of information about uncertain events outside the control of the agent and with no utility attached to them by themselves. Utilities are attached to outcomes, such as commodity bundles. So, beliefs are strictly about info and not about utilities, and with outcomes it is the other way around. In natural language, and psychology, this is of course different.

This paper proposes to give up the common terminology in economics regarding beliefs and the authors use the term belief in the natural-language/psychological way. So, beliefs can do just anything and, in particular, can give utility. Subjects can distort their beliefs to solve self-control problems, so, purposefully, or for self-signaling purposes (as in Calvinism). Now beliefs can describe almost everything but, I think, predict almost nothing.

I think that, if beliefs are as commonly taken in economics, but subjects treat them as in this paper, then subjects are subject to irrationalities, such as confusing uncertainties they cannot influence with act-choices that they can influence. So, it would fit into the behavioral approach. However, the conclusion of the paper distinguishes its approach from behavioral economics, suggesting that the irrationalities in behavioral economics are hard-wired and mechanical unlike what the theory of this paper is about. I do not understand this point, in particular, as regards hard-wired/mechanical, I do not understand why behavioral biases would be more or less hard-wired/mechanical than the biases considered in this paper.

If beliefs are partially used for informational purposes and partly purposefully to manipulate future behavior, then distorting beliefs involves a tradeoff with the pro of the intended improving of behavior but later the suboptimalities that wrong states of information can bring with then suboptimal behavior.

There have been models with motivated beliefs before, with self-deception and self-signaling, and moral hazard is a bit related, but those were more concrete and specific, allowing for predictions, which in this paper happens too little to my taste.

The optimistic concluding sentence of the paper is: "This, in turn, leads to novel views of risktaking, prosociality, identity, organizations, financial crises, and politics." The abstract (and other places) was also optimistic, e.g., in writing: "Over the last decade or so, the pendulum has started to swing again toward some form of adaptiveness, or at least implicit purposefulness, in human cognition."

I, when doing economics, prefer not to follow the proposal of this paper and to continue using the term belief in the common economic way. %}

Bénabou, Roland & Jean Tirole (2016) "Mindful Economics: The Production, Consumption, and Value of Beliefs," *Journal of Economic Perspectives* 30, 141–164.
http://dx.doi.org/10.1257/jep.30.3.141

{% %}

Benartzi, Shlomo, Alessandro Previtero & Richard H. Thaler (2011) "Annuitization Puzzles," *Journal of Economic Perspectives* 25 143–164.

{% **PT, applications**, loss aversion, equity premium puzzle

Christiane, Veronika & I, P. 82 bottom: nominal money is more psychologically relevant than real. Risk-free puzzle: treasury bills have about zero gains in terms of real money.

decreasing ARA/increasing RRA: use power utility;

P. 74: Because of the presence of loss aversion, these aggregation rules are not neutral. The authors use the same marvelous line of reasoning as Tversky & Kahneman (1981). Myopoic and global evaluation give different results. So, which is wrong? Answer: none! The mistake lies elsewhere, being that people deviate too much from expected value, primarily because of loss aversion.

SPT instead of OPT: P. 79 Eq. 3 and the hree lines below.

Use PT in simulations to explain the equity premium puzzle; the weighting function and the value function are not sensitive variables, but loss aversion does it (p. 83 3rd para, p. 85/86). So, nice ref. to suggest that loss aversion is the main factor in risk attitude.

Kahneman & Lovallo (1993) put forward similar arguments against myopic loss aversion.

This paper is typically prescriptive instead of normative. In a strictly normative approach the advice not to be informed about stocks or anything cannot be. The real problem is that people are too loss averse. This paper accepts so as given, and then given this violation of normativity, the smallest evil occurs if people do not inspect their stocks very often.

Thaler is less paternalistic than I am. He accepted, reluctantly, that people do have loss aversion (p. 86 ℓ. 2 "fact of life"), and then advised not to evaluate stocks often. He deliberately does not point at the real culprit. They explicitly write that periods of evaluation can be altered, but loss aversion cannot. This appears from p. 86: Loss aversion "can be considered a fact of life (or, perhaps, a fact of preferences). In contrast, frequency of evaluations is a policy choice that presumably could be altered, at least in principle. %}

Benartzi, Shlomo & Richard H. Thaler (1995) "Myopic Loss Aversion and the Equity Premium Puzzle," *Quarterly Journal of Economics* 110, 73–92.

{% **losses from prior endowment mechanism**: Seems that no prior endowment is given. Instead, if subjects lose, they get the option to earn money. %}

Benartzi, Shlomo & Richard H. Thaler (1999) "Risk Aversion or Myopia? Choices in Repeated Gambles and Retirement Investments," *Management Science* 45, 364–381.

{% Many qualitative observations, not closely related to prospect theory or their 1995 paper. %}

Benartzi, Shlomo & Richard H. Thaler (2007) "Heuristics and Biases in Retirement Savings Behavior," *Journal of Economic Perspectives* 21, 81–104.

{% %}

Benartzi, Shlomo & Richard H. Thaler (2013) "Behavioral Economics and the Retirement Savings Crisis," *Science* 339, 1152–1153.

{% **real incentives/hypothetical choice, for time preferences**: Consider delays to up to 6 months. Payment in 6 months is by promise that then cheque will be sent to university mailbox.

They consider a discount function consisting of a fixed loss b (say $4) for every delayed payment. This part accommodates the magnitude effect. They also consider a two-parameter hyperbolic discount function $((1-(1-\theta)rt)^{1/(1-\theta)}$, being a powerfunction applied to a translation of t. Then they take the convex combination of these two. This is a 4-parameter family. They assume linear utility. Given that they only have one nonzero outcome, powers are unidentifiable, so this is a pragmatic way to go. (See below for why they cannot have utility curvature.) Then they consider the simplest stimuli possible, being one nonzero outcome. They ask direct matching questions (so not the, nowadays (2000-2023) preferred, choice-based questions), asking for the present value of future payments (Q-present) or the value that at some given future timepoint is equivalent to a present payment (Q-future). Then they fit the 4-parameter function to the data, and discuss the results.

They have only N = 27 subjects. However, by implicitly using the controversial assumption that different choices of the same subject can be treated as statistically independent, they can still do statistical analyses with confidence intervals for individuals and with rejections of nulls.

P. 208 erroneously claims that the BDM (Becker-DeGroot-Marschak) mechanism needs expected value maximization for being incentive compatible.

P. 208 resolves doubts about understandability of the BDM mechanism by firm optimism: "We had no doubt that the subjects understood the incentive properties of the mechanism." Unfortunately, the authors do not understand the BDM mechanism very well, thinking that it requires risk neutrality. The full citation on p. 208 is: "Under risk neutrality it is a dominant strategy to report the true indifference amount in this procedure and this fact was explained to the subjects. We had no doubt that the subjects understood the incentive properties of the mechanism."

On p. 218 (§5.3) middle they do report an estimate of power utility. As just written, powers are in general unidentifiable from their stimuli with only one nonzero outcome. In the same way as discounting becomes identifiable if power of utility is no more free (such as by taking it linear), we can estimate the power of utility if the power of discounting is no more free. This is probably what happened here, with the scaling of the discount function that the authors chose leaving no more freedom of power.

They find that, on average, the fixed cost of $4 for delays works better than quasi-hyperbolic discounting.

P. 206 3rd para describes the contribution of this paper relative to others (psychologists it seems): "While experimental psychologists have collected an impressive amount of data on time preference … rarely have the data been analyzed with proper econometric instruments." What they mean here is simply the usual story: No real incentives. They conclude on their data fitting and statistical analysis (p. 222): "As such, this experiment is one of the few that generates data that is then rigorously estimated econometrically."

Criticisms of the analyses in this paper are in Andersen, Harrison, Lau, & Rutström (2013 Economica). %}

Benhabib, Jess, Alberto Bisin & Andrew Schotter (2010) "Present-Bias, Quasi-Hyperbolic Discounting, and Fixed Costs," *Games and Economic Behavior* 69, 205–223.

{% **updating: testing Bayes' formula**: survey %}

Benjamin, Daniel J. (2019) "Errors in Probabilistic Reasoning and Judgment Biases." *In* B. Douglas Bernheim, Stefano DellaVigna, & David Laibson (eds.) "*Handbook of Behavioral Economics; Volume 2*," Chy. 2, 69–186.

{% **foundations of statistics**: argue for taking 0.005 instead of 0.05 as common threshold for new evidence. 0.005 < p < 0.05 is to be called suggestive. %}

Benjamin, Daniel J., James O. Berger, Magnus Johannesson, Brian A. Nosek, E.-J. Wagenmakers, Richard Berk, Kenneth A. Bollen, Björn Brembs, Lawrence Brown, Colin Camerer, David Cesarini, Christopher D. Chambers, Merlise Clyde, Thomas D. Cook, Paul De Boeck, Zoltan Dienes, Anna Dreber, Kenny Easwaran, Charles Efferson, Ernst Fehr, Fiona Fidler, Andy P. Field, Malcolm Forster, Edward I. George, Richard Gonzalez, Steven Goodman, Edwin Green, Donald P. Green, Anthony Greenwald, Jarrod D. Hadfield, Larry V. Hedges, Leonhard Held, Teck Hua Ho, Herbert Hoijtink, Daniel J. Hruschka, Kosuke Imai, Guido Imbens, John P. A. Ioannidis, Minjeong Jeon, James Holland Jones, Michael Kirchler, David Laibson, John List, Roderick Little, Arthur Lupia, Edouard Machery, Scott E. Maxwell, Michael McCarthy, Don Moore, Stephen L. Morgan, Marcus Munafó, Shinichi Nakagawa, Brendan Nyhan, Timothy H. Parker, Luis Pericchi, Marco Perugini, Jeff Rouder, Judith Rousseau, Victoria Savalei, Felix D. Schönbrodt, Thomas Sellke, Betsy Sinclair, Dustin Tingley, Trisha Van Zandt, Simine Vazire, Duncan J. Watts, Christopher Winship, Robert L. Wolpert, Yu Xie, Cristobal Young, Jonathan Zinman, & Valen E. Johnson (2018) "Redefine Statistical Significance," *Nature Human Behavior* 2, 6–10. https:// rg/10.1038/s41562-017-0189-z

{% Ask Chilean high school students some simple risky choice questions, and simple intertemporal choice questions. The latter concern receiving money either tomorrow or in a week, and receiving it in four or five weeks. They use real incentives, explaining the short waiting times. They pay many choices and, hence, have income effects. As measure for cognitive ability they take grades in math. They find that subjects with higher cognitive abilities are closer to expected value maximization and have lower discounting (**cognitive ability related to risk/ambiguity aversion**). Taking EV and no discounting as rational, subjects with higher cognitive abilities are more rational. I would be interested in relations with inverse S probability weighting, but the data is not rich enough to determine this. %}

Benjamin, Daniel J., Sebastian A. Brown, & Jesse M. Shapiro (2013) "Who is 'Behavioral'? Cognitive Ability and Anomalous Preferences," *Journal of the European Economic Association* 11, 1231–1255.

{% %}

Benjamin, Daniel J., Mark Fontana, & Miles Kimball (2021) "Reconsidering Risk Aversion," working paper.

{% **questionnaire versus choice utility**: The authors take no position for or against introspective utility versus (hypothetical!) revealed preference, but study some discrepancies and are very open to the use of introspective utility in economics.

The authors use more than 2,600 subjects! It is remarkable, and encouraging, that the authors can use hypothetical choice in this journal. The authors defend hypothetical choice (**real incentives/hypothetical choice**). %}

Benjamin, Daniel J., Ori Heffetz, Miles S. Kimball, & Alex Rees-Jones (2012) "What Do You Think Would Make You Happier? What Do You Think You Would Choose?," *American Economic Review* 102, 2083–2110.

{% Use introspective data to derive utility from a 4,600 US subjects. Explicitly state that they deviate from revealed preference. %}

Benjamin, Daniel J., Ori Heffetz, Miles S. Kimball, & Nichole Szembrot (2014) "Beyond Happiness and Satisfaction: Toward Well-Being Indices Based on Stated Preference," *American Economic Review* 104, 2698–2735.

{% Again, use hypothetical choice & introspection, but introspection differs quite from choice. Their data concern rankings over residencies of 561 students from US medical schools, so we have rankings and not just choices. %}

Benjamin, Daniel J., Ori Heffetz, Miles S. Kimball, & Alex Rees-Jones (2014) "Can Marginal Rates of Substitution Be Inferred from Happiness Data? Evidence from Residency Choices," *American Economic Review* 104, 3498–3528.

{% **foundations of statistics** %}

Bennett, J. Henry (1983, ed.) "*Natural Selection, Heredity, and Eugenics: Selected Correspondence of R.A. Fisher with Leonard Darwin and Others.*" Clarendon Press, Oxford.

{% **foundations of statistics** %}

Bennett, J. Henry (1990, ed.) "*Selected Correspondence of R.A. Fisher.*" Clarendon Press, Oxford.

{% Paper questions overconfidence. Gives a theoretical model showing that overconfidence can be Bayesian rational, and gives conditions for when this happens. van den Steen (2004 American Economic Review) also argues that probability transformation can sometimes be rational. %}

Benoît, Jean-Pierre & Juan Dubra (2011) “Apparent Overconfidence,” *Econometrica* 79, 1591–1625.

{% %}

Benoît, Jean Pierre & Efe A. Ok (2006) “Maskin’s Theorem with Limited Veto Power,” *Games and Economic Behavior* 55, 331–339.

{% Consider three definitions of being more impatient, elaborating on Horowitz (1992). The first, more delay aversion, is very demanding and incomplete: In each outcome stream, preferring an early increase more than a late one by $\succcurlyeq_1$ should imply the same for $\succcurlyeq_2$. Under general discounted utility the condition holds if and only if one utility function is a transformation of the other and some minimal value of $\succcurlyeq_1$ exceeds some maximal value of the other. Utility and discounting interact here (p. 91 last para). The condition requiring it only for otherwise constant outcome streams is called being more impatient. The characterization still involves u and discounting. The third is being more cryonic impatient, restricting the above to one nonzero outcome. The characterization still involves u and discounting. %}

Benoît, Jean Pierre & Efe A. Ok (2007) “Delay Aversion,” *Theoretical Economics* 2, 71–113.

{% %}

Benoît, Jean Pierre & Efe A. Ok, & M. Remzi Sanver (2007) “On Combining Implementable Social Choice Rules,” *Games and Economic Behavior* 60, 20–30.

{% %}

Benson, Paul (1987) “Freedom and Value,” *Journal of Philosophy* 84, 465–486.

{% “But I have planted the tree of utility. I have planted it deep, and spread it wide.” %}

Bentham, Jeremy (1828-43) [1782-7], in John Bowring (ed.) *The Works of Jeremy Bentham*, Works, X, 588. Panace.

{% P. 495 seems to write, on interpersonal comparability of utility: “Tis in vsin to talk of adding quantities which after the addition will continue distinct as they were before, one man’s

happiness will never be another man's happiness … This addibility of the happiness of different subjects, however, when considered rigorously, it may appear fictitious, is a postulatum without the allowance of which all political reasoning is at a stand."

This text nicely illustrates that sometimes, even if things are difficult to measure, we just have to do our best because we cannot escape; they are crucial for our decisions. %}

Bentham, Jeremy (1781). *In* Elie Halévy (1901) *The Growth of Philosophical Radicalism*, Felic Alcan, Paris. Translated into English by M. Morris, London: Faber and Faber (1972).

{% P. 398 seems to use **just noticeable difference** for cardinal utility: "the faintest of any that can be distinguished" %}

Bentham, Jeremy (1782). *In* Elie Halévy (1901) *La Jeunesse de Bentham*, Felic Alcan, Paris.

{% First to Introduce utility as a full-blown concept. Utility did appear before in Bernoulli (1738) and Smith (1776). Still I like to credit Bentham as the one to "really" introduce the concept.

conservation of influence: Opens with: "Nature has placed mankind under the governance of two sovereign masters, *pain and pleasure*." Further, paras I.II I.VI takes action as deviation from status quo.

Opening para I of Ch. I uses beautiful metaphors, not only distinguishing gains (pleasure) and losses (pain), a distinction that to Bentham will not have carried the same meaning as it now does with prospect theory, but also normative (ought) and descriptive (shall), social science (right and wrong) and natural science (causes and effects) The penultimate sentence does not consider thinking and rationalite to exclude feeling and happiness, but rather as a tool to get the latter.

Para I.IV says that agent need not only be individual, but can also be society.

Para I.X says that "ought" and "right" and "wrong" should be taken as maximization of utility and nothing else. Is the explanation of "normative" that Mongin gave me during a dinner in Rotterdam.

Throughout (e.g., para I.XIII) emphasizes that utility maximization cannot be falsified. Like the reasoning that an altruist must derive pleasure from helping others and, hence, is just selfish.

At about para I.XIV - Ch. III I found it uninteresting.

Ch. IV is interesting because it discusses aggregation over certainty, persons, timepoints, all apparently to be done additively and separably. It distinguishes duration and discounting. This is virtually identical to Ch. 7 of Bentham (1802) "*Traités de Législation.*" See my annotations there.

P. 103 ff: **marginal utility is diminishing**: or in other book?

Stigler (1950 footnote 15) cites another writing of Bentham where Bentham takes **just noticeable difference** as basis of cardinal utility

risky utility u = strength of preference v (or other riskless cardinal utility, often called value) (Stigler, 1950), Bentham let aggregation over duration, certainty, and propinquity (temporal remoteness), in addition to intensity, play a role in one and the same utility index. Stigler (1950, footnote 10) cites Bentham on an, in my opinion appropriate, defense of utilitarianistic addition of utilities over different individuals, explicitly relating it to aggregation over uncertainty.

marginal utility is diminishing which implies risk aversion.

For small amounts of money, u is linear (Stigler, 1950). %}

Bentham, Jeremy (1789) "*The Principles of Morals and Legislation.*" At the Clarendom Press, Oxford.

{% Seems to be selection from many writings by Bentham, composed by his disciple Étienne Dumont.

P. 103 ff: **marginal utility is diminishing**: or in other book?

consequentialism/pragmatism: Stigler (1950) writes that on p. 103 in the Hildreth translation there is the citation hereafter where Bentham argues, as I see it, against consequentialism ("incorporate everything relevant whatsoever," à la Becker), in favor of pragmatism. I tried to check out Bentham's work to find the citation but did not find it. It is hard to know which of his books is which. Here is Stigler's alleged citation:

"It is to be observed in general, that in speaking of the effect of a portion of wealth upon happiness, abstraction is always to be made of the particular sensibility of individuals, and of the exterior circumstances in which they may be placed. Differences of character are inscrutable; and such is the diversity of circumstances, that they are never the same for two individuals. Unless we begin by dropping these two considerations, it will be impossible to announce any general proposition. But though each of these propositions may prove false or inexact in a given individual case, that will furnish no argument against their speculative truth and practical utility. It is enough for the justification of these propositions-1st, If they approach nearer the truth than any others which can be substituted for them; 2nd, If with less inconvenience than any others they can be made the basis of legislation."

Ch. 3 §1 is on "arbitrary principle" of "principle of sympathy and antipathy," where people justify decision only by them liking the decision without any further justification referring to the consequences of the decision, criticizing it much, for instance: "I wish you to think as I do, without giving me the trouble to reason with you."

Last para of Ch. III: good rational decision SHOULD take effort and be difficult.

conservation of influence: Ch. VII, first page:

"When one has become familiar with the process; when he has acquired that justness of estimate which results from it; he can compare the sum of good and of evil with so much promptitude as scarcely to be conscious of the steps of the calculation."

Schlee (1992) refers to a 1975 edn. of the editor Tripathi in Bombay.

marginal utility is diminishing; **risky utility u = strength of preference v (or other riskless cardinal utility, often called value)**:

Schlee cites from p. 65: "Though the chances so far as relates to money, are equal, in regard to pleasure, they are always unfavourable. I have a thousand pounds. The stake is five hundred. If I lose, my fortune is diminished one-half; if I gain, it is increased only by a third. Suppose the stake to be a thousand pounds. If I gain, my happiness is not doubled with my fortune; if I lose, my happiness is destroyed; I am reduced to undigence." This text shows that Bentham has some version of expected utility in mind, takes "pleasure" as vNM index, and in a way ascribes a rudimentary version of risk aversion to diminishing marginal utility.

Ch. VIII (this is as Ch. 4 in Bentham (1789) "*The Principles of Morals and Legislation.*") opens with value of a pleasure depending on

1st. Its intensity

2nd. Its duration

3rd. Its certainty

4th. Its proximity (called "propinquity" or "remoteness" in Ch. 4 in Bentham (1789) "*The Principles of Morals and Legislation.*")

but one should also incorporate

5th. Its productiveness (called fecuncity in Ch. 4 in Bentham (1789) "*The*

Principles of Morals and Legislation.”)

6th. Its purity

Here productiveness means it will induce further pleasure in the future, and putity is the opposite.

7th. Its extent

Is nr. of persons involved. %}

Bentham, Jeremy (1802) “*Traités de Législation.*” Translated into English by Richard Hildreth (1871) “Theory of Legislation,” Trübner, London. New edn. 1965, with introduction by Upendra Baxi.

{% Seems that in Book i Ch. vi Bentham suggests to use a scale on which witnesses can mark their degree of certainty. %}

Bentham, Jeremy (1827) “*Rationale of Judicial Evidence.*” J.W. Paget, London.

{% [1782-7]: 236 on loss aversion: “It is by fear only and not by hope, that [a worker] is impelled to the discharge of his duty—by the fear of receiving less than he would otherwise receive, not by the hope of receiving more. %}

Bentham, Jeremy (1828-43) [1782-7] “*The Rationale of Reward.*” John Bowring (ed.) *The Works of Jeremy Bentham*, part VII, 297–364.

{% Seems that (1785-6: p. 331) writes: “the pleasure of gaining is not equal to the evil of losing.” %}

Bentham, Jeremy (1828-43) [1785-6] “*Principles of the Civil Code.*” John Bowring (ed.) *The Works of Jeremy Bentham,* part II, 297–364.

{% Collection of Bentham’s writings.

marginal utility is diminishing: Vol. 1, p. 103, seems to write: “The quantity of happiness produced by a particle of wealth (each particle being the same magnitude) will be less and less every particle.” %}

Bentham, Jeremy (1952) in Werner Stark (ed.) “*Jeremy Bentham’s Economic Writings*, Vol. 1–3.” Georege Allen & Unwin, London.

{% P. 54 gives the following citation: “Brethren, here is a great deeficulty; let us look it firmly in the face and pass on.” %}

Bentzel, Ragnar & Bent Hansen (1954) “Replik till Johan Akerman,” *Ekonomisk Tidskrift* 56, 48–55.

{% %}

Benz, Matthias, & Bruno S. Frey (2008) “The Value of Doing What You Like: Evidence from the Self-Employed,” *Journal of Economic Behavior and Organization* 68, 445–455.

{% **time preference**; data reject constant discounting; support an implicit risk hypothesis according to which delayed consequences are associated with an implicit risk value, and an added compensation hypothesis that asserts that individuals require compensation for a change in their financial position. Confirm Thaler’s (1981) basic findings, including magnitude effect and smaller discounting for losses. Seem to find even negative impatience for losses. %}

Benzion, Uri, Amnon Rapoport, & Joseph Yagil (1989) “Discount Rates Inferred from Decisions: An Experimental Study,” *Management Science* 35, 270–285.

{% **proper scoring rules**; compare scoring-rule behavior for gains and for losses. For losses more risks are taken than for gains. This agrees with prospect theory, as the authors write. %}

Bereby-Meyer, Yoella, Joachim Meyer, & David V. Budescu (2003) “Decision Making under Internal Uncertainty: The Case of Multiple-Choice Tests with Different Scoring Rules,” *Acta Psychologica* 112, 207–220.

{% Under expected utility, linear utility can be generated by paying in probability units (as in Roth & Malouf 1979). A utility function U can be generated by paying in U^{inv}-probability units. The authors pointed this out, and did an experiment with it. %}

Berg, Joyce E., Lane A. Daley, John W. Dickhaut, & John R. O’Brien (1986) “Controlling Preferences for Lotteries on Units of Experimental Exchange,” *Quarterly Journal of Economics* 101, 281–306.

{% %}

Berg, Joyce, John Dickhaut, & Kevin McCabe (1995) "Trust, Reciprocity, and Social History," *Games and Economic Behavior* 10, 122–142.

{% Re-analyze past data on preference reversals, and compare real incentives to hypothetical choice. (**real incentives/hypothetical choice**) They focus on the classical Slovic-Lichtenstein stimuli, for which they find 11 references. For hypothetical choice they find the usual preference reversals. For real incentives they find less risk aversion. They find as many preference reversals for real as for hypothetical, only for real there are as many usual reversals as unusual preference reversals. They conclude that then EU with error may explain things, rather than real preference reversal. %}

Berg, Joyce E., John W. Dickhaut, & Thomas A. Rietz (2010) "Preference Reversals: The Impact of Truth-Revealing Monetary Incentives," *Games and Economic Behavior* 68, 443–468.

{% **paternalism/Humean-view-of-preference**: the authors clearly don't like classical decision theories, prospect theory, behavioral economics, consistency, utility, and what have you.

The authors throughout think that as-if automatically violates homeomorphic. They do not realize that as-if can still be homeomorphic. Prospect theory can be homeomorphic if somewhere in us processes go on that use the mathematical operations of prospect theory, *but still be as-if if these processes are not or only partly conscious*. This is why p. 141 footnote 1 is not correct.

Ecological rationality is like context dependence, the term that I am allergic to.

P. 137: The authors argue that prospect theory is only an attempt to repair the failing classical models: "Instead of asking how real people – both successful and unsuccessful– choose among gambles, the repair program focused on transformations of payoffs (which produced expected utility theory) and, later, transformations of probabilities (which produced prospect theory) to fit, rather than predict, data. The repair program is based largely on tinkering with the mathematical form of the mathematical epectation operator and cannot be described as a sustained empirical effort to uncover the process by which people actually choose gambles."

Pp. 141-142: "the assumption – almost surely wrong – of universal commensurability between all inputs in the utility function," where they next identify it with the

Archimedean axiom. Here they also kind of confuse restricted solvability and unrestricted solvability, unnecessarily adding an assumption of unbounded functions under additive decomposability for instance.

P. 146 2nd para: the authors are hopelessly confused on visual perception.

The authors throughout do not buy that normative axioms can be based on logic intrinsic nature without exogenous evidence (such as proved happier lives), e.g., p. 148 2nd half. Or see p. 149 ℓ. 3-4: "that logical deduction rather than inductively derived descriptions of behavioral process are the proper starting point for economic analyses." This is why they miss the normative foundation of for instance EU, justifying the interest, also empirically, of its concepts beyond merely as-if fitting data. Their oversight is common among people who only work empirically. Such people, when facing the introduction of a new measurement method, require as imperative an empirical horse-race between the new method and some existing method, and cannot understand that logical arguments can also work because that whole concept is unknown to them.

P. 148 bottom writes: "No studies we are aware of show that deviators from rational choice earn less money, live shorter lives, or are less happy."

P. 149 ff.: they argue for ecological rationality (adapting heuristics to environment) and against the importance of coherence (**coherentism**).

P. 150 ff.: Gigerenzer had decided to embark on proving that expected utility maximization and Bayesian updating are no good. He and his co-author come out with supporting evidence stronger than anyone could ever dream of …:

"Our own empirical research tries to answer some of these questions about the economic costs of deviating from neoclassical axioms, with surprising results. Expected utility violators and time-inconsistent decision makers earn more money in experiments (Berg, Eckel & Johnson 2009). And the beliefs about PSA testing of non-Bayesians are more accurate than those of perfect Bayesians—that is, better calibrated to objective risk frequencies in the real-world decision-making environment (Berg, Biele & Gigerenzer 2008). So far, it appears that people who violate neoclassical coherence, or consistency, axioms are better off as measured by correspondence metrics such as earnings and accuracy of beliefs."

It is like proving that non-elephants are more intelligent than elephants. The authors continue on the path taken: "There are a growing number of theoretical models, too, where individuals (Dekel 1999, Compte & Postlewaite 2004) and markets (Berg & Lien 2005) do better with incorrect beliefs. These results pose fundamental questions about the normative status of assumptions regarding probabilistic beliefs and other core assumptions of the rational choice framework. If individuals and aggregates both do better (Berg & Gigerenzer 2007) when, say, individuals satisfice instead of maximize, then there would seem to be no market discipline or evolutionary pressure (arguments often invoked by defenders of the normative status of rationality axioms) to enforce conformity with rationality axioms, which focus primarily on internal consistency rather than evaluation of outcomes themselves."

P. 161 is negative on prospect theory: "In prospect theory, behavioral economics has added parameters rather than psychological realism to model choice under uncertainty." %}

Berg, Nathan & Gerd Gigerenzer (2010) "As-if Behavioral Economics: Neoclassical Economics in Disguise?," *History of Economic Ideas* 18, 133–166.

{% The paper considers seven common biases from decision under risk and uncertainty, such as probability neglect, outcome neglect, and status quo bias, for policy decisions regarding reclaiming degraded sites. They first discuss in general, which is trivial for decision theorists, but then have, in §3, nice case studies illustrating the biases. Pp. 9-10, on climate change: people rather risk big loss than take sure small loss, which may explain small amount of abatement undertaken. %}

Berger, Alan, Case Brown, Carolyn Kousky, & Richard J. Zeckhauser (2011) "Perspective: The Challenge of Degraded Environments: How Common Biases Impair Effective Policy," *Risk Analysis* 31, 1423–1433.
http://dx.doi.org/10.1111/j.1539-6924.2010.01477.x

{% Consider choices under risk and ambiguity using known and unknown Ellsberg urns. Some subjects can choose the winning color but for others the winning color is chosen randomly. Subjects who can choose the winning color like that more under ambiguity, exhibiting less ambiguity aversion, but for risk it gives no difference. The authors interpret this finding as illusion of control for ambiguity, so that illusion of control reduces ambiguity aversion. They also did this experiment for decision under risk, where there was no preference for (illusion of) control.

As the authors discuss on p. 262, letting subjects choose winning color is often done in ambiguity measurements to control for suspicion, where it has been understood before that this can bring illustion of control (**suspicion under ambiguity**). We then usually cannot separate if subjects like it becasuse of illusion of control or because of control against suspicion. This paper seeks to do so by having a control treatment where not subjects choose the winning color themselves, but this is determined last moment by a random process carried out by an outsider, so that it is clear that there cannot have been any rigging. This controls for suspicion without illusion of control However, in this control treatment subjects can take it as two-stage with a risk stage added, and this can have all kinds of effects such as bringing extra risk aversion or extra complexity. It could also have an effect of reducing ambiguity in the spirit of Raiffa (1961) although it then would have increased attractiveness, whereas in this experiment it reduces it.

A useful sentence on p. 278: "Studies in economics have only studied the illusion of control in choice under risk, whereas studies in psychology did not distinguish between risk and ambiguity." It is important to be aware of this difference in terminology between the two fields.

P. 281: "Given that the distortion of beliefs seems to best explain the effect of the illusion of control in our study" suggests a bit the source method (if belefs are taken additive), but the authors use α maxmin and recursive expected utility (smooth model) for ambiguity. %}

Berger, Alex & Agnieszka Tymula (2022) "Controlling Ambiguity: The Illusion of Control in Choice under Risk and Ambiguity," *Journal of Risk and Uncertainty* 65, 261–284.
https://doi.org/10.1007/s11166-022-09399-4

{% ε-contamination %}

Berger, James O. (1994) "An Overview of Robust Bayesian Analysis" (with discussion)," *Test* 3, 5–124.

{% **foundations of statistics** %}

Berger, James O. & Thomas Sellke (1987) "Testing a Point Null Hypothesis: The Irreconcilability of *P* Values and Evidence," *Journal of the American Statistical Association* 82, 112–122.
Reprinted *in* Omar F. Hamouda & J.C. Robin Rowley (1997, eds.) "*Statistical Foundations for Econometrics.*" Edward Elgar, Cheltenham.

{% **foundations of statistics**; likelihood principle; **dynamic consistency: favors abandoning RCLA**, because criticisms of sufficiency are described that come down to rejecting collapse independence (Section 3.6.4 and Lane's "post-randomization" argument in the discussion). %}

Berger, James O. & Robert L. Wolpert (1984) "*The Likelihood Principle: A Review, Generalizations and Statistical Implications.*" Lecture Notes, Monograph Series, Volume 6, Institute of Mathematical Statistics, Hayward, California; 2nd edn. 1988.

{% **ambiguity attitude taken to be rational**: This paper discusses the role of uncertainty, taking the current (2021) covid pandemic as example. It pleas for using decision theory for good decision making, which I agree with. But it argues against Bayesianism and for ambiguity models, which I disagree with. The contribution is that it does so in the language of policy makers, bringing in concepts relevant for policy makers, with flow diagrams and so on. The main text does not even mention the particular models. Figure 2 gives a case study where the names of various models are mentioned, but not defined. The latter is in online apppendices.

I as a Bayesian of course disagree with some claims. I display two, which will never appear with my name as co-author.

(1) P. 4 4th para: "However, it may not always be rational to follow this [Bayesian] approach (34–37). Its limitation stems from its inability to distinguish between uncertainty across models (which has an epistemic nature and is due to limited knowledge or ignorance) and uncertainty within models (which has an aleatory nature and is due to the intrinsic randomness in the world)."

Of course Bayesians can distinguish there.

(2) P. 4 top of 2nd colmn: "They assume that policymakers cope with uncertainty without reducing everything to risk, a pretension that tacitly presumes better information than they typically have."

The basic argument the authors have against Bayesianism is that Bayesianism requires probabilities to be specified but this being ("too") difficult. Thus the authors write, on p. 4 4th para:

"In the response to the COVID-19 outbreak, the Bayesian approach requires the policymaker to express probabilistic beliefs (about the impact of a policy, about the correctness of a given model, etc.), without being told which probability it makes sense to adopt or being allowed to say "I don't know." "

One counterargument from Bayesians is that specifying a set of priors, or other ambiguity concepts, is more complex than specifying one prior. A second is that … well, let me not get into it here. %}

Berger, Loic, Nicolas Berger, Valentina Bosetti, Itzhak Gilboa, Lars Peter Hansen, Christopher Jarvis, Massimo Marinaci, & Richard D. Smith (2021) "Rational Policymaking During a Pandemic," *Proceedings of the National Academy of Sciences* 118(4):e2012704118. https://doi.org/10.1073/pnas.2012704118

{% Use smooth model of ambiguity to analyze the implications of ambiguity aversion on some medical decisions, where it may lead to more or less preference for treatment. %}

Berger, Loic, Han Bleichrodt, & Louis Eeckhoudt (2013) "Treatment Decisions under Ambiguity," *Journal of Health Economics* 32, 559–569.

{% %}

Berger, Loic & Valentina Bosetti (2016) "Ellsberg Revisited: An Experiment Disentangling Model Uncertainty and Risk Aversion," working paper.

{% Many authors take ambiguity aversion in the sense of Schmeidler's (1989) uncertainty aversion, being a preference for probabilistic mixing. I qualified this as a historical mistake in Wakker (2010 §11.6). This paper shows for many models that the two can work out differently. Whereas diversification is always good for risk under risk aversion, it can be bad under ambiguity aversion. For instance, it can lead to an enlarged set of possible priors. %}

Berger, Loïc & Louis Eeckhoudt (2021) "Risk, Ambiguity, and the Value of Diversification," *Management Science* 67(3):1639–1647. https://doi.org/10.1287/mnsc.2020.3823

{% Consider aggregation over several components at the same time, primarily persons, time, and uncertainty. Consider degrees of inequality aversion in each, and what effects they have on overall constant equivalents under different orders of aggregation. %}

Berger, Loïc & Johannes Emmerling (2020) "Welfare as Equity Equivalents," *Journal of Economic Surveys* 34, 727–752.

{% The paper uses the terms ambiguity and deep uncertainty interchangeably (p. 762 endnote 1).

This paper uses Marinacci's (2015) model of ambiguity with applications in climate change. Here the set of priors is assumed to be objectively given (p. 751). In climate change it is usually assumed to be the probability estimates provided by experts. Although this set can be quite different than the set of probabilities that possibly are the correct ones, which usually is what the set of priors in multiple prior models is taken to be, it is nevertheless used the same way in many papers. The paper assumes a subjective 2nd order probability distribution over the set of priors, and then uses the smooth model for calculations.

P. 754 Definition 2: For each event this paper takes the variance of the probabilities over the set of priors as index of degree of ambiguity (degree of disagreement), at least in the finite case. The definition does not specify if they use the counting measure available on the set of priors, or the subjective 2nd-order distribution. Because the paper focuses on one ambiguous event (a tipping point in climate is reached), this can readily be.

In their numerical examples and results, higher degree of ambiguity implies higher desirability of climate change mitigation and abatement. This may be because in the smooth model such a higher degree implies more ambiguity aversion, which may drive it. In other models, for events of moderate likelihood, bigger degree of ambiguity implies higher insensitivity and, hence, less desirability of precautionary measures. For extreme events, however, the opposite results. The smooth model does not have such insensitivity.

P. 749 writes, criticizing SEU normatively: "Therefore, it [ambiguity] requires a robust decision-making approach that is less sensitive to initial assumptions, is valid for a wide range of futures, and keeps options open (Lempert and Collins 2007), rather than a formal approach that maximizes the expected utility mechanically." P. 750 continues: "In view of this disagreement among experts or models, how should a rational policy decision maker proceed? If one follows the traditional Bayesian/subjective expected utility approach, one will simply aggregate the models by averaging them into a single representative model and then use the (subjective) expected utility framework (Newbold and Daigneault 2009). The problem with this approach is that the decision maker considers the resulting aggregated model in exactly the

same way as one would consider an equivalent objective model representing a specific risk, and model uncertainty has therefore no impact on the decisionmaking process." P. 752 reiterates: "Although the classical subjective expected utility framework has the advantage of being easily tractable, it is unable to take into account different attitudes toward different types of uncertainty that surround the economics of climate change. We now introduce different attitudes toward different types of uncertainty." As a Bayesian, I of course see things differently. Bayesians treat objective and subjective probabililities/ambiguity differently in the sense that in the second case they rather search for more information, and more easily update. Only, in the last second of the final decision, which is what static decision is about, the two are treated the same. At that last second, every ambiguity nonEU model has to be equally mechanic, and replacing a correct mechanic formula by an incorrect mechanic one does not help. If a hospital works 4 years on a treatment decision, objective statistical probabilities are important and collected all the time, whereas subjective probabilities long time play no role at all. They only do at the last second of the final decision.

P. 751 recognizes the predominance of EU: "Although we recognize the existence of a debate about the normative status of nonexpected utility models, and the *predominance of the expected utility theory paradigm for normative purposes in decision making*, we here follow the claim that there is nothing irrational about violating Savage's (1954) axioms in situations of deep uncertainty (Gilboa et al. 2008, 2009, 2012; Gilboa and Marinacci 2013)." [italics added here]

P. 753 ff. derive implications of prudence, which here corresponds with absolute ambiguity aversion decreasing in vNM utility. %}

Berger, Loïc, Johannes Emmerling, & Massimo Tavoni (2017) "Managing Catastrophic Climate Risks under Model Uncertainty Aversion," *Management Science* 63, 749–765.
https://doi.org/10.1287/mnsc.2015.2365

{% Pedagogic %}

Berger, Marcel (1990) "Convexity," *American Mathematical Monthly* 97, 650–678.

{% %}

Bergin, James & Adam Brandenburger (1990) "A Simple Characterization of Stochastically Monotone Functions," *Econometrica* 58, 1241–1243.

{% %}

Bergin, James & W. Bentley MacLeod (1993) "Continuous Time Repeated Games," *International Economic Review* 34, 21–37.

{% I agree with most claims. M*ain problem today* is that referees have too much influence on *content* of paper because of asymmetric power, and do not try to avoid this (authors write similarly on p. 234 lℓ. –6/–3). Despite this, I am more positive about quality improvements of papers due to referee inputs than the authors are. I am also one of the few who think that the best duration of a referee round is not the fastest one (because of lack of referee resources).

I agree much that referees too much focus on small imperfections, not properly balancing the overall contributions, which favors marginal smooth contributions at the cost of truly innovative nontrivial contributions that are more open to debate, a point properly emphasized many times by the authors. The authors write e.g. p. 234: "The emphasis on superficial perfection over substantive importance"

I also agree much that referees should distinguish essential points for acceptance decision from nonessential suggestions for improvements. I add that another closely related distinction is about points that authors should react to and points they need not. Especially editors emphasize too much today that authors should exactly explain how all comments were incorporated, making authors lose time. Yet another closely related distinction is points of subjective opinion/taste vs. objective criticisms.

May main disagreement with the authors is their claim (p. 238 bottom) that if you have been a referee of a paper before, you should always let the editor know. Especially for top journals, doing so is a death sentence to the paper. The busy editor, knowing his journal was not first choice and the paper has been rejected elsewhere, will find it psychologically impossible to go for the paper. There are more reasons why sometimes it is better not to let the editor know, and why there is a referee-responsibility decision to be taken (whether or not the paper deserves a new independent try) here before involving the editor.

P. 240: another role of the cover letter is to give info to the editor that is not suited for the authors.

I agree that editors should guard against referees trying to push their own work

and, in particular, trying to get their work cited. Whenever a referee asks for citation of own work, the referee is under suspicion. %}

Berk, Jonathan, Campbell R. Harvey, & David Hirshleifer (2017) "How to Write an Effective Referee Report and Improve the Scientific Review Process," *Journal of Economic Perspectives* 31, 231–244. https://doi.org/10.1257/jep.31.1.231

{% Seem to have argued that psychology is so much driven by anomalies that it tends to exaggerate their importance and generality. %}

Berkeley, Dina & Patrick C. Humphreys (1982) "Structuring Decision Problems and the "Bias" Heuristic," *Acta Psychologica* 50, 201–250.

{% **ordering of subsets** %}

Berliant, Marcus (1986) "A Utility Representation for a Preference Relation on a σ-Algebra," *Econometrica* 54, 359–362.

{% DC: Discusses the normative dillemma between resolute choice of Machina (1989) and McClennen (1990) and what is called action-guiding and what seems to be like consequentialism//forgone-event-independence. It is philosophy-style with the drawback that things haven't been fully formalized and at each stage new arguments and things can come in, but with the advantage that it is more flexible. %}

Bermúdez, José Luis (2010) "Pitfalls for Realistic Decision Theory: An Illustration from Sequential Choice," *Synthese* 176, 23–40.

{% **one-dimensional utility**: A concave utility function has a decreasing derivative. That can be equated with dual of distribution function. Thus, utility functions can be obtained from distribution functions. This paper, §4, does this, woith normal distribution intervening. It, thus, uses beta distributions to obtain a five-parameter family of utility functions that contains virtually all known families. %}

Bernard, Carole, Luca De Gennaro Aquino, & Lucia Levante (2021) "Optimal Annuity Demand for General Expected Utility Agents," *Insurance: Mathematics and Economics* 101, 70–79.

https://doi.org/10.1016/j.insmatheco.2020.07.004

{% Solve/discuss a number of analytical problems in optimizing portfolio choice under PT (the authors write CPT), giving closed form results. Consider as reference point the risk-free rate. Show that because of the overweighting of extremes by PT, skewness is important, and subjects may like skewness to the right. Footnote 2 points out the analyzing PT is complex because we cannot just use convex analysis. I often raise this point when explaining that insensitivity is a new concept that requires the development of new theory.

P. 280: Beware that their u_-, utility for losses, (they indicate gain-loss by the subscript) is defined on $\mathbb{R}^+$, and for a loss $x < 0$, $-u_-(-x)$ gives its utility. %}

Bernard, Carole & Mario Ghossoub (2010) "Static Portfolio Choice under Cumulative Prospect Theory," *Mathematics and Financial Economics* 2, 277–306.

{% **principle of complete ignorance**: Seems like principle of complete ignorance (true, untrue, or don't know). Doesn't say in citation below that for undetermined events statistics has nothing to offer. Does seem to say so for events that have been determined in the past but are as yet unknown to us. Seems to have said elsewhere that for undetermined events statistics is dangerous because it suggest a quasi-certainty.

Wrote on p. 103, according to Bossuyt (1997):

If faut reconnaître dans toute science deux classes de phénomènes, les uns dont la cause est actuellement déterminée, les autres dont la cause est encore indéterminée. Pour tous les phénomènes dont la cause est déterminée, la statistique n'a rien à faire; elle serait même absurde. Jamais la statistique, suivant moi, ne peut donner la vérité scientifique et ne peut constituer par conséquent une méthode scientifique définitive.

My translation into English:

In every science, two classes of phenomena should be recognized, those whose cause has actually been determined, and the others whose cause is as yet undetermined. For all phenomena whose cause is determined, statistics has nothing to offer; it would even be absurd …. Never statistics can, according to me, deliver the scientific truth and, consequently, it cannot be a conclusive

scientific method.

For the historical context, that this citation indeed was meant to discredit probability theory's applicability to medicine, see Murphy, Terence D. (1981). %}

Bernard, Claude (1865) "*Introduction à l'Étude de la Médicine Expérimentale.*" (Revised edn.: Paul F. Cranefield (1976, ed.) Science History Publications, New York.)

{% %}

Bernard, Georges (1966) "Sur les Fonctions d'Utilité," *Revu Française de Recherche Opérationelle* 41, 323–352.

{% **risky utility u = transform of strength of preference v** %}

Bernard, Georges (1974) "On Utility Functions," *Theory and Decision* 5, 205–242.

{% %}

Bernard, Georges (1984) "Utility and Risk Preference Functions." *In* Ole Hagen & Fred Wenstop (eds.) *Progress in Utility and Risk Theory*, 135–143, Reidel, Dordrecht.

{% **foundations of probability**, **foundations of quantum mechanics** %}

Bernard, Georges (1988) "Probability in Quantum Mechanics and in Utility Theory." *In* Bertrand R. Munier (ed.) *Risk, Decision and Rationality*, 545–556, Reidel, Dordrecht.

{% **foundations of statistics**

Frequentists, from Bayesian perspective, choose particular ignorance prior with a restricted ignorance zone. %}

Bernard, Jean -Marc (1996) "Bayesian Interpretation of Frequentist Procedures for a Bernoulli Process," *American Statistician* 50, 7–13.

{% Theorem 2 shows that, for three or more events, logarithm is only scoring rule for subjective probabilities that is both proper and has payment depend only on answer under event happening. %}

Bernardo, Jose M. (1979) "Expected Information as Expected Utility," *Annals of Statistics* 7, 686–690.

{% Axiomatize subjective expected utility taking a stochastic-independence type condition as a primitive in the axiomatization. They assume much richness, such as objective probabilities also being available. %}

Bernardo, Jose M., Juan R. Ferrándiz, & Adrian F.M. Smith (1985) "The Foundations of Decision Theory: An Intuitive, Operational Approach with Mathematical Extensions," *Theory and Decision* 19, 127–150.

{% P. 250: brief discussion of likelihood principle

§2.7.2: scoring rules

§2.8 (p. 87): argues that de Finetti assumes linear utility. %}

Bernardo, Jose M. & Adrian F.M. Smith (1994) "*Bayesian Theory*." Wiley, New York.

{% P. 160, defines DUR, that the only thing that matters is the probability distribution generated over outcomes, calling it the identity principle. Assumption 2.1.2 in Wakker (2010) calls it decision under risk.

P., 170: "And this implies that efforts in the direction of modeling possible mental and psychological processes by which people arrive at choices consistent with EU, along the liners suggested by Leland (1980) and Friedman (1989), are certainly worth pursuing." Goes bit in direction, but does not really say, that conforming with EU and s.th.pr. can be a heuristic rather than true preference. %}

Bernasconi, Michele (1992) "Different Frames for the Independence Axiom: An Experimental Investigation in Individual Decision Making under Risk," *Journal of Risk and Uncertainty* 5, 159–174.

{% **SPT instead of OPT**: p. 64

Violations of betweenness (due to "squiggle") and also of mixture symmetry of quadratic utility;

RDU better, "Squiggle Hypothesis" for **probability triangle** supports **inverse S** weighting functions; intersection point, however, seems to be below 0.16 instead of 0.33. That is, at 0.16 their observations already suggest convex probability transformation; leads him to question RDU.

Real incentives: the **random incentive system** was used.

second-order probabilities; **backward induction/normal form, descriptive**: shows that **RCLA** is violated more than compound independence and, therefore, gives evidence in favor of backward induction/backward induction.

PT falsified: deparable prospect theory is violated (pp. 64-65), repeated on p. 69 in the conclusion.

P. 67 top: RDU can accommodate data, but with less overweighing for small probabilities than commonly found (see above). %}

Bernasconi, Michele (1994) "Nonlinear Preference and Two-stage Lotteries: Theories and Evidence," *Economic Journal* 104, 54–70.
https://doi.org/10.2307/2234674

{% **RCLA**: Consider two-stage setup with probability of auditing in first stage and detection in second. People transform probabilities differently in the two stages. (**violation of risk/objective probability = one source**) %}

Bernasconi, Michele & Juliana Bernhofer (2020) "Catch Me If You Can: Testing the Reduction of Compound Lotteries Axiom in a Tax Compliance Experiment," *Journal of Behavioral and Experimental Economics* 84, 101479.
https://doi.org/10.1016/j.socec.2019.101479

{% **second-order probabilities to model ambiguity**: Test, and reject, some conjectures by Segal about the perception of single-stage lotteries as two-stage lotteries (violating RCLA) relating it to ambiguity attitudes. This also goes against later claims by Halevy (2007) and others. %}

Bernasconi, Michele & Graham Loomes (1992) "Failures of the Reduction Principle in an Ellsberg-Type Problem," *Theory and Decision* 32, 77–100.

{% Bernays has been credited for introducing in marketing, and public policy, the insight that to move people one has to make the right emotional connections. He famously arranged a smoking campaign end of 1920s to get women to smoke, calling cigarettes torches of liberty. %}

Bernays, Edward L. (1928) "Manipulating Public Opinion: The Why and the How," *American Journal of Sociology* 33, 958–971.

https://doi.org/10.1086/214599

{% Argues against Nash equilibrium. %}
Bernheim, B. Douglas (1984) “Rationalizable Strategic Behavior,” *Econometrica* 52, 1007–1028.

{% %}
Bernheim, B. Douglas, Stefano DellaVigna, & David Laibson (2019) “*Handbook of Behavioral Economics; Volume 2*.” Elsevier, Amsterdam.

{% %}
Bernheim, B. Douglas & Antonio Rangel (2007) “Behavioral Public Economics: Welfare and Policy Analysis with Non-Standard Decision Makers.” *In* Peter Diamond & Hannu Vartiainen (2007, eds.) *Economic Institutions and Behavioral Economics*, 7–77, Princeton University Press, Princeton, NJ.

{% Consider choosing from choice sets X, where they write (X,d) with d indicating an ancillary condition, meaning that the choice can depend on an ancillary condition. Same is the framing-dependence of Salant & Rubinstein (2008). A revealed preference is nonsuspect only if it is independent of d. Voilà the modeling of frame dependence. Reminds me some of Wang & Fischbeck (2004) who took as extra parameter whether subjects used a gain or loss frame. Anyway, this Bernheim & Rangel paper has sometimes been cited as a classic, but I find it trivial. %}
Bernheim, B. Douglas & Antonio Rangel (2009) “Beyond Revealed Preference: Choice-Theoretic Foundations for Behavioral Welfare Economics,” *Quarterly Journal of Economics* 124, 51–104.

{% This paper is criticized by Wakker (2023) “A Criticism of Bernheim & Sprenger’s (2020) Tests of Rank Dependence,” §9. It suggests that it reacts to the criticisms of Abdellaoui, Li, Wakker, & Wu (2020) of Bernheim & Sprenger (2020), but virtually none of the many problems are fixed. The authors only improve the layout of their stimuli and their explanations to the subjects, reducing fatigue and properly avoiding a cancellation heuristic. However, as Wakker (2022) explains,

contrary to their claims they do not improve the incentives. They ignore all other criticisms, such as wrong formula of prospect theory, identifying unidentifiable functions, having no viable alternative to rank-dependent weighting, and they reiterate their ridiculous claim that all counting statistics would be invalid using it to improperly denying priority of many preceding studies. Further, all their conclusions are based only on accepted H_0 with no power analysis or anything added, something criticized in every statistical textbook. %}

Bernheim, B. Douglas, Rebecca Royer, & Charles Sprenger (2022) "Robustness of Rank Independence in Risky Choice," *AEA Papers and Proceedings* 112, 415-420.
https://doi.org/10.1257/pandp.20221090

{% **PT falsified**: This paper claims to find that, but I disagree. The authors want economists to return to what has been known as separable prospect theory. That is, they want economists to set back the clock by 40 years and return to the state of the art in psychology before 1980. This makes no sense: separable PT has been discarded since then mainly because it violates stochastic dominance, and does so in unacceptable manners. The basic problem of that theory is that it equates over-weighting of a 1/n probability at a worst-ranked outcome (is due to pessimism) with overweighting of all 1/n probability outcomes (giving optimism for gains). This does not make sense and makes the formula completely implausible, also descriptively. For lab-choices between lotteries with up to, say, four outcomes, the damage may not be very big, but beyond it goes nowhere.

SECTION 1. INTRODUCTION

This paper, abbreviated SB henceforth (I avoid BS for linguistic reasons), criticizes rank dependence, introduced by Quiggin (1982) for risk, and independently by Schmeidler (1989) for uncertainty. Rank dependence is central in Tversky & Kahneman's (1992) new prospect theory and many of my works. I co-authored a criticism of SB, at
http://personal.eur.nl/Wakker/refs/pdf/bscritic/abd.li.wak.wu_bernh.sp_linenrs20aug2020.pdf
abbreviated AL henceforth. Thus, I am not a neutral commentator here. I think that SB is very weak, and damaging to the field.

As everyone will guess, AL was submitted to Econometrica (ECMA), and, as will be clear, it was rejected. Given that I still maintain all the criticisms expressed by AL here, it is also clear that I disagree with all of ECMA's objections to AL: They did not provide any serious counterargument. Now that ECMA has let Bernheim & Sprenger publish an incorrect formula of the Nobel-awarded 1979 prospect theory, and has refused to correct it, what else can one do than warn people so as to minimize damage? The same holds for Berrnheim & Sprenger's incorrect identification of an unidentifiable functional, their incorrect claim of invality of general statistical counting tests, their attempt to revive separable prospect theory that was properly abandoned in the 1980s because of not just violating stochastic dominance but absurdly violating stochastic dominance, their unfounded pushing of their misnomer complexity aversion that was empirically rejected decades ago, their incorrect priority claims, and their other mistakes below. When Nilsson, Rieskamp, & Wagenmakers discovered that their 2011 paper in *Journal of Mathematical Psychology* used an incorrect formula of 1979 prospect theory, this alone was enough reason for the authors and journal to publish a correction in 2020. In this regard, ECMA, Bernheim, and Sprenger behaved differently.

AL was written following academic conventions of diplomacy. Here, where I express subjective opinions on works, I can be more explicit and clear.

SECTION 2. ORGANIZATION

References below can be found in this bibliography. I will as much as possible use SB's notation and terminology, often reluctantly:

- "CPT" instead of PT
- "rank-independent probability weighting": This term is uninformative, like non-elephant zoology. SB use it to refer to what is often called separable probability weighting ($\Sigma w(p_i)u(x_i)$). It was popular in psychology (Preston & Baratta 1948; Edwards 1962) until the 1980s, when it was abandoned mostly because Fishburn (1978 JPE) and others discovered that it violates stochastic dominance.

- “complexity aversion”: That subjects supposedly have an aversion to many outcomes, also for gains. The claim is empirically incorrect (see Mistake 3.8 below). The literature uses the term complexity aversion for phenomena other than dependency on nr. of outcomes, where the term is correct.

Next, three more sections follow.

SECTION 3. LIST OF SB’S MISTAKES DESCRIBED BY AL

SB claim a “*novel*” *falsification of CPT showing its* “*stunning failure*.” Mistakes:

3.1. [Ignoring priority of stronger counterevidence]

Even if SB’s experiment had been correct, stronger violations of the same kind have been reported long before (and so have many different violations), ignored by SB, and invalidating their novelty claims. (AL §6.4)

3.2. [Ignoring ocean of positive evidence]

Many more positive results for CPT were obtained. One should look at the balance of all evidence $\Rightarrow$ CPT most popular today. Even if SB had been correct, it would have been a very marginal contribution to an ocean of preceding evidence, ignored by SB, and invalidating their “failure of CPT” claims. (AL p. 16 ℓ. 6-12)

SB claim that *rank-independent probability weighting is better*. Mistakes:

3.3. [Misleading presentation of rank-independent probability weighting]

SB once acknowledge that rank-independent weighting violates stochastic dominance (“This is a serious flaw”, SB p. 1364). But then the rest of their paper still presents it, misleadingly, as a promising alternative, apparently forgetting about the flaw, also prior to bringing in the (irrelevant; see below) complexity aversion (link to misleading citations from SB). SB are apparenty unaware of the problematic absurdity, also descriptively, of the stochastic dominance violations (AL p. 4 $\ell\ell$. 10-16). The following Mistake 3.4 continues on this.

3.4. [Complexity aversion as incorrect remedy for Mistake 3.3]

SB incorrectly suggest complexity aversion as a remedy for the violations of stochastic dominance (SB end of §6). However, it is not; see AL §6.3. A less diplomatic and, hence, clearer, explanation is here (link). Thus, SB's suggested alternative for rank-dependent probability weighting does not work.

SB's *rank-independent probability weighting*, further mistakes:

3.5. [Wrong formula of prospect theory]

SB use an incorrect formula of 1979 prospect theory for rank-independent probability weighting (AL p. 3 ℓ.24 – p. 4 ℓ.7).

3.6. [Models not identifiable from their data]

The models that SB claim to estimate are not even identifiable from their data. (AL p. 4 ℓ. 25 - p. 5 ℓ. 11) Mainly because of this mistake, and also Mistake 3.5, AL (e.g., in Mistake 3.1 above) ignore SB's claims on rank-independent weighting, and focus on what remains: SB's direct tests of rank dependence.

SB claim *novelty/usefulness of complexity aversion*; mistakes:

3.7. [Complexity aversion theoretically discarded long ago]

See AL §6.3 & AL Online Appendix (added at the end of the AL file.) This invalidates SB's novelty/interest claims.

3.8. [Complexity aversion empirically falsified long ago]

See AL Online Appendix p. 3 (added at the end of the AL file). This invalidates SB's empirical claims.

SB claim a *new general nonparametric measurement* of decision weights. Mistakes:

3.9. [Trifle problem]

Their preference measurement does not work because of Ramsey's trifle problem (payoff *differences* too small). (AL p. 7 ℓ. 20 - p. 8 ℓ. 27 & §5)

3.10. [Three-outcome lotteries are too complex]

It has often been pointed out that, in general, three-outcome lotteries, as used by SB, are too complex for subjects. Hence, all cited studies with three-outcome lotteries other than SB did special efforts, with special layouts and visual aids (AL p. 12 $\ell\ell$. 5-9). SB, unaware, did not do so.

3.11. [Linear utility]

The trifle problem can be avoided, but then linear utility is needed, invalidating SB's claims of generality and nonparametric analysis. (AL Assumption 1, p. 6 & p. 11 ℓ. 19 - p. 12 ℓ. 4)

3.12. [Further incorrect generality claim]

SB footnote 13, claiming validity even for nondifferentiable utility, is incorrect, and is based on a mathematical mistake. (AL p.6 Footnote 5)

3.13. [Invalid priority claim on measurement and test]

SB p. 1376 claims novelty: "However, our use of equalizing reductions has no counterpart in the existing literature." However, Diecidue, Wakker, & Zeelenberg (2007) used the (corrected) method before (AL p. 11 ℓ. 19 - p. 12 ℓ. 4) for uncertainty, which is more interesting than risk as in SB.

SB claim invalidity of statistical *counting tests*, used throughout all empirical sciences. Mistakes:

3.14. [Ignorance of randomness underlying statistical tests 1st]

SB do not know that *every* statistical test is based on an underlying probabilistic ("noise") model. (AL p. 13 ℓℓ. 14 -25). I add here the following citation, found May 2022, of Greenland et al. (2016 p. 338 2nd column 1st para): "Many problems arise however because this statistical model often incorporates unrealistic or at best unjustified assumptions. This is true even for so-called "non-parametric" methods, which (like other methods) depend on assumptions of random sampling or randomization."

3.15. [Ignorance of randomness underlying statistical tests 2nd]

SB's claimed first problem for counting tests only shows that *there exists* an error model under which counting tests are invalid. But this trivially holds for *every* statistical test, including all their own tests. (AL p. 13 ℓℓ. 30-33)

3.16. [Invalid no-power counterexample]

SB's claimed second problem for counting tests considers stimuli where EU and CPT make identical predictions. SB criticize counting tests for having no power then. But, again, this then trivially holds for *every* statistical test. (AL p. 14 ℓℓ. 9-19.)

SECTION 4. QUALIFICATIONS AND IMPLICATIONS OF THE PRECEDING SB MISTAKES

Elementary theoretical blunders: Mistakes 3.5 (wrong PT formula), 3.6 (nonidentifiability), 3.14 (randomness in statistics), and 3.16 (no-power)

Elementary experimental blunder: Mistake 3.9

Naive: Mistakes 3.1 and 3.2. Thinking, 30 years after the introduction of CPT, 20 years after its shared Nobel memorial prize, and after 1000s of applications, to be the first to ("properly") test one of its two main nonclassic components, is naive. Thinking that two (in fact only one; see Mistake 5.17 in §5 below) small experiments can speak final verdict, 30 years after, is so too. (Mistakes 3.14-3.16 are also naïve.) It is unbelievable that with dozens of falsifications available, and thousands of corroborations, Econometrica can put one, one!, falsification, well, supposed falsification, central.

*Further: S*B's other mistakes are more understandable, though still revealing lack of dedication/understanding & literature search/knowledge.

*Damage: O*ne can predict much damage to come from SB, augmented by the prominence of its outlet: Use of incorrect formulas/measurement methods, ignoring priority of preceding literature, wrong and useless separable probability weighting, nonsensical claims on general statistical procedures, rejections of papers using the currently best descriptive CPT, and so on.

SECTION 5. MISTAKES BY SB NOT MENTIONED IN AL

AL focused on SB's mistakes that were directly relevant for the main conclusions, and other mistakes whose mention could not be avoided (e.g., incorrect notation). However, having read their paper in detail, I know many more inaccuracies and weaknesses in SB, not mentioned by AL. I list such next.

Mathematical mistakes:

5.1. [Comonotonic independence]

SB p. 1376 ℓ. 8: Schmeidler's (1989) comonotonic independence is different than what SB claim. For instance, it involves a mixture operation.

5.2. [k independent of X]

P. 1367, Footnote 7: SB in fact need linear utility. Then, contrary to SB's claims, k does NOT depend on X there under PT and EU, and neither does it under rank dependence as long as ranks are kept fixed (comonotonicity), as follows from AL Eq. 8).

5.3. [$p = 1$ for common ratio]

P. 1390 ℓ. 10: The common ratio effect is only strong, and often only defined, with probability $p = 1$ involved. Nonlinearity of w in [0.9, 1] does accommodate this, contrary to SB's claim.

5.4. [brackets instead of braces]

SB's notation of lotteries violates mathematical rules (AL Footnote 2). Braces denote sets that are not ordered and cannot be used here.

Further:

5.5. [Reference dependence]

SB claim to also falsify models with reference dependence, but these claims are incorrect for the same reasons as their claims about rank dependence are (wrong formulas, unidentifiable estimates, bad stimuli, and so on).

Incorrect citations:

5.6. [No proper justice to Weber & Kirsner]

Weber & Kirsner (1997) find significant rank dependence for the same kind of stimuli as considered by SB, providing straight counterevidence to SB. SB do not make this clear but only cite them ambiguously in Footnote 6.

5.7. [Identifiability in other studies]

P. 1382: "Tversky and Kahneman (1992) and Tversky and Fox (1995) obtained probability weighting parameters from certainty equivalents by parameterizing both the utility and probability weighting functions and assuming each observation satisfies the indifference condition $u(C) = \pi(p)u(25)$."

Wrong citation. Those papers used essentially richer stimuli. For the stimuli mentioned there and used by SB, the model is not even identifiable (see Mistake 1.6).

5.8. [Real incentives in Birnbaum]

P. 1401 Footnote 69: "Interestingly, in incentivized tasks, we do not see the failure of coalescing noted by Birnbaum (2008) for hypothetical choice."

Wrong citation: Birnbaum used real incentives. His 2008 paper reviews Birnbaum (2004), in particular, his Table 3. His §2 there explains that he used real incentives. Probably SB gambled on their incorrect claim to cover up the puzzling point that their finding is opposite to Birnbaum's (as it is, unbeknownst to them, to most of the literature). Also note that Birnbaum (2008) extensively discussed what SB call complexity aversion, but they do not cite him for that, or the many other papers Birnbaum cites on it.

The next four mistakes show that almost every sentence in SB's footnotes 3 and 4, on prospect theory, is wrong.

5.9. [Only one version of 1979 prospect theory]

SB's Footnote 3: "Kahneman and Tversky (1979) actually provided two formulations of Prospect Theory"

Incorrect. There is only one (AL Eq. 3).

5.10. [No wrong prospect theory formula in other papers]

SB's Footnote 3: "extensions which correspond to our three-outcome formulation are provided by, for example, Camerer and Ho (1994) and Fennema and Wakker (1997)":

Incorrect citations. See AL p. 17 $\ell\ell$. 25-32).

5.11. [Explicit!]

SB's Footnote 3: "They implicitly invoked the same assumption [their Equation 1] when examining the Allais common consequence paradox (p. 282)."

Incorrect citation. Kahneman & Tversky (1979) write it explicitly on p. 282 top.

5.12. [Again, only one version of 1979 prospect theory]

SB's Footnote 4: "Kahneman and Tversky also provided a formulation for two-outcome lotteries with either all positive or all negative outcomes that does indeed respect dominance (see, e.g., Equation (2) of Kahneman and Tversky (1979))."

Incorrect. Their Eq. 2 is part of the ONLY version of 1979 prospect theory and, as is well known, this does violate stochastic dominance.

Weak writings:

5.13. [Statistical analysis lacking for main claims]

P. 1399 last para of §5: "equalizing reductions respond *strongly* to changes in X" [italics added]

No statistical analysis is given to justify this claim. The confidence intervals in Figure 5B overlap, leaving unclear whether what SB call "strongly" is even significant. SB make the same unfounded claim of dependence on X on p. 1396 ℓ. -5/-2 and p. 1398 last sentence of §5.3. Further, their claimed explanation, through utility curvature, is implausible because utility curvature is weak for moderate payoffs as in their experiment.

Besides the above point (SB's third finding end of §5), the first two findings there ((1): nonzero impact of probability; (2): absence of complete randomness) concern trivial strawmen. Their whole claim of genuine effects in their 2nd experiment, needed to claim genuine absence of rank dependence, hinges on the above, unsubstantiated, claim.

5.14. [Unfounded speculation]

P. 1380: "If isolation fails in this context, then our subjects would not exhibit standard patterns of probability weighting in binary tasks. [Then what else? Linear weighting???] Conversely, if our subjects do exhibit standard probability weighting patterns in binary tasks, then one cannot reasonably attribute the absence of implied discontinuities in the equalizing reduction tasks to a failure of isolation."

Unfounded speculations on what happens if isolation fails.

5.15. [Assumed properties u and w?]

SB never say what properties w and u have. Strictly increasing? Stoch. dom? Continuous? Yet they use such properties. This is why AL assumes them explicitly below their Eq. 1.

5.16. [apples vs. pears]

P. 1377: "because the essence of our approach is to measure characteristics of indifference curves (MRSs), all potential confounds associated with unintended variations in "distance to indifference" are eliminated."

A paraphrase: Because we measure apples, all problems of pears are eliminated. Their measurements of indifferences do have the analogous problem. See Mistake 3.15 in §3. For example, if the errors in their indifference measurements are not constant or are extreme, then their claimed p-values and confidence intervals are not valid either.

5.17. [No use reporting Experiment 1]

SB claim that Experiment 2 would show absence of cancellation in Experiment 1, (p. 1367 end of first para: "clearly refuting the cancellation hypothesis.") contradicting the consensus in the field (Weber & Kirsner 1997) and unfounded. SB *only* justify Experiment 1 by referring to Experiment 2. Experiment 1 adds nothing. Thus, one small Experiment 2 of 84 subjects (with no statistical analysis to support the main claim, see Mistake 3.13) should discard a Nobel-sharing theory used in 1000s of studies. SB's misleading claim is repeated in the last para of §5.3. Mistake 3.13 above showed how weak the evidence of their Experiment 2 in fact is.

5.18. [Complexity aversion is misnomer]

SB's complexity aversion for dependence on number of outcomes is a misnomer as explained at the beginning of these annotations and more in AL Online Appendix p. 2 $\ell\ell$. 17-32 & p. 1 $\ell\ell$. 17-21 (added at the end of AL).

If academia can publish a claim “2+2 = 5” and not allow this to be contradicted, then I live in a wrong world. %}

Bernheim, B. Douglas & Charles Sprenger (2020) “On the Empirical Validity of Cumulative Prospect Theory: Experimental Evidence of Rank-Independent Probability Weighting,” *Econometrica* 88, 1363–1409. https://doi.org/10.3982/ECTA16646

{% This paper is severely criticized by Wakker (2024) Wakker (2024) “A Criticism of Bernheim & Sprenger (2023)” %}

Bernheim, B. Douglas & Charles Sprenger (2023) “On the Empirical Validity of Cumulative Prospect Theory: A Response to the Wakker Commentaries,” *Journal of Behavioral and Experimental Economics* 107, 102120. https://doi.org/10.1016/j.socec.2023.102120

{% I incorporate this reference for its nice title. %}

Bernile, Gennaro, Vineet Bhagwat, & P. Raghavendra Rau (2017) “What Doesn’t Kill You Will Only Make You More Risk-Loving: Early-Life Disasters and CEO Behavior,” *Journal of Finance* 72, 167–206.

{% **utility families parametric**: utility is logarithmic (paragraph 5 calls it “highly probably”);

marginal utility is diminishing: Contrary to what is commonly thought, the St. Petersburg paradox (discussed on p. 31) is not Bernoulli’s primary motivation for deviating from EV (contrary to Cramer 1728). First, §2 nicely states the view up to then that best (in a rational sense) risk attitude should be objective. Then, §3 writes: “Somehow a very poor fellow obtains a lottery ticket that will yield with equal probability either nothing or twenty thousand ducats. Will this man evaluate his chance of winning at ten thousand ducats? Would he not be advised to sell this lottery ticket for nine thousand ducats? To me it seems that he answer is negative.” And then the main point: “it seems clear that all men cannot use the same rule to evaluate the gamble.” This formulates the big breakaway that EU brings, the necessity to bring in risk attitudes that are different from different persons. Later: “the utility, however, is dependent on the particular circumstances of the person making the estimate.” It is sometimes said that Bernoulli broke away from objectivity, treating different persons differently. But he does not do much so, letting marginal utility only depend on one’s wealth level in his main proposal of logarithmic utility for (almost) anyone. So, he does not sacrifice much tractability.

Arrow (1951, Econometrica, p. 412) suggests that Bernoulli was the first to formulate the principle of insufficient reason and has only this paper in his references. Latané (1959, Footnote 12) writes that Bernoulli is generally credited for being the first to use a utility function. Savage (1954, p. 95 in 1972 ed.) says this also.

P. 26 §6 ff.: I did not understand the analysis of the figure, and there may be mistakes.

P. 30 Para 16 argues that concave utility implies that spreading risks is good. P. 29 para 14 writes that strict risk aversion is rational. %}

Bernoulli, Daniel (1738) “Specimen Theoriae Novae de Mensura Sortis,” *Commentarii Academiae Scientiarum Imperialis Petropolitanae* 5, 175–192. Translated into English by Louise Sommer (1954) “Exposition of a New Theory on the Measurement of Risk,” *Econometrica* 22, 23–36.
Reprinted in Alfred N. Page (1968, ed.) *Utility Theory: A Book of Readings*, Ch. 11, Wiley, New York. Revised translation in William J. Baumol & Stephen M. Goldfeld (1968, eds.) *Precursors in Mathematical Economics: An Anthology*. Clowes and Sons, London, Selection 2, 15–26.

{% One of the first cost-effectiveness analysis for health. Did it for smallpox. %}

Bernoulli, Daniel (1766)

{% “What about problems such as those involving disease, weather or games of skill, where the causes are hidden and the enumeration of equally likely cases impossible? In such situations”

Above probably not literal citation (of course, translated) given by Stigler (1986) “The History of Statistics.”

Citation below seems to be literal.

“It would be a sign of insanity to learn anything in this manner.” %}

Bernoulli, Jacob (1713) “*Ars Conjectandi*.” Translated into German by Robert K.H. Haussner (1899) as “Wahrscheinlichkeitsrechnung,” *Ostwald’s Klassiker der Exakten Wissenschaften* 107 and 108, W. Englemann, Leipzig.

{% Use negative outcomes, losses, being unpleasant electric shocks, received with particular probabilities. N = 37 choose. They fit the T&K’92 family to their data and find similar best-fitting curves as did T&K’92 and others. Footnote 7 shows that probability distributions suggested to subjects had been predetermined. They do not really consider prospect theory but rather a sort of quasi-normalized separate-probability weighting formula (separable prospect theory) of Edwards (their Eq. 1, p. 238). (**SPT instead of OPT**)

Final sentence of abstract: our results provide evidence that probability weighting is a general phenomenon, independent of the source of disutility. %}

Berns, Gregory S., C. Monica Capra, Sara Moore, & Charles Noussair (2007) “A Shocking Experiment: New Evidence on Probability Weighting and Common Ratio Violations,” *Judgment and Decision Making* 2, 234–242.

{% **questionnaire versus choice utility**: Same experiment as Berns et al. (2007, JDM). Use negative outcomes, losses, being unpleasant electric shocks, received with particular probabilities. First N = 37 subjects are just told what probability distribution is exerted on them and they undergo it. So, experience but no decision. After that, subjects will choose between such things. During the experiencing stage, they measure brain activities, and use those to predict future choices (better said, they correlate them to future choices). In particular, they construct a neurobiological probability response ratio (NPRR). This nicely exhibits the **inverse S**-shape that they also find for probability weighting (although for the latter they only fitted the T&K’92 family which does not have other things than inverse S). They find that these measured experiences predict future choices as well as prior decisions. Nice, giving orthodox revealed-preference advocates food for thought. Implications of such findings for the revealed-preference discussions are in Abdellaoui, Barrios, & Wakker (2007).

P. 2055 discusses separation of probability and magnitude (latter means outcome). %}

Berns, Gregory S., C. Monica Capra, Jonathan Chappelow, Sara Moore, & Charles Noussair (2008) "Neurobiological Regret and Rejoice Functions for Aversive Outcomes," *Neuroimage* 39, 2047–2057.

{% Paper gives neuro-justification for using RDU and other theories. Last sentence of introduction writes: "For instance, our model implies a diminishing marginal sensitivity to value and probability, which is consistent with the available evidence from economic experiments." (p. 302) %}

Berns, Gregory S., C. Monica Capp, & Charles Noussair (2007) "Receptor Theory and Biological Constraints on Value," *Annals of the New York Academy of Sciences* 1104, 301–309.

{% **decreasing ARA/increasing RRA**: use power utility;

PT: data on probability weighting; their method of estimating loss aversion is not correct, and is based only on their scaling convention regarding power utility. %}

Bernstein, Lionel M., Gretchen B. Chapman, Caryn Christensen, David Potts, & Arthur S. Elstein (1997) "Five Models of Choice between Multioutcome Lotteries," *Journal of Behavioral Decision Making* 10, 93–115.

{% Fl. 59; Populair-wetenschappelijk; **foundations of probability** and risk %}

Bernstein, Peter L. (1996) "*Against the Gods*. The *Remarkable Story of Risk.*" Wiley, New York.

{% The author's Russian family name is sometimes written as Bernshtein in the Roman alphabet.

Seems that he had qualitative probability preceding de Finetti, and probability axioms preceding Kolmogorov. (**ordering of subsets**) %}

Bernstein, Sergi (1917) "Attempt at an Axiomatic Foundation of Probability Theory," [in Russian], *Communications of the Kharkov Mathematical Society* [in Russian] 15, 209–274. Translated into English In: Oscar Sheynin (2005) *Probability and Statistics: Russian Papers of the Soviet Period*. Berlin, Germany: NG Verlag.

{% Considers conditioning from frequentist perspective. %}

Bérod, Annick Clerc (1994) “Conditional Behavior of Confidence Intervals,” *Scandinavian Journal of Statistics* 21, 159–167.

{% Argue that randomization, not useful in individual Bayesianism other than to simplify calculations, may become really optimal in multiperson settings. %}
Berry, Scott M. & Joseph B. Kadane (1997) “Optimal Bayesian Randomization,” *Journal of the Royal Statistical Society, Ser. B*, 59, 813–819.

{% %}
Bertoluzza, Carlo, Mario di Baco, & Maria Luisa Capodieci (1999) “Bayes Rule and Expected Utility Rule: An Unified Axiomatic Approach,” *Journal of Statistics and Management Systems* 2, 9–21.

{% Idea to derive subjective probabilities from willingness to bet. It seems that he pointed out only that equal willingness to bet on or against shows subjective probability 0.5. (De Finetti, 1931 refers to him).
three-doors problem: seems that he introduced it. %}
Bertrand, Joseph (1889) “*Calcul des Probabilités.*” Gauthiers-Villars, Paris.

{% **questionnaire for measuring risk aversion;** Argue for usefulness of subjective (questionnaire) questions, then describe a number of biases, and end with describing an error theory. %}
Bertrand, Marianne & Sendhil Mullainathan (2001) “Do People Mean What They Say? Implications for Subjective Survey Data,” *American Economic Review, Papers and Proceedings* 91, 67–72.

{% **equity-versus-efficiency**: A theoretical study, illustrated with a case study, of the fairness-efficiency tradeoff. They in particular study the α-fairness criterion, which is a CES welfare functional with power 1−α. %}
Bertsimas, Dimitris, Vivek F. Farias, & Nikolaos Trichakis (2012) “On the Efficiency-Fairness Trade-off,” *Management Science* 58, 2234–2250.
http://dx.doi.org/10.1287/mnsc.1120.1549

{% %}

Bessembinder, Hendrik (2003) "Trade Execution Costs and Market Quality after Decimalization," *Journal of Financial and Quantitative Analysis* 38, 747–77.

{% **anonymity protection** %}

Bethlehem, Jelke G., Wouter J. Keller, & Jeroen Pannekoek (1988) "Disclosure Control of Microdata," *Proceedings of the Fourth Annual Research Conference of the Bureau of the Census,* 181–192, Arlington, USA.

{% **real incentives/hypothetical choice, for time preferences**; **random incentive system between-subjects** (paying only some subjects) %}

Bettinger, Eric & Robert Slonim (2007) "Patience among Children," *Journal of Public Economics* 91, 343–363.

{% %}

Bettman, James R., Eric J. Johnson, Mary-Frances Luce, & John W. Payne (1993) "Correlation, Conflict, and Choice," *Journal of Experimental Psychology: Learning, Memory, and Cognition* 19, 931–951.

{% Argue that Dutch people lose pension because government (with Rutte as prime minister) is too risk averse. %}

Beukelen, Nicolen, David van As, Inge van den Doel, Eric Uijen, & Peter Borgdorff (2018) "U krijgt minder pensioen omdat Rutte op safe spelt," *NRC Handelsblad* Monday September 24, Opinie, 18.

{% %}

Bewley, Ronald & Denzil G. Fiebig (1988) "A Flexible Logistic Growth Model with Applications in Telecommunications," *International Journal of Forecasting* 4, 177–192.

{% **completeness criticisms**; Page nrs. refer to the publised version.

Uses Anscombe-Aumann two-stage model with EU in second stage (Theorem 2 (numbered 1.2 in the working paper); in Theorem 1 (numbered 1.1 in the working paper), lotteries have been replaced by their vNM utilities. On horse

space, a family Delta of probability distributions is given. One act is singled out that is the status quo (**conservation of influence**). Another act is chosen only if its EU dominates the EU of the status quo for every element of Delta. Preferences can be incomplete. This model is called Knightian uncertainty. The term "inertia assumption" indicates the priviliged treatment of the status quo. It is defended partially by bounded rationality. P. 84 top: "inertia is not a consequence of rationality. Inertia is an extra assumption which is consistent with rationality."

P. 82 3rd para argues that ambiguity nonneutrality due to this paper's inertia, or also in the Gilboa-Schmeidler models (this was also in the 1986 working paper), is rational.

P. 85 3rd para: "If probabilities are not known, there seems to be no normative justification for completeness." As often, a "there is no reason that not" argument.

P. 94: "Inertia is the refusal to change plans unless doing so leads to an improvement."

This paper was preceded by Giron & Rios (1980). %}

Bewley, Truman F. (1986) "Knightian Decision Theory Part I," Cowles Foundation Discussion Paper No. 807.
Reprinted in *Decisions in Economics and Finance* 25 (2002), 79–110.

{% Notion of inertia appeared here. %}

Bewley, Truman F. (1988) "Market Innovation and Entrepreneurship: A Knightian View," Cowles Foundation DP 905, Yale University.

{% %}

Bezembinder, Thom G.G. (1981) "Circularity and Consistency in Paired Comparisons," *British Journal of Mathematical and Statistical Psychology* 34, 16–37.

{% %}

Bezembinder, Thom G.G. (1991) "Circularity in Conjoint Paired Comparisons." *In* Jean-Claude Falmagne & Jean-Paul Doignon (eds.) *Mathematical Psychology: Current Developments*, 157–180, Springer, Berlin.

{% %}

Bezembinder, Thom G.G. (1996) "The Plurality Majority Converse under Single Peakedness," *Social Choice and Welfare* 13, 365–380.

{% %}

Bezembinder, Thom G.G. & Peter van Acker (1980) "Intransitivity in Individual and Social Choice." *In* Ernest D. Lantermann & Hubert Feger (eds.) *Similarity and Choice*, Huber Publishers, Bern.

{% %}

Bezembinder, Thom G.G. & Peter van Acker (1985) "The Ostrogorski Paradox and its Relation to Nontransitive Choice," *Journal of Mathematical Sociology* 11, 131–158.

{% %}

Bezembinder, Thom G.G. & Peter van Acker (1987) "Factual versus Representational Utilities and their Interdimensional Comparisons," *Social Choice and Welfare* 4, 79–104.

{% %}

Bezembinder, Thom G.G. & Patrick M.M. Bossuyt (1989) "Strong Stochastic Transitivity in a Multidimensional Probabilistic Unfolding Model," *Journal of Mathematical Psychology* 33, 496–499.

{% %}

Bezembinder, Thom G.G. & Peter P. Wakker (1990) Review of Ch. 2.10 of Richard C. Atkinson, Richard J. Herrnstein, Gardner E. Lindzey, & R. Duncan Luce (1988, eds.) "*Stevens Handbook of Experimental Psychology*" (Wiley, New York), *Acta Psychologica* 75, 193–194.
Direct link to paper

{% **paternalism/Humean-view-of-preference**: Show for representativeness bias, and ambiguity aversion (in sense of unclear info about stocks), that decision aids in the sense of clearer information reduces biases such as status quo bias (where status quo was clearly inferior to some other options) for ambiguous choice. %}

Bhandari, Gokul, Khaled Hassanein & Richard Deaves (2008) "Debiasing Investors with Decision Support Systems: An Experimental Investigation," *Decision Support Systems* 46 399–410.

{% %}
Bhaskar Rau, G.N. (2019) "An Ancient History of Insurance Concepts," *The Journal of Insurance & Management* 19, 19–35.

{% **finite additivity**; pp. 142-143, that nonatomicity need not imply convex-rangedness, but does under countable additivity.

Nonatomic: there do not exist atoms; finitely additive P is strongly nonatomic: for each event B, and each x < P(B), there exists a subset A of B with P(A) = x. %}
Bhaskara Rao, Kopparty P.S. & Marepalli B. Bhaskara Rao (1983) "*Theory of Charges*." Academic Press, London.

{% A brief account reiterating the findings of Peterson et al. (2021 Science). %}
Bhatia, Sudeep & Lisheng He (2021) "Machine-Generated Theories of Human Decision-Making," *Science* 372(6547), 1150–1151.

{% **Best core theory depends on error theory**: they show this. In particular, they assume noise both in the "true" parameters of a subject and in the response/acts generated. %}
Bhatia, Sudeep & Graham Loomes (2017) "Noisy Preferences in Risky Choice: A Cautionary Note," *Psychological Review* 124, 678–687. http://dx.doi.org/10.1037/rev0000073

{% The authors list many, over 150, decision theories and organize them according to some criteria, revealing many links, relations, and overlaps. The general message is that we should have fewer new models, and more deepening of existing models. As I see it, there is a difference between economics and psychology here. In psychology there is more tendency to develop new models, and in economics it is more on deepening existing models. %}

Bhatia, Sudeep, Graham Loomes, & Daniel Read (2021) "Establishing the Laws of Preferential Choice Behavior," *Judgment and Decision Making* 16, 1324–1369. https://doi.org/10.1017/S1930297500008457

{% They consider a psychological model where prospects are evaluated by sampling from memory. Doing this coding efficiently can explain decision-theory models. (**calculation costs incorporated**) The model builds on the decision-by-sampling model by Neil Stewart and others. They point out that their approach can be taken as a normative justification. %}

Bhui, Rahul & Samuel J. Gershman (2018) "Decision by Sampling Implements Efficient Coding of Psychoeconomic Functions," *Psychological Review* 125, 985–1001. http://dx.doi.org/10.1037/rev0000123

{% %}

Biagioli, Francesca (2023) "Hermann von Helmholtz and the Quantification Problem of Psychophysics," *Journal for General Philosophy of Science* 54, 39–54. https://doi.org/10.1007/s10838-022-09605-6

{% **correlation risk & ambiguity attitude**: find it weakly negative.

Have administrative panel of clients of investment company. So, all their subjects invest and they cannot investigate whether ambiguity aversion has a positive or negative relation with investing. Measure their risk attitude by one certainty equivalent measurement (positively correlating with some casual measurements of risk attitude) and a matching probability of a gain with completely unknown probability (step sizes p = 0.10). All this is hypothetical, so, suspicion is not really a problem (**suspicion under ambiguity**). Whereas their sample is not very big or 100% representative and their measurements are hypothetical, they have refined data on financial decisions and portfolio dynamics. They find: Conditional on participation in the investments, ambiguity averse people exhibit more home bias, choose riskier contracts, more rebalance contrary to market giving more stable risk over time, and (probably because of risky choices) have better returns in good times and worse in bad times. They have detailed results on how ambiguity aversion affects changes in investments over time.

correlation risk & ambiguity attitude:

reflection at individual level for risk: positive correlation between risk aversion for gains and losses;

ambiguity seeking for losses: they find some ambiguity aversion there, although less than for gains. %}

Bianchi, Milo & Jean-Marc Tallon (2019) "Ambiguity Preferences and Portfolio Choices: Evidence from the Field," *Management Science* 65, 1486–1501.

{% **conservation of influence** %}

Bich, Leonardo & Sara Green (2018) "Is Defining Life Pointless? Operational Definitions at the Frontiers of Biology," *Synthese* 195, 3919–3946.

{% **proper scoring rules**: shows that logarithmic scoring rule is better regarding "rank order" properties than quadratic or spherical, and gives numerical arguments that probably it is less affected by utility curvature. %}

Bickel, J. Eric (2007) "Some Comparisons among Quadratic, Spherical, and Logaritmic Scoring Rules," *Decision Analysis* 4, 49–65.

{% **proper scoring rules**: cites many places where they use them to grade students. %}

Bickel, J. Eric (2010) "Scoring Rules and Decision Analysis Education," *Decision Analysis* 7, 346–357.

{% $S = [0,1]$ is a state space with the Lebesgue measure, so, it is rich and atomless and generates all probability distributions. A regret based representation is $(E_1{:}x_1,\ldots,E_n{:}x_n) \succcurlyeq (E_1{:}y_1,\ldots,E_n{:}y_n) \Leftrightarrow V(P(E_1).\Psi(x_1.y_1),\ldots, P(E_n).\Psi(x_n.y_n)) \geq 0$ with everything continuous and monotonic and $\Psi(-\alpha) = -\Psi(\alpha)$ so that $\Psi(0) = 0$. Theorem 1 shows that transitivity holds iff it is EU. The main idea is that the Ψ functions then give independence of common outcomes. This theorem gives the clearest statement of this result in the literature. %}

Bikhchandani, Sushil & Uzi Segal (2011) "Transitive Regret," *Theoretical Economics* 6, 95–108.

{% **real incentives/hypothetical choice, for time preferences**: Find that it does not matter, with same discount weights and same brain activities. Problem may be that this is all based on acceping H_0. %}

Bickel, Warren K., Jeffery A. Pitcock, Richard Yi, & Edgardo J.C. Angtuaco (2009) "Congruence of Bold Response across Intertemporal Choice Conditions: Fictive and Real Money Gains and Losses," *Journal of Neuroscience* 29, 8839–8846.

{% Asset-pricing models are examined assuming fat-tail rather than normal distributions. %}

Bidarkota, Prasad V. & J. Huston McCulloch (2003) "Consumption Asset Pricing with Stable Shocks: Exploring a Solution and its Implications for Mean Equity Returns," *Journal of Economic Dynamics and Control* 27, 399421.

{% Asset-pricing models are examined assuming fat-tail rather than normal distributions. %}

Bidarkota, Prasad V. & Brice V. Dupoyet (2007) "The Impact of Fat Tails on Equilibrium Rates of Return and Term Premia," *Journal of Economic Dynamics and Control* 31, 887905.

{% Analyze economic models incorporating model uncertainty, modeled using maxmin EU of Gilboa & Schmeidler (1989), also citing Hansen & Sagent for it. %}

Bidder, Rhys & Ian Dew-Becker (2016) "Long-Run Risk Is the Worst-Case Scenario," *American Economic Review* 106, 2494–2527.

{% All hypothetical. Find that optimism negatively affects ambiguity aversion for positive frame and not for negative. So, sign dependence of ambiguity!

Studies 1 & 2: They consider the occurrence of side effects for medical treatments. It is a bit of deception because subjects are told probabilities of side effects that may not be real (**deception when implementing real incentives**). They either state it positively (probability of no side effect; can we consider it as gains? Debatable.) or negatively (probability of side effect). They have only low-likelihood nonzero outcome events (≤ 0.14).

ambiguity seeking: They find ambiguity seeking for positive frame and ambiguity neutrality for negative frame in both studies. They are surprised by the first finding (p. 175, Limitations, line 2). On p. 179 they conjecture that the multiatribute nature of their outcomes may be a reason for their unexpected finding.

The findings of ambiguity are not very clear. In study 1 the ambiguous probabilities refer to two studies, which may have raised confidence, as the authors point out. In study 2 there is a trend but it is not significant.

It may also be that the positive probabilities of absence of side effects are perceived as gains by some subjects, but as losses by others.

reflection at individual level for ambiguity: both studies 1&2 have data within individual but do not report this. %}

Bier, Vicky M. & Brad L. Connell (1994) “Ambiguity Seeking in Multi-Attribute Decisions: Effects of Optimism and Message Framing,” *Journal of Behavioral Decision Making* 7, 169–182.

{% Presents the Allais paradox very explicitly, by making explicit the structure that supports independence. I conjecture, if a statement is added: “Note that the most desirable outcome is $5,000,000,” then this will also greatly affect results.
The author does not discuss whether making things salient leads to more genuine preference or to heuristic. %}

Bierman, Harold, Jr. (1989) “The Allais Paradox: A Framing Perspective,” *Behavioral Science* 34, 46–52.

{% %}

Bierman, H. Scott & Luis Fernandez (1995) “*Game Theory with Economic Applications.*” Addison-Wesley, Reading, Mass. (2^{nd} edn. 1998)

{% **foundations of statistics** %}

Biggerstaff, Brad J. (2000) “Comparing Diagnostic Tests: A Simple Graphic Usng Likelihood Ratios,” *Statistics in Medicine* 19, 649–663.

{% %}

Biggins, John D., R.M. Loynes, & A.N. Walker (1986) "Combining Examination Marks," *British Journal of Mathematical and Statistical Psychology* 39, 150–167. https://doi.org/10.1111/j.2044-8317.1986.tb00853.x

{% Use Dirichlet family for learning etc. Carnap's induction work may be relevant here. %}

Bikhchandani, Sushil & Sunil Sharma (1996) "Optimal Search with Learning," *Journal of Economic Dynamics and Control* 20, 333–359.

{% %}

Bikhchandani, Sushil, Uzi Segal, & Sunil Sharma (1992) "Stochastic Dominance under Bayesian Learning," *Journal of Economic Theory* 56, 352–377.

{% %}

Bilalic, Merim, Kieran Smallbone, Peter McLeod, & Fernand Gobet (2009) "Why Are (the Best) Women so Good at Chess? Participation Rates and Gender Differences in Intellectual Domains," *Proceedings of the Royal Society B* 276, 1161–1165.

{% Loss aversion may be due to more disutility under losses than utility under gains, but also due to more attention/weight being paid to losses, as has often been discussed. This paper presents several psychological experiments that more weight adds to loss aversion and that it is not just more disutility. It does not refer to the overweighting interpretation, but takes it as being perceived as more likely. This is one of the possible interpretations of overweighting. The experiments do not clearly show it is perception of more likely rather than more attention and overweighting for other reasons. %}

Bilgin, Baler (2012) "Losses Loom more Likely than Gains: Propensity to Imagine Losses Increases Their Subjective Probability," *Organizational Behavior and Human Decision Processes* 118, 203–215.

{% %}

Billingsley, Patrick (1968) "*Convergence of Probability Measures.*" Wiley, New York.

{% Pp. 31-32 seem to point out that events in a sigma-algebra cannot be obtained constructively through repeated set-operations. Theorem 3.1 seems to show that any countably additive probability measure on an algebra has a countably additive extension to the generated sigma-algebra. This becomes less surprising if one realizes that, in the presence of finite additivity, countable additivity only needs to be imposed for sets converging to the empty set. %}

Billingsley, Patrick (1995) "*Probability and Measure*; 3rd edn." Wiley, New York.

{% Argues that CEU (Choquet expected utility) had more impact than other things. %}

Billot, Antoine (1992) "From Fuzzy Set-Theory to Nonadditive Probabilities - How Have Economists Reacted," *Fuzzy Sets and Systems* 49, 75–90.

{% **CBDT** %}

Billot, Antoine, Itzhak Gilboa, & David Schmeidler (2008) "Axiomatization of an Exponential Similarity Function," *Mathematical Social Sciences* 55, 107–115.

{% Assume maxmin EU. Agents do not bet if and only if they share one common probability measure in their sets of priors. %}

Billot, Antoine, Alain Chateauneuf, Itzhak Gilboa, & Jean-Marc Tallon (2000) "Sharing Beliefs: Between Agreeing and Disagreeing," *Econometrica* 68, 685–694.

{% **CBDT**; **measure of similarity**

If beliefs given a union of two databases are a convex combination of beliefs given each database, then beliefs are similarity-weighted averages of beliefs induced by each past case. %}

Billot, Antoine, Itzhak Gilboa, Dov Samet, & David Schmeidler (2005) "Probabilities as Similarity-Weighted Frequencies," *Econometrica* 73, 1125–1136.

{% **common knowledge** %}

Binmore, Kenneth G. (1990) "*Essays on the Foundations of Game Theory.*" Basil Blackwell, Oxford.

{% %}
Binmore, Kenneth G. (1992) "Foundations of Game Theory." *In* Jean-Jacques Laffont (ed.) *Advances in Economic Theory* I, 1–31, Cambridge University Press, Cambridge.

{% Closed universe: all uncertainties completely specified (à la small world), says SEU is a closed universe. %}
Binmore, Kenneth G. (1993) "DeBayesing Game Theory." *In* Kenneth G. Binmore, Alan P. Kirman, & Piero Tani (eds.) *Frontiers of Game Theory*, MIT Press, Cambridge, MA.

{% P. 97/98 seem to write, in context of game theory, in consequentialistic spirit, that is, all relevant should have been incorporated into consequences. Pp. 108-109 seem to be even clearer on this point. If players do not maximize self-interest, then payoffs should not be interpreted in terms of self-interest.

Seems to discuss "memes," units of behavior, as a unit of evolution.

Seems to write that preferences are not actually observed but are what Ramsey (1931) called disposition: how you would choose if … And then the word hypothetical comes in for the experimental economist Binmore. P. 106 seems to write: "if [Jack] knew he had to choose between only … [x and y], then he actually would choose x" %}
Binmore, Kenneth G. (1994) "*Game Theory and the Social Contract, Vol. 1: Playing Fair*." MIT Press, Cambridge, MA.

{% Poses THE central question of experimental economics (p. F.16 & p. F23): "Would it not be better to leave laboratory experiments to psychologists who are trained to run them properly?" Answer is on p. F.23, that there is a lot to learn from psychologists but economists know better what are the central economic questions etc.

real incentives/hypothetical choice: Argues in favor of real incentives. For example, p. F17: "…asking them what they would do if $100 were hanging on the outcomes are therefore out."

Argues that subjects perform reasonably in accordance with economic principles if questions are not too complex, they get chance to learn, and incentives are "adequate."

Presents Kahneman & Tversky as destroying economic theory and his group as defending it. %}

Binmore, Kenneth G. (1999) "Why Experiments in Economics?," *Economic Journal* 109, F16–F24.

{% Much of the book could be used as a text on decision under uncertainty. The author criticizes the Bayesian approach for problems with **small worlds**. I disagree with the author on the interpretation that Savage would consider small worlds to be a reason to deviate from expected utility. Savage thinks that it is impossible to model the large world, but surely sees no reason in this for violating his axioms. A beautiful discussion is in §5 of Schervish, Seidenfeld, & Kadane (1990, JASA). %}

Binmore, Kenneth G. (2008) "*Rational Decisions*." Princeton University Press, Princeton, NJ.

{% In a careful design, measure matching probabilities (using bisection) for 3-color Ellsberg urn. If they go by just one choice then they find ambiguity aversion similarly as others do, but if they take stricter criteria, that only robust ambiguity aversion counts, then they find almost none. **ambiguity seeking**)

Paper controls for suspicion by generating ambiguity through 2nd order probabilities and showing subjects the mechanism. (This has the well-known problem that 2nd order probabilities may be taken and also be perceived as objective.)

Paper gives link to

http://aversion-to-ambiguity.behaviouralfinance.net/

which has many references on ambiguity aversion.

P. 229: the authors specify two hedging strategies in choices under ambiguity, but write that it is unlikely that subjects can do that. %}

Binmore, Ken, Lisa Stewart, & Alex Voorhoeve (2012) "How Much Ambiguity Aversion? Finding Indifferences between Ellsberg's Risky and Ambiguous Bets," *Journal of Risk and Uncertainty* 45, 215–238.

http://dx.doi.org/10.1007/s11166-012-9155-3

{% %}

Binmore, Ken, Joe Swiezbinski, Steven Hsu, & Chris Proulx (1993) "Focal Points and Bargaining," *International Journal of Game Theory* 22, 381–409.

{% **real incentives/hypothetical choice**: like Kachelmeier & Shehata (1993), he uses actual payments of considerable amounts of money;

decreasing ARA/increasing RRA: both are found.

Only choices between 50/50 lotteries.

I disagree with some suggestions in the literature that this paper be the first to use the choice list. It does present choices that involved bigger and bigger risks versus safety, and takes the point where subjects turn from risky choice to safe choice as index of risk aversion, but this is not really the same as using the choice list to measure indifferences. It is a nice way of: **questionnaire for measuring risk aversion**. %}

Binswanger, Hans P. (1981) "Attitudes towards Risk: Theoretical Implications of an Experiment in Rural India," *Economic Journal* 91, 867–890.

{% **cognitive ability related to risk/ambiguity aversion**: Subjects are asked, introspectively, for their probability of a stock going up next year, where they can give more or less sophisticated answers (§2). There is info about their cognitive level, with special questions to measure it, level of education, and some other things. There is also info about investments of the subjects. The authors find that for subjects with high cognitive skills their investment decision is more driven by their probability estimate. This fits well with the interpretation of likelihood insensitivity, which is related with low cognitive skill and also with decisions being less affected by likelihood information. Low cognitive skills also go together with more inconsistencies in answers.

A difficulty for me in reading the paper is that it is entirely based on the concept of but true existing but unknown objective probability, automatically connected with the multiple prior idea. As a Bayesian I firmly believe in the existence of a "best" subjective probability for an agent, but the concept of a true existing objective probability, which only happens not to be known, has little meaning to me. Thus, the claim on p. 84 penultimate para, that most experts assume one true known probability measure for stocks, is weird to me.

P 84 writes: "Our preferred interpretation is that individuals with lower cognitive skills view stock returns in more fuzzy and ambiguous terms," which I like, although I less connect with the continuation "potentially characterized by multiple priors."

P. 74 4th para cites Gilboa et al. (2008) on nonneutral ambiguity attitudes being rational, and then proceeds to conjecture that subjects of lower cognitive level, who are found to deviate more from ambiguity neutrality, accordingly may be more rational in their handling of ambiguity. Could I as a Bayesian disagree more? P. 84 repeats the point, first using the qualification "particularly rational" for people deviating from ambiguity neutrality, but then fortunately going the other way: "Notwithstanding the merit of this view, there are also plausible arguments why individuals with high cognitive skills can be expected to view stock returns as less ambiguous than individuals with lower cognitive skills."

The authors are enthusiastic about their research and write, on p. 84: "In this study, we bridge the literature on subjective probabilities and the literature on the role of cognitive skills in economic decision making." %}

Binswanger, Johannes & Martin Salm (2017) "Does Everyone Use Probabilities? The Role of Cognitive Skills," *European Economic Review* 98, 73–85.

{% %}

Bird, Ronald & Michael McCrae (1984) "Gambling Markets: A Survey of Empirical Evidence." *In* Geoffrey Caldwell, Bryan Haig, Mark Dickerson, & Louise Sylvan (eds.) *Gambling in Australia*, 114–122, Croom Hlem, Sydney.

{% **Dutch book; ordered vector space;** Possible tools for Dutch book: The Lemma of Farkas, possibly some lemma of Ky Fan for solving an infinite number of inequalities. Further related mathematics may be the Lemma of Hölder, the theory of ordered vector spaces.

Theorem 13, p. 266, seems to show that no countably additive atomless measure can be defined on the sigma-algebra of all subsets, the result first demonstrated by Banach & Kuratowski (1929) and Ulam (1930). %}

Birkhoff, George D. (1967) "*Lattice Theory*." American Mathematical Society Colloquium Publications, vol. 35. Providence, RI.

{% **foundations of statistics**: a later paper is Gandenberger (2015). %}

Birnbaum, Alan (1962) "On the Foundations of Statistical Inference," (with discussions) *Journal of the American Statistical Association* 57, 269–326. https://doi.org/10.1080/01621459.1962.10480660

{% Already some ideas of configural weighting theory %}
Birnbaum, Michael H. (1972) "Morality Judgments: Tests of an Averaging Model," *Journal of Experimental Psychology* 93, 35–42.

{% Introduced configural weighting theory? %}
Birnbaum, Michael H. (1973) "Morality Judgment: Test of an Averaging Model with Differential Weights," *Journal of Experimental Psychology* 99, 395–399.

{% Introduces configural weighting theory; contains several verbal expressions of dependence of decision weights on ranking, but writes it only for two dimensions, and does not present the RDU model or something close. Domain: likeability of a person depending on (intensities of) adjectives.

P. 559, footnote 4: "The configural-weight averaging model assumes that the weight of a stimulus depends upon its rank within the set to be judged"

Experiment 3 is example of scale convergence (although term may have been different) %}
Birnbaum, Michael H. (1974) "The Nonadditivity of Personality Impressions," *Journal of Experimental Psychology* 102, 543–561.

{% %}
Birnbaum, Michael H. (1974) "Using Contextual Effects to Derive Psychophysical Scales," *Perception & Psychophysics* 15, 89–96.

{% Clear discussion of scale convergence (in difference/ratio case) %}
Birnbaum, Michael H. (1978) "Differences and Ratios in Psychological Measurement." *In* John Castellan & Frank Restle (eds.) *Cognitive Theory* 3, 33–74, Erlbaum, Hillsdale NJ.

{% Discussion of scale convergence in §F. %}

Birnbaum, Michael H. (1982) "Controversies in Psychological Measurement." *In* Bernd Wegener (ed.) *Social Attitudes & Psychological Measurement*, Erlbaum, Hillsdale NJ.

{% %}
Birnbaum, Michael H. (1992) "Violations of Monotonicity and Contextual Effects in Choice-Based Certainty Equivalents," *Psychological Science* 3, 310–314.

{% Survey. Uses the nice term nonconfigural for probability weighting of separate-outcome probabilities (separable prospect theory). %}
Birnbaum, Michael H. (1992) "Issues in Utility Measurement," *Organizational Behavior and Human Decision Processes* 52, 319–330.

{% Link to paper
Poulton's (1989) book, reviewed here, comprises a nice survey of biases in subjective quantitative estimations. Birnbaum disagrees with the implicit assumption of the book that every way to have context influence subjects' answers is a bias. It can also be good and lead to more unbiased answers than absence of contexts, where subjects may have no clue. It criticizes Poulton's preference for between-subject designs, where the later Birnbaum, Michael H. (1999) "How to Show That 9 > 221 …" beautifully shows it.

P. 21 top of 2nd column first defines the assumption that context means bias, next to be criticized.

P. 22 top of 1st column: Ch. 7 of Poulton is on contraction biases, which are like regression to the mean. In many places, e.g. p. 22 2nd column, Birnbaum pleas for not avoiding biases, but studying them and then correcting them.

P. 22 last column penultimate para: systextual design: manipulate context and study its effects.

P. 23 1st column 2nd para: Contextual effects and biases can concern subjective values, responses, or both. That is, it can be just measurement error, or genuine error. This point is often discussed in the context of the endowment effect. %}
Birnbaum, Michael H. (1992) "Should Contextual Effects in Human Judgment Be Avoided?," Book Review of: E. Christopher Poulton (1989) "Bias in Quantifying Judgments," Erlbaum, Hillsdale NJ; *Contemporary Psychology* 37, 21–23.

Around 2010 the journal seems to be called *PsychCritiques*.

{% Survey on research by Michael on, well, see title. Seems to show that violations of stochastic dominance can be found in experiments only if the dominance relation is not transparent. Gives a general recipe for producing the kinds of violations of stochastic dominance first demonstrated by Tversky & Kahneman (1986). %}

Birnbaum, Michael H. (1997) "Violations of Monotonicity in Judgment and Decision Making." *In* Anthony A.J. Marley (ed.) (1997) *Choice, Decision, and Measurement: Essays in Honor of R. Duncan Luce*, 73–100, Lawrence Erlbaum Associates, Mahwah, NJ.

{% %}

Birnbaum, Michael H. (1998, ed.) "*Measurement, Judgment, and Decision Making.*" Academic Press, San Diego.

{% Real incentives: **random incentive system**.

PT falsified: Tables 5 and 6 give some violations of the s.th.pr. Here, after change of the common outcome, also one other outcome of one gamble is increased, whence preference reversals in one direction do not really violate the s.th.pr., but reversals in other direction do so strongly. The stimuli were so constructed that in each case most reversals were in the direction that entails strong violation of s.th.pr. In each case, all gambles could be considered comonotonic and it was also a violation of the comonotonic s.th.pr. The violations could simply be inconsistency were it not that the violations in one direction are significantly more frequent than in the other direction. So, violation of PT. Not violation of **inverse S.** %}

Birnbaum, Michael H. (1999) "Testing Critical Properties of Decision Making of the Internet," *Psychological Science* 10, 399–407.

{% %}

Birnbaum, Michael H. (1999) "How to Show That 9 > 221: Collect Judgments in a between-Subjects Design," *Psychological Methods* 4, 243–249.
https://doi.org/10.1037/1082-989X.4.3.243

{% %}

Birnbaum, Michael H. (1999) “The Paradoxes of Allais, Stochastic Dominance, and Decision Weights.” *In* James C. Shanteau, Barbara A. Mellers, & David A. Schum (eds.) *Decision Science and Technology: Reflections on the Contributions of Ward Edwards*, 27–52, Kluwer, Dordrecht.

{% %}

Birnbaum, Michael H. (2000) “Decision Making in the Lab and on the Web.” *In* Michael H. Birnbaum (ed.) *Psychological Experiments on the Internet*, 3–34, Academic Press, San Diego, CA.

{% %}

Birnbaum, Michael H. (ed.). (2000) “*Psychological Experiments on the Internet.*” Academic Press, San Diego.

{% %}

Birnbaum, Michael H. (2000) “SurveyWiz and FactorWiz: JavaScript Web Pages That Make HTML Forms for Research on the Internet,” *Behavior Research Methods, Instruments, and Computers* 32, 339–346.

{% **coalescing**: as much evidence for complexity aversion (if splitting the lowest outcome) as for complexity seeking.

Real incentives: **random incentive system**;

An interesting decomposition of some things going on in the Allais paradox.

Finds violations of the s.th.pr. as in Birnbaum & McIntosh (1996), falsifying the **inverse S** prob weighting of PT. (**PT falsified**)

P. 98 3rd para explains that splitting the best outcome improves, but splitting the worst worsens. Increasing weights nonnormalized, as in separable OPT, means that splitting gains always improves. Increasing weights normalized means that splitting lowest outcome worsens, also if gain. This is Birnbaum’s model.

That salience of common outcome enhances s.th.pr om p. 94: “Event framing would be expected to reduce violations of branch independence in the split forms. Such choices might be termed “transparent” tests of branch independence in the framed form, because both gambles would clearly share a common event–consequence branch. In such a framed format, a decision-maker should find it easy to cancel branches that are identical in two choices and to make a choice based strictly on what is left." %}

Birnbaum, Michael H. (2004) "Causes of Allais Common Consequence Paradoxes: An Experimental Dissection," *Journal of Mathematical Psychology* 48, 87–106. https://doi.org/10.1016/j.jmp.2004.01.001

{% In Birnbaum's models, splitting the branch with the lowest consequence can make a gamble worse, and splitting the branch with the highest consequence can make a gamble better. The paper investigates coalescing to generate violations of sotochastic dominance, and then it is not clear if complexity aversion or seeking is involved. %}

Birnbaum, Michael H. (2004) "Tests of Rank-Dependent Utility and Cumulative Prospect Theory in Gambles Represented by Natural Frequencies: Effects of Format, Event Framing, and Branch Splitting," *Organizational Behavior and Human Decision Processes* 95, 40–65.

{% Clear definition of RAM and TAX models. Some paradoxes to distinguish between RAM and TAX.. Choices 9&15 in Table 4, p. 1356, give clear complexity seeeking/event splitting (with transitivity). Choice 7 also involves event splitting but in the context of stochastic dominance violation, where it is not clear if there is complexity aversion of seeking. (**coalescing**) **biseparable utility** %}

Birnbaum, Michael H. (2005) "Three New Tests of Independence That Differentiate Models of Risky Decision Making," *Management Science* 51, 1346–1358. https://doi.org/10.1287/mnsc.1050.0404

{% %}

Birnbaum, Michael H. (2006) "Evidence against Prospect Theories in Gambles with Positive, Negative, and Mixed Consequences," *Journal of Economic Psychology* 27, 737–761.

{% **coalescing**

P. 171: "Instead, splitting a branch appears to give that branch greater weight."

P. 171: "Fourth, there is strong evidence that splitting the branch with the higher valued

consequence improves a gamble. Fifth, there is statistically significant, but far less dramatic, evidence that splitting the branch with the lower-valued consequence can make a gamble worse."
%}

Birnbaum, Michael H. (2007) "Tests of Branch Splitting and Branch-Splitting Independence in Allais Paradoxes with Positive and Mixed Consequences," *Organizational Behavior and Human Decision Processes* 102, 154–173. https://doi.org/10.1016/j.obhdp.2006.04.004

{% %}

Birnbaum, Michael H. (2008) "Evaluation of the Priority Heuristic as a Descriptive Model of Risky Decision Making: Comment on Brandstätter, Gigerenzer, and Hertwig (2006)," *Psychological Review* 115, 253–260.

{% %}

Birnbaum, Michael H. (2008) "Postscript: Rejoinder to Brandstätter et al. (2008)," *Psychological Review* 115, 260–262.

{% A wonderful and useful review of all the findings of Birnbaum on risky choice accumulated over many years.

The author has a deep desire to write negative about prospect theory. Two of the many examples:

(1) P. 468, top, that different versions of prospect theory have differences in descriptions for some choices (how else could they be different), is formulated as: "so it is best to consider "prospect theory" as a large family of different, *contradictory* theories." [italics added here]

(2) p. 466 2nd column 4th para, on the often useful convention of using the same term for a theoretical property and also for its empirical implication, where the latter however assumes some underlying theory (such as equating concave utility with risk aversion where this only works under EU theory) which also happens in prospect theory for loss aversion. The author is unreasonably negative about it ("circular terminology"), even though the point that this can raise confusion is in itself correct.

(3) The author uses terms such as "self-contradiction" for claimed violations of prospect theory.

Most experiments have, apparently, been done without real incentives.

Many violations of prospect theory put forward are only violations of prospect theory of the exact parametric form put forward by Tversky & Kahneman (1992). Of course, that exact parametric form will not predict all choices 100% perfectly well, and finding single choices deviating (such as certainty equivalents not being 100% identical) is by itself trivial.

P. 466, as well as several other parts, claim that configural weighting theory can give an alternative explanation for loss aversion but this is not so. It is simply that configural weighting theory has its way of accommodating risk aversion in general, and simply uses that to accommodate loss aversion. It, then, does not treat risk aversion with mixed prospects in any way different than risk aversion with gains. The definition of loss aversion that the author gives, that it is risk aversion for mixed prospects, is horribly wrong. It is like EU saying that loss aversion is nothing but a special case of risk aversion and that nothing needs to be added to concave utility.

P. 467: I disagree with the interpretation

P. 467: note that stochastic dominance as defined implies coalescing.

P. 467 (also p. 490) suggests that his work on difference between buying-selling = endowment effect. This is not so. Buying-selling has more to do with reflection effect. Endowment effect concerns different framings WITH SAME FINAL WEALTH.

P. 469, 2nd para of 2nd column, mentions scale convergence ("the assumption that two ways to measure utility for the same person in the same context should be the same")

P. 469 bottom of 2nd column: **linear utility for small stakes**

P. 470: prior RAM is RAM of Eq. 7 with $a(i,n,s_i) = i$, $t(p) = p^\gamma$ with $0 < \gamma < 1$ (so, overweighting) and $u(x) = x^\beta$ with $0 < \beta < 1$.

P. 468/470: The prior TAX model and the special RAM model use rank dependence only to transfer weights from high to low outcomes, enhancing risk aversion. Risk seeking as with **inverse S**, what they do for binary prospects, comes from the concave probability weighting.

P. 477 writes, properly: "A descriptive model should be able to predict when stochastic dominance will or will not be violated." Many authors justify a model violating stochastic dominance by the mere existence of violations of stochastic dominance, but that is no good, and there should be concrete predictive power. Similar with transitivity and any other condition.

P. 477: "Birnbaum (2005a) tested the counting heuristic, in which people choose the gamble with the greater number of branches with higher consequences."

P. 478: Gigerenzer's priority heuristic fails.

P. 480 4th para points out that the probability triangle is too small to distinguish several theories. Contrary to the claim in the second para of 2nd column of p. 481, Wakker (2001) does not suffer from this problem. Instead, Wakker, Erev, & Weber (1994) pointed out this point before.

P. 481, 2nd column, 2nd para, nicely explains that the probability triangle is not well suited to test rank dependence, using simulations.

P. 481, 2nd column, 2nd para, incorrectly cites my Wakker (2001) paper as studying the classical paradoxes "trapped inside the [probability] triangle." My paper extensively discusses tests of the comonotonic sure-thing principle that typically involve 4 or more distinct outcomes and it is in no way trapped inside the triangle. Wakker, Erev, & Weber (1994, p. 196 penultimate para: p. 222) signaled the problem: "In addition, most tests have almost exclusively studied the **probability triangle**, which is not a suited domain for testing RDU for the following two reasons. ... Second, the probability triangle considers no more than three fixed outcomes, whereas any test of comonotonic independence requires four or more distinct outcomes."

P. 481 ff. discusses a decomposition of the Allais paradox into RBI and **coalescing**. The author uses this decomposition to dismiss the empirical evidence against the sure-thing principle, saying it is coalescing and not RBI (the other part of the s.th.pr.) that is violated. In this, he implicitly assumes that RBI is "true" s.th.pr. without coalescing, so that the nonreduced choices give a true test of the s.th.pr. This is not well justified. In the noncollapsed presentation subjects may cancel common outcomes, not because it is their true preference, but as an easy heuristic just to simplify their choice. Then Birnbaum's test of RBI gives no insight into true s.th.pr. The author's implicit assumption is explicit on p. 467 1st column ℓ. –3 where he, without justification, equates RBI with comonotonic independence.

inverse S: Pp. 484-486 present the evidence against inverse S initiated by Birnbaum & McIntosh (1996) where in three-outcome-prospect choices with one common outcome increasing the common outcome does not increase risk aversion as PT would predict, but decreases it in the spirit somewhat of risk aversion decreasing with increasing wealth.

P. 493, 2nd column, 1st para suggests finding opposite of Allais if noncollapsed presentation.

P. 493, 2nd column, 3rd para argues that evidence favoring inverse S is confounded by framing effects. However, the author only cites his, in itself valid, counterevidence against one particular implication of inverse S and not much other evidence favoring it.

Much of the counterevidence of Birnbaum (p. 475, p. 479, p. 483) can be explained through the following heuristic, which also underlies much of Wu & Markle (2008). It is a special case of Birnbaum's counting heuristic (on his p. 477; see above), but a strong special case. It underlies the famous violation of stochastic dominance first found by Tversky & Kahneman (1986). Imagine two prospects with 3 outcomes each. The first prospect has its best outcome better than the second prospect, also has its second-best outcome better, and also has its third-best outcome better. Then subjects often immediately decide that the first prospect must be superior by some supposed stochastic dominance, as a heuristic. It is not correct because the probabilities should be considered, with the first prospect maybe assigning much probability to its lowest outcome, and the second prospect to its highest. It is a heuristic where people simply don't even look at the probabilities. The countertest of this heuristic on p. 477 is too coarse.

P. 493: the author himself prefers TAX to RAM.

P. 497, 2nd para of 1st column, **paternalism/Humean-view-of-preference**: Discusses measurements of sizes, which is context-dependent according to range-frequency theory. If we reckon with range-frequency theory and correct for it, we can get back a context-free psychophysical function. Refers to Roe et al. (2001) for a similar approach. So, here Birnbaum exhibits the economists' way of thinking! Similarly, I would like to see coalescing as a bias to be corrected for so as to get the underlying true preference. %}

Birnbaum, Michael H. (2008) "New Paradoxes of Risky Decision Making," *Psychological Review* 115, 463–501.
https://doi.org/10.1037/0033-295X.115.2.463

{% Proposes another error model where within an agent there are different blocks within which there is a same preference but between which it can change. %}

Birnbaum, Michael H. (2011) "Testing Mixture Models of Transitive Preference: Comment on Regenwetter, Dana, and Davis-Stober (2011)," *Psychological Review* 118, 675–683.

{% Data of an experiment conform more with configural weighting than with "3rd generation prospect theory," to use the unfortunate term that its inventors gave to this theory. %}

Birnbaum, Michael H. (2018) "Empirical Evaluation of Third-Generation Prospect Theory," *Theory and Decision* 84, 11–27.

{% %}

Birnbaum, Michael H. (2018) "Behavioral Models of Decision Making under Risk." *In* Martina Raue, Eva Lermer, & Bernhard Streicher (eds.) *Psychological Perspectives on Risk and Risk Analysis: Theory, Models and Applications*, 181–200, Springer, Berlin.

{% The tests of plitting always involve multiple splits, or losses, and do not speak to complexity aversion or seeking. %}

Birnbaum, Michael H., & Jeffrey P. Bahra (2007) "Gain-Loss Separability and Coalescing in Risky Decision Making," *Management Science* 53, 1016–1028.

{% Branch independence is the sure-thing principle for events for which probability is also given.

PT falsified: evidence against **inverse S:** finds violations of the s.th.pr. like Birnbaum & McIntosh (1996), falsifying the inverse S prob weighting of PT;

real incentives: all choices were hypothetical

SEU = SEU: five lines below (1), and in the citation of Edwards in first paragraph of second column of p. 87;

biseparable utility %}

Birnbaum, Michael H. & Darin Beeghley (1997) "Violations of Branch Independence in Judgments of the Value of Gambles," *Psychological Science* 8, 87–94.

{% **PT falsified**: evidence against **inverse S**

real incentives: all choices were hypothetical

Finds violations of the s.th.pr. like Birnbaum & McIntosh (1996), falsifying the inverse S prob weighting of PT, also for four-outcome gambles distribution-independence is something of that kind, shifting probability mass from one common outcome to the other. Humphrey & Verschoor (2004) independently found the same. %}

Birnbaum, Michael H. & Alfredo Chavez (1997) "Tests of Theories of Decision Making: Violations of Branch Independence and Distribution Independence," *Organizational Behavior and Human Decision Processes* 71, 161–194. https://doi.org/10.1006/obhd.1997.2721

{% **inverse S:** Find that (Fig. 11, p. 341). As explained by Birnbaum's email, this is the first paper to discover the violations of monotonicity generated by the zero-outcome effect. For example, (.95, $96; .05, $24) receives lower CE (certainty equivalent) than (.95, $96; .05, $0) (p. 339 2nd column 2nd paragraph.). What is going on here is that when considering the CE for (.95, $96; .05, $0), people say "Ah a 0 outcome is nothing and I need not think about it." Then they ignore it too much, are only thinking about 96 which is a high number, and they come out with a high CE number. In (.95, $96; .05, $24) there is a 24 outcome and people will not ignore it but will think about it, give it weight. A similar dual phenomenon is mentioned by Goldstein & Einhorn (1987), who ascribe the idea to Slovic (1984, personal communication).

P. 333 Fig. 2 bottom panel shows how utility, derived under the classical elicitation assumption (so, analyzed under the descriptive assumption of EU), can deviate from the true utility if configural weighting theory is the real model, which for these two-outcome fifty-fifty gambles depends only on the parameter w, where the decision weight of the best outcome is .5 + w.

risky utility u = strength of preference v (or other riskless cardinal utility, often called value): P. 334, 1st column, 2nd paragraph, on configural weight theory: "In this theory, u(x) represents a psychophysical function that characterizes the subjective value of money, apart from risk."

P. 334 discusses buyer's, neutral, and seller's point of view nicely, that income effects depending on whether or not people received prior endowment of lottery/sure amount to be given up is not strong enough to explain empirical differences found, referring to Knetsch & Sinden (1984) for it.

P. 325 clearly explains the idea of asymmetric loss functions to explain the disparity between buyer's and seller's point of view. As far as I can see, this idea is completely plausible from a psychological point of view but I see no revealed-preference interpretation for this loss function. Therefore, if I understand right, the asymmetric loss function is typically useful for psychologists but less so for economists. %}

Birnbaum, Michael H., Gregory Coffey, Barbara A. Mellers, & Robin Weiss (1992) "Utility Measurement: Configural-Weight Theory and the Judge's Point of View," *Journal of Experimental Psychology: Human Perception and Performance* 18, 331–346.

{% %}

Birnbaum, Michael H. & Roman J. Gutierrez (2007) "Testing for Intransitivity of Preferences Predicted by a Lexicographic Semi-order," *Organizational Behavior and Human Decision Processes* 104, 96–112.

{% %}

Birnbaum, Michael H. & Jr-Wen Jou (1990) "A Theory of Comparative Response Times and "Difference" Judgments," *Cognitive Psychology* 22, 184–210.

{% Test a noncompensatory heuristic, the priority heuristic by Gigerenzer et al., versus compensatory approaches, and find the latter prevailing. %}

Birnbaum, Michael H. & Adam R. LaCroix (2008) "Dimension Integration: Testing Models without Trade-offs," *Organizational Behavior and Human Decision Processes* 105, 122–133.

{% **PT falsified**: evidence against **inverse S**

Real incentives: it was all hypothetical choice;

Considers choices (R_1, R_2, C) versus (S_1, S_2, C), $R_1 > S_1 > S_2 > R_2$. PT with inverse S predicts that there will be fewer risky choices as C increases. (If C increases from worst ($< R_2$) to intermediate (between S_1 and S_2) then inverse S would have the decision weight of S_2 and R_2 increase, enhancing safe choice. If C increases from intermediate to highest (> R_1) then inverse S would have the decision weight of S_1 and R_1 *decrease*, which *again* enhances risk aversion.) However, it is found that there are more risky choices (in agreement, in fact, with Machina's fanning out). As the lotteries get better because of C increasing, people get more risk seeking rather than risk averse. See Table 1 where the percentage of safe choices decreases rather than increases as we move to the right. So, the extreme outcomes seem to be underweighted rather than overweighted.

The paper gives an extensive theoretical analysis. The most extensive tests are in Birnbaum & Navarrete (1998) (the main topic of which, by the way, is another one), which also describes the other preceding evidence. In particular, the B&M paper considers only three equally likely outcomes, B&N considers richer probability triples.

P. 91 gives refs to people who argue that independence-tests are mixed up with other assumptions. %}

Birnbaum, Michael H. & William R. McIntosh (1996) "Violations of Branch Independence in Choices between Gambles," *Organizational Behavior and Human Decision Processes* 67, 91–110. https://doi.org/10.1006/obhd.1996.0067

{% %}

Birnbaum, Michael H. & Barbara A. Mellers (1983) "Bayesian Inference: Combining Base Rates with Opinions of Sources Who Vary in Credibility," *Journal of Personality and Social Psychology* 45, 792–804.

{% **PT: data on probability weighting**; **coalescing**;

PT falsified: evidence against **inverse S**

Real incentives: it was all hypothetical choice;

evidence against inverse S probability weighting, especially Table 4, see the comments in Birnbaum & McIntosh (1996).

coalescing: a systematic method for studying event splitting and the violations of stochastic dominance, the effect nicely illustrated by Tversky & Kahneman (1986, p. 178, problem 7). %}

Birnbaum, Michael H. & Juan B. Navarrete (1998) “Testing Descriptive Utility Theories: Violations of Stochastic Dominance and Cumulative Independence,” *Journal of Risk and Uncertainty* 17, 49–78.

{% **biseparable utility**: does RDU for 50-50 lotteries;
Domain: judges give subjective assessment of average length of group of lines, or of average loudness of group of tones, etc. %}

Birnbaum, Michael H., Allen Parducci, & Robert K. Gifford (1971) “Contextual Effects in Information Integration,” *Journal of Experimental Psychology* 88, 158–170.

{% %}

Birnbaum, Michael H., Jamie N. Patton, & Melissa K. Lott (1999) “Evidence against Rank-Dependent Utility Theories: Violations of Cumulative Independence, Interval Independence, Stochastic Dominance, and Transitivity,” *Organizational Behavior and Human Decision Processes* 77, 44–83.

{% Find that violations of transitivity are mostly due to noise in choice and are not systematic. %}

Birnbaum, Michael H. & Ulrich Schmidt (2008) “An Experimental Investigation of Violations of Transitivity in Choice under Uncertainty,” *Journal of Risk and Uncertainty* 37, 77–91.

{% Tested transitivity and found that violations are mostly due to noise. %}

Birnbaum, Michael & Ulrich Schmidt (2010) “Testing Transitivity in Choice under Risk,” *Theory and Decision* 69, 599–614.

{% %}

Birnbaum, Michael & Ulrich Schmidt (2015) “The Impact of Learning by Thought on Violations of Independence and Coalescing,” *Decision Analysis* 12, 144–152. https://doi.org/10.1287/deca.2015.0316

{% Test violations of independence as in common ratio and common consequence, but use a sophisticated error theory to disinguish real violations from errors-for

one, they allow unequal error rates for different questions. Find that real violations remain. Also find violations of branch independence. P. 81 raises the very relevant question which layout then is best to test for real violations, but says that even the layout favoring independence most leaves violations. Violations of coalescing (**coalescing**) reduce under learning. %}

Birnbaum, Michael H., Ulrich Schmidt, & Miriam D. Schneider (2017) “Testing Independence Conditions in the Presence of Errors and Splitting Effects,” *Journal of Risk and Uncertainty* 54, 61–85. https://doi.org/10.1007/s11166-017-9251-5

{% Domain: subjects receive experts opinions on aspects of car and aggregate those into one overall evaluation of the car.

Rank-dependence formulated in several places (where the “range-model” is a special case of the configural-weight model):

P. 61: “The range model assumes that the effective relative weight of a stimulus depends on the rank of its scale value in the set of stimuli to be combined.”

P. 70: “Perhaps the buyer’s and seller’s price estimations reflect persuasive judgments, meant as the opening round for bargaining.”

Seems that they already put forward the asymmetric loss function hypothesis. %}

Birnbaum, Michael H. & Steven E. Stegner (1979) “Source Credibility in Social Judgment: Bias, Expertise, and the Judge’s Point of View,” *Journal of Personality and Social Psychology* 37, 48–74.

{% **EU+a*sup+b*inf**: Eq. 3 gives special case of configural-weight model where only highest or lowest outcome is weighted differently; domain is where subjects have to predict IQ of a child as aggregation of IQs of parents plus other variables such as socio-economic. %}

Birnbaum, Michael H. & Steven E. Stegner (1981) “Measuring the Importance of Cues in Judgment for Individuals: Subjective Theories of IQ as a Function of Heredity and Environment,” *Journal of Experimental Social Psychology* 17, 159–182.

{% **risky utility u = strength of preference v (or other riskless cardinal utility, often called value)** & **utility measurement**: **correct for probability distortion**: p. 184, second-to-last paragraph expresses views of utility that I agree with, and that underly much of my work on utility: "The principle of scale convergence states that when considering rival theories proposed to describe different empirical phenomena involving the same theoretical constructs, preference should be given to coherent theoretical systems (in which the same measurement scales can be used to account for a variety of empirical phenomena) as opposed to theoretical systems that require different measurements for each new situation. … Configural weighting theory has the hope of resolving the inconsistent scales for utility and value measurement by separating the scaling of stimuli from the scaling of uncertainty and risk."

I cite this paragraph in Wakker (1994, Theory and Decision, p. 5). Exactly the same paragraph is cited by Ganzach (1994, Journal of Applied Psychology 79, p. 445). Ganzach and I discovered this funny coincidence in December 1998 when I visited Tel Aviv.

ratio-difference principle: seems that they discuss this.

decreasing ARA/increasing RRA: p. 209/211 discuss several arguments in favor, and some in disfavor, of power functions for utility of money. %}

Birnbaum, Michael H. & Sara E. Sutton (1992) "Scale Convergence and Utility Measurement," *Organizational Behavior and Human Decision Processes* 52, 183–215.

{% Certainty equivalents, inferred indirectly through choices, still show the famous violations of monotonicity. %}

Birnbaum, Michael H. & Laura A. Thompson (1996) "Violations of Monotonicity in Choices between Gambles and Certain Cash," *American Journal of Psychology* 109, 501–523.

{% Strength of prefs is over lotteries, not over outcomes. %}

Birnbaum, Michael H., Laura A. Thompson, & David J. Bean (1997) "Testing Interval Independence versus Configural Weighting Using Judgments of Strength of Preference," *Journal of Experimental Psychology: Human Perception and Performance* 23, 939–947.

{% %}

Birnbaum, Michael H., Richard Veira (1998) "Configural Weighting in Judgments of Two- and Four-Outcome Gambles," *Journal of Experimental Psychology: Human Perception and Performance* 24, 216–226.

{% %}

Birnbaum, Michael H. & Clairice T. Veit (1974) "Scale Convergence as a Criterion for Rescaling: Information Integration with Difference, Ratio, and Average Tasks," *Perception & Psychophysics* 15, 7–15.

{% %}

Birnbaum, Michael H., Sherry Yeary, R. Duncan Luce, & Li Zhao (2016) "Empirical Evaluation of Four Models of Buying and Selling Prices of Gambles," *Journal of Mathematical Psychology* 75, 183–193.

{% %}

Birnbaum, Michael H., Rebecca Wong, & Leighton K. Wong (1976) "Combining Information from Sources That Vary in Credibility," *Memory & Cognition* 4, 330–336.

{% %}

Birnbaum, Michael H., & Jacqueline M. Zimmermann (1998) "Buying and Selling Prices of Investments: Configural Weight Model of Interactions Predicts Violations of Joint Independence," *Organizational Behavior and Human Decision Processes* 74, 145–187.

{% **maths for econ students.** Good introduction maths for psychology-students %}

Bishir, John W. & Donald W. Drewes (1970) "*Mathematics in the Behavioral and Social Sciences.*" Hartcourt, Brace & World, New York.

{% Seems to have introduced phenomenon of probability matching: not doing the rational thing of always choosing highest probability of winning, but instead randomizing and choosing the highest probability of winning only with that same probability rather than with certainty. %}

Bitterman, Morton E. (1965) "Phyletic Differences in Learning," *American Psychologist* 20, 396–410.

{% Ch. 3 is on arbitrage. %}
Björk, Thomas (2009) "*Arbitrage Theory in Continuous Time*; 3rd edn." Oxford University Press, New York.

{% %}
Börjesson, Maria, Eliasson, Jonas (2011) "On the Use of "Average Delay" as a Measure of Train Reliability," *Transportation Research Part A: Policy and Practice* 45, 171–184.

{% The risk-neutral probabilities of finance may in some sense be considered probability transformations; have to check it. %}
Black, Fischer & Myron Scholes (1973) "The Pricing of Options and Corporate Liabilities," *Journal of Political Economy* 81, 637–654.

{% Show that all risk seeking individuals can aggregate into risk aversion of the group, and vice versa. %}
Blackburn, Douglas W. & Andrey D. Ukhov (2013) "Individual vs. Aggregate Preferences: The Case of a Small Fish in a Big Pond," *Management Science* 59, 470–484.
http://dx.doi.org/10.1287/mnsc.1120.1608

{% **paternalism/Humean-view-of-preference**: In the lab, use hypothetical and real-incentive WTP questions. In this way they estimate the discrepancy, interpreted as bias in the hypothetical questions (i.e., the difference in probability of acceptance). Hypothetical WTP is considerably larger. Then they apply this correction procedure to hypothetica field data.

P. 1084: "The hypothetical responses can still be informative as to the real responses if the bias between the two is systematic and predictable." They say such a correction-of-bias-estimation was first proposed by Kurz (1974), and also explicit in the National Oceanic and Atmospheric Administration (1994). That they are the first to actually test the ida for private goods. My reading of Kurz (1974) is different. He

does not propose a correction mechanism. He only proposes to take a representative sample into the lab, and from them get unbiased estimates.

P. 1088: "First, we find that bias functions do have some statistical ability to describe the effect of observable socioeconomic characteristics on the extent to which subjects misrepresent their preferences in hypothetical DC [dichotomous choice] surveys." %}

Blackburn, McKinley, Glenn W. Harrison, & E. Elisabet Rutström (1994) "Statistical Bias Functions and Informative Hypothetical Surveys," *American Journal of Agricultural Economics* 76, 1084–1088.

{% **conservation of influence; free will/determinism**; This author has worked much on these topics, arguing that there is only experience and not decision or consciousness, and considering it a mystery what experience is. She also worked much on memes. %}

Blackmore, Susan J. (2002) "There is no Stream of Consciousness," *Journal of Consciousness Studies* 9, 17–28.

{% %}

Blackorby, Charles, Walter Bossert, & David Donaldson (1993) "Multi-Valued Demand and Rational Choice in the Two-Commodity Case," *Economics Letters* 47, 5–10.

{% Axiomatizations in bargaining games, similar to RDU; refers to Weymark. %}

Blackorby, Charles, Walter Bossert, & David Donaldson (1994) "Generalized Ginis and Cooperative Bargaining Solutions," *Econometrica* 62, 1161–1178.

{% Social evaluation of populations over different generations %}

Blackorby, Charles, Walter Bossert, & David Donaldson (1996) "Leximin Population Ethics," *Mathematical Social Sciences* 31, 115–131.

{% %}

Blackorby, Charles, Walter Bossert, & David Donaldson (1999) "Information Invariance in Variable-Population Social-Choice Problems," *International Economic Review* 40, 403–422.

{% %}

Blackorby, Charles, Walter Bossert, & David Donaldson (2001) "Population Ethics and the Existence of Value Functions," *Journal of Public Economics* 82, 301–308.

{% This book is, mostly, a book on preference axiomatizations for aggregations. That is, it considers a preference relation on Re^n and properties of it that are necessary and sufficient for particular quantitative representations. It considers both n fixed and n variable (the latter called variable population). It interprets the results for welfare evaluations. It virtually always assumes symmetry/anonymity, so, permutation invariance of preference. In most theorems the real numbers, inputs of preferences, are assumed to be individual utilities that have been measured in some way, reminiscent of the Anscombe-Aumann framework. Because of this, it considers many representations that are linear in these inputs, as in expected value. The term generalized, as in generalized utilitarianism, indicates that the input numbers are transformed nonlinearly, as in expected utility. The models in this book are mostly special cases of generalized utilitarianism for same-number and extensions to variable population sizes, with Gini-type generalizations. (§5.7 will open with: "Most of the principles considered in this book are variable-population extensions of generalized utilitarianism.")

Chs. 2 & 3 give didactical elementary results. Ch. 3 gives conditions on social welfare functions implying that they amount to maximizing a preference relation on Re^n.

Ch. 4 starts with fixed-population results; i.e., n is fixed. Part A, sections 4.1-4.5, discusses many principles verbally. Part B, Sections 4.6 ff., gets to business with theorems and axioms, the expertise if the authors. P. 92 defines Euclidean continuity and inequality aversion conditions such as preference for bistochastic matrices.

§4.7 defines generalized utilitarianism as $SUMg(u_i)$ with u_i the utility of individual i (objectively given beforehand, so, like money) and g a nonlinear transformation. (They write g^n to express the dimension n for later purposes.) So, this could be n times expected utility for 1/n probability distributions. Representative utility is g^{-1} of SUM/n, so, certainty equivalent.

P. 102 bottom considers difference of representative utility and average utility, which is risk premium.

§4.9 considers information requirements. Imagine that preference is not affected if we add a prospect (add coordinate-dependent constant). This is what my 2010 book calls additivity in Ch. 1. Under some continuity it implies invariance under multiplication by a positive scalar. Thus, any positive affine transformation does not affect preference. The book calls it cardinal unit comparability (CUC; p. 112). This book interprets it as information invariance, an interpretation initiated by Amartya Sen it seems. The condition is appropriate if we know no more than the cardinal class of the preference inputs. In the same spirit we can interpret constant absolure or relative risk aversion as information requirements. Anyway, CUC is like additivity in my 2010 book and axiomatizes subjective expected value maximization. Anonymity then implies same subjective probabilities, so, just sum.

§4.10 considers fixed population sizes. Same-people independence (p. 115) is joint separability for each fixed n. Theorem 4.7 shows that we get generalized utilitarianism with n-dependent g^n, for each n.

Then follow some theorems (4.9, 4.10) axiomatizing utilitarianism, which is just the sum of inputs. §4.11 considers variable population size but with comparisons only between n-tuples of the same length. Replication invariance: $x \succcurlyeq y \Leftrightarrow kx \succcurlyeq ky$ for each natural k if x and y are of the same length. Theorem 4.22 axiomatizes generalized utilitarianism with same g for each n, as always in this book, g being continuous. Theorems 4.19 & 4.21 prepare, with the latter using population substitution (kind of conditional certainty equivalence substitution; this implies for the representative agent exactly what Nagumo (1930) and Kolmogorov (1930) call associativity) instead of replication invariance (which is implied by it). Wakker (1986, Theory and Decision) is in fact the generalization of Theorem 4.21 to general, possibly noncontinuous, utility.

Ch. 5 turns to variable populations with comparisons between n-tuples of different length. In additive representations, it then is important where utility is 0. This is called the critical level. It is comparable to the reference point for prospect theory although not the same (no different dimensions in PT). Section 5.1 p. 130

mentions that continuity now must be strengthened to go across different n. §5.1.3 discusses what is called the repugnant conclusion (Parfit 1976), where the authors are as emotional as several others, something that I have never understood. Tännsjö (2002) seems to agree with me. §5.2.6 discusses average utilitarianism. For fixed n it is the same utilitarianism, but for variable n is makes a difference. Then comes Part B with axioms. §5.5, p. 158, formulates extended continuity, $\{x \in \mathbb{R}^n: x \succcurlyeq y\}$ must be closed for $y \in \mathbb{R}^m$ also, and same with weak reversed preference.

§5.6 defines same-number independence, being joint independence for each fixed n. Utility independence: Joint independence if length of the two vectors compared may be different (satisfied under generalized utilitarianism but not under average generalized utilitarianism). Existence independence: Preference between two vectors of possibly different length is not affected if common part is added. It implies utility independence but gives links between variable length. P. 160 $\ell\ell$. 5-6 define critical level. There is an existence of critical levels assumption. P. 165, end of §5.6: extended replication invariance: uRv ⇔ kuRkv extended to u,v of different length. There are also number-dampened models, which have each extra dimension weighted less than the one before.

§5.8 discussed average generalized utilitarianism (AGU) and some other models, such as number-dampened, with axiomatizations to come in Ch. 6. §6.2 discusses it again. Part B starts at §6.5. Theorem 6.1 axiomatizes continuous same-number generalized utilitarianism with dimension-dependent utility, and Theorem 6.2 axiomatizes it with dimension-independent utility. These results follow directly from Theorems 4.21 and 4.22. §6.6 has number-sensitive critical levels, §6.7 has them constant, §6.9 considers representative-utility principles (CEs (certainty equivalents) represent). It involves replication equivalence: x ~ kx for each k. Theorem 6.15 axiomatizes it (axioms: continuity, Pareto, minimal increasingness, and replication invariance), with the text following the proof on p. 198 verbally expressing the axiomatization of average generalized utility by adding same-number independence. §6.10 considers number-deampening. Theorem 6.24 axiomatizes power utility by invariance w.r.t. unit change of inputs (called information invariance with respect to ratio scale full comparability). %}

Blackorby, Charles, Walter Bossert, & David Donaldson (2005) "*Population Issues in Social Choice Theory, Welfare Economics and Ethics.*" Cambridge University Press, Cambridge, UK.

{% This paper, pointed out to me by Horst Zank in November 2000, proves some interesting representation theorems. It formulates these results in a social choice context, where individual utilities are given as primitives and social preferences are derived. As pointed out on p. 251 third paragraph, the results are isomorphic to preference representations on Re^n. Theorem 3 shows that additively decomposable functionals that satisfy CARA (constant absolute risk aversion) are, in fact, expected utility functionals with exponential utility. The result precedes Theorem VII.7.6 of Wakker (1989, Additive Representations of Preferences). Corollary 1.1, the special case of Theorem 1 restricted to monotonicity, shows that additively decomposable functionals that satisfy constant RRA are, in fact, expected utility functionals with power utility. It thereby precedes Theorem VII.7.5 of Wakker (1989, Additive Representations of Preferences). A special aspect of the theorem is that they permit both positive and negative inputs, and characterize a case of power utility x^r for positive x, and $-\lambda(-x)^r$ for negative x, with λ positive a scale factor. The authors point out that this result gives a special meaning to the zero outcome. So, the value function often used in prospect theory is already here!

There are references to earlier works in social choice theory on similar functionals. %}

Blackorby, Charles & David Donaldson (1982) "Ratio-Scale and Translation-Scale Full Interpersonal Comparability without Domain Restrictions: Admissible Social Evaluation Functions," *International Economic Review* 23, 249–268.

{% **Harsanyi's aggregation** %}

Blackorby, Charles, David Donaldson, & John A. Weymark (1999) "Harsanyi's Social Aggregation Theorem for State-Contingent Alternatives," *Journal of Mathematical Economics* 32, 369–387.

{% **dynamic consistency** %}

Blackorby, Charles, David Nissen, Daniel Primont & Robert R. Russell (1973) “Consistent Intertemporal Decision Making,” *Review of Economic Studies* 40, 239–248.

{% %}

Blackorby, Charles, Daniel Primont, & Robert R. Russell (1978) “*Duality, Separability and Functional Structure: Theory and Economic Applications.*” North-Holland, Amsterdam.

{% Paper characterizes SEU by assuming additive representability through separability (Debreu 1960 etc.), and then assuming symmetry of preference with respect to all n states of nature, so that equal probabilities come out. (It suggests something else, being that they work with general n states that may not be equally likely, but then they assume that there exists an underlying refinement such that … etc.) It may be argued that this is decision under risk with known probabilities 1/n, and that what they characterize is a generalized quasi-linear mean. The assumption of replication equivalence (x ~ mx for any n-tuple x where mx means the mn tuple with x repeated m times), often used in axiomatizations of average utility, is not stated explicitly but is implicit in their Assumption 5, and in their implicit assumption in the proof of lemma 2 that u is independent of ||S||.

Section IV briefly discusses EU with **utility of gambling** (EU only when restricted to nondegenerate prospects). %}

Blackorby, Charles, Russell Davidson, & David Donaldson (1977) “A Homiletic Exposition of the Expected Utility Hypothesis,” *Economica* 44, 351–358. https://doi.org/10.2307/2553568

{% %}

Blackwell, David (1953) “Equivalent Comparisons of Experiments,” *Annals of Mathematical Statistics* 24, 265–272.

{% %}

Blackwell, David & Lester E. Dubins (1962) “Merging of Opinions with Increasing Information,” *Annals of Mathematical Statistics* 38, 886–896.

{% **Dutch book**s. Theorem 4.3.1 shows that for a nontrivial weak order $\succcurlyeq$ on Re^n that satisfies weak monotonicity and additivity, there exist probabilities $p_1, \ldots, p_n$ such that $f \succ g$ if f has strictly greater EV. Problem 4.3.1 states the if and only if implication if continuity is added, and also states a mixture-independence ($f \succcurlyeq g$ implies $\lambda f + (1-\lambda)h \succcurlyeq \lambda g + (1-\lambda)h$ for all f,g,h and $0 < \lambda < 1$) that implies additivity and in the presence of continuity is equivalent to additivity. The technique of Theorem 10.1 in Fishburn Peter C. (1982) "The Foundations of Expected Utility" could be used to generalize the result. %}

Blackwell, David & Meyer A. Girshick (1954) "*Theory of Games and Statistical Decisions.*" Wiley, New York.

{% Interview patients and see what role unknown probabilies (ambiguity) plays here. %}

Blaisdell, Laura L., Caitlin Gutheil, Norbert A. M. Hootsmans, & Paul K. J. Han (2016) "Unknown Risks: Parental Hesitation about Vaccination," *Medical Decision Making* 36, 479–489.

{% **decreasing ARA/increasing RRA**: seems to find decreasing, rather than increasing, RRA. %}

Blake, David (1996) "Efficiency, Risk Aversion and Portfolio Insurance: An Analysis of Financial Asset Portfolios Held by Investors in the United Kingdom," *Economic Journal* 106, 1175–1192.

{% Eq. 6 uses a definition of loss aversion that has mathematical problems (Wakker 2010 §9.6).

N=4016 subjects in representative sample from the UK. Loss aversion is measured using a method of Abdellaoui (2008). Do data fitting with certainty equivalents. Assume no probability weighting, mostly for pragmatic reasons.

They confirm the usual findings of concave utility for gains, convex for losses, where, remarkably, they find more curvature for losses. Report many correlates.

gender differences in risk attitude: Women are slightly more risk and loss averse than men, but this disappears when correcting for other variables.

Representative sample has average loss aversion of 2.41, but student sample has 5.24.

reflection at individual level for risk: their data set could report it but my superficial reading did not find it. %}

Blake, David, Edmund Cannon, & Douglas Wright (2021) "Quantifying Loss Aversion: Evidence from a UK Population," *Journal of Risk and Uncertainty* 63, 27–57.
https://doi.org/10.1007/s11166-021-09356-7

{% If revealing beliefs about games, and then playing games, and then paying for both, income effects can arise. The method widely used to avoid income effects, the RIS, can, of course, also be used in the case just mentioned. This is what this paper proposes and tests. They find that with repeated payments, income effects do arise. %}

Blanco, Mariana, Dirk Engelmann, Alexander K. Koch, & Hans-Theo Normann (2010) "Belief Elicitation in Experiments: Is there a Hedging Problem?," *Experimental Economics* 13, 412–438.

{% **updating under ambiguity with sampling**: They test updating under ambiguity, using Ellsberg urns, with compound risk and ambiguity. 60% of subjects does classical Bayesian updating. 25% does Bayesian updating under compound risk but something ambiguity nonneutral under ambiguity. As ambiguity model, they take maxmin EU with an Epstein-Schneider updating, a model with ignoring all unlikely priors and then something more. For the sets of priors, they consider two parametrizations. The first is simplex, the second uses beta-priors. Although the authors conclude "This result shows that the extent to which behavior under ambiguity differs from behavior under compound risk is relatively moderate" (p. 175) one can take this differently. Of the non-Bayesians, more than half treat compound risk differently than ambiguity. (**second-order probabilities to model ambiguity**) %}

Bland, James R. & Yaroslav Rosokha (2021) "Learning under Uncertainty with Multiple Priors: Experimental Investigation," *Journal of Risk and Uncertainty* 62, 157–176.
https://doi.org/10.1007/s11166-021-09351-y

{% **equity-versus-efficiency**: Describes situations in which equity is not much at the cost of efficiency. If equity is at the cost of efficiency, this is called the "leacky bucket effect." %}

Blank, Rebecca M. (2002) "Can Equity and Efficiency Complement Each Other?," *Labour Economics* 9, 451–468.

{% %}

Blaschke, Wilhelm (1928) "Topologische Fragen der Differentialgeometrie, I," *Mathematische Zeitschrift* 28, 150–157.

{% %}

Blaschke, Wilhelm & Gerrit Bol (1938) "*Geometrie der Gewebe.*" Springer, Berlin.

{% Jan. 18, 2002 I discussed this book with Mark Blaug. He said that he did not write things to express his opinions, but rather to provoke students and make them think.

Ch. 8: "The marginal revolution." §18.1, p. 278, on period following 1870, "For the first time, economics truly became the science that studies the relationship between *given* ends and *given* scarce means that have alternative uses for the achievement of those ends." (Italics from original.)

§8.4, p. 284, on philosophers emphasizing introspection as an instrument for economics and on hedonism in England in the 1850s. Blaug is negative on Mirowsky.

Ch. 9: "Marshallian Economics: Utility and Demand"

§9.2, p. 313, ascribes, as did Stigler (1950, §V), to Fisher the same way of measuring cardinal utility under additive decomposable MAU. However, Blaug does not ascribe it to Fisher (1892) as did Stigler, but to Fisher (1927). I spent many hours checking both Fisher-works, and found that this idea of standard sequences simply is not there. Blaug (Feb. 12, 2002, personal communication) explained that he had taken the reference from Stigler (1950) without checking the original.

§9.2, end (p. 316) seems to suggest that for utilitarian welfare evaluations the origin of utility must be determined??

§9.4, p. 320, deals with marginal utility derived from vNM utility and is awfully close to equating it with riskless utility, although the text immediately follows by saying that no one can measure the latter yet.

§9.7, p. 330, mentions an observability problem of indifference, as follows, for two commodities x and y (say x are apples and y pears): "we do not presume that he can say how much more y would be equivalent to a unit reduction in x. To make that presumption is to suppose that the individual can compare increments and decrements of marginal utility, which would imply cardinal measurement of utility." That is, Blaug confuses, for instance, marginal rates of substitution with cardinal utility. §9.10, p. 332 seems to (re)state the observability problem of indifference (we can never be sure from an observed choice whether or not the agent was indifference), but claims that, in the absence of introspection, indifference is as unobservable as strength of preference. It immediately gives one solution, indifference can be observed statistically. Another is that indifference can be observed approximately (every ε improvement determines a strict preference). P. 333 ℓ. 1 then goes on to suggest that avoidance of this indifference problem, together with unobservability of strength of preference, were the main motivations for Samuelson to develop the revealed preference approach. I don't think that the indifference problem played such a role, neither that it is in the same league as the unobservability of strength of preference.

P. 337, §9.12, seems to identify the difference between Benthamite utility and choice-based utility with a normative-descriptive difference, and then criticizes others for not having grasped this difference.

P. 338, bottom line, seems to equate violations of revealed preference axioms with changing tastes.

Ch. 17, "A Methodological Postscript," is on empirical status, formal status, and falsifiability. P. 695, §17.3: "… theories are overthrown by better theories, not simply by contradictory facts."

P. 698, §17.4, "After a serious of attacks on utilitarian welfare economics, a new Paretian welfare economics was erected in the 1930s that purported to avoid interpersonal comparisons of utility."

End of §17.4, p. 700, points out that welfare economics must involve value judgments. %}

Blaug, Mark (1962) "*Economic Theory in Retrospect.*" Cambridge University Press, Cambridge. (5th edn. 1997).

{% Eq. 2 is a clever way of approximating PT when the probability weighting function is a power function $w(p) = p^\gamma$. Then with $U(x) = x^\alpha$, PT of the St. Petersburg paradox prospect is finite iff $\alpha < \gamma$. The author considers this to be a problem for PT. Refers to Tversky & Bar-Hillel (1983) who actually predicted risk seeking in the St. Petersburg paradox, if properly truncated to get empirical realism. %}

Blavatskyy, Pavlo R. (2005) “Back to the St. Petersburg Paradox?,” *Management Science* 51, 677–678.

{% Urn contains one white and one black ball. Random drawing with replacement, white ball delivers \$1. Then another black ball is added, again random drawing with replacing, with \$1 if white; etc. So, the subject receives (1/2:\$1) + (1/3:\$1) + (1/4:\$1) + (1/5:\$1) + … etc. Probability that total payment is below x is zero for every real x, so, with probability 1 it yields infinite much. Yet subjects pay only finite amount for it. So, it is a variation of the St. Petersburg paradox, one that falsifies every existing theory. %}

Blavatskyy, Pavlo R. (2006) “Harmonic Sequence Paradox,” *Economic Theory* 28, 221–226.

{% You choose between two prospects by seeing which has the higher probability of giving a better outcome. This simple heuristic is tested descriptively. %}

Blavatskyy, Pavlo R. (2006) “Axiomatization of a Preference for Most Probable Winner,” *Theory and Decision* 60, 17–33.

{% **tradeoff method’s error propagation**; **tradeoff method;** Assume that first Wakker & Deneffe’s (1996) Tradeoff method is used to elicit a sequence $x_0, \ldots, x_k$ of outcomes equally spaced in utility units. They can be given utilities $U(x_j) = j/k$. Then $x_j \sim x_{k_{p_j}} x_0$) implies that $w(p_j) = j/k$ for probability weighting w. This method was used by Abdellaoui (2000). We can continue and use the elicited weights to refine the utilities measured. We can for instance consider indifferences $y_i \sim x_{1_{p_i}} x_0$ to conclude that $U(y_i) = j/k*1/k = j/k^2$. The author considers a three-stage approach of this kind, considers response-errors, and analyzes which of the adaptive method has the smallest overall errors. %}

Blavatskyy, Pavlo R. (2006) "Error Propagation in the Elicitation of Utility and Probability Weighting Functions," *Theory and Decision* 60, 315–334.

{% Assumes EU with error theory. Says that purported violations of betweenness found empirically may be due to errors in choice rather than being genuine violations of betweenness. %}

Blavatskyy, Pavlo R. (2006) "Violations of Betweenness or Random Errors?," *Economics Letters* 91, 34–38.

{% Reanalyzes existing data sets using stochastic choice theories; **concave utility for gains, convex utility for losses**: p. 271;

losses give more/less noise: P. 271 finds lower error for losses than for gains. This agrees with findings of Yechiam, Retzer, Telpaz, & Hochman (2015).

error theory for risky choice %}

Blavatskyy, Pavlo R. (2007) "Stochastic Expected Utility Theory," *Journal of Risk and Uncertainty* 34, 259–286.

{% A theoretical paper deriving a stochastic choice result from preference assumptions about stochastic choice. %}

Blavatskyy, Pavlo R. (2008) "Stochastic Utility Theorem," *Journal of Mathematical Economics* 44, 1049–1056.

{% N = 48 subjects answered 19 general knowledge questions. Then they could choose to either gamble on one of their answers, or on an objective probability, of getting a prize. The objective probability was taken equal to the percentage of correct answers for each subject. So, the two options are indifferent. Although the paper does not write it explicitly, I assume that the subjects were NOT informed about how the probability had been chosen. Most subjects preferred to gamble on the known probability, which can be interpreted as underconfidence. %}

Blavatskyy, Pavlo R. (2009) "Betting on Own Knowledge: Experimental Test of Overconfidence," *Journal of Risk and Uncertainty* 38, 39–49.

{% Shows that preference reversals, with more common than uncommon ones, can follow from merely errors in choice, using a probabilistic choice model that avoids violations of stochastic dominance. %}

Blavatskyy, Pavlo R. (2009) "Preference Reversals and Probabilistic Decisions," *Journal of Risk and Uncertainty* 39, 237–250.

{% Köbberling & Wakker (2003) defined, for PT with monetary outcomes, a more loss averse concept that implies the same risk attitudes for gains and for losses, in other words, that can only be used if the same risk attitudes for gains and for losses. It means that same basic utility and same weighting functions, but stronger kink. This paper generalizes the condition to general, nonmonetary, outcomes and splits the condition up into two. The first half, called more loss averse, imposes the condition only on mixed prospects that are preferred to the reference point. The second half, called less gain prone, imposes it only on mixed prospects worse than the reference point. It does not formulate the conditions for PT but only for RDU and, preceding that, for the special case of EU. It also gives a probabilistic extension.

Kõbberling & Wakker's (1993) preference conditions compare mixed prospects only to unnmixed sure outcomes, and not to unmixed general prospects as does this paper. Because K&W have a continuum of outcomes, and because the two agent s compared have the same preferences over nonmixed prospects, this difference does not matter.

I prefer a terminology where less gain seeking means just the same as more risk averse, as this has been done in other papers, and in the same way as less risk seeking is the same as more risk averse. So, in this sense I would have preferred a different terminology for this paper.

Köbberling & Wakker (2003) defined comparative loss aversion also under the restriction of same risk attitudes, and presented this as a restriction to be generalized in the future. This author proceeds differently. He argues that this restriction is intuitive and good and is how it should be. See his text below Proposition 1, p. 130: "Thus, to have a meaningful concept of comparative loss aversion, we need to consider individuals with identical preferences over the set of loss-free lotteries." It reminds me of people who, for subjective expected utility, use the particular Yaari-type more-risk-averse-than condition, notice that it implies the same subjective probabilities so that Yaari's method only works for the special case of identical subjective probabilities, and then start arguing that this is a law of nature and that we should never try to compare risk attitudes if different subjective probabilities; a common misunderstanding in the field. %}

Blavatskyy, Pavlo R. (2010) "Loss Aversion," *Economic Theory* 46, 127–148.

{% biseparable utility; Fishburn (1986 EL has something similar). This paper modifies the well-known mean-variance model where variance is replaced by absolute deviation from the mean. This replacement is desirable in many situations. Often, the quadratic nature of variance puts too much weight on outliers. Big point is that mean-variance leads to violations of stochastic dominance and the model of this paper does not. The paper gives a preference axiomatization, no empirical evidence. %}

Blavatskyy, Pavlo R. (2010) "Modifying the Mean-Variance Approach to Avoid Violations of Stochastic Dominance," *Management Science* 56, 2050–2057. https://doi.org/10.1287/mnsc.1100.1224

{% real incentives: RIS. **PT falsified**

Obtains systematic examples of reversed common ratio. If to choose between sure outcome and prospect with considerably higher EV, most choose the latter, risky, option. If then the probabilities of nonzero outcomes are scaled down by a common factor, many switch to a safe choice. For example, $60 \prec 100_{3/4}0$ (64.9%) but $60_{1/3}0 \succ 100_{1/4}0$ (67.1%). I wondered if some error theory could account for it, with simply more errors in the latter choice because then the options are more indifferent. But this does not work well because the paradoxical choices are majority choices. The finding $60_{1/3}0 \succ 100_{1/4}0$ (67.1%) is amazing and puzzling. The paper considers some error theories but they cannot account for the finding. These findings violate every existing theory. %}

Blavatskyy, Pavlo R. (2010) "Reverse Common Ratio Effect," *Journal of Risk and Uncertainty* 40, 219–241.

{% %}

Blavatskyy, Pavlo R. (2011) "Probabilistic Risk Aversion with an Arbitrary Outcome Set," *Economics Letters* 112, 34–37.

{% The version of March 2011 lets 38 subjects choose between all prospects generated by the probabilities j/4 and amounts €5, €20, €25, €40. Tests virtually all presently existing theories. RDU and EU do well, quadratic utility and Chew's betweenness do bad. Best is the heuristic of first minimizing probability of worst outcome and then maximizing probability of best outcome. This fits well with extreme **inverse S** and neo-additive. %}

Blavatskyy, Pavlo R. (2011) "Which Decision Theory?

{% Probabilistic choice with an error theory that, however, is never allowed to violate stochastic dominance. Theoretical derivation using preference conditions is given, and it is fit to data.

The papers Blavatskyy (2011 *Management Science*) and Blavatskyy (2012 *Economic Theory*) are very close, with the same model, but, inappropriately, have no proper cross references. The 2012 ET paper does not cite the 2011 MS paper. The 2011 MS paper does cite the 2012 ET paper (as forthcoming) but only in the appendix for technical steps in the proof, and in no way explains the overlap. This MS paper more discusses empirical implications, and implications for consumer choice, and the ET paper more does the mathematical proof. This MS paper also gives the representation theorem but only sketches the proof. %}

Blavatskyy, Pavlo R. (2011) "A Model of Probabilistic Choice Satisfying First-Order Stochastic Dominance," *Management Science* 57, 542–548.

{% Probabilistic choice with an error theory that, however, is never allowed to violate stochastic dominance. Theoretical derivation using preference conditions is given.

The papers Blavatskyy (2011 *Management Science*) and Blavatskyy (2012 *Economic Theory*) are very close, with the same model, but, inappropriately, have no proper cross references. The 2012 ET paper does not cite the 2011 MS paper. The 2011 MS paper does cite the 2012 ET paper (as forthcoming) but only in the appendix for technical steps in the proof, and in no way explains the overlap. This ET paper more does the mathematical proof, and the MS paper more discusses empirical implications, and implications for consumer choice. %}

Blavatskyy, Pavlo R. (2012) “Probabilistic Choice and Stochastic Dominance,” *Economic Theory* 50, 59–83.

{% A pretty test of the multiplicative model (p:x, 1-p:0) -->w(p)U(x) by testing what in fact is the Thomsen condition. I informed the author that his condition is the Thomsen condition around 2009. I regret that he does not cite the Thomsen condition but inappropriately continues to claim novelty. Other than this, the empirical demonstration is pretty. %}

Blavatskyy, Pavlo R. (2012) “The Troika Paradox,” *Economics Letters* 115, 236–239.

{% Characterizes a probabilistic generalization of the subjective-mixture SEU axiomatization by Ghirardato et al. (2003, Econometrica). It shares the drawback with the result by Ghirardato et al. that the endogenous mixture operation is not observable by finitely many observations. Using it in preference axioms is the same as using utility as an input in preference axiomatizations. I did not understand in the proof of Proposition 1 why different outcomes cannot be indifferent, and why this would contradict Axiom 4. %}

Blavatskyy, Pavlo R. (2012) “Probabilistic Subjective Expected Utility,” *Journal of Mathematical Economics* 48, 47–50.

{% %}

Blavatskyy, Pavlo R. (2013) “The Reverse Allais Paradox,” *Economics Letters* 119, 60–64.

{% **tradeoff method**: Interestingly, this paper weakens my tradeoff consistency condition that generalizes the Reidemeister condition by considering inter-attribute difference comparisons. It does not turn it into a consistency for endogenous midpoints (which would generalize the hexagon condition by considering inter-attribute comparisons), and for which it has been an open question since my youth whether it gives SEU for more than two states. It does something in between. On one coordinates it uses differences, as does tradeoff consistency, but on the other it considers endogenous midpoints. Still the condition is strong enough to imply SEU. The difficult step in this is to show that

the condition implies joint independence (separability), but the author succeeds in doing it. %}

Blavatskyy, Pavlo R. (2013) "The Simplest Behavioral Characterization of Subjective Expected Utility Theory Using the Connected Topology Approach," *Operations Research* 61, 932–940.

{% %}

Blavatskyy, Pavlo R. (2014) "Stronger Utility," *Theory and Decision* 76, 265–286.

{% **intertemporal separability criticized**: In common discounted utility, time separability is problematic. It implies that splitting $2 today up into $1 today and $1−ε tomorrow is favorable if utility is sufficiently concave. This paper takes a discounted sum, but not of separate amounts received today, but of all cumulated payments received up to a timepoint. It avoids the above monotonicity violations and relaxes time separability. The basic problem, and the cumulative formula as solution, was proposed before by David Bell in his master's thesis published as Bell (1974). %}

Blavatskyy, Pavlo R. (2016) "A Monotone Model of Intertemporal Choice," *Economic Theory* 62, 785–812.

{% This paper applies Abdellaoui's (2000) method for eliciting RDU and PT in a simple manner. It uses a loss-gauge to elicit a standard sequence of gains and a corresponding gain-gauge to elicit a correponding standard sequence of losses. These give utility for gains and losses, which is then used to elicit the weighting functions for gains and losses. The loss aversion parameter cannot be determined without varying the reference point or further assumptions. A plausible further assumption that would do is that basic utility (global utility but with the loss aversion parameter taken out) is close to linear in a nontrivial neighborhood of 0. The data confirm the usual findings. %}

Blavatskyy, Pavlo R. (2021) "A Simple Non-Parametric Method for Eliciting Prospect Theory's Value Function and Measuring Loss Aversion under Risk and Ambiguity," *Theory and Decision* 91, 403–416.

{% Further results on the valuable version of intertemporal choice where cumulative payoffs over time, rather than single, are combined, as in Blavatskyy (2016). %}
Blavatskyy, Pavlo R. (2022) "Intertemporal Choice as a Tradeoff between Cumulative Payoff and Average Delay," *Journal of Risk and Uncertainty* 64, 89–107.
https://doi.org/10.1007/s11166-022-09370-3

{% The author proposes the following definition of ambiguity neutrality, erroneously suggesting novelty: for any outcomes x > y and events A, B, with an obvious notation for acts, if $x_Ay \succcurlyeq x_By$ then $x_{A^c}y \preccurlyeq x_{B^c}y$. However, this condition has been proposed and discussed in numerous papers. It underlies Schmeidler's (1989) definition of uncertainty aversion through $1 - W(A) - W(A^c)$. For several years before now when I write this (2023), this annotated bibligraphy has had a keyword
Ambiguity = amb.av = source.pref, ignoring insensitivity
referring to that definition and criticizing it for ignoring insensitivity. In several papers I proposed calling the author's definition ambiguity indifference rather than ambiguity neutrality. It is amazing that the author even went public with this so obviously wrong novelty claim. As for the editor handling this paper, it is amazing that he has found two referees unaware of the literature. %}
Blavatskyy, Pavlo (2023) "Who Is Ambiguity Neutral?," *Geneva Risk and Insurance Review* 49, 181–193.
https://doi.org/10.1057/s10713-023-00086-1

{% New def. of loss aversion: dispreference for lottery whose certainty equivalent of its positive part is the certainty equivalent of its negative part (the latter taken as having negative outcomes). Big pro: this definition can readily be used for uncertainty and ambiguity. Prospect theory's gain-loss separability, as tested/discussed in Wu & Markle (2008), is central here. %}
Blavatskyy, Pavlo R. (2024) "A Behavioral Definition of Loss Aversion," *Economic Letters* 235, 111555.
https://doi.org/10.1016/j.econlet.2024.111555

{% Proposes an error model between probit and logit. Has flatter tails than those two and is steeper at 0 (random choice). %}

Blavatskyy, Pavlo R. (2024) “Harmonic Choice Model,” *Theory and Decision* 96, 49–69.
https://doi.org/10.1007/s11238-023-09939-7

{% Do a truncated BDM (Becker-DeGroot-Marschak), with upper/lower bound, and use error theory to analyze. Give a multistage explanation with nonEU and each price set a new stage. For p > 0.5 the restricted BDM gives higher prices than the unrestricted, for p < 0.5 it is the other way around. %}
Blavatskyy, Pavlo R. & Wolfgang R. Köhler (2009) “Range Effects and Lottery Pricing,” *Experimental Economics* 12, 332–349.

{% Thy use the measurement method of Attema, Bleichrodt, Gao, Huang, & Wakker (2016) to measure discounting independently of utility. They use it for a simple important question: Is the discount function convex or concave? For 1/3 of subjects it is convex, for 1/3 it is concave and, finally, for 1/3 undetermined. %}
Blavatskyy, Pavlo R. & Hela Maafi (2020) “A New Test of Convexity–Concavity of Discount Function,” *Theory and Decision* 89, 121–136.

{% **survey on nonEU**: On the common-consequence version of the Allais paradox, to be precise. The authors review 89 tests in 29 papers and specify conditions when the paradox is strong, weak, or sometimes even reversed. It is strong if: high hypothetical payoffs, the medium outcome close to the highest outcome, and in simple presentations (not compound/frequency). It can be reversed if the highest and lowest outcomes in the risky lottery have the same probability. (This is reminiscent of **risk seeking for symmetric fifty-fifty gambles**). The paradox is not as strong as some literature suggests, as many teachers have experienced when teaching it. %}
Blavatskyy, Pavlo R., Andreas Ortmann, & Valentyn Panchenko (2022) “On the Experimental Robustness of the Allais Paradox,” *American Economic Journal: Microeconomics* 14, 143–163.
https://doi.org/10.1257/mic.20190153

{% Blavatskyy, Ortmann, & Panchenko (2022 AEJ Micro) presented a meta-analysis of the common-consequence Allais Paradox. This paper does the same for the common-ratio Allais Paradox, handling 39 papers. It is more likely if: low common-ratio factor, high ratio of middle to highest outcome, in simple presentations (not compound/frequency), and with high hypothetical incentives. The paradox is not as strong as some literature suggests, as many teachers have experienced when teaching it. %}

Blavatskyy, Pavlo R., Valentyn Panchenko, & Andreas Ortmann (2023) “How Common Is the Common-Ratio Effect?” *Experimental Economics* 26, 253–272. https://doi.org/10.1007/s10683-022-09761-y

{% **Best core theory depends on error theory**: Find that. In particular, best fitting parameters within one theory depend on the error theory. Thus, when fitting EU with CRRA, they find risk seeking convex U for a random utility model, risk neutrality for a tremble model, and risk aversion for a Fechner model. They find **inverse S** probability weighting confirmed for all error models except Fechner. In Fechner error component does similar things as inverse S, so takes over.

They find that log-power (CRRA) utility fits worse than expo-power. Probably because both very small and very large amounts are involved. %}

Blavatskyy, Pavlo R. & Ganna Pogrebna (2010) “Models of Stochastic Choice and Decision Theory: Why Both Are Important for Analyzing Decisions,” *Journal of Applied Econometrics* 25, 963–986.

{% In the deal-or-no-deal show, the authors make the questionable assumption that in a choice between the offer of the bank (a sure option) and a prospect, a choice for the prospect entails a violation of loss aversion. %}

Blavatskyy, Pavlo R. & Ganna Pogrebna (2006) “Loss Aversion? Not with Half-a-Million on the Table!,” IEW WP # 274.

{% People can gamble on 20% price or 80% price but exhibit similar risk aversion in a deal or no deal context. %}

Blavatskyy, Pavlo R. & Ganna Pogrebna (2008) “Risk Aversion when Gains Are Likely and Unlikely: Evidence from a Natural Experiment with Large Stakes,” *Theory and Decision* 64, 395–420.

{% %}

Bleichrodt, Han (1995) “QALYs and HYEs: Under What Conditions Are They Equivalent?,” *Journal of Health Economics* 14, 17–37.

{% %}
Bleichrodt, Han (1996) “Applications of Utility Theory in the Economic Evaluation of Health Care.” Ph.D. dissertation, iMTA, Erasmus University, Rotterdam, the Netherlands.

{% %}
Bleichrodt, Han (1997) “Health Utility Indices and Equity Considerations,” *Journal of Health Economics* 16, 65–91.

{% %}
Bleichrodt, Han (1998) “Health Utility Indices and Equity Considerations.” *In* Morris L. Barer, Tom E. Getzen, & Greg L. Stoddart (eds.) *Health, Health Care and Health Economics*, 331–362, Wiley, Chichester.

{% %}
Bleichrodt, Han (2000) “Rational Risk Policy by W. Kip Viscusi,” *Journal of Economic Literature* 38, 127–128.

{% %}
Bleichrodt, Han (2000) “De Waardering van Gezondheidsbaten.” *In* Robert Spreeuw & Diederik Stapel (eds.) *Over de Grenzen van het Weten*, 25–29, KNAW, Amsterdam (in Dutch).

{% Compares utilities measured through adaptive PE to utilities measured through nonadaptive PE, all with two-outcome gambles. Under classical elicitation assumption (doing calculations assuming EU descriptively), discrepancies arise, falsifying EU. If a correction is carried out for probability weighting using **inverse S** within RDU, the discrepancies only increase. This is counterevidence against RDU (**PT falsified**). Earlier counterevidence, by Wakker, Erev, & Weber (1994), Birnbaum & McIntosh (1996), and Birnbaum & Navarrete (1998), always

concerned three-outcome gambles, this paper has two-outcome gambles. The author suggests that loss aversion and framing can explain the findings. %}

Bleichrodt, Han (2001) "Probability Weighting in Choice under Risk: An Empirical Test," *Journal of Risk and Uncertainty* 23, 185–198.

{% %}

Bleichrodt, Han, (2001) "Utility of Gains and Losses by R. Duncan Luce," *Journal of Economic Literature* 39, 130–131.

{% **PE doesn't do well**; **PE higher than CE**

Biases in PE utility measurements all go in the same direction (upwards); biases in the TTO go in different directions. Scale compatibility and loss aversion give bias upwards, utility curvature a bias downwards. Hence, TTO may not be so bad on average. My guess is that the two upwards biases are stronger than the one downward bias, suggesting that on average TTO comes out too high.

Also contributes to **CE bias towards EV. %**}

Bleichrodt, Han (2002) "A New Explanation for the Difference between SG and TTO Utilities," *Health Economics* 11, 447–456.

{% %}

Bleichrodt, Han (2002) "Het Dilemma van de Minister van Volksgezondheid." *In* Harry van Dalen & Frank Kalshoven (eds.) M*eesters van de Welvaart: Topeconomen over Nederland. Balans*, 201–211, Amsterdam (in Dutch).

{% **tradeoff method** is used.

Paper assumes choices from choice sets where one of the elements in the choice set is the reference point. It means that the preference relation given each reference point, as derivable using revealed preference techniques, cannot compare options worse than the reference point (they are never chosen because rather the reference point is chosen). This is a very realistic assumption. Sugden (2003) assumed such preferences observable which is unconvincing. Thus, reference dependence leads to incomplete preference (or, put another way in this case, to complete preference on a subset). The author develops additive representations for this case.

This paper is the first to illustrate that reference dependence makes completeness more questionable and adds to the desirability to study weakenings of completeness. %}

Bleichrodt, Han (2007) "Reference-Dependent Utility with Shifting Reference Points and Incomplete Preferences," *Journal of Mathematical Psychology* 51, 266–276.

{% %}

Bleichrodt, Han (2009) "Reference-Dependent Expected Utility with Incomplete Preferences," *Journal of Mathematical Psychology* 53, 287–293.

{% **PE higher than others**: seem to show that PE results are too high. %}

Bleichrodt, Han, Jose Maria Abellán, José Luis Pinto, & Ildefonso Mendez-Martinez (2007) "Resolving Inconsistencies in Utility Measurement under Risk: Tests of Generalizations of Expected Utility," *Management Science* 53, 469–482.

{% %}

Bleichrodt, Han & Werner B.F. Brouwer (1999) "Disconteren." *In* Maureen P.M.H. Rutten-van Mölken, Jan J. van Busschbach, & Frans F.H. Rutten (eds.) *Van Kosten tot Effecten: Een Handleiding voor Evaluatiestudies in de Gezondheidszorg*, 123–129, Elsevier, Maarssen (in Dutch).

{% **tradeoff method**

The first paper to actually measure the regret theory functional quantitatively. This has not been done before, probably, because people thought that something as strange as a nontransitive functional can never be measured in any sensible way. This paper shows it can.

Confirms the main empirical hypothesis that Loomes & Sugden put up in the 1980s, that people are disproportionally averse to large regrets. This is even after controlling for event splitting. (In later papers, after the 1980s, Loomes, Sugden, and others conjectured that their original findings may have been just due to event splitting.)

Under regret theory, we have

$$x > y \quad \text{iff} \quad p_1Q(U(x_1) - U(y_1)) + \ldots + p_nQ(U(x_n) - U(y_n)) > 0$$

where x_i (y_i) is the outcome of act x (y) at state i, and p_i the subjective probability of that state. The tradeoff method with indifferences

$\alpha^{j+1}{}_i x \sim \alpha^j{}_i y$ for many j

still implies that the α^j's are equally spaced in utility units. (It, first, implies that $Q(\alpha^{j+1},\alpha^j)$ is the same for all j. This then implies the same $U(\alpha^{j+1}) - U(\alpha^j)$ for all j. That is, the tradeoff method is robust not only against probability weighting as shown many times before, but also against violations of transitivity. This paper, thus, measures U. Then, with U available, it derives Q from PE questions.

tradeoff method's error propagation; simulations based on a Fechner error model suggest that it is not strong (p. 164). They also have a clever test of whether subjects act strategically in view of the adaptive nature: Two questions from the beginning, when subjects could not yet know about adaptive stimuli, are repeated near the end, where subjects know if they ever. Then the second questions should receive higher answers. But they don't (p. 168). So, this gives evidence of no seeing through the adaptive setup and no strategic answers.

They find no subject doing the linear-constant-distance heuristic for TO. All of this because TO not from matching but from binary choice. %}

Bleichrodt, Han, Alessandra Cillo, & Enrico Diecidue (2010) "A Quantitative Measurement of Regret Theory," *Management Science* 56, 161–175.

{% Use mostly the smooth ambiguity model (also a bit neo-additive) to analyze the value of a statistical life under ambiguity. Increased aversion/perception need not always increase that value. Ambiguity prudence plays a role. %}

Bleichrodt, Han, Christophe Courbage, & Béatrice Rey (2019) "The Value of a Statistical Life under Changes in Ambiguity," *Journal of Risk and Uncertainty* 58, 1–15.

{% %}

Bleichrodt, Han, David Crainich, & Louis Eeckhoudt (2003) "The Effect of Comorbidities on Treatment Decisions," *Journal of Health Economics* 22, 805–820.

{% %}

Bleichrodt, Han, David Crainich, & Louis Eeckhoudt (2003) “Comorbidities and the Willingness to Pay for Health Improvements,” *Journal of Public Economics* 87, 2399–2406.

{% %}

Bleichrodt, Han, David Crainich & Louis Eeckhoudt (2008) “Aversion to Health Inequalities and Priority Setting in Health Care,” *Journal of Health Economics* 27, 1594–1604.

{% %}

Bleichrodt, Han, Enrico Diecidue, & John Quiggin (2004) “Equity Weights in the Allocation of Health Care: The Rank-Dependent QALY Model,” *Journal of Health Economics* 23, 157–171.

{% %}

Bleichrodt, Han, Jason N. Doctor, Martin Filko, & Peter P. Wakker (2011) “Utility Independence of Multiattribute Utility Theory Is Equivalent to Standard Sequence Invariance of Conjoint Measurement,” *Journal of Mathematical Psychology* 55, 451–456.

https://doi.org/10.1016/j.jmp.2011.08.001

Direct link to paper

{% %}

Bleichrodt, Han, Jason N. Doctor, Yu Gao, Chen Li, Daniella Meeker, & Peter P. Wakker (2019) “Resolving Rabin’s Paradox,” *Journal of Risk and Uncertainty* 59, 239–260.

https://doi.org/10.1007/s11166-019-09318-0

Direct link to paper

{% **equity-versus-efficiency;**

tradeoff method: used that to measure the utility of QALYs.

An impressive sample: not only 69 students, but also 208 members from the general public in 22 group sessions of about 15 each, with three interviewers present at each session.

In an experiment, subjects had to choose between different hypothetical allocations of QALY scores over n individuals. The authors used the tradeoff method to measure how people transformed QALYs into utilities and, next, used these to measure the rank-dependent weights that people assigned to individuals. They found preference for equality in sense of overweighting of the worst-off, but also: **inverse S:** People overweight the richest and poorest, suggesting insensitivity to groupsize. Insensitivity dominated pessimism, so that the typical inverse S shape resulted. The authors then advance an interesting argument: Insensitivity is a cognitive limitation at the level of numerical misperception, so that it is reasonable to correct for it. (**cognitive ability related to likelihood insensitivity (= inverse S)**) They present the equity weighting that results after doing so, which is, obviously, convex and pessimistic. %}

Bleichrodt, Han, Jason N. Doctor, & Elly Stolk (2005) "A Nonparametric Elicitation of the Equity-Efficiency Tradeoff in Cost-Utility," *Journal of Health Econonomics* 24, 655–678.
https://doi.org/10.1016/j.jhealeco.2004.10.001

{% %}

Bleichrodt, Han & Louis Eeckhoudt (2005) "Saving under Rank-Dependent Utility," *Economic Theory* 25, 505–511.

{% Investigate effects of probability weighting in a two-period market with cost-benefit ratios that come out too high. Elasticity of probability weighting is an important index. %}

Bleichrodt, Han & Louis Eeckhoudt (2006) "Survival Risks, Intertemporal Consumption, and Insurance: The Case of Distorted Probabilities," *Insurance: Mathematics and Economics* 38, 335–346.

{% %}

Bleichrodt, Han & Louis Eeckhoudt (2006) "Willingness to Pay for Reductions in Health Risk when Probabilities Are Distorted," *Health Economics* 15, 211–214.

{% **dynamic consistency**: They measured first in standard Ellsberg urn who were ambiguity averse, and there was 32.5%. They put a small price on ambiguity

aversion, to have it strict, and then their result is common. Then came the main experiment, as follows.

The main experiment was with cards, but let me say Ellsberg balls and urns. So, an urn contains 200 numbered balls, 100 odd and 100 even numbered. Both odd and even are three-color Ellsberg: 33 red and 67 blue/yellow in unknown proportion, but same for odd and even. I regret that the authors chose color blue instead of Ellsberg's color black. A priori, subjects can bet on a color for odd-numbered balls and separately for even-numbered. By choosing blue for odd and red for even, they get the biggest possible objective known probability of 67%. Then, they receive a signal if the number was odd or even. (**updating under ambiguity**) Let us assume RCLA or its analog for events. I did not read the entire paper but did not see the authors state it. A decision maker, also if ambiguity averse, can satisfy both dynamic consistency and consequentials by doing backward induction in the prior situation. But, as I learned from Tversky (personal communication), backward induction is not plausible if there are few outcomes with many events, which is the case here.

Now, subjects can then either maintain their choice, or switch. Under ambiguity aversion, dynamic consistency requires maintaining but consequentialism requires switching. 73% did consequentialism, similar to Dominiak et al. (2012) but better implemented experimentally. %}

Bleichrodt, Han, Jürgen Eichberger, Simon Grant, David Kelsey, & Chen Li (2021) "Testing Dynamic Consistency and Consequentialism under Ambiguity," *European Economic Review* 134, 103687.
https://doi.org/10.1016/j.euroecorev.2021.103687

{% %}

Bleichrodt, Han & Martin Filko (2008) "New and Robust Testes of QALYs when Health Varies over Time," *Journal of Health Economics* 27, 1237–1249.

{% %}

Bleichrodt, Han & Martin Filko (2010) "A Reply to Gandjour and Gafni," *Journal of Health Economics* 29, 329–331.

{% %}

Bleichrodt, Han, Martin Filko, Amit Kothiyal, & Peter P. Wakker (2017) "Making Case-Based Decision Theory Directly Observable," *American Economic Journal: Microeconomics* 9, 123–151.
http://dx.doi.org/10.1257/mic.20150172
Direct link to paper

{% **Kirsten&I**, finitely many timepoints %}
Bleichrodt, Han & Amiram Gafni (1996) "Time Preference, the Discounted Utility Model and Health," *Journal of Health Economics* 15, 49–67.

{% They use the time-tradeoff sequences of Attema et al. (2010) to measure deviations from constant discounting. Do it for (economic) money and (health) life duration. A minority of 25% to 35% exhibit increasing impatience. The authors use Rohde's (2010) convenient hyperbolic factor to analyze their data. They only fit discount families that cannot accommodate increasing impatience, being hyperbolic, quasi-hyperbolic, constant, and proportional. Of these, hyperbolic and proportional are relatively best. The authors write, in their conclusion: "To explain increasing impatience other discount functions are needed (Ebert and Prelec 2007; Bleichrodt et al. 2009)."

Seems that they discuss the problem of transferability of money over time (instead of consumption) when measuring discounting. %}
Bleichrodt, Han, Yu Gao, & Kirsten I.M. (2016) "A Measurement of Decreasing Impatience for Health and Money," *Journal of Risk and Uncertainty* 52, 213–231.

{% This paper aims to empirically measure Hurwicz expected utility (HEU) of Gul & Pesendorfer (2015). However, as explained in my annotations there, this is impossible: it would require a rich set of "ideal events" (events that have EU maximization) and ALL if them to have been measured, and further unrealistic assumptions about "diffuse" (maximally ambiguous) events. Instead, this paper uses what I call the source method of Abdellaoui et al. (2011 AER): assume local probabilistic sophistication within sources and then measure source-dependent probability weighting functions, which I call source functions. The only relation with HEU is that this paper uses a parametric family of weighting function that

satisfies the requirements for those of HEU. One can praise the authors for having ignored the many unobservable aspects of HEU.

The new probability weighting family, called HEU familiy, is interesting: First, in Eq. 8 on p. 1398, the authors define

$$w^*(p) = \frac{(1-\beta)p}{(1+\beta)(1-p) + (1-\beta)p}$$

The function is decreasing in β, which can, hence, be taken as a index of source dispreference. Then, Eq. 9 takes $w(p) = \alpha w(p) + (1-\alpha)(1-w(1-p))$.
Now α is an index of ambiguity aversion, and β of ambiguity perception or a-insensitivity. It satisfies the requirements of Gul & Pesendorfer's HEU.

The authors claim in several places that their family best fits the data of their experiment, but Table 1 shows that Prelec's family does better. They also claim in several places that their parameters of aversion and perception (insensitivity) are cleaner and clearer than others in the literature, but the only argument really put forward is that in Prelec's family the parameters interact. No counterargument is given against the other parameters in the literature and neither arguments are given to support their own parameters. Or it should be that their parameters are uncorrelated in their data. But (1) this is based only on an accepted null hypothesis; (2) they do not test correlations of the other parametric families; (3) this is empirical unrelatedness and not conceptual. For instance, Baillon, Bleichrodt, Li, & Wakker (2021 JET) show that their indexes are mathematically orthogonal, which suggests conceptual independence.

P. 1394 claims that HEU is the first axiomatized empirically realistic theory, but I disagree. Choquet expected utility/rank-dependent utility, prospect theory, and α maxmin were also axiomatized and are better. HEU is a special case of these, but an empirically unsatisfactory one given its ideal and diffuse events.

Many claims in the paper, such as that ambiguity aversion α is independent of source, are based only on accepted H_0, most with $N = 48$ subjects in the first experiment.

When they derive HEU's claimed prediction that ambiguity aversion is positively related to first-order risk aversion, they don't give a real argument but only a terminological move: pessimism in the source function is equated there both with ambiguity aversion and with, what they call there, (source-dependent) first-order risk aversion.

The authors claim to be the first to have an ambiguity aversion index valid for all weighting functions (p. 1408), but their index is identical to the aversion index of Baillon et al. (2018). The authors, incorrectly, claim that the indexes of Baillon et al. (2018) are valid only for RDU with neo-additive weighting (p. 1408). First, Baillon et al. (2018) claim them for all weighting families under biseparable utility and, second, Baillon, Bleichrodt, Li, & Wakker (2021 JET, §7) prove mathematically that their indexes are valid under most ambiguity theories also beyond RDU. %}

Bleichrodt, Han, Simon Grant, & Jingni Yang (2023) "Testing Hurwicz Expected Utility," *Econometrica* 2023, 1393–1416. https://doi.org/10.3982/ECTA19221

{% Propose, if I understand well, that U(dead) = 0 for all individuals, and U(M) = 1 where M, depending on an individual, is the best conceivable health state for the group that the individual belongs to. %}

Bleichrodt, Han, Carmen Herrero, & José Luis Pinto (2002) "A Proposal to Solve the Comparability Problem in Cost-Utility Analysis," *Journal of Health Economics* 21, 397–403.

{% %}

Bleichrodt, Han & Magnus Johannesson (1997) "The validity of QALYs: An Experimental Test of Constant Proportional Trade-Off and Utility Independence," *Medical Decision Making* 17, 21–32.

{% %}

Bleichrodt, Han & Magnus Johannesson (1997) "Standard Gamble, Time-Trade-Off and Rating Scale: Experimental Results on the Ranking Properties of QALYs," *Journal of Health Economics* 16, 155–175.

{% %}

Bleichrodt, Han & Magnus Johannesson (1997) "An Experimental Test of a Theoretical Foundation for Rating-Scale Valuations," *Medical Decision Making* 17, 208–216.

{% **Kirsten&I**: finitely many timepoints %}

Bleichrodt, Han & Magnus Johannesson (2001) "Time Preference for Health: A Test of Stationarity versus Decreasing Timing Aversion," *Journal of Mathematical Psychology* 45, 265–282.

{% This paper uses the method of Abdellaoui, Bleichrodt, l'Haridon, & van Dolder (2016 JRU) to measure loss aversion. It uses the **tradeoff method** of Wakker & Deneffe (1996) and thus corrects for probabilityweighting. It finds loss aversion between 1.25 and 1.45, less than usual, but similar for small and large stakes. %}

Bleichrodt, Han, Emmanuel Kemel, & Olivier L'Haridon (2023) "Prospect Theory's Loss Aversion Is Robust to Stake Size," *Judgment and Decision Making* 18, e14. https://doi.org/doi:10.1017/jdm.2023.2

{% Kirby (2006) is somewhat related, as I discovered 2022. %}

Bleichrodt, Han, Umut Keskin, Kirsten I.M. Rohde, Vitalie Spinu, & Peter P. Wakker (2015) "Discounted Utility and Present Value—A Close Relation," *Operations Research* 63, 1420–1430.
http://dx.doi.org/10.1287/opre.2015.1433
Direct link to paper

This paper received the Decision Analysis Publication award of 2016

{% %}

Bleichrodt, Han, Amit Kothiyal, Drazen Prelec, & Peter P. Wakker (2013) "Compound Invariance Implies Prospect Theory for Simple Prospects," *Journal of Mathematical Psychology* 57, 68–77.
http://dx.doi.org/10.1016/j.jmp.2013.04.002
Direct link to paper

{% %}

Bleichrodt, Han & Marc A. Koopmanschap (1999) "Economische Evaluatie." *In* Ruud Lapré, Frans F.H. Rutten & Frederik T. Schut (eds.) *Algemene Economie van de Gezondheidszorg*, 251–272, Elsevier/de Tijdstroom, Maarssen (in Dutch).

{% %}

Bleichrodt, Han, Olivier l'Haridon, & David van Ass (2018) "The Risk Attitudes of Professional Athletes: Optimism and Success Are Related," *Decision* 5, 95–118.

{% %}

Bleichrodt, Han, Chen Li, Ivan Moscati, & Peter P. Wakker (2016) "Nash Was a First to Axiomatize Expected Utility," *Theory and Decision* 81, 309–312. https://doi.org/10.1007/s11238-016-9542-3

Direct link to paper

{% Use **tradeoff method**; Extends axiomatizations of QALYs (quality adjusted life years), known under expected utility, to PT; Theorem 3.1 adapts the PT axiomatization of Wakker & Tversky (1993) to a case of nonconnected outcomes, using the zero-condition for health states. One novelty concerns the definition of loss aversion, which is conditional on the health state. %}

Bleichrodt, Han & John Miyamoto (2003) "A Characterization of Quality-Adjusted Life-Years under Cumulative Prospect Theory," *Mathematics of Operations Research* 28, 181–193.

{% **tradeoff method**: They use it. P. 1490/1491 gives nice details about their implementation for finding indifferences. They first ask for values that give sure decisions, then narrow these down.

tradeoff method's error propagation: P. 1495 did simulation suggesting that error propagation of the tradeoff method is not very serious.

inverse S: They find that, doing it for health outcomes instead of monetary. The curve is more elevated/curved than for money. Table 1, p. 1488, gives a convenient listing of studies of probability weighting. They clearly find inverse S, more than for monetary experiments. P. 1492 bottom of 2nd column: They find more bounded SA (so, lower and upper SA) than monetary experiments did. Strangely enough, p. 1493/1494 finds slightly more lower SA than upper SA in

one analysis, slightly less in another. So, roughly, it looks equal.

P. 1494 1st column: they find approximately linear probability weighting in the middle region.

P. 1495: compares fit of different parametric weighting function families.

Weighting function for health is both more elevated (abstract, p. 1495; higher δ in Table 4) and more inverse S (p. 1492 bottom; lower γ in Table 4) than commonly found for money. %}

Bleichrodt, Han & José Luis Pinto (2000) “A Parameter-Free Elicitation of the Probability Weighting Function in Medical Decision Analysis,” *Management Science* 46, 1485–1496.
https://doi.org/10.1287/mnsc.46.11.1485.12086

{% Use medical stimuli, i.e., chronic health states with two dimensions, health state and life duration. Consider (i) Effects of varying loss aversion when scale compatibility effects are constant (ii) Effects of varying scale compatibility when loss aversion effects are constant (iii) What happens if scale compatibility goes one way, loss aversion the other? Stimuli: To get $(x_1, x_2) \sim (y_1, y_2)$, three of the four values are fixed and the fourth is established through choice-bracketing, e.g. $(x_1, x_2) \sim (y_1,?)$ with ? to be revealed from the subject. Next, in a return question, the matching value obtained is substituted and any of the other should be substituted, as, for example, with x_1 to be substituted, in $(?, x_2) \sim (y_1, y_2)$.

Results: All effects occur, scale compatibility and loss aversion seem about equally strong for they neutralize each other when they can. Loss aversion is not constant but depends on stimuli: it seems to decrease with life duration.

Suggest to do utility measurement in contexts where scale compatibility and loss aversion are minimal.

restrictiveness of monotonicity/weak separability: Subjects preferred death to a severely impaired health state following stroke. However, if these outcomes resulted with probability .25 (.75 probability of full recovery), then the preferences reversed.” [Death and stroke are not explicitly modeled as multiattribute here but are similar.] %}

Bleichrodt, Han & José Luis Pinto (2002) “Loss Aversion and Scale Compatibility in Two-Attribute Trade-Offs,” *Journal of Mathematical Psychology* 46, 315–337.

{% Use **tradeoff method**; empirically show that utility of life duration is concave which, as they write themselves, is not surprising in itself. The new contribution of this paper is to show it in a way not affected by violations of expected utility. Given the widespread belief in, and use of, concavity of utility of life duration, and the total absence of empirical support not distorted by violations of expected utility, this is an important result. %}

Bleichrodt, Han & José Luis Pinto (2005) “The Validity of QALYs under NonExpected Utility,” *Economic Journal* 115, 533–550.

{% %}

Bleichrodt, Han & José Luis Pinto (2006) “Conceptual Foundations for Health Utility Measurement.” *In* Andrew Jones (ed.) *The Elgar Companion to Health Economics*, 347–358, Edward Elgar, Vermont.

{% **real incentives/hypothetical choice**: Of N = 300 subjects, 150 accepted an invitation for returning next week and participating in a next round of the experiment, taking about 45 minutes. Of these, 50 were randomly selected. They were offered a flat payment of €12 for that. However, 34 of the 50 did not want the payment, and preferred to participate for free (p. 716 end of §2)! This illustrates once more how well motivated people are to participate in health investigations, where several of these investigations are financed by charity donations. Many subjects have, with FH denoting full health,

$(FH_{0.75}death) > (FH_{0.75}X)$ but death < X

which can be taken as a violation of stochastic dominance (or independence if death and X are not taken as outcomes but as prospects) (**restrictiveness of monotonicity/weak separability**). The authors take it as preference reversal. %}

Bleichrodt, Han & José Luis Pinto (2009) “New Evidence of Preference Reversals in Health Utility Measurement,” *Health Economics* 18, 713–726.

{% %}

Bleichrodt, Han, José Luis Pinto, & José Maria Abellán (2003) “A Consistency Test of the Time Trade-Off,” *Journal of Health Economics* 22, 1037–1052.

{% **inverse S**; **paternalism/Humean-view-of-preference**; **tradeoff method**; **utility elicitation**; **utility measurement**: **correct for probability distortion**;

PE doesn't do well: p. 1505 has it extremely;

utility elicitation: different EU methods give different curves: This paper shows that reconciliation can result from prospect theory. %}

Bleichrodt, Han, José Luis Pinto, & Peter P. Wakker (2001) "Making Descriptive Use of Prospect Theory to Improve the Prescriptive Use of Expected Utility," *Management Science* 47, 1498–1514.

https://doi.org/10.1287/mnsc.47.11.1498.10248

Direct link to paper

{% Quasi-hyperbolic discounting, also called the beta-delta model, has discount function $\delta^0 = 1$ for $t = 0$ but $\beta\delta^t$ for all $t > 0$. For $\delta \neq 1$, it can be rewritten as $\delta^{\tau+t}$ for all $t > 0$, with $\tau = (\ln\beta)/(\ln\delta)$. Whereas for some purposes β is a better index, better capturing the utility loss of nonstationarity, for other purposes τ is, better capturing the time duration ("number of future selves") during which there can be nonstationarities. τ is, indeed, the length of the period during which inconsistencies can occur. The intro does not give a balanced account by mentioning drawbacks of β but not mentioning the similar drawbacks of τ (that it ignores the utility lost). The discussion and rest of the paper similarly oversell τ, using overly strong words, wih the usual cliché policy and even normative claims.

τ and its measurement have big problems for $\delta = 1$. Then τ is undefined or infinite. Further, δ close to 1 gives extreme values of τ. How to do statistical estimations then? The authors duck the issue in their numerical illustration in §6. The beginning of §6 considers $\beta < 1$ and then points out that $\delta = 1$ may be due to a form of high irrationality: that agents do not distinguish between future timepoints, with the only distinction now versus later. Although I did not find it stated in the paper, the authors apparently removed these subjects from the analysis. (How else could they do their regressions?) I have three problems here. First, $\delta = 1$ (with $\beta < 1$) need not be high irrationality but can be very moderate irrationality, if at all. Second, even if irrational, why are these subjects removed from the analysis? Don't we want to analyze irrationalities here? Third, the usual thing when removing subjects from an analysis: can this removal bring biases for the things analyzed, if the group removed is extreme in some sense? %}

Bleichrodt, Han, Rogier J. D. Potter van Loon, & Drazen Prelec (2022) "Beta-Delta or Delta-Tau? A Reformulation of Quasi- Hyperbolic Discounting," *Management Science* 68, 6326–6335.
https://doi.org/10.1287/mnsc.2022.4453

{% %}

Bleichrodt, Han, Rogier J.D. Potter van Loon, Kirsten I.M. Rohde, & Peter P. Wakker (2013) "A Criticism of Doyle's Survey of Time Preference: A Correction on the CRDI and CADI Families," *Judgment and Decision Making* 8, 630–631.
https://doi.org/10.1017/S1930297500003715
Direct link to paper

{% **tradeoff method** %}

Bleichrodt, Han & John Quiggin (1997) "Characterizing QALYs under a General Rank Dependent Utility Model," *Journal of Risk and Uncertainty* 15, 151–165.

{5 **tradeoff method** %}

Bleichrodt, Han & John Quiggin (1999) "Life-Cycle Preferences over Consumption and Health: When is Cost-Effectiveness Analysis Equivalent to Cost-Benefit Analysis?," *Journal of Health Economics* 18, 681–708.

{% %}

Bleichrodt, Han & John Quiggin (2002) "Life-Cycle Preferences over Consumption and Health: A Reply to Klose," *Journal of Health Economics* 21, 167–168.

{% **tradeoff method**; **restricting representations to subsets** %}

Bleichrodt, Han, Kirsten I.M. Rohde, & Peter P. Wakker (2008) "Combining Additive Representations on Subsets into an Overall Representation," *Journal of Mathematical Psychology* 52, 304–310.
https://doi.org/10.1016/j.jmp.2008.04.005
Direct link to paper

{% %}

Bleichrodt, Han, Kirsten I.M. Rohde, & Peter P. Wakker (2008) “Koopmans’ Constant Discounting for Intertemporal Choice: A Simplification and a Generalization,” *Journal of Mathematical Psychology* 52, 341–347.
https://doi.org/10.1016/j.jmp.2008.05.003
Direct link to paper

{% On July 1, 2010, Drazen Prelec pointed out to us that our CRDI function appeared before in Prelec (1998, *Econometrica*) as conditional invariance in his Proposition 4, and our CADI function was defined there on p. 511, Eq. 4.2. Prelec also provided an axiomatization by his conditional invariance preference condition (p. 511 top), which is almost identical to our CRDI preference condition. Our CRDI condition is slightly weaker, being the special case of Prelec´s conditional invariance with q = r and x´ = y. Thus, our theorem is slightly more general, but this difference is minor. Prelec formulated his theorem for the context of decision under risk, with his p from [0,1] or from (0,1), designating probability. We formulated our theorem for intertemporal choice, with our t (the same role as Prelec’s p) from any subinterval from [0, ∞), and with utility slightly more general. Our details are again slightly more general than Prelec’s, but, again, the differences are minor. Thus, the priority of the CRDI family is with Prelec (1998). I regret that we did not know this at the time of writing our paper and, accordingly, could not properly credit Prelec then.

CRDI generalizes the constant sensitivity family of Ebert & Prelec (2007). Now I think unit invariance is a better name. March 2014 I discovered that Read (2001 JRU Eq. 16) proposed this basic family before, and so did Takahashi (2006 Eq. 6). %}

Bleichrodt, Han, Kirsten I.M. Rohde, & Peter P. Wakker (2009) “Non-Hyperbolic Time Inconsistency,” *Games and Economic Behavior* 66, 27–38.
https://doi.org/10.1016/j.geb.2008.05.007
Direct link to paper

{% %}

Bleichrodt, Han & Ulrich Schmidt (2002) “A Context-Dependent Model of the Gambling Effect,” *Management Science* 48, 802–812.

{% MAUT adapted to PT, with either global reference points (and then also globally determined rank-dependent weights) or within-attribute reference points (and then also within-attribute determined rank-dependent weights). Whereas the title does not make it very clear, this is the main topic of the paper. The global approach is called holistic, and the other is called attribute-specific. Attribute-wise would be a more tractable term for the latter. They cite several other papers, such as the well-known Tversky & Kahneman (1991), on attribute-specific reference points.

Formally, PT uses the holistic approach. This appears, for instance, from Wakker & Tversky (1993) where the outcome set is a connectec topological space, which includes a convex set of commodity bundles with the usual Euclidean topology as a special case. It is stated verbally by Tversky & Kahneman (1981) p. 456, penultimate paragraph. Yet, what is empirically more useful, and what is more interesting, that is another question. The holistic approach has been primarily chosen for pragmatic reasons, having fewer parameters. Similarly, for RDU, Schmeidler (1989) chose the holistic approach.

A preference foundation is given. Decision weighting and loss aversion can depend on the attribute. They give a model that is essentially addition, over attributes, of attribute-dependent PT values.

The attribute-specific approach does still satisfy transitivity and in this sense is holistic still. It is not the regret-theory type of deviation from transitivity.

tradeoff method: used in axioms. %}

Bleichrodt, Han, Ulrich Schmidt, & Horst Zank (2009) “Additive Utility in Prospect Theory,” *Management Science* 55, 863–873.

{% Use rank-dependence in axiomatizing/justifying measures of inequality for the health domain. %}

Bleichrodt, Han & Eddy van Doorslaer (2006) “A Welfare Economics Foundation for Health Inequality Measurement,” *Journal of Health Economics* 25, 945–957.

{% **inverse S:** find that because incorporating inverse S probability weighting improves utility measurement:

The consistency of QALYs is increased if probability transformation is incorporated. After that, utility curvature does not add much more. P. 253: probability transformation alone improves fit better than utility curvature alone.

Power utility fits some better than exponential utility. %}

Bleichrodt, Han, Jaco van Rijn, & Magnus Johannesson (1999) "Probability Weighting and Utility Curvature in QALY-Based Decision Making," *Journal of Mathematical Psychology* 43, 238–260.

{% %}

Bleichrodt, Han & Paul van Bruggen (2022) "The Reflection Effect for Higher Order Risk Preferences," *Review of Economics and Statistics* 104, 705–717.
https://doi.org/10.1162/rest_a_00980

{% %}

Bleichrodt, Han & Peter P. Wakker (2015) "Regret Theory: A Bold Alternative to the Alternatives," *Economic Journal* 125, 493–532.
http://dx.doi.org/10.1111/ecoj.12200
Direct link to paper

{% %}

Bleichrodt, Han, Peter P. Wakker, & Magnus Johannesson (1997) "Characterizing QALYs by Risk Neutrality," *Journal of Risk and Uncertainty* 15, 107–114.
https://doi.org/10.1023/A:1007726117003
Direct link to paper

{% **proper scoring rules-correction**;

Throughout, expected utility is assumed. P. 408: "Cross sections of option prices have long been used to estimate implied probability density functions (PDFs). … Unfortunately, theory also tells us that the PDFs estimated from options prices are risk-neutral. If the representative investor who determines options prices is not risk-neutral, these PDFs need not correspond to the representative investor's (i.e., the market's) actual forecast of the future distribution of underlying asset values." It is reasonable that on average the subjective probabilities equal objective probabilities. This paper corrects by assuming nonlinear utility, and seeing what utility best corrects. They report RRA for both (so, for exponential utility multiply the Pratt-Arrow index by the amount). Table III, p. 424, finds powers such as –4 (i.e., relative risk aversion indexes of 5) as median and mean. Table V, p. 429, has more extreme values, ranging from power 0 (ln) to power –14 for all kinds of time horizons. Table VI, p. 431, is likewise. A nice table of previous estimates is on p. 432, Table VII, with wide variation. Exponential utility seems to fit better than power. %}

Bliss, Robert R. & Nikolaos Panigirtzoglou (2004) "Option-Implied Risk Aversion Estimates," *Journal of Finance* 59, 407–446.

{% Seems to discuss (p. 99) the observability problem of indifference; i.e., the difficulty to falsify indifference empirically. %}

Block, Henry David & Jacob Marschak (1960) "Random Orderings and Stochastic Theories of Responses." *In* Ingram Olkin (ed.) *Contributions to Probability and Statistics. Essays in Honor of Harold Hotelling*, Stanford University Press, 97–132, Stanford, CA.

{% The recursive formulas of Bellmann-Koopmans can have several fixed points. This paper argues that this complication mostly comes from Koopmans' model. They argue that the greatest fixpoint should have priority. %}

Bloise, Gaetano, Cuong Le Van, & Yiannis Vailakis (2024) "Do not Blame Bellman: It Is Koopmans' Fault," *Econometrica* 92, 111–140. http://dx.doi.org/10.2139/ssrn.3943709

{% Uses data of Wakker, Erev, & Weber (1994), does parameter fitting at an individual level. Then new prospect theory = RDU does well, better than the original '79 prospect theory (denoted PT in this paper) and Gul's (1991) disappointment aversion theory (p. 260 end of §4; also p. 261). Some other less well-known theories do even better. Utility is strongly concave under EU, and more weakly concave, but still concave, under nonEU theories. For 1979 OPT, the author (his Eq. 8) does not really use that theory but, instead, the Edwards-type separable prospect theory. (**SPT instead of OPT**).

linear utility for small stakes: concave utility improves some over linear utility. %}

Blondel, Serge (2002) "Testing Theories of Choice under Risk: Estimation of Individual Functionals," *Journal of Risk and Uncertainty* 24, 251–265. https://doi.org/10.1023/A:1015687502895

{% %}

Blonski, Matthias (1999) "Social Learning with Case-Based Decisions," *Journal of Economic Behavior and Organization* 38, 59–77.

{% Beautiful data set of 25,000 manufacturing plants wavers in 2010, 2015, 2021. Their subjective probabilities were measured of own outcomes per shipment using the bin-method with five bins. Fit well with what is known about probabilities. Variance of subjective probability distribution was taken as index of uncertainty; similar in spirit to insensitivity. They find that investment is negatively associated with higher uncertainty, and with employment growth and overall shipments growth, which highlights the damaging impact of uncertainty. Rental capital and temporary workers are positively correlated with uncertainty, demonstrating that businesses switch from less flexible to more flexible inputs under uncertainty. %}

Bloom, Nicholas, Steven J. Davis, Lucia Foster, Scott Ohlmacher, & Itay Saporta-Eksten (2024) "2020 Klein Lecture—Investment and Subjective Uncertainty," *International Economic Review* 65, 15911–606. https://doi.org/10.1111/iere.12709

{% %}

Blume, Lawrence, Adam Brandenburger, & Eddie Dekel (1989) "An Overview of Lexicographic Choice under Uncertainty," *Annals of Operations Research* 19, 231–246.

{% **ordered vector space**: seem to give lexicographic generalizations of de Finetti's theorem, standard in ordered vector spaces. %}

Blume, Lawrence, Adam Brandenburger, & Eddie Dekel (1991) "Lexicographic Probabilities and Choice under Uncertainty." *Econometrica* 59, 61–79.

{% **state space derived endogeously**:

This paper does not assume Savage's states, outcomes, and acts, but constructs them from, possibly incomplete, preferences on a finite set of other concepts, called syntactic programs. A syntactic program is: If test t then action a, else action b. Tests are like propositions, being true or false. We can construct the algebra generated by tests, which can serve as a state space, although sometimes more states will be needed. Outcomes can be constructed from, I guess, states combined with actions. Thus, it is close to models that take states and acts as given, and derive consequences from those.

Cancellation axioms are imposed, giving additive representations, i.e., state-dependent expected utility. The model allows for state-space and outcome-set constructions thus permissively that state-dependence and state-independence cannot be distinguished (p. 19 middle). It is written there that state independence needs justification external to the theory. (This is the typical case if states and acts are taken as primitive, and outcomes derived from those.) Objective probabilities and mixtures are also introduced, with mixure cancellation axioms on them giving mixture independence (Theorem 1).

It is allowed that an agent deciding, and a researcher studying the agent, have different state spaces. The agent may violate extensionality: May not know that different descriptions refer to the same event. This is similar to Tversky & Koehler's (1994) support theory, which the authors extensively discuss. I discussed support theory much with Tversky. Tversky had in mind one "true correct" state space and then a (mis)perceived state space by the agent. I several times told Amos that there does not exist something like a true correct state space (only the true state of nature "exists"), and that I would prefer that he replace it by just a subjective sophisticated state space of the researcher. I am glad to see that this paper does it that way. Another difference is that in support theory the state space(s) are exogenously given, but here they are derived.

One other thing I liked about the Tversky & Koehler paper is that they maintain additivity of subjective probabilities in the agent's perceived state space. What we model as violation of SEU due to nonlinear probability may then in fact be misperception of the state space. So, I regretted much when later papers on support theory gave up that additivity. Glad to see that this paper has the additivity that I like.

Luce worked on somewhat similar models and is also cited. %}

Blume, Lawrence, David Easley, & Joseph Y. Halpern (2021) "Constructive Decision Theory," *Journal of Economic Theory* 196, 105306. https://doi.org/10.1016/j.jet.2021.105306

{% %}

Blumenschein, Karen, Glenn C. Blomquist, Magnus Johannesson, Nancy Horn, & Patricia Freeman (2008) "Eliciting Willingness to Pay without Bias: Evidence from a Field Experiment," *Economic Journal* 118, 114–137.

{% **real incentives/hypothetical choice**: Test discrepancy between hypothetical and real choice. Subjects are considerably less willing to buy in real than hypothetical. An easy cure is given: if in hypothetical choice a follow-up question is asked for yes answers about how sure they are, then those that are sure match well with real choices. %}

Blumenschein, Karen, Magnus Johannesson, Glenn C. Blomquist, Bengt Liljas, & Richard M. O'Conor (1998) "Experimental Results on Expressed Certainty and Hypothetical Bias in Contingent Valuation," *Southern Economic Journal* 65, 169–177.

{% **real incentives/hypothetical choice**: Study method of Blumenschein, Johannesson, Blomquist, Liljas, & O'Conor (1998; *Southern Economic Journal* 65). Do it for treatment for 172 asthma patients, which is a nicer population than students in a lab. %}

Blumenschein, Karen, Magnus Johannesson, Krista K. Yokoyama, & Partricia R. Freeman (2001) "Hypothetical versus Real Willingness to Pay in the Health Care Sector: Results from a Field Experiment," *Journal of Health Economics* 20, 441–457.

{% They find strong effects of defaults in saving choices by employees in Afghanistan. They consider five possible causes, writing on p. 2870: "Here, we attempt to differentiate between five explanations offered by the literature; the first three are consistent with rational models, and the latter two with behavioral models. First, defaults may

persist because of an employer "endorsement" effect whereby decision makers, unsure of the best course of action, take the default as reflecting a recommendation by a benevolent planner (Madrian and Shea 2001; Choi et al. 2004; Madrian 2014). Second, there may be significant real or perceived costs involved in switching from the default election, due to mechanical frictions in changing one's contribution rate. Third, and closely related, there may be a large mental cost associated with the complexity of forming a financial plan (Lusardi and Mitchell 2011; Cole, Sampson, and Zia 2011; Drexler, Fischer, and Schoar 2014). Fourth, turning to behavioral theories, the possibility of switching may not be salient in the mind of the employee, or the employee may be inattentive (Karlan et al. 2016b; Taubinsky 2013; Kast, Meier, and Pomeranz 2016). Finally, because changing defaults involves some immediate costs with delayed benefits, individuals may not switch, particularly if they are present-biased and naive about their future preferences (O'Donoghue and Rabin 1999)."

They find that present bias and calculations being too complex are main explanations. %}

Blumenstock, Joshua, Michael Callen, & Tarek Ghani (2018) "Why Do Defaults Affect Behavior? Experimental Evidence from Afghanistan," *American Economic Review* 108, 2868–2901. https://doi.org/10.1257/aer.20171676

{% %}

Blyth, Colin R. (1972) "On Simpson's Paradox and the Sure-Thing Principle," *Journal of the American Statistical Association* 67, 364–366.

{% %}

Blyth, Colin R. (1973) "Some Probability Paradoxes in Choice from among Random Alternatives," *Journal of the American Statistical Association* 67, 366–382.

{% **proper scoring rules**: The authors apply classical test theory or, more precisely, its alternative Item Response Theory (IRT) to proper scoring rules, thus qualifying forecasters as high or low quality and events as hard or easy to predict. %}

Bo, Yuanchao Emily, David V. Budescu, Charles Lewis, Philip E. Tetlock, & Barbara A. Mellers (2017) "An IRT Forecasting Model: Linking Proper Scoring Rules to Item Response Theory," *Judgment and Decision Making* 12, 90–103.

{% Seems to show that it matters whether a task is performed in the morning or evening in combination with whether one is a morning or evening person. %}
Bodenhausen, Galen V. (1990) "Stereotypes as Judgmental Heuristics: Evidence of Circadian Variations in Discrimination," *Psychological Science* 1, 319–322.

{% %}
Boere, Raymond & Peter P. Wakker (2012) "Honderd Euro Polisgeld Is Snel Terugverdiend," Interview in *Algemeen Dagblad* 04 Oct 2012. (National Dutch newspaper).
Direct link to paper

{% **probability communication**: suggest to use more than one frame. %}
Bogardus, Sidney T, jr., Eric Holmboe, & James F. Jekel (1999) "Perils, Pitfalls, and Possibilities in Talking about Medical Risk," *Journal of the American Medical Association* 281, 1037–1041.

{% Imagine agent A prefers apple to banana, and agent B prefers banana to apple. Tomorrow, 50-50, either one apple or one banana comes. Ex-post fair is to give each half the fruit. Ex ante fair can be to give the fruit to the one preferring it most. The latter is more efficient. This paper examines allocation rules that depend on these things but one, for one thing, does not know probabilities (so need not be 50-50, contrary to above). Gives axioms to axiomatize rues. %}
Bogomolnaia, Anna, Hervé Moulin, & Fedor Sandomirskiy (2022) "On the Fair Division of a Random Object," *Management Science* 68, 1174–1194.
https://doi.org/10.1287/mnsc.2021.3973

{% %}
Bohm, David (1980) "*Wholeness and the Implicate Order*." ARK, London.

{% %}
Bohm, David (1985) "Unfolding Meaning - A Weekend of Dialogue with David Bohm." Mickleton.

{% **real incentives/hypothetical choice, for time preferences**; finds discrepancy between real/hypothetical, fewer preference reversals occur with real incentives. However, it seems that much of the difference compared to the literature is because Bohm uses buying prices whereas most of the literature uses selling prices. Within buying prices, Bohm finds some discrepancy, but not very strong. I never studied in detail the experimental setup and incentive scheme used here. %}

Bohm, Peter (1994) "Time Preference and Preference Reversal among Experienced Subjects: The Effects of Real Payments," *Economic Journal* 104, 1370–1378.

{% Field experiment with used cars: No pref. reversals at all (no surprise if matching cannot be done via quantitative dimension!?!?!?) This work has often been criticized for finding no preference reversals where no one would expect them in the first place. %}

Bohm, Peter (1994) "Behaviour under Uncertainty without Preference Reversal: A Field Experiment," *Empirical Economics* 19, 185–200.

{% Only 11% pref. reversal in real-world lotteries %}

Bohm, Peter & Hans Lind (1993) "Preference Reversal, Real-World Lotteries, and Lottery-Interested Subjects," *Journal of Economic Behavior and Organization* 22, 327–348.

{% Take money as set of integers (cents) instead of continuum. Adapt many results, such as (Theorem 4) that under EU more risk averse iff more concave utility. The latter had been proved before by Peters & Wakker (1987, Theorem 2), for completely general domains. %}

Bohner, Martin & Gregory M. Gelles (2012) "Risk Aversion and Risk Vulnerability in the Continuous and Discrete Case: A Unified Treatment with Extensions," *Decisions in Ecomics and Finance* 35, 1–28.

{% **probability elicitation**: applied to experimental economics;

Short summary:

This paper considers standard gamble (PE) measurements. The sure outcome is (**10**,10) (**10** for you and 10 for an anonymous other person). The PE question has a good outcome (**15**,15) and a, for you, bad outcome (**8**,22). Which probability p makes you indifferent between (**10**,10) and (**15**,15)$_p$(**8**,22)? I first present the 2nd treatment.

2ND TREATMENT: The probability p refers to some objective probability determined by some random mechanism that does not arouse any emotion (at least not by the info given to the subjects).

3RD TREATMENT: Like the 2nd, but with the payments for the other person removed.

1ST TREATMENT: The probability p refers again to some objective probability, but it is of an event that arouses nonneutral (here, negative) emotions (percentage of people betraying others).

All treatments use a BDM (Becker-DeGroot-Marschak) two-stage resolution of uncertainty. In the first stage an objective probability p is chosen in an ambiguous way (in treatments 2 & 3 no info at all is given to the subjects, and in treatment 1 it is the percentage of betrayal, unknown to subjects). In the second stage it is decision under risk, choosing between (**10**,10) and (**15**,15)$_p$(**8**,22). Under backward induction (*BI*) or isolation (in a strict sense) (or consequentialism as Machina, 1989, called it, or time invariance as Halevy, 2015, called it), the subject should let the indifference p be the indifference probability of the PE, so, it should be the same in treatments 1 and 2. In particular, under BI (in a strict sense) betrayal aversion can play no role. Indeed, rationally speaking, in treatment 2 any aversive betrayal event has happened anyhow and can no more be affected. In particular, it is no more reason to like (**10**,10) more than (**15**,15)$_p$(**8**,22). Still, in the experiment the subjects just dislike the probabilities of aversive events in Treatment 1 extra and hence require a higher probability p there to make them indifferent. This means that BI/isolation in the strict sense must be violated. (Something that Machina (1989) argued for on, for him, normative grounds, although he did not write those very explicitly.) Conditioning on a betrayal event induces extra dislike of (**15**,15)$_p$(**8**,22). Then betrayal aversion can come in. Ambiguity attitude can also come in (if this is considered a component separate from betrayal aversion). Maybe subjects dislike more, or perceive more, the ambiguity about betrayal in treatment 1 than the choice (which may be perceived as uniform) in treatment 2.

Under BI, it can be interpreted as: **violation of risk/objective probability =**

one source

More detailed summary:

GAME 1 [Trust game]: First I define the trust game, then I say what happened. In the trust game, a **principal**, who gets bold payoffs, can choose to either get (**10**,10) (**10** for self and 10 for agent) or move to second stage. In 2nd stage agent can choose (**15**,15) or (**8**,22) (in latter case principal gets only 8 and agent gets 22).

The trust game was not played for real by the principal, but something else is done. Under BI, it is just a task of decision under risk with known probability, as follows: The principal is asked the minimal probability(objective!), denoted MAP (minimally acceptable probability) at the good prize (so, (**15**,15)$_{\text{MAP}}$(**8**,22)) to make him willing to forgo the sure prize ((**10**,10)) and take the risky option. This is implemented in a BDM (Becker-DeGroot-Marschak)-like implementation as follows. Each agent was asked whether he would be trustworthy (go for (**15**,15)) if given the chance (without any other info; they just thought it was a trust game). Then it was measured which percentage p of the agents in the sample chose to be trustworthy. Then each principal was randomly matched with an agent. If p was better than the chosen threshold MAP ($p^* \geq$ MAP) then the game was played, but if p was worse ($p^* <$ MAP) then the sure (**10**,10) resulted. Under BI, for the principal it can be taken not as ambiguity but only as risk with known probability, where a probability equivalent question was asked for (**10**,10) in a lottery with (**15**,15) as good outcome and (**8**,22) as bad outcome. Then real incentives were implemented à la BDM where, however, the probability p was not chosen fully randomly from [0,1] but was determined by the agents' responses in the sample. Under BI, this does not affect the incentive compatibility. However, ambiguity attitudes may come in regarding the probability p chosen in the BDM mechanism, which in treatment 2 is done without any info given to the subjects (so, ambiguous) and in treatment 1 through the (objective, 1st stage) probability of betrayal the 2nd stage uncertainty about which however is ambiguous.

For control, besides the trust game, two other games were considered:

GAME 2 (called risky dictator game): Principal can choose to either get (**10**,10) or move to second stage. In second stage, randomness chooses: (**15**,15)$_p$(**8**,22). Here the principals were only told that it was a probability p, but not how it was determined. It was actually determined as in Game 1, as the probability of the agents in the sample choosing trustworthy, but principals had no knowledge of this.

GAME 3 (called decision problem): Principal can choose to either get **10** or **15**$_p$**8**. Here the principals were only told that it was a probability p, but not how that was determined. It was actually determined as in Game 1, as the probability of the agents in the sample choosing trustworthy. So, this is like Game 2 but without payments to another agent.

They find betrayal aversion: i.e., the matching probability in Game 1 is higher. In reality, and in deviation from BI, one can, pessimistically, expect subjects not to fully see through Game 1 (the same way as I, each time when rereading this paper, need nontrivial time to re-understand that it is just risk under BI) and be confused by and partly guided by beliefs in trust/betrayal still. Or, very plausibly, BI is violated. Then anything can be going on and, in particular, ambiguity attitudes may play a role. Let me henceforth assume BI.

In all games the probability regarding the decision situation of the principal can then be taken as objective. In Game 2 the only reason to be different than Game 3 then is welfare considerations regarding the payoff for the other. In Game 1, besides the welfare considerations, there is also the (dis)like of having been betrayed yourself by your matched agent or not. So, not the beliefs, but only the values of the outcomes matter, formally speaking.

In my preferred interpretation (still assuming BI), the finding of betrayal aversion is a special case of source preference, be it that here both sources concern risk (objective probabilities) (in the source method risk is usually taken as one source): people just dislike uncertainty (risk in this case) having to do with betrayal, in the same way as they just like to deal with uncertainty related to their hobby of basketball rather than other uncertainties (Heath & Tversky 1991). %}

Bohnet, Iris, Fiona Greig, Benedikt Herrmann, & Richard J. Zeckhauser (2008) “Betrayal Aversion: Evidence from Brazil, China, Oman, Switzerland, Turkey, and the United States,” *American Economic Review* 98, 294–310.

{% They did the same experiment as Bohnet, Greig, Herrmann, & Zeckhauser (2008 American Economic Review) but with a convenience-student sample and, thus, have most of the novelty. But people mostly cite the American Economic Review paper for its better sample, and I will add annotations there. %}

Bohnet, Iris & Richard J. Zeckhauser (2004) "Trust, Risk and Betrayal," *Journal of Economic Behavior and Organization* 55, 467–484.

{% **second-order probabilities to model ambiguity**: Paper considers ambiguity attitudes through second-order probabilities. People prefer positively-skewed second-order probability distributions, both for gains and for losses. P. 140 Table 1 gives a good impression of what goes on. All effects are weaker for losses than for gains.

ambiguity seeking for unlikely: If interpreted as ambiguity study, this paper finds considerable risk seeking for positively-skewed 2nd-order distributions, so, it is again evidence against the assumption of universal ambiguity aversion. However, I interpret it differently. First, the 2nd-order probabilities are so explicit and simple that I rather consider this to be a study of **RCLA** than of ambiguity. Second, I think that the subjects have simply treated the first-order probabilities as outcomes, somewhat as in Selten, Sadrieh, & Abbink (1999). Much in this paper enhances such processing, e.g., the manager-is-blamed-for-bad-1st-order-probability-interpretation on p. 136 (did author express such explanations to subjects, MBA students who had been taught in decision theory?). The interpretations of the author in many places and in the theoretical model take 1st order probabilities as outcomes. Then the findings of this paper are simply explained as an overweighting of small second-order probabilities. %}

Boiney, Lindsley G. (1993) "The Effects of Skewed Probability on Decision Making under Ambiguity," *Organizational Behavior and Human Decision Processes* 56, 134–148.

{% The Matthew effect means that young researchers who got grants approved early on, will also have more success later. If one can correct for quality of researchers and some other things, then does the effect remain, so that really the approval by itself has impact? How to correct for quality? The authors use a nice regression discontinuity design. In the Netherlands, applications are graded and all those passing a threshold are approved, those below aren't. Then, for applications just below the threshold and those just above, it is reasonable to assume that the researchers are of same quality and that the approval was random. So, here we control for quality and see if the approval in itself brings extra. The authors find that it does, where they investigate several other factors, and where it is often debatable to what extent those other factors are confounds to be corrected for or are not confounds but are the thing to be part of the Matthew effect and to be investigated. %}

Bol, Thijs, Mathijs de Vaan, & Arnout van de Rijt (2018) "The Matthew Effect in Science Funding," *Proceedings of the National Academy of Sciences* 115, 4887–4890.

{% %}

BolaÑos, Manuel J., Maria T. Lamata, & Serafin Moral (1988) "Decision Making Problems in a General Environment," *Fuzzy Sets and Systems* 25, 135–144.

{% Too much economics for me to understand. %}

Boldrin, Michele & Aldo Rustichini (1994) "Growth and Indeterminancy in Dynamic Models with Externalities," *Econometrica* 62, 323–342.

{% Argue for equal weighting in expert aggregation. %}

Bolger, Fergus & Gene Rowe (2015) "The Aggregation of Expert Judgment: Do Good Things Come to Those Who Weight?," *Risk Analysis* 35, 5–11.

{% **R.C. Jeffrey model** %}

Bolker, Ethan D. (1966) "Functions Resembling Quotients of Measures," *Transactions of the American Mathematical Society* 124, 292–312.

{% **R.C. Jeffrey model** %}

Bolker, Ethan D. (1967) "A Simultaneous Axiomatization of Utility and Subjective Probability," *Philosophy of Science* 34, 333–340.

{% **random incentive system between-subjects** (paying only some subjects): Analyzes it theoretically, and tests it, in an ultimatum game. Finds that paying all or doing this incentive system gives the same result, which is good news for the random incentive system. A Sefton (1992) paper will find differences. %}

Bolle, Friedel (1990) "High Reward Experiments without High Expenditure for the Experimenter," *Journal of Economic Psychology* 11, 157–167.

{% %}
Bolotin, David (1989) "The Concerns of Odysseus: An Introduction to the Odyssee," *Interpretation* 17, 41–57.

{% **social risks > nature risks in coordination games**
Point out what title says: In games with common interests (coordination games), people prefer social risks to nature risks. The authors write this clearly and explicitly. %}
Bolton, Gary E., Christoph Feldhaus, & Axel Ockenfels (2016) "Social Interaction Promotes Risk Taking in a Stag Hunt Game," *German Economic Review* 17, 409–423.

{% **crowding-out**: government subsidies seem to crowd-out private donations and charitable contributions. %}
Bolton, Gary E. & Elena Katok (1998) "An Experimental Test of the Crowding Hypothesis: The Nature of Beneficient Behavior," *Journal of Economic Behavior and Organization* 37, 315–331.

{% **equity-versus-efficiency** %}
Bolton, Gary E. & Axel Ockenfels (2006) "Inequality Aversion, Efficiency, and Maximin Preferences in Simple Distribution Experiments: Comment," *American Economic Review* 96, 1906–1911.

{% Groups are more risk averse than individuals because of social responsibility (enhancing caution and blaming for bad outcomes). Conformity has no directional effect because it can as well be conformity with more risk averse as with more risk seeking others. Preference for distributional fairness has no effect either. The authors used the stimuli of Holt & Laury (2002) to measure risk attitude. (**Prospect theory not cited**) %}

Bolton, Gary E., Axel Ockenfels, & Julia Stauf (2015) "Social Responsibility Promotes Conservative Risk Behavior," *European Economic Review* 74, 109–127.
https://doi.org/10.1016/j.euroecorev.2014.10.002

{% **conservation of influence**: on partial influence.
People only do partial influence, leaving future influences for crossing that bridge when we come to it (also contingent on state of nature), where such decisions are postponed based on a cost-of-decision calculation. Have results such as Proposition 3 (p. 1218): a reduction of uncertainty reduces the attractiveness of both complete planning and of complete nonplanning, and favors a step-by-step approach. %}

Bolton, Patrick & Antoine Faure-Grimaud (2009) "Thinking Ahead: The Decision Problem," *Review of Economic Studies* 76, 1205–1238.

{% P. 152: "general aversion to gambling with one's health, a "gambling aversion" which must be distinguished from the "risk aversion" familiar to student of decision analysis." Relates PE to TTO. %}

Bombardier, Claire, Alan D. Wolfson, Alexandra J. Sinclair, & Allison McGreer (1982) "Comparison of Three Preference Measurement Methodologies in the Evaluation of a Functional Status Index." *In* Raisa B. Deber & Gail G. Thompson (eds.) *Choices in Health Care: Decision Making and Evaluation of Effectiveness*, University of Toronto.

{% They observe choices of contestants in an Italian tv show (it is deal or no deal) and find that logarithmic utility fits the data well both for small and large stakes. NonEU does not improve, and they suggest that they do not find Rabin's discrepancy. However, their stimuli set may not be well suited to detect violations of EU. Further, logarithmic utility gives extreme risk aversion if the status quo is incorporated and given utility $\ln(0) = -\infty$.

The biggest problem in this study is that at each stage the authors model the decision not to accept (so, to continue playing) simply as the probability distribution over the remaining sums of money. In reality, continuing is more attractive because later new information will be received and relatively better bank offers will come. Many studies of these shows have shown that the bank offers at the beginning are indeed relatively more unfavorable than later. Hence, the authors take subjects as more risk seeking than they really are, especially at the beginning of the show when the offers still concern relatively low amounts of money. A second problem is that subjects who face low offers have been unlucky so far and will be in a frame of mind of facing losses and wanting to make up (as losing gamblers in a casino do not take their losses but go for ruin), wanting to break even, and increasing their risk seeking (as found by Post et al. 2008). Because of this complication, I disagree with the authors' discussions of Rabin's paradox and do not think that they provided counterevidence.

Another problem, and this one the authors do signal and analyze, is that the bank offers constitute a complex game. But an extra complication here is that not so much the real bank strategy, but rather the subject's perception of it, is relevant. %}

Bombardini, Matilde & Francesco Trebbi (2012) "Risk Aversion and Expected Utility Theory: An Experiment with Large and Small Stakes," *Journal of the European Economic Association* 10, 1348–1399.

{% **decreasing/increasing impatience**: provides theoretical arguments for the possibility of increasing impatience.

restrictiveness of monotonicity/weak separability: is violated in this theoretical paper because risk attitude depends on time. %}

Bommier, Antoine (2006) "Uncertain Lifetime and Intertemporal Choice: Risk Aversion as a Rationale for Time Discounting," *International Economic Review* 47, 1223–1246.

{% %}

Bommier, Antoine, (2007) "Risk Aversion, Intertemporal Elasticity of Substitution and Correlation Aversion," *Economics Bulletin* 4, 1–8.

{% **criticism of monotonicity in Anscombe-Aumann (1963) for ambiguity**: Criticizes separability of single states in Anscombe-Aumann framework. A similar criticism is in Wakker (2010 Section 10.7.3). Considers the Anscombe-

Aumann framework, but does not assume EU, or Anscombe-Aumann monotonicity, and only assumes monotonicity w.r.t. stochastic dominance; replacing, conditional on a horse, a lottery by a stochastically dominating lottery is preferred. Then, in the horse-state contingent model imposes the comonotonic sure-thing principle, giving the Green-Jullien-Chew-Wakker type representation there. Part of the analysis consists of replacing a horse-race contingent act by an equivalent objective lottery that has all cumulative events equivalent, in the spirit of cumulative dominance of Sarin & Wakker (1992). It can be considered to be a generalized version of matching probabilities. %}

Bommier, Antoine (2017) "A Dual Approach to Ambiguity Aversion," *Journal of Mathematical Economics* 71, 104–118. https://doi.org/10.1016/j.jmateco.2017.05.003

{% Consider Yaari's (1969) more risk averse than relation (worse certainty equivalents), but also generalizations with richer more-risky-than relations between prospects than only riskless-risky. Their theorems focus on when the distributions cross only once. They cCharacterize more-risk-averse than for various theories, including EU (called Kihlstrom-Mirman) and Quiggin's rank dependence (RDU). The Epstein-Zin model gives no clear results. In the general definition of RDU they assume general, nonlinear utility (Definition 1, u_2 there). But in the sufficiency proofs of Results 2 and 3, where convexity of w (they denote φ) is derived, they take utility linear. This may have come about as follows, as a colleague told me: The authors, in their appendix (but not in the main text) take the more-risk-averse than relation stronger than usually done. They let it imply not only same ordering of riskless outcomes, but also things like same additive representation up to AFFINE transformation, giving a sort of cardinal equivalence. Then being more risk averse than risk neutral, under RDU, automatically implies cardinally equivalent utility functions and, hence, linear utility under RDU. This is an inaccuracy in this paper.

P. 1617 takes vNM utility as additively separable not if it is a strictly increasing transform of an additively decomposable function, but only if it is that function itself.

P. 1616, as do many, cites Kihlstrom & Mirman (1974) on the strange claim that more risk averse comparison is possible only under the prior restriction of same ordering of riskless outcomes. Peters & Wakker (1987) show, to the contrary, … see my annotations of the K&M paper.

Many results are first presented for fifty-fifty lotteries (§3.2), e.g. regarding w(0.5) in RDU, and next for general lotteries (§3.3).

P. 1626 points out that we should acknowledge, rather than ignore by arbitrary choice, the problem that there is no unique definition of more-risk-averse-than, and then choose a definition of single crossing over of distribution functions ("simple spreads"). %}

Bommier, Antoine, Arnold Chassagnon, & François Le Grand (2012) "Comparative Risk Aversion: A Formal Approach with Applications to Saving Behavior," *Journal of Economic Theory* 147, 1614–1641.

{% They assume a group of experts reported their beliefs (mostly assumed additive probabilities) and decisions. They set up an ambiguity model where first the beliefs are aggregated, can be ambiguity-averse/pessimistic, and then an ambiguity model is used to derive decisions, for which they take Bommier's (2017) dual model. Of course, this procedure can violate the unanimity principle where one deviates from a *preference* unanimously held by all experts. %}

Bommier, Antoine, Adrien Fabre, Arnaud Goussebaïle, & Daniel Heyen (2021) "Disagreement Aversion," working paper.

{% Consider decisions with both risk and time involved, with infinite horizon. Study recursive preferences that satisfy monotonicity. Here monotonicity means that, given each state of nature, we have a preferred time profile. So, it first integrates over time and only then over uncertainty. They explain that this assumption is nontrivial because the underlying relation is, in my terminology, subjective (they use the term "not totally ordered") (**restrictiveness of monotonicity/weak separability**), and in Footnote 7, p. 1438, points out that monotonicity in Anscombe-Aumann is similarly nontrivial. (**criticism of monotonicity in Anscombe-Aumann (1963) for ambiguity**) I favor the term separability for such conditions instead of monotonicity. They also write that it comprises nontrivial separability. Epstein-Zin preferences are not included. They characterize some functional forms that specify their conditions, where Chew & Epstein 1990 papers are important.

P. 1437: stationarity and the slightly weaker history independence are considered. %}

Bommier, Antoine, Asen Kochov, & François le Grand (2017) "On Monotone Recursive Preferences," *Econometrica* 85, 1433–1466. https://doi.org/10.3982/ECTA11898

{% %}

Bommier, Antoine & François le Grand (2014) "Too Risk Averse to Purchase Insurance?," *Journal of Risk and Uncertainty* 48, 135–166.

{% %}

Bommier, Antoine & François le Grand (2019) "Risk Aversion and Precautionary Savings in Dynamic Settings, *Management Science* 65, 1386–1397.

{% Consider a dynamic setup with time consistency, consequentialism, and the restrictions they impose on inequality comparisons. %}

Bommier, Antoine & Stéphane Zuber (2012) "The Pareto Principle of Optimal Inequality," *International Economic Review* 53, 593–608.

{% %}

Bonanno, Giacomo & Klaus D.O. Nehring (1998) "Assessing the Truth Axiom under Incomplete Information," *Mathematical Social Sciences* 36, 3–29.

{% Law of maturity means that unlikely events will be more likely to occur in the future. Seems like the law of small numbers. Violates exchangeability. The authors reconcile it with a finite version of exchangeability. %}

Bonassi, Fernando V., Rafael B. Stern, Cláudia M. Peixoto, & Sergio Wechsler (2015) "Exchangeability and the Law of Maturity," *Theory and Decision* 78, 603–615.

{% %}

Bond, Gary & Bernard Wonder (1980) "Risk Attitudes amongst Australian Farmers," *Australian Journal of Agricultural Economics* 24, 16–34.

{% %}
Bondareva, Olga N. (1963) "Some Applications of Linear Programming Methods to the Theory of Cooperative Games" (in Russian), *Problemy Kibernet* 10, 119–139.

{% %}
Bone, John, John Hey, & John Suckling (1999) "Are Groups More (or Less) Consistent than Individuals?," *Journal of Risk and Uncertainty* 18, 63–81.

{% A nice paradox: A person can choose between UP or DOWN, and then between UP1 or UP2, or between DOWN1 and DOWN2. UP1 stochastically dominates all others, so, UP and then UP1 should be it. However, UP2 is extremely unfavorable, and people erroneously seem to take the UP option as something like a 50-50 choice between UP1 and UP2, because of which they prefer to go DOWN. They confuse their influence with randomness (**conservation of influence**). Nice! The authors interpret this finding as evidence that people do not plan. The conclusion is vague and broad, and I guess that more can be gotten from the paradox. %}
Bone, John, John D. Hey, & John Suckling (2009) "Do People Plan?," *Experimental Economics* 12, 12–25.

{% %}
Bonferroni, Carlo Emilio (1924) "La Media Esponenziale in Matematica Finanziaria," *Annuario del Regio Istituto Superiore di Scienze Economiche e Commerciali di Bari AA 23-24*, 1–14.

{% **probability communication**: a useful survey, giving many recommendations. %}
Bonner, Carissa, Lyndal J. Trevena, Wolfgang Gaissmaier, Paul K. J. Han, Yasmina Okan, Elissa Ozanne, Ellen Peters, Daniëlle Timmermans, & Brian J. Zikmund-Fisher (2021) "Current Best Practice for Presenting Probabilities in Patient Decision Aids: Fundamental Principles," *Medical Decision Making* 41, 821–833. https://doi.org/10.1177/0272989X21996328

{% **real incentives/hypothetical choice**; Tables 3-4 seem to show that real incentives mostly have no effect on performance. %}

Bonner, Sarah E.S., Mark Young, & Reid Hastie (1996) "Financial Incentives and Performance in Laboratory Tasks: The Effects of Task Type and Incentive Scheme Type," Department of Accounting, University of Southern California, Los Angeles, CA.

{% %}

Bontempo, Robert N. (1990) "Cultural Differences in Decision Making," *Commentary: Special Issue on Judgement and Decision Making*, published by the National University of Singapore.

{% %}

Boogaards, Erik & Peter P. Wakker (2009) "Doe de Polis-Check (en Bespaar Geld)," *Plus Magazine* 20 no. 11, 28–29.

Direct link to paper

{% **gender differences in risk attitudes**: Find that women are more risk averse than men. Because this study, unlike most other studies, separates utility curvature, probability weighting, and loss aversion, it can show that it is loss aversion where women are more extreme than men. **tradeoff method** %}

Booij, Adam.S. & Gijs van de Kuilen (2009) "A Parameter-Free Analysis of the Utility of Money for the General Population under Prospect Theory," *Journal of Economic Psychology* 30, 651–666.

{% Ask hypothetical WTP questions about payments with both risks and delays to a large sample representative of the working class of the Dutch population. Estimate average relative risk aversion (if no initial wealth assumed) to be 2, and discounting 6% per month. Typical thing of this study is that risk aversion and discounting are estimated jointly. Seem to find negative relation between discounting and risk aversion. %}

Booij, Adam S. & Bernard M.S. Van Praag (2009) "A Simultaneous Approach to the Estimation of Risk Aversion and the Subjective Time Discount Rate," *Journal of Economic Behavior and Organization* 70, 374–388.

{% **tradeoff method; inverse S:** Confirm it using the Goldstein & Einhorn (1987) and Prelec 2-parameter families. Reanalyze the data of Booij & van de Kuilen (2009) but now use parametric fitting, and add to it that they also estimate probability weighting; confirm all the findings of the earlier paper and find inverse S. Find loss aversion $\lambda = 1.58$. %}

Booij, Adam S., Bernard M.S. Van Praag, & Gijs van de Kuilen (2010) "A Parametric Analysis of Prospect Theory's Functionals," *Theory and Decision* 68, 115–148.

{% %}

Booker, Lashon B., Naveen Hota, & Connie L. Ramsey (1990) "Bart: A Bayesian Reasoning Tool for Knowledge Based Systems." *In* Max Henrion, Ross D. Shachter, Laveen N. Kanal, & John F. Lemmer (eds.) "U*ncertainty in Artificial Intelligence* 5," 271–282, North-Holland, Amsterdam.

{% Jack Stecher pointed out to me April 2015: Seems to have discussed a coin with unknown probability of landing heads. Argued that it would be incorrect to give p a "definite value" of 1/2. Instead, he thought it should receive an indefinite value of 0/0. %}

Boole, George (1854/2003) "The Laws of Thought." Facsimile of 1854 edn., with an introduction by J. Corcoran. Buffalo: Prometheus Books (2003). (Reviewed by James van Evra (2004) *Philosophy in Review* 24, 167–169.)

{% The following was pointed out to me by Jack Stecher (15Dec2017):
For events with no observations the probability is 0/0, i.e., undefined. P. 252: "Hence in the present theory the numerical expression for the probability of an event about which we are totally ignorant is not ½, but c [indeterminate]." Here c is a constant that can be anything between 0 and 1. A footnote on p. 251 cites Bishop Terrot, who seems to have had similar ideas before. Keynes (1921) p. 46 also seems to cite Boole and Terrot for it. %}

Boole, George (1862) "On the Theory of Probabilities," *Philosophical Transactions of the Royal Society of London* 152, 225–252.

{% They study distorted risk measures, which is essentially Yaari's RDU with linear utility. There can be several insurers with different beliefs (so, the probabilities are subjective) and different distortion functions, i.e., probability weighting functions. So, this all fits smoothly into the source method. %}

Boonen, Tim J. & Mario Ghossoub (2021) "Optimal Reinsurance with Multiple Reinsurers: Distortion Risk Measures, Distortion Premium Principles, and Heterogeneous Beliefs," *Insurance: Mathematics and Economics* 101, 23–37. https://doi.org/10.1016/j.insmatheco.2020.06.008

{% A thorough measurement of 1992 prospect theory (PT). They use the simple pragmatic measurement of Tanaka, Camerer, & Nguyen (2010). In the baseline (Glo: gains low) treatment three choice lists (the authors call them series) are measured, two with only gains and one with mixed prospect. In the Ghi treatment all outcomes are multiplied by 2. In the Llo (loss low) treatment the outcomes of Glo are multiplied by −1, and in the Lhi treatment the outcomes of Glo are multiplied by −2. The authors then do parametric fitting where they fit the most common parametric families, with logpower (CRRA) utility with different parameters for gains than losses, Prelec's two-parameter family with different parameters for gains than for losses, and λ denoting loss aversion. The authors implemented for real, for every subject, one Gain choice and one Loss choice. Although in practice it does not matter if we implement one or two choices, I regret that the incentive compatibility is theoretically lost. P. 598: they do not pay directly in money, but in experimental points, each worth half a cent.

losses from prior endowment mechanism: They do it.

The main findings are: Result 1. The usual findings of PT, with the fourfold pattern, utility concave for gains and convex (but some closer to linear by Result 2) for losses, are confirmed.

Result 3: no effect of doubling stakes, suggesting constant relative risk aversion (**decreasing ARA/increasing RRA**) although only measured for one doubling of stakes only and probably only a H_0.

Further Result: loss aversion is very volatile, depending much on treatment and parametric assumptions made.

The authors seem to find inverse S probability weighting, but write little about it.

They do report no difference between probability weighting for gains and for losses.

reflection at individual level for risk: they have the data but do not report much on it. Suggest a bit to confirm it in that most subjects have both concave utility for gains and convex utility for losses. %}

Bocquého, Géraldine, Julien Jacob, & Marielle Brunette (2023) "Prospect Theory in Multiple Price List Experiments: Further Insights on Behaviour in the Loss Domain," *Theory and Decision* 94, 593–636.
https://doi.org/10.1007/s11238-022-09902-y

{% Measure prospect theory for French farmers. %}

Bocquého, Géraldine, Forence Jacquet, & Arnaud Reynaud (2014) "Expected Utility or Prospect Theory Maximisers? Assessing Farmers' Risk Behaviour from Field-Experiment Data," *European Review of Agricultural Economics* 41, 135–172.

{% Show that SEU in the Anscombe-Aumann framework can be characterized by restricting axioms to a subset of acts, which contains all lottery acts, all act preferences with identity except for one horse. Then authors impose separability only for such acts. They do involve a mixture operation in it that directly implies mixture-independence and, hence, EU on roulette lotteries. %}

Borah, Abhinash & Christopher Kops (2016) "The Anscombe–Aumann Representation and the Independence Axiom: A Reconsideration," *Theory and Decision* 80, 211–226.
https://doi.org/10.1007/s11238-015-9498-8

{% Seems to argue that sure-thing principle is normative for all who think about it. %}

Borch, Karl H. (1968) "The Allais Paradox: A Comment," *Behavioral Science* 13, 488–489.

{% Relates moments approaches (mean-variance etc.) to EU, showing that usually mean-variance really violates EU. He seems to also have shown here that mean-variance violates stochastic dominance. %}

Borch, Karl H. (1969) “A Note on Uncertainty and Indifference Curves,” *Review of Economic Studies* 36, 1–4.

{% **maths for econ students**. %}
Borch, Karl H. (1974) “*The Mathematical Theory of Insurance.*” Lexington Books, Lexington, MA.

{% %}
Borcherding, Katrin, Thomas Eppel, & Detlof von Winterfeldt (1991) “Comparison of Weighting Judgments in Multiattribute Utility Measurement,” *Management Science* 37, 1603–1619.

{% Review of descriptive studies of behavioral influences on attribute weighting in MAUT.

Swing-method of determining decision weights qualitative strategies (e.g. letting most important dimension decide) is more likeley to be employed in qualitative method of choice; quantitative strategy such as making tradeoffs between dimensions is more likely to be employed in the quantitative method of matching. %}
Borcherding, Katrin, Stefanie Schmeer, & Martin Weber (1995) “Biases in Multiattribute Weight Elicitation.” *In* Jean-Paul Caverni, Maya Bar-Hillel, Francis Hutton Barron, & Helmut Jungermann (eds.) *Contributions to Decision Making* I, 3–28, Elsevier, Amsterdam.

{% The authors propose a model where probability estimations are obtained by retrieving cases from memory and weighing them based on similarity. They use this simple general framework to accommodate numerous phenomena from numerous fields, although they much focus on works by Kahneman and Tversky. Models like the authors’ have been known and widely studied in computer science, psychology, and many other fields under the name case-based reasoning. A model should not only accommodate but also predict and, hence, the authors state some qualitative predictions for which they find “strong experimental support.” This does not test their model in the same way as a test of risk aversion does not test the expected utility model. The authors use this “trick” in many of

their papers.

The authors are enthusiastic about their work and write: "Our analysis opens the gates for many research directions, and in conclusion we list three we find particularly promising." (p. 305 top) %}

Bordalo, Pedro, John J. Conlon, Nicola Gennaioli, Spencer Y. Kwon, & Andrei Shleifer (2023) "Memory and Probability," *Quarterly Journal of Economics* 138, 265–311.
https://doi.org/10.1093/qje/qjac031

{% This paper is based on a good and new intuition, but the modeling is problematic. There is a fundamental problem: the model is essentially intransitive (similarly as regret theory is), making it unsuited for virtually all applications in economics and finance. There is also a theoretical problem that needs further fixing: The model as written is too general with too many parameters. Before discussing more, here is the basic idea of the model.

====================

BASIC IDEA

(1) Assume states of nature that have objective probabilities (as with regret theory, although the latter also allows for subjective probabilities);

(2) consider only binary choices between two prospects, say x,y;

(3) let x and y have outcomes x_i and y_i for state s_i, and define the salience function $\sigma(x_i,y_i)$, specifying how salient state s_i is due to the outcome difference. σ is independent of i. "Ordering": it is increasing in the max of $\{x_i, y_i\}$ and decreasing in the min, like, for instance, the difference $|x_i-y_i|$.

(4) Transform decision weights of states in a somewhat complex way: Rank states by their salience value from largest (rank nr. $r_i = 1$) to smallest (rank nr. equal to nr. of states/outomes), so that each state s_i has a salience rank number r_i. So, salience is only used ordinally. Then adjust odds of all state pairs (s_i,s_j) by a factor $\delta^{(ri-rj)}$ where $0 < \delta \le 1$.

Classical EU results from $\delta = 1$ with no overweightings, and the smaller δ the more sensitivity to salience. (The formula is sound in the sense that readjusting the odds of s_i and s_j, and then of s_j and s_k, gives the right adjustment of s_i and s_k. Getting this soundness in is nontrivial. It is reminiscent of Birnbaum's RAM and

TAX models, where probability weights are moved from some states to others as terms.) In this way we can overweigh the salient states. There is a cealing effect in the sense that small probabilities are more overweighted than large ones can be. (This could hardly be otherwise numerically; here a weighting of goodnews probabilities, as in rank dependence, would be worthwhile.) Note that this ranking part is independent of the probability of the state, which will generate discontinuities under convergence to null. There will also be discontinuities of outcomes pass some levels. The authors mention the latter discontinuity on p. 1255. This part also brings in interactions between different states, not precluded by the sure-thing principle, which is not very restrictive in the absence of transitivity. This part is a new part of the theory, distinguishing it from regret theory by having more interactions between states. However, the authors are not strong on this aspect, appearing from their p. 1255, discussed more below.

(5) There is a reference point, and salience becomes less as outcomes, in absolute sense, move farther away from the reference point. The paper therefore favors, in examples, not using the difference $x_i–y_i$, but rather $\sigma(x_i,y_i) = |x_i - y_i|/(|x_i| + |y_i|)$, to assess salience. For doing this, the reference point is crucial.

=====================

THE GOOD INTUITION

As regards the good intuition of salience theory, prospect theory assumes that the state (of nature ≈ event) generating the largest outcome, and the state generating the lowest outcome, are overweighted; they are salient. It is just as plausible that, when comparing two prospects, the state with the largest DIFFERENCE in outcomes (or a transformation of difference) is salient and gets extra weight. The idea that people directly compare outcomes of a prospect to outcomes of the competing prospect before any aggregation of the prospect's value is not new (regret theory has it too, and other theories have it also; it is the basis of the tradeoff concept that I used in many papers). To let this lead to overweighting of large differences is not new either (regret theory has this too, again, and it is central in regret theory). But to model these things through state weighting rather than through utility is new. It makes salience theory an interesting counterpart to regret theory. Salience theory modifies prospect theory as regret theory modified expected utility. Modeling the extra weighting through event weights, as salience theory does, seems more natural to me than modeling it through outcomes and utility as regret theory does. Hence, salience theory can turn into an improved version of regret theory.

Moderating this pro: It is also plausible that people sometimes UNDERweight states with big differences, in something like diminishing sensitivity with respect to difference. If one prospect yields €1 more in 5 states, and €5 less in one state, then being better five out of six times may decide. Similarly, later studies in regret theory found no clear empirical evidence for its original hypotheses of overweighting of big differences. Salience theory can easily accommodate these things by allowing their δ to exceed 1, and I recommend using this generalization.

FIRST PROBLEM (INTRANSITIVITY)

The essence of transitivity is that each prospect is evaluated on its own, independently of the other prospects it is competing with. To wit, skipping minor technicalities, if transitivity holds, then there exists a function V such that, for all prospects x,y, we have $x > y$ if and only if $V(x) > V(y)$. It means that when evaluating x by V(x), we do not even look at its competitor y. This excludes anything like salience. The essence of salience theory (and the above good intuition) is that the evaluation of a prospect does depend on the one it is competing with (only binary choice is treated). Here salience theory is like regret theory. The essence of salience is violating transitivity, and it doesn't bring any novelty outside intransitivity. Problem 1a: Intransitivity entails irrationality at a basic level. For most work in economics and finance such irrationalities are of no interest. Salience theory can, therefore, only be of use in psychologically oriented applications, such as understanding behavior of subjects in labs, and in marketing for instance where such irrationalities are also important. Problem1b: Intransitive models are intractable. It is not clear how to choose from more than two prospects (the web appendix has suggestions but their dependence on whole choice set is too general to be tractable). It even is not clear how to define optimality. Thus, quantitative assessments are hard to imagine, as it is with regret theory. For these reasons, regret theory hasn't been used in quantitative applications, and with salience theory it will be the same. The only paper that measured regret theory quantitatively is Bleichrodt, Cillo, & Diecidue (2010

Management Science), using my tradeoff technique (☺), and this may also work for measuring the salience function.

SECOND PROBLEM

To explain the second problem, expected utility has one one-variate function, utility of money, as parameter. Prospect theory has two such one-variate functions, with probability weighting in addition (and one more number, loss aversion; I assume the reference point fixed, here as with salience theory). Salience theory has a two-variable function, the salience $\sigma(x,y)$ as function. This is much larger generality, and it is something like infinitely many univariate functions. (There is also one more number, being δ; I assume loss aversion is also good to add). This is way too general. Good subfamilies with fewer parameters will have to be developed. Eq. 5, p. 1250, gives a tractable subfamily, but it will take more to prove its value. Regret theory faced the same problem, with two-variable $U(x_i,x_j)$ too general. They quickly went for the special case $\varphi\big((U(x_i)–U(x_j)\big)$ with φ a nonlinear univariate function. Salience theory may go for $\varphi(|x_i–x_j|/(|x_i|+|x_j|)$, similar to their Eq. 5 (p. 1250).

Related to the second problem, there is no preference foundation (properly mentioned as an open problem on p. 1259 end of §III), and no verification of natural conditions such as continuity (will fail for probabilities tending to 0 for instance) or some kinds of monotonicity with respect to outcomes; or, for that matter, transitivity is violated. The editing operations generate discontinuities and suggest other anomalies. There also is no way to measure/calibrate the functions, as in describe-predict. It is not discussed if they are at all identifiable. There are no quantitative assessments, which I think will be very hard at the present stage, and there are hardly ways to falsify the general theory (mostly the sure-thing principle is; see below). The theory does add some qualitative assumptions, and all tests and predictions concern those qualitative assumptions rather than the theory itself. Similarly, a test of risk aversion is not a test of the expected utility model. On the positive side, the two qualitative assumptions are plausible and they well predict right directions in the many examples chosen. It is obvious that the theory captures something substantive.

Because of its many parameters, salience theory can accommodate almost everything, and the paper gives many examples, but it is almost impossible to falsify the theory. This second problem, concerning the theoretical problems, can be fixed if specific subfamilies are developed, and possibly some changes are made to the decision model itself.

The only clearly restictive (so, falsifiable, which is desirable) implication that I see (explained on pp. 1259 and 1267 for instance) is the sure-thing principle: States with the same outcome for both prospect have 0 salience and can be ignored, so that it does not matter if the common outcome is changed there. I add here that the sure-thing principle is not very restrictive under intransitivity. Under transitivity it amounts to completely excluding interactions between disjoint events, but here it need not. Tradeoffs between two states can be affected by a third state, which can interfere via the salience rankings I guess.

DETAILS

- Throughout, the authors do not make sufficiently clear, and do not sufficiently realize, that the essence of their theory lies in violating transitivity. They mention intransitivities once casually (p. 1246 ℓ. −4). Near the bottom of p. 1259 they claim a positive result on transitivity on a subdomain (meaning their theory does not bring anything new there!). And at the bottom of p. 1273 they criticize intransitivity of regret theory.

- The editing of the paper is not very good. Footnote 10 (p. 1255), referring to empirical measurements of probability weighting, an active field during the last two decades, cites only one 1996 paper, (nonincentivized and) 16 years old at the time of appearance of this salience paper (2012), and calls it “recent.” Pp. 1257-1258 out of the blue discuss contexts with apparently more than two choice options (whereas the paper restricts to binary choices), with vague claims and a vague consideration set (can be bigger than the choice set, but also smaller …). The idea about prospects that are permutations of each other at the bottom of p. 1257 is vague and ad hoc. (One problem: It matters much which of the permutations is randomly kept, because the correlation with other prospects matters.) When referring to “Both forms of editing” the paper means, besides the permutation idea, also the removal of dominated prospects.

- The paper does not use the terms risk seeking (and risk aversion) in the usual way, but risk seeking means choosing the riskier of two prospects. For example, a preference $100_{0.9}0 \succ 50$ is called risk seeking.

- I regret that the authors throughout use original 1979 prospect theory, and not the corrected 1992 version (e.g., footnote 2 on p. 1248 does not help).

- The differences with regret theory listed on p. 1259 1st para are not important: Adding framing, reference dependence, and reflection in the definition of regret theory can trivially be done; the non-trivial parts of these moves, maintaining tractability, is not done by salience theory either. Salience theory is a weighting-counterpart of utility-regret theory. But providing such a counterpart is interesting enough! However, the authors do not have a strong opinion on this counterpart-point at all. P. 1255, in passing by, mentions a "continuous" variation of the theory. Here odds are adjusted simply by multiplying the weight of a state s_i by a function $f(\sigma(x_i,y_i))$. One can then renormalize but, given that the preference functional is unique up to multiplication by any positive function g(x,y) that can entirely depend on gambles x and y (only its sign matters), this is not important. Anyway, then salience theory is simply a special case of generalized regret theory:

$$\sum_{j=1}^{n} V(x_i,y_i).$$

It seems that in 2021 most authors take salience theory in this manner, which I would call regret theory rather than salience theory. See Herweg & Müller (2021) and Herweg & Müller (2021). Pfff! Such is marketing in research. Then there is an ocean of theoretical work by Fishburn and Karl Vind on it. Then there is no novelty in salience theory!

P. 1259 2nd para is neither to the point. First, ordering and diminishing sensitivity do not make strong predictions, being only qualitative (although still good in their kind). Second, regret theory and the SSB theories by Fishburn (1982) also satisfy the sure-thing principle (although Fishburn 1982 concerns decision under risk and the analog there is bilinearity; other papers by him are directly for uncertainty and directly have the sure-thing principle there). As an aside, Vind (2003) provides advanced mathematics on intransitive preferences, where the sure-thing principle can still be satisfied. Third, the transitivity and dominance for independent prospects, suggested as a positive result, in fact means that salience theory has nothing new to offer there.

P. 1264: The violation of prospect theory is not tight: The common view is that utility (value) becomes less concave as stakes increase, and then risk aversion may turn into risk seeking (risk seeking by w may start to dominate the concavity of utility for high stakes). The footnote ater only claims that the common calibrations of prospect theory do not accommodate, which is a weaker criticism. The more so as no common calibration of salience theory is available yet.

P. 1267 ff. put forward as defense of salience theory, that the predicted sure-thing principle holds in framing that make the common consequence event clear. This is indeed a positive argument. It is weakened though because several people have argued that such independence of common consequence may reflect a heuristic that subjects use to simplify their task, rather than their preference. (This also weakens the, still positive, argument discussed on p. 1270, regarding what Kahneman & Tversky (1979) called the pseudo-certainty effect (term not used in this paper).) Important: A psychological effect such as salience perception will not be restricted within a state but it will be global, generating violations of the sure-thing principle.

P. 1276 claims as positive point that salience theory can explain the fourfold pattern while assuming linear utility, whereas prospect theory supposedly could not do this. This is incorrect. Prospect theory also predicts the fourfold pattern if utility is linear, where it then is generated by probability weighting. P. 1278 incorrectly writes: "In prospect theory, the main driver of risk attitudes is the curvature of the value function." In PT, probability weighting is also a big driver or risk attitude (and also loss aversion, taking this "kink" not to be part of utility curvature).

The authors throughout use the term local thinker to refer to an agent behaving according to their theory. I guess local means missing things. In this way everything can be called local. The prospect theory probability weighting function means that people pay too much attention to small probabilities and too little to large probabilities. So, they are missing the importance of large probabilities. Why not call this local?

CONCLUSION. Positive: The basic intuition, that states with large *differences* of outcomes are overweighted, is good. Modeling it through event weighting is good and more natural than regret theory's modeling through outcome utility. The qualitative assumptions of ordering and diminishing sensitivity work well to accommodate many findings. Negative: Biggest restriction is that intransitivity is the essence of the theory, limiting usefulness for economics and finance, and not well realized or presented by the authors. A problem that may be fixed (further work and creativity needed here) is that the model as is, especially with the bivariate salience function, is too general. There are no preference conditions to suggest that the model chosen is natural, and several aspects of it are not. Another problem is that the authors do not compare well with regret theory and prospect theory. Different fields should be able to exchange inputs and, therefore, this is not a serious problem. %}

Bordalo, Pedro, Nicola Gennaioli, & Andrei Shleifer (2012) "Salience Theory of Choice under Risk," *Quarterly Journal of Economics* 127, 1243–1285.

{% Show that salience theory can accommodate the endowment effect. %}

Bordalo, Pedro, Nicola Gennaioli, & Andrei Shleifer (2012) "Salience in Experimental Tests of the Endowment Effect," *American Economic Review, Papers and Proceedings* 102, 41–46.

{% Show that salience theory can accommodate may phenomena. Problem is that salience can accommodate too many phenomena. Again there is no discussion of the violations of transitivity. The conclusion compares with probability weighting of prospect theory and, incorrectly, claims that the overweighting of small probabilities would imply that risk aversion would increase in good times and decrease in bad times. Here is the sentence with the mistake: "In a recession, when the objective probability of left-tail payoffs increases, standard probability weighting would imply that the low payoff will be less overweighted than before." If the probability increases from 0 (or something very small) to ε, the overweighting will INCREASE. Another problem for the authors, also underlying the preceding reasoning, can be inferred from the sentence in the conclusion where they try to separate salience theory from prospect theory: "In our model, extreme payoffs are overweighted not because they have small probabilities but because they are salient relative to the market payoff." Here one sees, as in the other papers by the authors, being that they go by the outdated and incorrect 1979 version of prospect theory, and not by the updated and corrected version of 1992. In the latter, not the small probability of an outcome makes it being overweighted, but the extremity of being best or worst. Which is as close to salience as one can get without giving up transitivity. %}

Bordalo, Pedro, Nicola Gennaioli, & Andrei Shleifer (2013) “Salience and Asset Pricing,” *American Economic Review, Papers and Proceedings* 103, 623–628.

{% **SIIA/IIIA** %}

Bordes, Georges & Nicolaus Tideman (1991) “Independence of Irrelevant Alternatives in the Theory of Voting,” *Theory and Decision* 30, 163–186.

{% A nicer result is in Kim (1996). (So, there Kim is not first name but family name). I assume that the reader red my annotations there, such as on Border’s nice discussion of observability. Border considers the special case where the outcome set is a compact subset of $\mathbb{R}$, such as a bounded closed interval. As often, the more general the result (such as Kim’s), the nicer and more accessible. Border has the special case where we can have stochastic dominance, and “misuses” it to state the preference condition involving stochastic dominance. His condition now varies on Kim’s by requiring that the probabilistic mixture $\sum_{j=1}^{n} \lambda_j Q^j$ should not stochastically dominate $\sum_{j=1}^{n} \lambda_j P^j$. This is more complex than Kim’s condition. It is also more restrictive, because one can always add some stochastic-dominance preferences to Border’s condition to turn it into Kim’s condition.

Border, in turn, is mathematically very close to Fishburn (1975, Theorem 3), but makes it quite nicer, by reinterpreting Fishburn’s duality weights as prior mixing conditions. See my annotations to Kim (1996) for those interpretations.

Border extends Fishburn’s Theorem 3, in Border’s main Theorem 2.4, to general, possibly infinite, sets of preferences, by adding continuity conditions, such as the set of outcomes being a compact subset of the reals, being money. Late, only on p. 31 para -3, Border writes that Fishburn (1975) [5] is closests. This is important for novelty and would better have been stated in the intro.

A nice sentence is on p. 30: “One way to view my results is that they describe when this partial ordering has an extension to a continuous total ordering which satisfies the independence axiom.” (**desirable to extend preferences while satisfying/maintaining conditions**:) %}

Border, Kim C. (1992) “Revealed Preference, Stochastic Dominance, and the Expected Utility Hypothesis,” *Journal of Economic Theory* 56, 20–42. https://doi.org/10.1016/0022-0531(92)90067-R

{% Show that if $P_1,\ldots,P_n$ are nonatomic countably additive probability measures on a measurable space S, A, where A is a sigma-algebra on S, then there is a subsigma algebra B of A on which all P's agree, and such that for every p in [0,1] there is an event in B taking that probability. %}

Border, Kim C., Paolo Ghirardato, & Uzi Segal (2008) "Unanimous Subjective Probabilities," *Economic Theory* 34, 383–387.

{% Many have alluded to strategic complications in the **Dutch book** game. The authors analyze these strategic complications formally by really considering the book making situation as a game. People can then deviate from Bayesianism. The results are enforced by the author's 2002-JMP-paper. %}

Border, Kim C. & Uzi Segal (1994) "Dutch Books and Conditional Probability," *Economic Journal* 104, 71–75.

{% **Dutch book**; p. 181-182 describes strange Dutch book; **dynamic consistency** %}

Border, Kim C. & Uzi Segal (1994) "Dynamic Consistency Implies Approximately Expected Utility Preferences," *Journal of Economic Theory* 63, 170–188.

{% **Nash bargaining solution** %}

Border, Kim C. & Uzi Segal (1997) "Preferences over Solutions to the Bargaining Problem," *Econometrica* 65, 1–18.

{% Follows up on their 1994 EJ paper and proves stronger results, where an equilibrium can necessitate the book maker to use nonadditive odds. %}

Border, Kim C. & Uzi Segal (2002) "Coherent Odds and Subjective Probability," *Journal of Mathematical Psychology* 46, 253–268.

{% **foundations of quantum mechanics** %}

Bordley, Robert F. (1995) "Relating Probability Amplitude Mechanics to Standard Statistical Models," *Physics Letters A* 204, 26–32.

{% %}

Bordley, Robert F. (1998) "Quantum Mechanical and Human Violations of Compound Probability Principles: Toward a Generalized Heisenberg Uncertainty Principle," *Operations Research* 46, 923–926.

{% %}
Bordley, Robert F. & Gorden B. Hazen (1991) "SSB and Weighted Linear Utility as Expected Utility with Suspicion," *Management Science* 37, 396–408.

{% Two different **small worlds** X and Y are two different partitions of the state space S. Their junction leads to receipt of two-dimensional outcomes (x,y). The utility assesments of these pairs can have all kinds of forms. If x and y are correlated, then. %}
Bordley, Robert F. & Gorden B. Hazen (1992) "Nonlinear Utility Models Arising from Unmodelled Small World Intercorrelations," *Management Science* 38, 1010–1017.

{% P. 57 2nd para in Kyburg & Smokler (1964) discusses that subjective probabilities can be calibrated using matching probabilities. %}
Borel, Émile (1924) "A Propos d'un Traité de Probabilités," *Revue Philosophique* 98, 321–336.
Reprinted as Note II in Émile Borel (1939) "*Valeur Pratique et Philosophique des Probabilités.*" Gauthier-Villars, Paris.
Translated into English as "Apropos of a Treatise on Probability."
Reprinted in Henry E. Kyburg Jr. & Howard E. Smokler (1964, eds.) *Studies in Subjective Probability*, Wiley, New York (not Reprinted in 2nd, 1980, edn. of the book).

{% Pp. 6-7 seems to say that on the human scale negligible probability is 10^{-6}, on terrestrial level 10^{-15}, and on the cosmic level 10^{-50}.
§39, p. 73 and §48, pp. 84-86, discuss that subjective probabilities can be calibrated through gambles on objective probabilities
Pp. 60-66 discusses St. Petersburg paradox; %}

Borel, Émile (1939) "*Valeur Pratique et Philosophique des Probabilités*." Gauthier-Villars, Paris.

{% Seem to argue that economic subjective attitude indexes such as risk aversion and discounting should be submitted to the same psychometric standards, e.g., test-retest reliability (≥ 0.7 correlation is desirable), as personality traits in psychology. %}

Borghans, Lex, Angela L. Duckworth, James J. Heckman, & Bas ter Weel (2008) "The Economics and Psychology of Personality Traits," *Journal of Human Resources* 43, 972–1059.

{% **real incentives**: Cumulative payments, with income effects (subjects were informed about cumulative earnings throughout, p. 653). Average earning per subject is €21.30, average time of experiment 1.5 hour.

N = 347 high-school students aged 15/16. Tested 4 urns of 2 colors, first fifty-fifty so risk, then bit ambiguity ($0.4 \leq p \leq 0.6$, then more, $0.2 \leq p \leq 0.8$, then all $0 \leq p \leq 1$). P. 650 3rd para says these are Halevy urns, but this is not so.

suspicion under ambiguity: ambiguity tests: subjects can choose color, which controls for suspicion (though maybe illusion of control).

Women are more risk averse than men (**gender differences in risk attitudes**). Psychometric scales are related to risk attitude but not to ambiguity attitudes (p. 655, 657). Men are more ambiguity averse than women, which disappears after correcting for risk attitude (which I do not understand but did not read in detail).

correlation risk & ambiguity attitude: although a central theme of the paper is that ambiguity is different than risk (their correlation is not 1), the actual correlation of these two is not reported. %}

Borghans, Lex, Bart H.H. Golsteyn, James J. Heckman, & Huub Meijers (2009) "Gender Differences in Risk Aversion and Ambiguity Aversion," *Journal of the European Economic Association* 7, 649–658.

{% Shows that s.th.pr. is implied by vNM independence, and the other way around if continuity. %}

Borglin, Anders (1993) “Conditional Preferences of a Savage Agent Who Satisfies Savage-Independence and Is Consistent with a von Neumann-Morgenstern Agent,” Institute of Economics, University of Copenhagen, Denmark.

{% **ambiguity attitude taken to be rational**: Apply not only SEU, but also the smooth model and maxmin (which can be taken as a limiting case of smooth) ambiguity models to some decision analysis problems, with decision trees. They connect well with the decision analysis literature and terminology, considering decision trees and referring to simulation techniques. They calculate risk and ambiguity premiums. In the smooth model, they seem to take the two-stage setup as exogenously given, although not very explicitly.

§7 then analyses a well-known decision example used for illustration in the decision analysis literature: the Carter racing case study. I must admit that I did not understand part of the notation here, apparently not having read the paper in sufficient detail. The discussion section 7.1 is more positive about ambiguity than I Bayesian could be. The end of the discussion properly mentions that a dynamic implementation of nonEU is nontrivial. I think that no nonEU model will survive any dynamic implementation for normative purposes. The strongest arguments in favor of Bayesianism come from dynamic consistency type conditions, the violation of which no rational agent should desire. %}

Borgonovo, Emanuele & Massimo Marinacci (2015) “Decision Analysis under Ambiguity,” *European Journal of Operational Research* 244, 823–836.

{% Shows that incomplete preference relation over lotteries satisfying independence can be extended to a complete one. Gives a lexicographic representation. (**extending preference relations using conditions**) %}

Borie, Dino (2016) “Lexicographic Expected Utility without Completeness,” *Theory and Decision* 81, 167–176.
https://doi.org/10.1007/s11238-015-9523-y

{% **Ambiguity = amb.av = source.pref, ignoring insensitivity**: this paper does it (Definition 1), but in the maxmin EU model, where it is this way because of the restrictive nature of maxmin EU. Definition 1 defines as unambiguous events that have source preference over all other events. This holds iff al priors assign the

same probability to the event. Priors should be finitely additive and need not be countably additive.

The paper works with Savage-type richness in the sense that every element of the set of priors is convex-ranged (what is sometimes called atomless). Theorem 1 axiomatizes maxmin EU with this as only restriction. Very nice! A similarly nice derivation but with richness of outcomes is in Alon (2022), not cited here.

Key in this paper is a division of an ambiguous event A into two equally likely events $A \cap E$ and $A \cap E^c$ where E is unambiguous, so that E serves as an independent randomization device reminiscent of the Anscombe-Aumann framework. This follows if E is unambiguous and $A \cap E$ and $A \cap E^c$ are exchangeable in the sense that

$$E^c = (A \cap E^c) \cup (A^c \cap E^c) \sim (A \cap E) \cup (A^c \cap E^c).$$

In any multiple priors model, this readily implies that $P(A \cap E) = P(A \cap E^c)$ for all priors P. If such a thing is possible for each event, then it becomes possible to define endogenous fifty-fifty mixtures of acts f and h, denoted g. Take any event $A = \{s: f = \alpha \text{ and } h = \gamma)$, divide it into two halves as above, and let g take value α on one half and value γ on the other. Axiom 9 assumes that such is possible for each act. That this can be done if the case is isomorphic to Anscombe-Aumann is easy to see. But the surprising (to- me) thing is that this is always possible if all priors in the set of priors are convex-ranged (Axiom 9). The derivation is, I assume, in the spirit of Liapunov (1940). To illustrate, assume that P and Q are defined on [0,1), $P([0,1/2)) = 1/3$, $P([1/2,1)) = 2/3$, but $Q([0,1/2)) = 2/3$, $P([1/2,1)) = 1/3$, and both P and Q are uniform on [0,1/2) and [1/2,1). Then we can divide the event A = [0,1) into two halves as $[0,1/4) \cup [1/2, 2/4)$ and $[1/4,1/2) \cup [3/4,1)$, which both have probability 0.5 under both P and Q. Similar things can always be done, apparently, for any set of priors, even if infinite, that are all convex-ranged, and even if only finitely additive. This is all somewhat reminiscent of Machina (2004), who showed that in a rich-enough Savagean statespace one can always specify events with objective probabilities, although he heavily uses differentiability in the statespace.

Important axioms are:

Axiom 2.1 [unambiguous sure-thing principle]: consider f_A (act f restricted to event A) and f'_A to be unambiguous if f_Ax and f'_Ax are unambiguous for some

outcome x (my interpretation). Then we have $f_Ag \succcurlyeq f_Ag' \Leftrightarrow f'_Ag \succcurlyeq f'_Ag'$\
Axiom 2.2 [homotheticity]: If, for unambiguous events E,F and outcome x, f_Ex is subjective midpoint of act f and outcome x and g_Fx is subjective midpoint of act g and outcome x, then $f \succcurlyeq g \Leftrightarrow f_Ex \succcurlyeq g_Fx$.
Axiom 3 [Mixture monotonicity] I did not try to understand.
Axiom 4 (Savage's P4)
Axiom 6 [Ambiguity Aversion] $f_Ag \sim f_Ag' \Rightarrow f'_Ag \succcurlyeq f'_Ag'$ whenever f_Ag' is unambiguous. Further, if ~ is replaced by ≻ then there is ≻ in the conclusion. The axiom says that turning part of an unambiguous act into ambiguous always does more harm there than the same turning in an ambiguous act. The idea is that interactions in the ambiguous act can bring desirable hedging, which will not happen in the unambiguous act.
Axioms 8 and 9 are the only ones not necessary for maxmin EU: Axiom 8 is unambiguous solvability and Axiom 9 is discussed above.

P. 2 end of 2nd para is naïve in claiming that in medical decisions one faces only a few deterministic consequences.

Many motivations in this paper agree with my opinions. For instance, p 2 top indicates that ambiguity aversion can be different than probabilistic mixture preference. (I called equating the two a historical mistake in my 2010 book.) A drawback of the axioms in this paper is that it heavily uses the endogenous midpoint operation in its axioms, where that operation is not directly a (preference) primitive but a derived concept (**derived concepts in pref. axioms**). But the author is aware of it and discusses it p. 4 penultimate para. I did a similar thing in my youth when used derived tradeoffs, but always verified that the rewritings directly in terms of preferences were not complex, as appears from its use in many experiments. See the keyword **tradeoff method**.
A difference in motivation: the paper takes unambiguous endogenous whereas I prefer it exogenous.

Section 4 presents comparative ambiguity aversion but, as common in the field, uses the Yaari-type certainty-equivalent condition (extended to subjectively unambiguous acts) that only works if everything else than the thing to be compared is identical. Here, the utility functions must be the same. Given that, we get the Yaari-type condition if and only if one set of priors is contained in the other. Which still is a thin ordering leaving most things incomparable. %}

Borie, Dino (2023) "Maxmin Expected Utility in Savage's Framework," *Journal of Economic Theory* 210, 105665.
https://doi.org/10.1016/j.jet.2023.105665

{% **completeness criticisms**: Brings in incompleteness in Savage (1954) by a set of EU models where preference only holds of unanimous. Here the EU models in the set may differ both in utility and in probability measure. Bewley (1986, 2002) had such a model where only the probabilities can vary, but it is one fixed utility function. Another difference is the Bewley used an Anscombe-Aumann framework whereas this paper uses a Savage-type richness of events with general outcomes. Efe Ok and co-authors worked on related models. %}

Borie, Dino (2023) "Expected Utility in Savage's Framework without the Completeness Axiom," *Economic Theory* 76, 525–550.
https://doi.org/10.1007/s00199-022-01464-y

{% Do simulation to see effects of publication bias. This study could appear in any academic journal. %}

Borm, George F., Martin den Heijer, & Gerhard A. Zielhuis (2009) "Publication Bias Was not a Good Reason to Discourage Trials with Low Power," *Journal of Clinical Epidemiology* 62, 47–53.

{% %}

Bornemann, Ernest (1976) "*The Psychoanalysis of Money*." Urizen Books, New York.

{% %}

Bosch, Johanna L. & Maria G.M. Hunink (1996) "The Relationship between Descriptive and Valuational Quality-of-Life Measures in Patients with Intermittent Claudication," *Medical Decision Making* 16, 217–225.

{% **losses from prior endowment mechanism**: Did this, but very carefully, where 32 subjects received a prior endowment and then had to return 3 months later, giving them as much chance as possible to integrate the prior endowment into their reference point. 30 subjects indeed returned to undergo the losses from their prior endowment. Nice again, they asked about subjects' perception. About 25% or 30% suggested that they do not consider the later losses as losses because they integrate with the prior endowment. The data were not very good for prospect theory, but I forgot details now in August 2006 (about month after hearing lecture). %}

Bosch-Domènech, Antoni & Joaquim Silvestre (2010) "Averting Risk in the Face of Large Losses: Bernoulli vs. Tversky and Kahneman," *Economics Letters* 107, 180–182.

{% Consider a bias in the Holt Laury (2002) risk aversion measurement that results from adding/removing some options. The method of Abdellaoui, Driouchi, & l'Haridon (2011) is found not to be subject to such biases. %}

Bosch-Domènech, Antoni & Joaquim Silvestre (2013) "Measuring Risk Aversion with Lists: A New Bias," *Theory and Decision* 75, 465–496.
https://doi.org/10.1007/s11238-012-9332-5

{% %}

Bosch, Johanna L., James K. Hammitt, Milton C. Weinstein, & Maria G.M. Hunink (1998) "Estimating General-Population Utilities Using One Binary Gamble Question per Respondent," *Medical Decision Making* 18, 381–390.

{% **risk seeking for symmetric fifty-fifty gambles**: they don't have fifty-fifty gambles, but do find risk seeking for small amounts.

PT falsified.

Consider gains and losses, and probabilites 0.20 and 0.80 of getting the gain or loss.

Compare $\$80_{0.2}\$0$ and $-\$80_{0.2}\$0$). Can be done in two steps: Step 1, translation by subtracting \$80, so that $\$80_{0.2}\$0$ is changed into $\$0_{0.2}{-}\$80$. Step 2, switching good- and bad-outcome probability, so that $\$0_{0.2}{-}\$80$ is changed into $\$0_{0.8}{-}\$80$.

They find that translation from gains to losses always increases risk seeking, both for high-probability and for low-probability for best outcome. They find that switching probability of bad outcome from 0.2 to 0.8 always increases risk seeking, both for gains and for losses.

Testing reflection for high-probability nonzero has translation and switch go in same direction, enhancing risk seeking for losses. Testing reflection for low-probability nonzero has translation and swiches go in opposite directions. In prospect theory, probability weighting and utility curvature have opposite effects for small-probability-nonzero-outcomes, although they both support the reflection effect because they both switch from gains to losses.

Also consider seven different stakes. People are risk averse for high stakes and risk seeking for small, for high and low probabilities and for gains and losses (**probability weighting depends on outcomes**). Maybe some **utility of gambling** generating the risk seeking for small amounts!? So that we may want to avoid small-amount prospects, considering this just a bias? %}

Bosch-Domènech, Antoni & Joaquim Silvestre (2006) “Reflections on Gains and Losses: A 2×2×7 Experiment,” *Journal of Risk and Uncertainty* 33, 217–235.

{% Wealthy are more risk seeking at low stakes but, strangely enough, the poor at high stakes. %}

Bosch-Domènech, Antoni & Joaquim Silvestre (2005) “Do the Wealthy Risk More Money? An Experimental Comparison,” CREA, University Pompeu Fabra, Barcelona.

{% Auctions with ambiguity aversion (ε contamination) give different results than under EU. %}

Bose, Subir & Arup Daripa (2009) “A Dynamic Mechanism and Surplus Extraction under Ambiguity,” *Journal of Economic Theory* 144, 2084–2114.

{% Assume a finite number of observations from budget sets that contain event-contingent payoffs (acts). Give necessary and sufficient conditions for these choices to maximize maxmin EU or the smooth model. The conditions given are not directly in terms of preferences, but instead require existence of sets of

probabilities, utilities, and so on, such that their necessary and sufficient condition is satisfied. %}

Bose, Subir, Matthew Polisson, & Ludovic Renou (2012) "Ambiguity Revealed."

{% Introduces ambiguity averse (maxmin EU) agents into mechanism design. %}

Bose, Subir & Ludovic Renou (2014) "Mechanism Design with Ambiguous Communication Devices," *Econometrica* 82, 1853–1872.

{% %}

Bosi, Gianni (1995) "Linear Representations of Preference Relations on a Mixture Set," Trieste, Italy.

{% %}

Bosi, Gianni & Gerhard Herden (2012) "Continuous Multi-Utility Representations of Preorders," *Journal of Mathematical Economics* 48, 212–218.

{% %}

Bosi, Gianni & Romano Isler (1995) "Representing Preferences with Nontransitive Indifference by a Single Real-Valued Function," *Journal of Mathematical Economics* 24, 621–631.

{% Their global risk idea, not finding all the same results as before; now also measuring emotions and relating them to observed behavior. %}

Bosman, Ronald & Frans van Winden (2010) "Global Risk, Investment and Emotions," *Economica* 77, 451–471.

{% %}

Bosmans, Kristof (2007) "Comparing Degrees of Inequality Aversion," *Social Choice and Welfare* 29, 405–428.

{% Ambiguity in market. Heterogeneity in ambiguity attitude has extra inertia effects of neither buying nor selling ambiguous option for wider ranges of prices, which is something different than heterogeneity in risk attitude. Some qualitative theoretical predictions about agents being more certainty-seeking under

ambiguity than any smooth model could explain, with bid-ask spread, are confirmed in experiments.

correlation risk & ambiguity attitude: find positive correlation between risk aversion and ambiguity aversion.

They use α-maxmin model. The authors assume, in 3-color urn, that red has weight 1/3, and for black they assume a set of possible probabilities [a,b]. It was not clear to me if a and b are exogenous or endogenous. The theoretical part does not say, in the experiment it seemed to be endogenous (or was it [0, 2/3]?). But then they influence ambiguity aversion and interact with α.

They find support for nonsmooth ambiguity attitudes as opposed to the smooth KMM model (e.g. p. 1329 3rd para). They paid subjects repeatedly, so that income effects could arise. They do several drawings from the same unknown urn without replacement. Bayesian rational subjects, hence, will be ambiguity seeking in the sense of rather playing the unknown urn! I will rather gamble on the unknown color that occurred most often so far than on the known color. %}

Bossaerts, Peter, Serena Guarnaschelli, Paolo Ghirardato, & William Zame (2010) "Ambiguity and Asset Prices: An Experimental Perspective," *Review of Financial Studies* 23, 1325–1359.

{% Use computational complexity theory to argue that Savage's (1954) model is complex. P. 2 para from first to seond column has strange criticism of Savage (1954): that it cannot express causal relations or for-all quantification. It is like criticizing Savage (1954) for not telling how to bake fish. %}

Bossaerts, Peter, Nitin Yadav, & Carsten Murawski (2019) "Uncertainty and Computational Complexity," *Philosophical Transactions of the Royal Society B* 374(1766), 20180138.
https://doi.org/10.1098/rstb.2018.0138

{% Refers to Peters & Wakker (1992) %}

Bossert, Walter (1994) "Rational Choice and Two-Person Bargaining Solutions," *Journal of Mathematical Economics* 23, 549–563.

{% **ordering of subsets** %}

Bossert, Walter (1996) "Uncertainty Aversion in Nonprobabilistic Decision Models," *Mathematical Social Sciences* 34, 191–203.

{% **Nash bargaining solution** %}
Bossert, Walter, Ed Nosal, & Venkatraman Sadanand (1996) "Bargaining under Uncertainty and the Monotone Path Solutions," *Games and Economic Behavior* 14, 173–189.

{% Single-basined means that there can be multiple worst alternatives. Consider as choice domain all compact convex subsets of $\mathbb{R}^n$. Assume IIA, and derive representation. Corollary 2 shows that the choice function is representable by a weak order. (They show transitivity there, but completeness can then be obtained.) %}
Bossert, Walter & Hans J.M. Peters (2014) "Single-Basined Choice," *Journal of Mathematical Economics* 52, 162–168.

{% Define a choice function usual way, assigning to each subset of set of alternative an element. If I understand right, for each choice function they can associate with each subset of alternatives a game in extensive form with perfect information having those alternatives as possible outcomes and the chosen element as the solution of backward induction. Exact restrictions of domains here I did not study enough. %}
Bossert, Walter & Yves Sprumont (2013) "Every Choice Function Is Backwards-Induction Rationalizable," *Econometrica* 81, 2521–2543.

{% Show for welfare evaluations that all relations satisfying the transfer principle (something like elementary mean-preserving spread) and Pareto and anonymity are extensions of a Suppes relation, which is the most elementary transitive extension of Pareto and the transfer principle. %}
Bossert, Walter, Yves Sprumont, & Kotaro Suzumura (2007) "Ordering Infinite Utility Streams," *Journal of Economic Theory* 135, 579–589.

{% **time preference** %}

Bossert, Walter & Frank Stehling (1992) "A Remark on Admissible Transformations for Interpersonally Comparable Utilities," *International Economic Review* 33, 739–744.

{% **revealed preference**: variations on Richter's (1966) consistency condition, with and without reflexivity/completeness and if domain does not contain all two-point subsets. %}

Bossert, Walter & Kotaro Suzumura (2005) "Consistent Rationalizability," *Economica* 72, 185–200.

{% Theorem 2, p. 716, characterizes an incomplete and intransitive EU representation, with a best outcome M and a worst outcome m, and:

$M \succ m$;

$x \sim M_p m$ with p the EU of lottery x (so, we can use the standard gamble method).

$x \succ y \Rightarrow EU(x) > EU(y)$

$x \sim y \Rightarrow EU(x) = EU(y)$

Necessary and sufficient preference conditions: Suzumura consistency, solvability, monotonicity and independence. %}

Bossert, Walter & Kotaro Suzumura (2015) "Expected Utility without Full Transitivity," *Social Choice and Welfare* 45, 707–722.

{% **foundations of probability**: nineteenth century debates of physicians on use/meaning of probability. %}

Bossuyt, Patrick M.M. (1997) "De Idolen van Kieslowski," inaugurale rede, University of Amsterdam, the Netherlands.

{% **bisection > matching;**

Many references on preference reversal; find that ping-pong method of elicitation greatly reduces Choice vs. Pricing preference reversals.

Judged CEs (certainty equivalents) and choice-based CEs can differ substantially for some gambles. %}

Bostic, Raphael, Richard J. Herrnstein, & R. Duncan Luce (1990) "The Effect on the Preference-Reversal Phenomenon of Using Choice Indifferences," *Journal of Economic Behavior and Organization* 13, 193–212. https://doi.org/10.1016/0167-2681(90)90086-S

{% P. 18: Advantageous selection is opposite of adverse selection. They find opposite of moral hazard; people who take insurance against fluds, also take better precautions.

P. 23: the author writes that climate change is caused by [human] consumption and production processes. %}

Botzen, W.J. Wouter (2017) "Economie van Klimaatverandering en Natuurrampen." Inaugural address.

{% **PT, applications**: Analyze risks due to flooding in the Netherlands, with special interest in changing climate. Use prospect theory and RDU to calculate risk premiums. See if there is space for insurance. %}

Botzen, W.J. Wouter & Jeroen C.J.M. van den Bergh (2008) "Insurance Against Climate Change and Flooding in the Netherlands: Present, Future, and Comparison with Other Countries," *Risk Analysis* 28, 413–426.

{% **(very) small probabilities**: The authors ask not only for assessment of the likelihoods of extreme events, but also of the damage resulting. They claim this joint assessment as their novelty.

inverse S: They confirm overestimation of small probabilities. The extreme damages are underestimated. %}

Botzen, W.J. Wouter, Howard Kunreuther, & Erwann Michel-Kerjan (2015) "Divergence between Individual Perceptions and Objective Indicators of Tail Risks: Evidence from Floodplain Residents in New York City," *Judgment and Decision Making* 10, 365–385.

{% The authors use their beautiful data set with some 3000 subjects from 30 countries to measure gender differences in loss aversion. They estimate loss aversion from fitting PT (they write CPT) with all kinds of specifications. The results are not clear because they depend entirely on the specifications made. %}

Bouchouicha, Ranoua, Lachlan Deer, Ashraf Galal Eid, Peter McGee, Daniel Schoch, Hrvoje Stojic, Jolanda Ygosse-Battisti, & Ferdinand M. Vieider (2019) "Gender Effects for Loss Aversion: Yes, No, Maybe?" *Journal of Risk and Uncertainty* 59, 171–184.

{% **ambiguity seeking for unlikely & ambiguity seeking for losses**: They find both.

$N = 157$ subjects from Ethiopia, students from Addis Ababa University. Measure certainty equivalents (CEs) for binary prospects, both risky and Ellsberg ambiguous, using choice lists, for all probabilities j/8. Incentives like weekly income. For gains and losses (**losses from prior endowment mechanism**). First risky gains, then ambiguous gains, then risky losses, then ambiguous losses. The authors prefer order effects to the cognitive difficulties for subjects if losses precede gains.

The authors find the best fit for

CE/X = c + s $\times$ EV/X

with X the maximum amount of the prospect and EV being expected value. With $c > 0$ and $0 < s \leq c$ this means that for small EV/X, so, small probabilities, CE > EV with risk/uncertainty seeking, and for large EV/X risk/uncertainty aversion. This measure relates to proportional risk/uncertainty aversion. Then from c and s they derive sensitivity (through s) and optimism (through $c + s/2$) the usual way. This agrees with measures in Abdellaoui et al. (2011 AER) for weighting functions under linear utility, as the authors point out in footnote 2 (version of March 29 2012). Concave utility will push c and s down for big gains as opposed to small gains. It is not clear to what extent the findings concern utility or probability weighting and, hence, it does not directly speak to: **probability weighting depends on outcomes**.

The paper, unusually, finds prevailing risk seeking, and no prevailing uncertainty aversion. It finds that increasing (doubling, between-subjects) stakes increases ambiguity seeking for small-probability gains and large-probability losses, and more ambiguity averse for large-probability gains and small-probability losses. That is, a-insensitivity is increased. The text suggests that for gains mostly uncertainty aversion for high probabilities is increased.

reflection at individual level for risk: The authors consider it, but it is hard to interpret with prevailing risk seeking for gains. The authors also consider it for ambiguity and losses, and many correlations between the various variables.

decreasing ARA/increasing RRA: the authors study relative risk aversion, and find that it increases, rather than decreases, with stakes, over the whole probability range. %}

Bouchouicha, Ranoua, Peter Martinsson, Haileselassie Medhin, & Ferdinand M. Vieider (2017) "Stake Effects on Ambiguity Attitudes for Gains and Losses," *Theory and Decision* 83, 19–35.

{% Comments on Dec. 2024 version.

This paper compares choice lists, where *binary choices* are grouped together in a way to make them transparent to subjects, with binary choices that are not grouped together. A preceding paper on this difference, not cited here, is Bostic, Herrnstein, & Luce (1990). The authors call the first form of binary choice evaluation, and the second form choice, and this termonology is central in their marketing. However, it is misleading because what they call evaluation is as much binary choice as what they call choice. The former could better be called transparent choice and the latter complex choice. Thus, Tversky & Kahneman (1992, p. 306), who used what I call transparent choice, wrote:

"We wish to emphasize that although the analysis is based on certainty equivalents, the data consisted of a series of choices between a given prospect and several sure outcomes. Thus, the cash equivalent of a prospect was derived from observed choices rather than assessed by the subject. The computer monitored the internal consistency."

The authors do what many authors do: target their arrows solely to prospect theory, especially inverse-S probability weighting. However, the discrepancy between transparent choice and complex choice that they find rejects every deterministic choice model satisfying basic properties such as transitivity. Every economic and decision-analysis model assumes the latter. One can't do economics or decision analysis anymore then. Their finding is of the same fundamental kind as preference reversals from the 1980s, with differences between choice and matching. The term evaluation (versus choice) fits better with matching than with the choice lists of this paper.

Now to probability weighting. Although findings on loss aversion are the strongest for risk attitudes, they are also most volatile. Findings on probability weighting are not weaker, but they are more volatile, then findings on utility curvature. In general, the overweighing of small probabilities is less strong than TK92 suggested. As for volatility, several studies found a majority UNDER, rather than overweighting of small probabilities, without clear explanation for why. One such was a paper by van de Kuilen and me (2011 MS). Kahneman and Tversky pointed out that for small probabilities there are many irregularities with also underweighting, so much that Kahneman & Tversky (1979) left it unspecified.

The authors propose Vieider's (2024) Bayesian inference model (BIM) model for better fitting the data. However, his model does not separate a deterministic and probabilistic part but has them joint, implying, again, that it cannot be used in usual economics or management science models. See my annotations to the Vieider paper. There are other models that better describe and predict than prospect theory, such as Birnbaum's RAM and TAX, and Erev's BEAST, but they share the drawback with Vieider's BIM model that they cannot be used in economics or management science.

What the authors call evaluation but I call transparent choice is more popular these days because it gives less noise. Therefore, its support for inverse-S probability weighting is more convincing than the, apparently deviating, findings of the authors' complex choice. Could it be that on the latter they only found H_0? For what they really do, showing fundamental problems, they seem to do a thorough job, especially with the meta analysis. %}

Bouchouicha, Ranoua, Ryan Oprea, Ferdinand M. Vieider, & Jilong Wu (2024) "Is Prospect Theory Really a Theory of Choice?" working paper of Dec. 2024.

{% Find risk seeking for small outcomes but risk aversion for large ones. A generalized logarithmic utility (ln (x + a)) fits better than the common log-power or linear-exponential. The authors use hypothetical choices for losses and so as to examine real large stakes. They also find some violations of separability of probability weighting versus utility of outcome. (**PT falsified; probability weighting depends on outcomes**).

decreasing ARA/increasing RRA: they find increasing relative risk aversion!

%}

Bouchouicha, Ranoua & Ferdinand M. Vieider (2017) “Accommodating Stake Effects under Prospect Theory,” *Journal of Risk and Uncertainty* 55, 1–28.

{% %}

Bouchouicha, Ranoua & Ferdinand M. Vieider (2025) “Loss-Sensitivity versus Loss-Aversion,”

{% %}

Bouchouicha, Ranoua, Jilong Wu, & Ferdinand M. Vieider (2023) “Choice Lists and `Standard Patterns' of Risk Taking,” Technical Report, Ghent University Discussion Papers.

{% It is well known that besides expectation and variance, also skewness of lotteries plays a role in risky choices, where people are usually skewness seeking, and that this amounts to inverse S probability weighting. This paper provides data clearly supporting these things, e.g. by separately measuring skewness preference and probability weighting and seeing they are closely related. %}

Bougherara, Douadia, Lana Friesen, & Céline Nauges (2021) “Risk Taking with Left- and Right-Skewed Lotteries,” *Journal of Risk and Uncertainty* 62, 89–112.

{% %}

Bourbaki, Nicolas (1971) “*Eléments de Mathématiques, Topologie Générale.*” Diffusion CCLS, Paris.

{% Neuro-studies seem to find regret in the brains. The author suggests that this gives a normative basis to regret theory. %}

Bourgeois-Gironde, Sacha (2010) “Regret and the Rationality of Choices,” *Philosophical Transactions of the Royal Society B* 365, 249–257. http://dx.doi.org/10.1098/rstb.2009.0163

{% %}

Boutilier, Craig (2002) “A POMDP Formulation of Preference Elicitation Problems,” Dept. of Cumputer Science, University of Toronto, Toronto, Canada.

{% %}

Boutilier, Craig, Nir Friedman, & Joseph Y. Halpern (2002) "Belief Revision with Unreliable Observations," Dept. of Cumputer Science, University of Toronto, Toronto, Canada.

{% %}

Bouyssou, Denis (2005) "Conjoint Measurement Tools for MCDM; A Brief Introduction." *In* José Figueira, Salvatore Greco & Matthias Ehrgott (2003, eds.) *State of the Art of Multiple Criteria Decision Analysis*, 73–132, Springer, Berlin.

{% %}

Bouyssou, Denis, Didier Dubois, Henri Prade, & Marc Pilot (2006) "*Decision-Making Process: Concepts and Methods*." Wiley, New York.

{% Additive conjoint measurement when there are only a finite number of categories that the n-tuples can belong to. %}

Bouyssou, Denis & Thierry Marchant (2009) "Ordered Categories and Additive Conjoint Measurement on Connected Sets," *Journal of Mathematical Psychology* 53, 92–105.

{% Paper assumes that we only observe whether acts are better or worse than a status quo. It shows that the tradeoff consistency condition (**tradeoff method**) then still gives expected utility. This approach with incomplete preference is in the spirit of works by Karl Vind and by Han Bleichrdt (2009, JMP). %}

Bouyssou, Denis & Thierry Marchant (2011) "Subjective Expected Utility without Preferences?," *Journal of Mathematical Psychology* 55, 457–468.

{% %}

Bouyssou, Denis, Thierry Marchant, Marc Pirlot, Alexis Tsoukias, & Philippe Vincke (2006) "*Evaluation and Decision Models with Multiple Criteria*." Springer, Berlin.

{% **cancellation axioms**: Examines cancellation axioms without transitivity. The results are also of interest to readers interested only in transitive relations,

because these general models nicely illustrate the meaning of all kinds of preference conditions. For instance, Table 1 on p. 683 nicely illustrates how triple cancellation and tradeoff consistency axioms amount to separability of pairs (x_i,y_i) in preferences $(x_1, ..., x_n) \succcurlyeq (y_1, ..., y_n)$, and how separability amounts to similar separability only of pairs (x_i,x_i) ("void influence").

Triple cancellation:

$\mathbf{z}_i a_{-i} \preccurlyeq \mathbf{w}_i b_{-i}$ & $\mathbf{z}_i c_{-i} \succcurlyeq \mathbf{w}_i d_{-i}$ &

$\mathbf{x}_i a_{-i} \succcurlyeq \mathbf{y}_i b_{-i} \Rightarrow$

$\mathbf{x}_i c_{-i} \succcurlyeq \mathbf{y}_i d_{-i}$

RC1 on p. 686:

(not $\mathbf{z}_i a_{-i} \succcurlyeq \mathbf{w}_i b_{-i}$) & $\mathbf{z}_i c_{-i} \succcurlyeq \mathbf{w}_i d_{-i}$ &

$\mathbf{x}_i a_{-i} \succcurlyeq \mathbf{y}_i b_{-i} \Rightarrow$

$\mathbf{x}_i c_{-i} \succcurlyeq \mathbf{y}_i d_{-i}$

RC2 on p. 686 (with change of symbols):

$\mathbf{z}_i a_{-i} \preccurlyeq \mathbf{w}_i b_{-i}$ & $\mathbf{z}_i c_{-i} \succcurlyeq \mathbf{w}_i d_{-i}$ &

(not $\mathbf{x}_i a_{-i} \preccurlyeq \mathbf{y}_i b_{-i}$) $\Rightarrow$

$\mathbf{x}_i c_{-i} \succcurlyeq \mathbf{y}_i d_{-i}$

They are the kinds of weakenings called independence by Karl Vind. %}

Bouyssou, Denis & Marc Pirlot (2003) "Nontransitive Decomposable Conjoint Measurement," *Journal of Mathematical Psychology* 46, 677–703.

{% **standard-sequence invariance**; **tradeoff method** %}

Bouyssou, Denis & Marc Pirlot (2004) "A Note on Wakker's Cardinal Coordinate Independence," *Mathematical Social Sciences* 48, 11–22.

{% Intransitivity in multi-attribute. %}

Bouyssou, Denis & Marc Pirlot (2004) "Preferences for Multi-Attributed Alternatives: Traces, Dominance, and Numerical Representations," *Journal of Mathematical Psychology* 48, 167–185.

{% %}

Bouyssou, Denis & Marc Pirlot (2004) "Additive Difference' Models without Additivity and Subtractivity," *Journal of Mathematical Psychology* 48, 263–291.

{% **tradeoff method**: Use it to obtain a joint generalization of expected utility and the likely dominance model (choice the alternative that on more than half of the state space (measured in terms of subjective probability) dominates the other). Show that in terms of comparing tradeoffs, the latter model is very crude in only considering the sign of the tradeoff. %}

Bouyssou, Denis & Marc Pirlot (2008) "On Some Ordinal Models for Decision Making under Uncertainty," *Annals of Operations Research* 163, 19–48.

{% **risky utility u = strength of preference v (or other riskless cardinal utility, often called value)** if normative; maybe also descriptive. %}

Bouyssou, Denis & Jean-Claude Vansnick (1988) "A Note on the Relationships between Utility and Value Functions." *In* Bertrand R. Munier (ed.) *Risk, Decision and Rationality*, 103–114, Reidel, Dordrecht.

{% %}

Bouyssou, Denis & Jean-Claude Vansnick (1990) "Utilité Cardinale dans le Certain 5et Choix dans le Risque," *Revue Économique* 41, 979–1000.

{% Use **tradeoff method** %}

Bouzit, A. Madjid & Guy Gleyses (1996) "Empirical Estimation of RDEU Preference Functional in Agricultural Production," GRID, ENS, Cachan, France.

{% text of inugurale redeof 15Dec2016.

ubiquity fallacy: p. 6 footnote 2: "dat het er in het programma niet in de eerste plaats om gaat dat de scholier de economiepagina in de krant begrijpt maar ook zijn of haar eigen leven."

P. 12 "Hoe meer mensen verschillen in voorkeuren of talenten, hoe groter de potentiële meerwaarde van samenwerken."

P. 15 ℓ. 1: "Toen de mens de kracht van werderzijds voordeel ontdekte, explodeerde de welvaart."

P. 15 ℓ. 3: "Adam Smith—doorgrondde de grote betekenis van de balans win-win." Then writes that besides win-lose and lose-win there is a third road, being win-win.

P. 16: "Landen waar de overheid en de economie in dienst staan van een kleine elite zijn arm." Has suggested before that this concerns, besides North Korea, also East Germany before unification with West Germany.

P. 21: " '*Nobody ever saw a dog make a fair and deliberate exchange of one bone for another with another dog*.' … De mens heeft de wereld veroverd vanwege zijn verstand (deliberate and moraliteit (fair)." [italics from original]. The italics are a citation from Adam Smith, who therefore shares in this idea that animals know no ("delibrerate") collaboration or exchange. %}

Bovenberg, Lans (2016) "Economieonderwijs in Balans: Kiezen en Samenwerken.'

{% **foundations of probability** %}

Bovens, Luc & Stephan Hartmann (2003) "*Bayesian Epistemology*." Oxford University Press, New York.

{% **one-dimensional utility** %}

Bowen, Robert (1968) "A New Proof of a Theorem in Utility Theory," *International Economic Review* 9, 374.

{% %}

Bowman, David, Deborah Minehart, & Matthew Rabin (1999) "Loss Aversion in a Consumption-Savings Model," *Journal of Economic Behavior and Organization* 38, 155–178.

{% P. 424: "Essentially, all models are wrong, but some are useful." %}

Box, George E. P. & Norman R. Draper (1987) *Empirical Model Building and Response Surfaces*, John Wiley & Sons, New York, NY.

{% Assumes the repeated two-stage recursive utility form à la Koopmans. Proves existence and continuity of optima under proper assumptions. %}

Boyd, John H. (1990) "Recursive Utility and the Ramsey Problem," *Journal of Economic Theory* 50, 326–345.

{% P. 59: "Category rating scales are subject to the same inconsistencies as the standard gamble."

Use PEs (if I remember right, they call it SG), VAS, and treatment choice;

value colostomy for carcinoma of the rectum; five groups of, roughly, 35 subjects each (patients with colostomy, physicians, two groups of healthy volunteers, and patients treated with radiotherapy but with no colostomy).

Patients with colostomy valued it highest on PE and VAS, and were close second next to physicians in treatment choice.

P. 66: "Thus, patients may regard a particular outcome of treatment as highly undesirable but then become accustomed to it when it is directly experienced, and learn to tolerate it well." %}

Boyd, Norman F., Heather J. Sutherland, Karen Z. Heasman, David L. Tritchler, Bernard J. Cummings (1990) "Whose Utilities for Decision Analysis"?, *Medical Decision Making* 10, 58–67.

{% %}

Bozbay, Irem, Franz Dietrich, Hans J.M. Peters (2014) "Judgment Aggregation in Search for the Truth," *Games and Economic Behavior* 87, 571–590.

{% %}

Brachinger, Hans-Wolfgang & Martin Weber (1997) "Risk as a Primitive: A Survey of Measures of Perceived Risk," *OR-Spektrum* 19, 235–260.

{% Use housing market data of 1987-1991 and 2004-2013 to estimate discount rates. Find them between 2% and 3% and, a point put central, find them declining. %}

Bracke, Philippe, Edward W. Pinchbeck, & James Wyatt (2018) "The Time Value of Housing: Historical Evidence on Discount Rates," *Economic Journal* 128, 1820–1843.

{% Use quasi-hyperbolic discounting (β-δ) to predict real-life choices. %}

Bradford, W. David, Charles Courtemanche, Garth Heutel, Patrick McAlvanah, & Christopher Ruhm (2017) "Time Preferences and Consumer Behavior," *Journal of Risk and Uncertainty* 55, 119–149.

{% **nonconstant discount = nonlinear time perception**: Follow Zauberman et al. (2009) by measuring introspective time perception by direct subjective assessment, and seeing how much of discounting can be captured by such nonlinear perception of time. They find that most of non-constant discounting comes from nonlinear time perception.

P. 45 2nd para enthusiastically writes: "We innovatively build on the literature" %}

Bradford, W. David, Paul Dolan, & Matteo M. Galizzi (2019) "Looking ahead: Subjective Time Perception and Individual Discounting," *Journal of Risk and Uncertainty* 58, 43–69. https://doi.org/10.1007/s11166-019-09298-1

{% **nonconstant discount = nonlinear time perception**: they also consider this, with introspective measurements of time perception.

Subjects who had to do discount-calculations, after discounted less than others.

The abstract ends, enthusiastically, with the usual important policy implications: "This has important implications for the possibility of designing interventions to lower individual discount rates." They are also enthusiastic in the beginning of §6.4: "While our study design is strong". Further, they are enthusiastic about Bradford, Dolan, & Galizzi (2019), co-authored by the first author. %}

Bradford, W. David & Meriem Hodge Doucette (2023) "Effect of a Brief Intervention on Respondents' Subjective Perception of Time and Discount Rates," *Journal of Risk and Uncertainty* 66, 47–75. https://doi.org/10.1007/s11166-022-09390-z

{% %}

Bradley, Darren (2015) "Everettian Confirmation and Sleeping Beauty: Reply to Wilson," *British Journal for the Philosophy of Science* 66, 683–693.

{% By considering choice of gamble stake, favorite long-shot bias can be reconciled with prospect theory, but also with risk seeking for gains and risk aversion for losses. %}

Bradley, Ian (2003) "The Representative Bettor, Bet Size, and Prospect Theory," *Economics Letters* 78, 409–413.

{% Provides a detailed discussion and clarification of Ramsey's theorem. %}

Bradley, Richard (2004) "Ramsey's Representation Theorem," *Dialectica* 58, 483–497.

{% **R.C. Jeffrey model**: shows that utilitarian aggregation is possible only if agents have same probability distribution. %}
Bradley, Richard (2005) “Bayesian Utilitarianism and Probability Homogeneity,” *Social Choice and Welfare* 24, 221–253.

{% **R.C. Jeffrey model**: Unifies Savage etc. unconditional versus Jeffrey etc. conditional, referring to the work of Krantz et al. (1971) and others. Much logic in the paper. %}
Bradley, Richard (2007) “A Unified Bayesian Decision Theory,” *Theory and Decision* 63, 233–263.

{% Argues that subjects can assign values to probabilities as they do to outcomes. This is a different interpretation than probability weighting. Mathematical differences remain to be investigated. %}
Bradley, Richard (2016) “Ellsberg’s Paradox and the Value of Chances,” *Economics and Philosophy* 32, 231–248.

{% %}
Bradley, Richard (2017) “*Decision Theory with a Human Face.*” Cambridge University Press, Cambridge.

{% Consider the way climate change organizations report their uncertainty, including uncertainty about probabilities, and then propose ways to make normative decisions based on that. %}
Bradley, Richard, Casey Helgeson, & Brian Hill (2017) “Climate Change Assessments: Confidence, Probability and Decision,” *Philosophy of Science* 84, 500–522.

{% %}
Bradley, Richard & Christian List (2009) “Desire-as-Belief Revisited,” *Analysis* 69, 31–37.

{% Counterfactuals impacting desirability sounds like violation of consequentialism. %}

Bradley, Richard & H. Orii Stefansson (2015) "Counterfactual Desirability," *British Journal for the Philosophy of Science* 68, 485–533.

{% Useful for me as decision theorist working on ambiguity to learn about the ideas of the imprecise probability (IP) community.

This paper is written in the spirit of multiple priors. This is popular in the IP community, although also other approaches are considered. First, it assumes a true existing but unknown objective probability, which I find a problematic concept the moment one leaves Ellsberg's urn and goes to natural events. Second, it assumes that we don't know exactly what that true probability is, but we do know an exact set that contains that true probability, which again is ad hoc to me. It sometimes seems to me that many people working on ambiguity can only think this way.

The intro lists many fields where IPs are used. It assumes linear utility for risk, and "indifference" to risk, which means expected utility and even expected value for risk. §1.2 states that the main interest of this paper is normative. The section distinguishes between imprecision due to absent info or due to imperfect processing of info. To me this distinction can sometimes be useful but is not very fundamental.

§2.2: indifference ties will be broken by very small extra payments, but incompleteness ties will not.

Important: End of §2.3 cites the nice Skyrms (2011) and Leitgeb (2014) who seem to use the terms resilience and stability, respectively, to indicate that Keynes' weight of evidence (vs. balance of evidence) should play no role in static decisions, but only in updating, which surely is my opinion.

End of §2.7: Set of priors is set of all probability measures consistent with your evidence. It was called the credal committee by Joyce (2011). This is an informational basis for the set of priors, and not a decision-basis. I as critic if multiple priors argue that it usually is not the black/white consistent/inconsistent, but it is gradual more/less plausible.

§3.1 has the nice topic of dilation. Unfortunately, the example regarding Figure 1 is not well explained. In the 3rd para ("Let's imagine …") it is not explained what is written if coins lands up (from context: then a lie is written), and the difference between H being true or H being written is also something to keep in mind. Here is a simpler example of dilation, although not with conditioning involved.

MY EXAMPLE OF DILATION; BEGINNING

Imagine an Ellsberg two-color urn containing 100 numbered balls, each red (R) or black (B). There are 50R and 50B, as follows. Of the odd-numbered balls, (50+ε)% are R and of the even numbered balls, (50−ε)% are R. Here ε is unknown but can be anything between −50 or 50. So, ε can as well be positive as negative. P(R) from the whole urn is a known probability and is 0.5. But if we get informed about whether the number of the ball drawn is odd or even, then it is ambiguity. Extra info changes risk into ambiguity (without making things more favorable or unfavorable under Bayesian ambiguity neutrality).

MY EXAMPLE OF DILATION; END

Here is Bradley's example, if I understand it right. Imagine the following probabilities:

	H	−H
X	¼+ε	¼+ε
−X	¼−ε	¼−ε

where ε is unknown, say if may as well be +1/10 as −1/10. Then P(H) = P(−H) = ½. Y = (X&H) or (−X & −H). P(Y) = ½. Conditioning on X does not affect P(H), but if we first condition on Y, then conditioning on X turns H into ambiguous. This is complex.

In general statistics, dilation seems to mean that the posterior distribution is wider than the prior one. A good illustration that risk need not reflect more info than ambiguity.

End of §3.1 (on dilation) writes: "We cannot take narrowness of the interval [lower probability, higher probability] as a characterisation of weight of evidence since the interval can be narrow for reasons other than because lots of evidence has been accumulated."

Section 3.5: Lindley (1996) and others have argued that we can neither know the set of priors exactly. This section considers if we should then consider sets of sets of priors. It argues for not doing so for pragmatic reasons, because things then get too complex. Using sets of priors nicely captures some aspects of ambiguity/IP and Bradley is satisfied with that. He writes, 1st para of §3.5: "For the functionalist interpretation suggested above, this is something of a pragmatic choice. The further we allow this regress to continue, the harder it is to deal with these belief-representing objects. So let's not go further than we need." I think this deprives the approach of any normative force. He doesn't say: "if there is ambiguity then one should use sets of priors." He says, in my words: "We use multiple priors only when it pleases us." %}

Bradley, Seamus (2016) "Imprecise Probabilities." *In* Edward N. Zalta (ed.) *The Stanford Encyclopedia of Philosophy*, 16–26, Metaphysics Research Lab, Stanford University, Stanford, CA. https://plato.stanford.edu/entries/imprecise-probabilities/

{% %}

Bradley, Seamus & Katie Steele (2014) "Should Subjective Probabilities be Sharp?," *Episteme* 11, 277–289.

{% Dilation means that a state of objective probabilities can turn into imprecise info if new info is received. Although there is noting surprising about this, it is a paradox to those who erroneously think that a state of objective probability always reflects more info than states of ambiguity. Many in modern theories of ambiguity make the latter mistake implicitly. The authors discuss the cases with examples, references, and so on. %}

Bradley, Seamus & Katie Steele (2014) "Uncertainty, Learning and the 'Problem' of Dilation," *Erkenntnis* 79, 1287–1303.

{% **information aversion**; discusses its relations to dynamic decision principles, similar to Brocas & Carrillo (2000). %}

Bradley, Seamus & Katie Steele (2016) "Can Free Evidence Be Bad? Value of Information for the Imprecise Probabilist," *Philosophy of Science* 83, 1–28.

{% %}

Bradley, W. James, Jonathan K. Hodge, & D. Mark Kilgour (2005) "Separable Discrete Preferences," *Mathematical Social Sciences* 49, 335–353.

{% Probably related to the shaping hypothesis. %}

Braga, Jacinto, Steven J. Humphrey, & Chris Starmer (2009) "Market Experience Eliminates some Anomalies—and Creates New Ones," *European Economic Review* 53, 401–416.

{% Discuss Plott's discovered preference hypothesis and suggest that it cannot explain all anomalies. %}

Braga, Jacinto & Chris Starmer (2005) "Preference Anomalies, Preference Elicitation, and the Discovered Preference Hypothesis," *Environmental and Resource Economics* 32, 55–89.

{% %}

Brams, Steven J. & Peter C. Fishburn (1992) "Coalition Voting," *Math. Comput. Modelling* 16, 15–26.

{% **gender differences in risk attitudes**: women more risk averse than men. %}

Branas, G. Pablo & Aldo Rustichini (2011) "Organizing Effects of Testosterone and Economic Behavior: Not Just Risk Taking," *PLoS ONE* 6, e29842+.

{% **real incentives/hypothetical choice**: They do a simplified version of tasks by Holt & Laury (2002), real and hypothetical, with 178 Spanish students in the lab, 360 households in Nigeria, and 360 households in Honduras. (The households came to do the experiment so, in this sense, it was not a field experiment.) Find no difference between real and hypotheical.

A difficulty is that there is little novelty. The keyword "real incentives/hypothetical choice" in this bibliography gives over 150 references on this (I write this Sept. 2021), about half finding differences and half finding no differences. This paper does not cite much literature, focusing only on a small group of experimental economists (Harrison and others), suggesting that Holt & Laury (2002) had novelty, and so on. (**Prospect theory not cited**) It is remarkable because this journal is more psychologically oriented. Their conclusion that hypothetical is OK may have made it hard for them to find an economic outlet. They cite the survey Camerer & Hogarth (1999) but not Hertwig & Ortmann (2001). %}

Brañas-Garza, Pablo, Lorenzo Estepa-Mohedano, Diego Jorrat, Victor Orozco, & Ericka Rascón-Ramírez (2021) "To Pay or not to Pay: Measuring Risk Preferences in Lab and Field," *Judgment and Decision Making* 16, 1290–1313.

{% %}

Brañas-Garza, Pablo, Matteo Galizzi, & Jeroen Nieboer (2018) "Experimental and Self-Reported Measures of Risk Taking and Digit Ratio (2D:4D): Evidence from a Large, Systematic Study," *International Economic Review* 59, 1131–1157.

{% **real incentives/hypothetical choice**: big study on intertemporal choice, finding no differences. %}

Brañas-Garza, Pablo, Diego Jorrat, Antonio M. Espín, & Angel Sánchez (2023) "Paid and Hypothetical Time Preferences are the Same: Lab, Field and Online Evidence," *Experimental Economics* 26, 412–434. https://doi.org/10.1007/s10683-022-09776-5

{% **games with incomplete information**, Bayesian Rationality %}

Brandenburger, Adam (1996) "Strategic and Structural Uncertainty in Games." *In* Richard J. Zeckhauser, Ralph L. Keeney, & James K. Sibenius (1998) "*Wise Choices: Games, Decisions, and Negotiations*, 221–232. Harvard Business School Press, Boston.

{% **common knowledge**; Seems to be readable version of Mertens & Zamir (1985) %}

Brandenburger, Adam & Eddie Dekel (1993) "Hierarchies of Beliefs and Common Knowledge," *Journal of Economic Theory* 59, 189–198.

{% Whereas virtually all results in economic decision theory, based on revealed preference, get their mileage from variations in the choice sets, Arrow's social choie theory gets mileage from varing social preference profiles. This papers assumes/uses both. A variation on the impossibility result of Mongin (1995) is given. Gives a model where the average of both the agents' beliefs and, normalized, utilities is given. Uses, among others, a weakening of Arrow's (1951) independence of irrelevant alternatives of voting theory. %}

Brandl, Florian (2021) "Belief-Averaging and Relative Utilitarianism," *Journal of Economic Theory* 198, 105368. https://doi.org/10.1016/j.jet.2021.105368

{% The priority heuristic works as follows: for gains:

(1) Compare worst outcomes. If their difference is more than 1/10 times the best outcome, go for best worst outcome. (So, no probabilities inspected apart from them being nonzero. Ratio-scale structure.)

(2) If (1) did not decide, consider probabilities of worst outcomes. If they differ by more than 1/10, go for minimal probability.

(3) If (2) did not decide either, consider best outcomes. For two-outcome prospects, now the best outcome decides (by point (2) their probabilities do not differ by much). For three- or more outcome prospects, if the difference of the best outcomes is more than 1/10 times the best outcome, go by the best one here.

(4) If (3) did not work (then prospects have more than two outcomes), if probabilities of best outcomes differ by more than 1/10, go by them.

(5) If not (4), then I guess indecision.

For losses things are reflected. So, we start with inspecting the best losses, and so on.

There is only one example with mixed prospect, suggesting a bit that then the treatment is as with gains and with signs ignored, but it is not clear to me. %}

Brandstätter, Eduard, Gerd Gigerenzer, & Ralph Hertwig (2006) "The Priority Heuristic: Making Choices without Trade-offs," *Psychological Review* 113, 409–432.

{% %}

Brandstätter, Eduard, Gerd Gigerenzer, & Ralph Hertwig (2008) "Risky Choice with Heuristics: Reply to Birnbaum (2008), Johnson, Schulte-Mecklenbeck, and Willemsen (2008), and Rieger and Wang (2008)," *Psychological Review* 115, 281–289.

{% %}

Brandstätter, Eduard, Gerd Gigerenzer, & Ralph Hertwig (2008) "Postscript: Rejoinder to Johnson et al. (2008) and Birnbaum (2008)," *Psychological Review* 115, 289–290.

{% **utility depends on probability**

inverse S: Confirm it. In exp. 3 elicited certainty equivalents for some gambles (hypothetical only) using ping-pong à la Tversky & Fox (1995), only for one nonzero outcome. Assume that utility is $x^{0.88}$ and then find inverse S w confirmed. Do not say whether or not they used real incentives.

They propose that inverse S, overweighting of extreme outcomes, may be due to the surprise (elation if positive, disappointment if negative) that you feel about them if they are unlikely, and the extra utility or disutility that that surprise gives. So, utility depends on probabilities. They ask people how surprised they feel if some low-probability outcome occurs, and like that grade the degree of surprise. Propose a formula that derives inverse S from the degree of surprise (**inverse S (= likelihood insensitivity) related to emotions;**

cognitive ability related to risk/ambiguity aversion): They don't link data on surprise to data on probability weighting. They don't consider whether subjects with more surprise have more extreme inverse S. The basic idea, that inverse S is not through probability-perception per se, but through utility, is interesting. %}

Brandstätter, Eduard, Anton Kühberger, & Friedrich Schneider (2002) "A Cognitive-Emotional Account of the Shape of the Probability Weighting Function," *Journal of Behavioral Decision Making* 15, 79–100.

{% Subjects do speak-aloud. Subjects do more between-gamble examinations (as formalized in tradeoffs) than within. %}

Brandstätter, Eduard & Manuela Gussmack (2013) "The Cognitive Processes Underlying Risky Choice," *Journal of Behavioral Decision Making* 26, 185–197.

{% %}

Brandstätter, Herman (1991) "Emotions in Everyday Life Situations: Time Sampling of Subjective Experience." *In* Fritz Strack, Michael Argyle, & Norbert Schwarz (eds.) *Subjective Well-Being: An Interdisciplinary Perspective*, 173–192, Pergamon, Oxford.

{% This paper combines α maxmin with no arbitrage. I guess that they can be combined if the set of assets considered is so poor that α-maxmin and SEV cannot be distinguished, and both can fit data. This may happen in comonotonic subsets of acts. %}

Braouezec, Yann & Robert Joliet (2019) "Valuing an Investment Project Using No-Arbitrage and the Alpha-Maxmin Criteria: From Knightian Uncertainty to Risk," *Economics Letters* 178, 111–115.

{% %}

Brauers, Jutta & Martin Weber (1988) "A New Method for Scenario Analysis in Strategic Planning," *Journal of Forecasting* 7, 31–47.

{% %}

Braun, Michael & Alexander Muermann (2004) "The Impact of Regret on the Demand for Insurance," *Journal of Risk and Insurance* 71, 737–767.

{% Seem to have written on the comparison of decision analysis advice with actual decisions. %}

Brazier, John & Mark Deverill (1999) "A Checklist for Judging Preference-Based Measures of Health Related Quality of Life: Learning from Psychometrics," *Health Economics* 8, 41–52.

{% **intertemporal separability criticized**:test intertemporal separability and find it violated, though not to a very pronounced degree. %}

Brazier, John, Paul Dolan, Korina Karampela, & Isabel Towers (2006) "Does the Whole Equal the Sum of the Parts? Patient-Assigned Utility Scores for IBS-Related Health States and Profiles," *Health Economics* 15, 543–551.

{% %}

Bréban, Laurie & André Lapidus (2019) "Adam Smith on Lotteries: An Interpretation and Formal Restatement," *European Journal of the History of Economic Thought* 26, 157–197.

{% This paper shows that in the financial market one can obtain any indicator function for any event and, thus, and simple event-contingent payment. That is, one can get an essentially complete Savagean act-space. The authors refer to it as the time-state preference approach by Arrow (1964) and Debreu (1959). %}

Breeden, Douglas T. & Robert H. Litzenberger (1978) "Prices of State-Contingent Claims Implicit in Option Prices," *Journal of Business* 51, 621–651.

{% The authors let subjects choose twice from budget sets of lotteries with one nonzero outcome: subjects can choose $0 \le x \le M$ and then receive the lottery

x_p0 $\big(= (p{:}x, 1{-}p{:}0)\big)$ with $x + pM/m = M$.

That is, they choose a lottery from the line between (M_00) and (0_m0), being $(1-\lambda)M_{\lambda m}0$ for a $0 \le \lambda \le 1$. I must admit that even I as expected value maximizer with math degree specialized in probability theory and linear optimization, need time to know what to choose ($\lambda = 0.5$; with thanks to Nash bargaining solution). Next subjects get the chance to reconsider their choices.

P. 228: "We propose and carry out a methodology to study mistakes, which we define as deviations from the decision maker's true preferences. Specifically, we argue that if a choice is revised *without any new information or change in circumstances*, then either the initial choice or the revision is revealed to be a mistake." [italics from original]

That is, whenever a subject revises a choice, the authors assume that the first choice was a mistake and was not a "true" preference. Modifying a choice from a budget set is more readily done than revising a binary choice. Indeed, 75% of initial choices were revised.

§6.2: Subjects revised choices better satisfy normative principles such as stochastic dominance, and can better be fitted with standard models. Further, choices made early on in the first stage are more likely to be revised in the reconciliation stage than choices made later on in the first stage.

Subjects are more revisions for low-probability prizes, suggesting that these are more difficult to process. %}

Breig, Zachary & Paul Feldman (2024) "Revealing Risky Mistakes through Revisions," *Journal of Risk and Uncertainty* 68, 227–254. https://doi.org/10.1007/s11166-024-09429-3

{% Argues for the use of machine-learing techniques to replace many statistical modeling techniques. The author first did research, then consultancy, and then went back to research. For predictions from large data sets machine learning works better than statistical modeling techniques.

P. 202 §5 1st para, on data models: "This enterprise has at its heart the belief that a statistician, by imagination and by looking at the data, can invent a reasonably good parametric class of models for a complex mechanism devised by nature."

P. 204: The author several times points out that statisticians uncritically start from some common modeling assumption, e.g. multivariate normal distribution of regressions, which will usually not hold: "Nobody really believes that multivariate data is multivariate normal, but that model occupies a large number of pages in every graduate textbook on multivariate statistical analysis."

P. 205 2nd para points out that machine learning etc. usually does assume iid drawings. The author gives many examples where optimal fits in classical statistics and elsewhere have many local optima almost equally good but far apart, with minor changes in the data completely changing the solutions.

P. 210 displays a claim: "The goal is not interpretation, but accurate information." This may be true if in an application all one wants is good predictions there, but is not true in academic studies where one wants interpretations connecting with other fields and studies to acquire general knowledge. %}

Breiman, Leo (2001) "Statistical Modeling: The Two Cultures," S*tatistical Science* 16, 199–215.

{% %}

Breiman, Leo & Don Freeman (1983) "How Many Variables Should be Entered in a Regression Equation," *Journal of the American Statistical Association* 78, 131–136.

{% Neural responses were monitored for monetary gambles, prior and posterior to deciding and learning about outcomes. P. 620, 2nd col. defines loss aversion as

−U(−x) > U(x). They did repeated gambles with real payments and, hence, there was an income effect (p. 626).

P. 627, top of 2nd col.: "The predominant responses to gains or their prospects were noted in the right hemisphere, whereas left hemisphere activations predominated in response to negative prospects." There had been prior endowment to guarantee that no overal net loss results (**prior endowment mechanism**). P. 627 2nd column mentions that this may have reduced loss aversion effects. %}

Breiter, Hans C., Ithak Aharon, Daniel Kahneman, Anders Dale, & Peter Shizgal (2001) "Functional Imaging of Neural Responses to Expectancy and Experience of Monetary Gains and Losses," *Neuron* 30, 619–639.

{% %}

Bremmer, David & Peter P. Wakker (2008) "Verzeker vooral niet Alles," *Algemeen Dagblad*, September 26, 2008.
Direct link to paper

{% Seems to have suggested that the usual psychophysical laws do not exactly apply to money, because money does not give direct physical sensation. %}

Brendl, C. Miguel (2000) "Subjective Experience and the Effect of Sample Size on 88Likelihood Judgments." *In* Herbert Bless & Joseph P. Forgas (2000, eds.) *The Message Within: The Role of Subjective Experience in Social Cognition and Behavior*, 69–87, Psychology Press, Philadelphia.

{% Criticizes, a.o., way in which the authors assume a true underlying model. Wallsten, Erev, & Budescu (2001) reply to it. %}

Brenner, Lyle (2000) "Should Observed Overconfidence Be Dismissed as a Statistical Artifact? Critique of Erev, Wallsten, and Budescu (1994)," *Psychological Review* 107, 943–946.

{% Consider pricing and direct probability judgments. Work along the lines of prospect theory, but bring in psychological processes of how likelihood judgments are derived from case-based reasoning (not related to the Gilboa-Schmeidler theory). %}

Brenner, Lyle A., Dale W. Griffin, & Derek J. Koehler (2012) "A Case-Based Model of Probability and Pricing Judgments: Biases in Buying and Selling Uncertainty," *Management Science* 58, 159–178.

{% Seem to derive and confirm a number of implications of support theory. %}

Brenner, Lyle & Derek J. Koehler (1999) "Subjective Probability of Disjunctive Hypotheses: Local-Weight Models for Decomposition of Evidential Support," *Cognitive Psychology* 38, 16–47.

{% %}

Brenner, Lyle & Yuval Rottenstreich (1999) "Focus, Repacking, and the Judgment of Grouped Hypotheses," *Journal of Behavioral Decision Making* 12, 141–148.

{% **natural sources of ambiguity**: Empirically measures ambiguity attitudes and risk attitudes and subjective beliefs for natural events, which is desirable to have rather than Ellsberg urns or experimenter-specified probability intervals. The natural events concern equity markets. Now, when correcting for beliefs and ambiguity attitudes, the authors find a positive relation between risk and expected returns which is natural, and deviates from puzzling preceding opposite findings. They find that ambiguity attitude ("aversion" rather than "attitude" is the proper term here) depends on the a-neutral probability ("expected probability" in the two-stage model of this paper), referring to it as probabilistic contingent ambiguity attitude ("aversion" is, again, the proper term also here). See p. 519, Figure 3, with ambiguity seeking for unlikely gains and ambiguity aversion for likely gains, reflected for losses, and perfectly agreeing with the fourfold pattern of ambiguity described by the survey Trautmann & van de Kuilen (2015; not cited here) (**ambiguity seeking for unlikely**).

I prefer to interpret this as a(mbiguity)-generated insensitivity, and as independent of a-neutral probability. Aversion is not the right concept here, but insensitivity is, similar as in well-known philosophical discussions where the colors bleen and grue are not the right concepts, but the colors green and blue are.

The authors distinguish ambiguity, a property of info, from ambiguity aversion, an attitude, as do so many studies. Ambiguity is captured by a second-order probability distribution. They achieve this distinction in the experiment by

ASSUMING a set of priors derived from monthly variation in daily priors (daily mean and variance of returns on the SPDR), and ASSUMING normal distributions of 1st order distributions (§3.2, p. 509 above Eq. 8), and ASSUMING that this captures ambiguity of the info. These assumptions are pragmatic and plausible but essentially ad hoc, relating exogenous finance variables and ambiguity perception, not derived from preference.

P. 505 penultimate para reports a test that it must have been a set of probabilities, and not a unique one, but this test is GIVEN the assumptions made as just derived, and does not preclude deviating models. §2, pp. 506-507, surveys other approaches in the literature that assume sets of priors or other parameters to capture ambiguity. They are always just assumed and not justified by preference conditions.

The authors derive risk- and ambiguity premia (Eq.1 p. 504), expressed in monetary units. Ambiguity attitude and premium is a component separate from risk attitude and risk premium (p. 504 bottom), which is desirable. Many studies in the literature will compare ambiguity attitudes only if risk attitudes are the same, but this is undesirably restrictive.

Footnote 3, p. 505, properly points out that studies by Baillon and others do not use particular functional forms, and that that is the difference with the present study. %}

Brenner, Menachem & Yehuda Izhakian (2018) "Asset Pricing and Ambiguity: Empirical Evidence," *Journal of Financial Economics* 130, 503–531. https://doi.org/10.1016/j.jfineco.2018.07.007

{% Applications of Bayesian statistics in medical/biological world. Nice, personal. %}

Breslow, Norman (1990) "Biostatistics and Bayes," *Statistical Science* 5, 269–298.

{% Seems to write also on: total harm of seeding hurricanes is reduced, but they went to Cuba and Castro objected, so the US stopped. %}

Breuer, George (1980) "*Weather Modification, Prospects and Problems.*" Cambridge University Press, Cambridge.

{% **suspicion under ambiguity**: points it out in the Ellsberg paradox. %}

Brewer, Kenneth R.W. (1963) “Decisions under Uncertainty: Comment,” *Quarterly Journal of Economics* 77, 159–161.

{% Discuss Ellsberg experiment when and when not subject can choose color to bet on, so, controlling for suspicion (**suspicion under ambiguity**). Consider slanting probability only rational in latter case when there is reason for suspicion. %}

Brewer, Kenneth R.W. & William Fellner (1965) “The Slanting of Subjective Probabilities—Agreement on Some Essentials,” *Quarterly Journal of Economics* 77, 657–663.

{% An empirical study showing that figures work better than tables. %}

Brewer, Noel T., Melissa B. Gilkey, Sarah E. Lillie, Bradford W. Hesse, & Stacey L. Sheridan (2012) “Tables or Bar Graphs? Presenting Test Results in Electronic Medical Records,” *Medical Decision Making* 32, 532–544.

{% %}

Brickman, Philip, Dan Coates, & Ronnie Janoff-Bulman (1978) “Lottery Winners and Accident Victims: Is Happiness Relative?,” *Journal of Personality and Social Psychology* 37, 917–927.

{% %}

Bridgman, Percy W. (1922) “*Dimensional Analysis.*” Yale University Press, New Haven (revised edn. 1931.)

{% Wonderful book on operationalism that I borrowed from Bob Nau

Citations from Ellsberg (1954):

P. 6: we must demand that the set of operations equivalent to any concept be a unique set, for otherwise there are possibilities of ambiguity in practical applications that we cannot admit ...

P. 10: if we have more than one set of operations we have more than one concept, and strictly speaking there should be a separate name to correspond to each different set of operations.

P. 23 seems to write:

“If we deal with phenomena outside the domain in which we originally defined our concepts,

we may find physical hindrances to performing the operations of the original definition, so that the original operations have to be replaced by others. These new operations are, of course, to be chosen so that they give, within experimental error, the same numerical results in the domain in which the two sets of operations may be both applied; but we must recognize in principle that in changing the operations we have really changed the concept.” %}

Bridgman, Percy W. (1927) “*The Logic of Modern Physics.*” MacMillan, New York. (8th edn. 1958.)

{% Introduces the quadratic proper scoring rule. This is a version of incentive compatibility that preceded Hurwicz (1972).

P. 2 nicely points out the very useful fact that n events with relative frequencies $p_1,\ldots,p_n$ to be given same judged probability on each observation should be given judged probabilities $f_j = p_j$ to minimize punishment. Also mentions, informally in an example, the difference between calibration and discrimination. What an ideas in three pages! %}

Brier, Glenn W. (1950) “Verification of Forecasts Expressed in Terms of Probability,” *Monthly Weather Review* 78, 1–3.

{% **statistics for C/E** (cost-effectiveness) %}

Briggs, Andrew, Mark J. Sculpher, & Martin J. Buxton (1994) “Uncertainty in the Economic Evaluation of Health Care Technologies: The Role of Sensitivity Analysis,” *Health Economics* 3, 95–104.

{% %}

Brinks, Mirjam & Peter P. Wakker (2012) “Risico is geen Nederlands Woord,” Interview in *Het Parool* 09 Aug. 2012 (National Dutch newspaper).
Direct link to paper

{% Seem to argue that measurement is not well possible in the social sciences (got this reference from Pfanzagl 1959). I also have a Ferguson et al. (1940) reference on this. %}

British Association for the Advancement of Science (1933) “Interim Report of the Committee Appointed to Consider and Report upon the Possibility of

Quantitative Estimates of Sensory Events," *Report of the Annual Meeting*, 277–334.

{% Was cited as a good didactical example to illustrate decision analysis. %}
Brittain, Jack & Sim Sitkin (1989) "Facts, Figures, and Organizational Decisions: Carter Racing and Quantitative Analysis in the Organizational Behavior Classroom," *Organizational Behavior Teaching Review* 14, 62–81,

{% %}
Broadstock, Marita & Susan Michie (2000) "Processes of Patient Decision Making: Theoretical and Methodological Issues," *Psychological Health* 15, 191–204.

{% A game between selves at different times, with equilibria resulting. %}
Brocas, Isabelle (2011) "Dynamic Inconsistency and Choice," *Theory and Decision* 71, 343–364.

{% **dynamic consistency**; **information aversion**; **value of information**
This paper shows that dynamic inconsistency leads to aversion to information. With some benevolence on the reader's part, the same result can be inferred from Wakker (1988) "Nonexpected Utility as Aversion of Information," *JBDM* 1. Forgone branch independence (mostly called consequentialism after Machina 1989) is stated there on p. 173, as part of the "first objection" in §4, RCLA is assumed as self-evident, after which the independence considered by Wakker amounts to dynamic consistency. %}
Brocas, Isabelle & Juan D. Carrillo (2000) "The Value of Information when Preferences Are Dynamically Inconsistent," *European Economic Review* 44, 1104–1115.

{% %}
Brock, William A. (1970) "An Axiomatic Basis for the Ramsey Weizsäcker Overtaking Criterion," *Econometrica* 38, 927–929.

{% **utility families parametric**; consider all functions that have the sign of derivatives alternating (u´ > 0, u´´ < 0, etc. Relate them to Laplace transforms of distributions. %}

Brockett, Patrick L. & Linda L. Golden (1987) "A Class of Utility Functions Containing all the Common Utility Functions," *Management Science* 33, 955–964.

{% **foundations of statistics**: a large empirical analysis of p-hacking. %}

Brodeur, Abel, Nikolai Cook, & Anthony Heyes (2020) "Methods Matter: p-Hacking and Publication Bias in Causal Analysis in Economics," *American Economic Review* 110, 3634–3660.
https://doi.org/10.1257/aer.20190687

{% **foundations of statistics**: a large empirical analysis of p-hacking. %}

Brodeur, Abel, Nikolai Cook, & Carina Neisser (2024) "p-Hacking, Data Type and Data-Sharing Policy," Economic Journal 134, 985–1018.
https://doi.org/10.1093/ej/uead104

{% **information aversion**?, test for AIDS/Huntington's disease (I don't know which) %}

Brody, Jane E. (1988) "Personal Health," *New York Times*, August 25, 1988, B17.

{% **random incentive system between-subjects**: finds that it works well. %}

Brokesova, Zuzana, Cary Deck, & Jana Peliova (2017) "Comparing a Risky Choice in the Field and across Lab Procedures," *Journal of Economic Psychology* 61, 203–212.
https://doi.org/10.1016/j.joep.2017.04.008

{% %}

Broll, Udo, Kit Pong Wong, & Itzhak Zilcha (1999) "Multiple Currencies and Hedging," *Economica* 66, 421–432.

{% Use PT to analyze resource allocation, finding that loss aversion is the main factor. %}

Bromiley, Philip (2009) "A Prospect Theory Model of Resource Allocation," *Decision Analysis* 6, 124–138.

{% **PT, applications**: Table 1 lists many applications of prospect theory in strategic management.

Two specialists in strategic management write about applications of prospect theory there, making it lively for managers by adding examples such as "thus a manager who faces …". One cannot expect theoretical perfection with people from other fields and, hence, there are theoretical inaccuracies.

The paper does not distinguish between prescriptive and descriptive as clearly as I would want to. It mentions it in passing by on p. 137 ℓ. -5.

P. 2022 3rd para strongly suggests that probabilities would always be underweighted, contrary to the prevailing inverse S shape, but later the paper will write about inverse S.

P. 127 2nd para ℓ. 4 suggestst that OPT would only concern two-outcome lotteries. However, for two-outcome lotteries OPT agrees with PT (this is how I abbreviate new 1992 (cumulative) prospect theory) [given that sign-dependence of w is at will for both theories]. OPT allows for three-outcome lotteries if one outcome is 0, and only there deviates.

An elementary confusion throughout is that the authors confuse steepness of utility with curvature/degree of concavity (risk aversion under EU), which is roughly like confusing first and second derivative or, more precisely, first derivative u´ and –u´´/u´ (the Pratt-Arrow index). The authors accordingly think that if you multiply the utility function by 2, then risk aversion will double, whereas in reality risk aversion is unaffected by this. Thus, on p. 2022 end of 1st para they claim that there is more risk seeking for losses then for gains because utility is steeper for losses. However, in reality utility is LESS convex (thus LESS risk seeking) for losses than for gains. The whole rest of p. 131 is based on this confusion. Thus, the 2nd para there continues on the confusion, leading to erroneous criticisms of claims on associations between risk and returns put central and repeated several times. P. 131 2nd para writes "This decrease in marginal value for potential outcomes far from the reference point and the resulting almost-linear value function in this region implies risk neutrality (i.e., neither risk aversion nor risk seeking)."

clearly showing this confusion. Throughout all the rest of the paper, all claims on degrees of risk aversion are confused and erroneous because of this. One symptom of problems here is that the authors never define what degree of risk aversion is. Thus, they claim that pople are less risk averse for higher gains, whereas the empirical finding is more absolute but less relative risk aversion. (Yes, there are different versions of risk aversion!)

Another elementary mistake is that the author many times, in many parts of the paper, erroneously claim that PT can only be used if known probabilities are available, i.e., for risk, and not for uncertainty/ambiguity. Well, most of my work today (Aug. 2022) is on PT for ambiguity, as expressed even in the title of my book Wakker (2010).

P. 133 3rd para criticizes people who only use loss aversion, and not probability weighting, writing: "By ignoring the probability weighting function, scholars ignore half of the theory." Several other places repeat this criticism. However, it can completely be justified for reasons of tractability.

P. 133 last para is too strong on claiming that PT looks at every single decision in isolation and never integrates seveal choices. Several other places repeat this claim. However, PT is not at all that strict on this point. It allows for it, but does not claim it to be universal.

Several places argue that more things in life are relevant than PT. For instance, P. 135 after first para discusses strategic complications. However, PT does not preclude such! It never claimed that it can solve all problems in life.

P. 137: "For example, we do not see prospect theory as necessary to argue that people do not behave according to expected utility theory." Everyone will agree!

P. 138 1st para cites Stanford (2017) on theories that are empirically indistinguishable but then goes on to write that they are empirically distinguishable after all.

P. 139 final sentence is nice: "We hope our discussion sparks a conversation on how to best balance the use of an academic theory in a complicated real world." %}

Bromiley, Philip & Devaki Rau (2022) "Some Problems in Using Prospect Theory to Explain Strategic Management Issues," *Academy of Management Perspectives* 36, 125–141.
https://doi.org/10.5465/amp.2018.0072

{% **criticizing Knight (1921) for low quality**: They criticize Knight (1921) for making mistakes. For instance, they write: "we argue that Knight made a combination of errors and poor modeling choices" %}

Brooke, Geoffrey & Lydia Cheung (2021) "Uncertainty and General Equilibrium: An Evaluation of Professor Knight's Contributions to Economics," *Cambridge Journal of Economics* 45, 901–918.
https://doi.org/10.1093/cje/beab022

{% **value of information**: Extending Blackwell (1953), one signal is more valuable than another regardless of preferences/access-to-other-signals iff revealor-refine: reveal state or refine other signal. More comparisons are given. %}

Brooks, Benjamin, Alexander Frankel, & Emir Kamenica (2024) "Comparisons of Signals," *American Economic Review* 114, 2981–3006.
https://doi.org/10.1257/aer.20230430

{% Test PT with more than three outcomes. Separate gain prospects, loss prospects, and mixed prospects. Their main interest is testing aversion to mean-preserving spreads. The controversial Levy & Levy (2002 Management Science) did this too. Find usual things of PT, but less loss aversion and less pronounced probability weighting. Fox mixed prospects, the probability of losing does much.

losses from prior endowment mechanism: they do that (p. 161).

reflection at individual level for risk: P. 171 ff. consider it. They find the usual reflection at the aggregate level. At the individual level they find no clear classifications at all, which seems like H_0, but makes them conclude that it may not be at the individual level. %}

Brooks, Peter, Simon Peters, & Horst Zank (2014) "Risk Behavior for Gain, Loss, and Mixed Prospects," *Theory and Decision* 77, 153–182.

{% Use **random incentive system**.

Consider choices between (p:x, r:z, p:–x) and (p:x+ε, r:z, p:–x–ε) for all variables nonnegative; i.e., they test aversion to particular mean-preserving spreads, with always $-x \le z \le x$. Because these spreads concern mixed prospects, they interpret aversion as loss aversion. They find that most subjects are loss averse, women

considerably more than men (**gender differences in risk attitudes**). They also consider what happens under variations of z without affecting rank-ordering, amounting to tests of comonotonic independence, and find violations there, with more risk aversion as z gets lower. %}

Brooks, Peter & Horst Zank (2005) "Loss Averse Behavior," *Journal of Risk and Uncertainty* 31, 301–325.

{% **foundations of statistics**: P. 2694 seems to write: "Thus, if your primary question of interest can be simply expressed in a form amenable to a t test, say, there really is no need to try and apply the full Bayesian machinery to so simple a problem." My opinion, say for a t-test of a single null versus a single alternative: In one test, Bayesian likelihood ratio and p-value are equivalent, being two ways of specifying the cutoff point. But when comparing across different tests, the Bayesian likelihood ratio gives the relevant quantity, ad p-value does not. %}

Brooks, Stephen P. (2003) "Bayesian Computation: A Statistical Revolution." *Philosophical Transactions of the Royal Society of London: Series A. Mathematical, Physical and Engineering Sciences* 361, 2681–2697.

{% Argue that biases and WTP-WTA discrepancy can be solved by exercise, feedback and incentives. %}

Brookshire, David S. & Don L. Coursey (1987) "Measuring the Value of a Public Good: An Empirical Comparison of Elicitation Procedures," *American Economic Review* 77, 554–566.

{% **equity-versus-efficiency**: Seems to describe case known as U.S. versus Holmes. Seaman Holmes was involved in throwing people overboard from an overcrowded lifeboat, in 1841. Judge Baldwin found him guilty because he had not done it by lot: "In no other than this or some like way are those having equal rights put upon equal footing" %}

Broome, John R. (1984) "Selecting People Randomly," *Ethics* 95, 38–55.

{% %}

Broome, John R. (1985) "The Economic Value of Life," *Economica* 52, 281–294.

{% **R.C. Jeffrey model**: Reformulates Harsanyi's theorem for Bolker/Jeffrey **restricting representations to subsets**: P. 493: points out that a Hammond paper, to apply Gorman's theorem, requires full product structure, and cites personal communication with Gorman claiming that it could be considerably generalized. %}

Broome, John R. (1990) "Bolker-Jeffrey Expected Utility Theory and Axiomatic Utilitarianism," *Review of Economic Studies* 57, 477–502.

{% This book has been one of the most influential works for my academic thinking. The book focuses on aggregation over persons, time, or uncertainty. See its subtitle. (Also Section 2.2. "These are the dimensions I shall be dealing with in this book. Perhaps there are other dimensions that could usefully be treated similarly, but I cannot think of any.")

Preface: the book considers "good" rather than preference (whenever those two might deviate).

The book argues that aggregation over uncertainty and maybe also persons and time, should be additivite with respect to one same cardinal index, being "goodness." Goodness is a kind of cardinal utility (may deviate from preference if latter are irrational). The required separability can be justified by assuming that "all relevant" be incorporated in the outcomes ("individuation of outcomes"). The book gives an advanced discussion of this point in §§5.3-5.7.

Ccr. 1: "good" = "relation of betterness." It adheres to consequentialism, rather called teleology (adj: teleological), by saying that anything relevant should be incorporated into consequences.

Often: the "right" act is the one that brings most "goodness," so as to reconcile teleological and nonteleological theories.

Section 1.2, p. 7 reminds me of my tradeoff thinking: "metaphor of weighing often fits teleology ... good and bad features are weighed against each other."

P. 11/12: "being more Westerly" is a nice example of intransitive relation. "At least as good as" should be transitive and reflexive (and for that the term ordering will be used. However, p. 65 defines ordering as also being complete). Need not be complete by an "I see no reason" argument. It is permitted that different things are incommensurable. (This is stated explicitly later, Section 5.1 p. 92/93.)

P. 16, end of Section 1.3: Announces that book will defend that EU is normative. End of Section 2.2 will say book is not to be understood as defense of utilitarianism, but only as exploration of its logical relations to separability.

coherentism: Section 1.4, P. 19, ed of 2nd paragraph: "It follows that teleological ethics cannot be *fully* justified on grounds of internal consistency ... It also follows that there are, actually, external criteria available for assessing the goodness of acts."
Same section, p. 20: "The view that one should maximize pain is excluded by a substantive limit. This book is concerned with the structural limits." Beginning of Section 2.4: "This book is about the structure of good, not the content of good." Points out that structural work cannot deal with substantive issues but thinks it still is valuable. Such a fine, nuanced, statement, right on target, is not to be found in any of the writings of Sen for instance!

Section 2.1 points out that decisions come about by weighing of goods, or aggregation. Points out that the weighing metaphor fares well if separability, less so otherwise. Presents separability for uncertainty, interpersonal, and time.

Section 2.2 explains that uncertainty, interpersonal, and intertemporal are special dimensions because separability can be defended there. For other dimensions it cannot be. I disagree because I think that only for uncertainty, separability has a special status (because of mutual exclusiveness of states of nature, explained on p. 96, Section 5.3 of Broome's book). Interpersonal and intertemporal do not have this; there an undesirably strong appeal will have to be invoked that the description of consequences contains everything relevant.

The coordinate value functions (as I would call it) are called "good at locations."

Section 2.2, near end, says that book argues for separability and utilitarianism, but that the case is ultimately inconclusive and that the arguments will contain gaps. John mentions that separability over time seems implausible to him.

Section 2.2, p. 28 bottom, gives precisely the same argument as Kahneman, I, & Sarin (1997) needed to defend that we assume instant utility measurement in intertemporal aggregation. John formulates it for interpersonal aggregation:

"For instance, between people, separability of income is implausible, but I think separability of good turns out to be an acceptable assumption. That is why my argument is conducted in terms of good rather than income. At places in this book the framework of the argument may seem contrived. *But if some artifice is required to gain access to the theorems, it is worthwhile.* It will reveal features of the structure of good that would otherwise remain hidden." [italics added]

Section 2.5, p. 33, points out that Broome thinks, like me, that completeness is the weakest of the EU axioms. However, he thinks it mainly because of incommensurability and I don't find that a good argument. Anybody who worked in a hospital will disagree with philosophers on this point. Philosphers can relax in their chair and argue that human lives and money are incommensurable. In the hospital, doctors do not have this luxury, but have to trade off human lives against money on a daily basis. My main counterargument against completeness is different: that many choice situations are too unrealistic to consider, which is related to Broome's rectangularity property.

Section 2.5, p. 36, "The conclusion is that general good can be represented by an expectational function that is the sum of expectational utility functions representing the good of individuals."

Chapter 3 is on a similarity argument by Harsanyi (1953) that Broome doesn't like too much.

Section 4.1, p. 60/61, discusses the Samuelson game where you don't want one gamble, you do like them when repeated often and only sum total matters, you don't want them maybe when repeated often but money is not transferable from one moment to the other.

Section 4.2, p. 70, states "second separability theorem" which has also been known as the "problem of aggregation" in the literature. The two-dimensional separability is called "crosscutting separability." For its proof, Gorman (1968) is cited.

Section 4.4 calls the assumption that the domain is a full product set the "rectangular field" assumption, and expresses interest in weakenings thereof.

Appendix to Chapter 4, p. 87/88, gives informal proof of Gorman's theorem in line with what I plan to do in the future. ("future" was written in

1998. Now, 2021, it is postponed until next life.)

Section 5.1, p. 91 (about EU): "It claims only that there *are* numbers p_1, p_2 and so on and a function u that allow the preferences to be represented in the manner of ... It says nothing about what the numbers and the function signify."

Section 5.1, p. 92/93: John repeates, for EU, that completeness is dubious.

P. 93 has reached additive separability for EU, and does not know how to make the last step to EU (the move from (5.1.2) to (5.1.1)); precisely here, my tradeoff consistency axiom would do the trick! Also, the intuition in the writing is precisely how I presented tradeoff consistency in my lectures in my young years.

p. 93 also points out the derivation of SEU from additive separability when there are equally-likely states.

independence/sure-thing principle due to mutually exclusive events: Sections 5.3 - 5.7 provide the best discussion I know in the literature of this issue. Section 5.3, p. 96, discusses the argument for independence, being the mutual exclusiveness of states of nature.
Broome describes an argument: "How can something that never happens possibly affect the value of something that does happen?"

Section 5.3, p. 98 (through endnote 15), mentions refs to people who explain Allais paradox. Always it's a kind of regret. Section 5.6, p. 107 etc., will discuss that in detail.

End of Section 5.3, p. 99/100, discuss consequentialistic trick of incorporating "everything relevant" into consequences (called "individuation," referring to separating consequences as different individuals), cites people on it, seems favorable to doing it, and says criteria for it should be developed. Cites Allais and ascribes to him that it should be monetary outcomes and cites Machina who said it should be "physically observable aspects."

Section 5.4 discusses "individuation" more, in the context of transitivity. It says that sometimes, when much appeal has to be made to individuation, transitivity becomes vacuous, but not violated. I fully agree with that.

P. 101 uses term "nonpractical" preference for what I describe as choice situations that are so hypothetical as to be useless.

P. 103, “principle of individuation by justifiers,” as formulated, does not help much, it is not verifiable but in a way circular. “Justifier” is a reason making it rational to have preference between two outcomes.

A nice point by Broome is that, even if one were to distinguish between an outcome with or without regret, it would still be irrational to have a preference between them. He says there is no “justifier” for the difference (justifiers should refer to “good” or “bad” features). This is Broome’s preferred viewpoint, he says with or without regret is different but should still be equivalent. (I prefer to put the difference at the statistical, not physical, level.) He writes: “Our principle for individuating outcomes has to be this: take one outcome as different from another if and only if it is rational to have a preference between them.” (this is written on p. 108.)

paternalism/Humean-view-of-preference: Section 5.5 discusses whether preferences can be just anything (that is in fact “consumer sovereignty”). It deepens the discussion, bringing in Humean considerations. “... it is a common opinion that rationality allows you to prefer anything to anything else” and says that that is part of a Humean tradition. It seems that the Humean view permits just any preference. (I: really???) Refers (footnote 23) to paper by Broome where the issue is discussed more.

Moderate Humeans: They restrict the above a little, by requiring internal consistency conditions, but nothing more. Then comes a strange step in Broome’s reasoning. He seems to think that internal consistency for *preference* does not impose any restriction for indifference. Probably, when John writes requirement of indifference, he means modeling requirement on degree of individuation. At any rate, I can surely appreciate his point that without any modeling restriction, consistency still is vacuous.

Broome writes (p. 106): “internal conditions of consistency require external criteria of goodness to give them meaning.”

p. 107: explains Allais-defenses as individuation through regret, and says there is no justifier for it.

p. 108: Here Broome states what I consider the paradigmatic interpretation of the sure-thing principle, that it shows how one defines consequences: “My only point is that Allais’s preferences are irrational if and only if we decline to distinguish outcomes that are given the same label in Table 14.” Critics might argue that in speaking of the preference for an outcome, separability is implicit?

P. 109/110, end of Section 5.6, on Machina who wants to consider only monetary outcomes, and then John's desire to individuate more: "For many purposes, this may not be the most convenient way of individuating. But it is the best way for the theoretical purpose of understanding rationality. Furthermore, because it preserves separability between states of nature, I hope to show in this book that it gives access to important discoveries about the structure of good."

Section 5.7 considers "dispersion of value between states," i.e., interactions between different states due to disappointment are to be incorporated in the consequences.

It also discusses that for fairness. Fairness is a bit different because it is more process-oriented, depending on the history of the act, and is not so easy to model as experienced emotion in the outcome such as is for instance regret. Several refs are given.

For Broome the special nature of fairness is not a big issue. He apparently does not want to distinguish much between act and consequence, and does not think that permitting the utility of an outcome to depend on the process leading to it is a big restriction. P. 114: "Any value an action or process possesses can perfectly well be counted into the value of its outcome. So that is not the real problem." I think that dependency is a more serious problem than Broome seems to think. I basically agree with Broome's discussion, but think the fairness thing makes the theory vacuous for too many preferences will become "inpractical." Later: that is exactly and entirely what he writes later in Section 5.8.

p. 114/115 discusses again relevance of counterfactuals. He says fairness is a genuine property of an outcome, based on a counterfactual conditional. Compares it to dispositional properties such as "inflammability" of ships, which also holds if they never catch fire. I would say that in such a case the dispositional property stands for nothing but the physical factors from which we derive the dispositional property. Ramsey (1931) wrote nicely about this for poison.

Section 5.8, I completely and entirely agree with every word of it. I think completeness is the major weakness in the EU axioms, exactly for the argument that Broome calls the "rectangular field assumption." Broome very very correctly points out that his individuation trick to save sure-thing principle, is at variance with the rectangular field property, and that in the latter lies the real problem. Only his one-before-the-last sentence suggests hope that the EU representation as is can be extended to incomplete product sets. That is not true, in such case conditions like continuity lose much of their force, finitistic axiomatizations must be considered which are well known to be hopelessly complicated.

Chapter 6 extends the EU defense, that was given in Chapter 5 for rationality/preference, to goodness.

Section 6.2, p. 132, argues that preferences do not always maximize good because we observe that empirically.

discounting normative: §6.2, p. 134, seems to assume, implicitly without further motivation, that discounting is irrational.

P. 137, footnote *: assumes, and I agree, that rational preference should be transitive and reflexive but not complete.

Section 6.5, p. 142, Bernoulli's hypothesis is EU with the "goodness" index as utility.

risky utility u = strength of preference v (or other riskless cardinal utility, often called value): P. 146/147, first mentions that U of EU should be a strictly increasing transformation of the goodness index. But why should it be the goodness index, of the same cardinal class? It then argues that that is plausible by thinking similar to tradeoff thinking, and saying that it is reasonable that U is the goodness index. **This is the intuition of tradeoff thinking that I presented in lectures of my youth!** Broome agrees there is no definite proof, last sentence of this Chapter 6: "the hypothesis is defensible, but the defence is inconclusive." Later, e.g., p. 217, Broome will point out that if the cardinal index for EU and for utilitarianism is the same, then that strongly suggests that these actually *are* quantities of good.

The text also argues that the cardinal index should be the same for uncertainty as interpersonally. This follows formally from the mathematics of weak separability in both dimensions for matrices ("crosscutting separability," e.g. if row = person and column = state of nature), by Gorman (1968), leading to additive representability. (The same maths has been used by economists such as Van Daal & Merkies and others under the name "theorem of aggregation"). P. 146/147 (§6.5) will write, on distinctions between various cardinal indexes: "And it is natural to think this an empty distinction."

P. 149, footnote 19 says Bernoulli's hypothesis is implicit in vNM, and cites Ellsberg for it.

Chapter 7, p. 152, explains that Pareto cannot be satisfied under EU if persons have different probabilities.

Chapter 8 is on equity, I guess; I mostly skipped it.

Chapter 9 is on inequality.

p. 177 offers some funny citations of ancient writers who discriminated women.

Section 9.3, p. 186, explains that violation of separability due to equity can be removed by describing people's state not in terms of money, but in terms of "good."

Broome distinguishes equality within the utilitarian model, by concavity of individual utilities ("priority view," "individualistic egalitarianism"), and other kinds of equity ("communal egalitarianism") that lead to violation of separability.

Chapter 10, p. 202, summarizes the previous discussions in the "interpersonal addition theorem." General goodness is obtained by summing individual goodnesses and taking expectation over uncertainty.

Section 10.2 discusses how the problem of aggregation, applied to uncertainty and persons as dimensions, leads to identical utility for uncertainty as for persons. Then, Bernoulli's hypothesis also implies that the general good should be the sum of the individual goods.

P. 217: Same U for risk and interpersonal strongly supports it being goodness index. The utilitarianism custom of combining interpersonal addition with expected utility is nicely captured formally in this chapter.

p. 219/220, very correctly, points out that interpersonal comparability of utility is not a conclusion of Harsanyi (1955), but it is a presupposition, needed in the very definition of social welfare ordering.

Chapter 11 is on time preference. To aggregate within a person over time, the person at each timepoint is considered a separate unit. Broome puts in heavy machinery, "disuniting metaphysics," to justify it. The good of a life consists of the aggregate of the goods at each timepoint. A thought experiment where a person, halfway his life, is replaced by an exact copy, with identical memories etc., is used to support the claim. "The unifying relations must not be axiologically significant" is written (later, on p. 239) where "unifying relations" are wholistic (interaction) aspects of life time and axiologically probably refers to goodness in some way.

P. 228 mentions an example (from Parfit) that may be the hardest testcase for separability over time, i.e., a person who works all her life to save Venice. The example I always use to illustrate the point is of a person willing to sacrifice his life for a good cause, such as saving other people.

p. 239 repeats that incommensurability is the most serious gap in the normative theories. Broome then says he is inclined !not! to believe the disuniting metaphysics argument. A Dutch movie had an actor, a soldier going to die a heroic death, say in his goodbye letter to his wife: "I did not search for happiness but for meaning."

Book ends with: "The truth of the utilitarian principle becomes, in the end, merely a matter of meaning. It is a matter of choosing a metric for good." These sentences suggest to me that he takes the work in the same paradigmatic way that I am inclined to, where separability etc. only show how we intend to interpret the primitives of our model.

Reviews of this book:

Hausman, Daniel M. (1993) "The Structure of Good," *Ethics* 103, 792–806. Gives nice summary of Broome's arguments on separability, goodness, completeness, etc., with some own opinions added.

Hollis, Martin (1992) *Mind* 101, 553–554. Positive and presents main themes; doesn't try to be deep.

Sugden, Robert (1992) *Economica* 59, 253–254.

Pattanaik, Prasanta K. (1993) *Economic Journal* 103, 752–753.

Arneson, Richard J. (1993) *Journal of Economic Literature* 31, 1443–1445.

Temkin, Larry S. (1994) *Philosophy and Public Affairs* 23, 350–380. This review is superficial; in particular the listing of arguments against utilitarianism, at the end, is off because Broome's book discusses each of them extensively. %}

Broome, John R. (1991) "*Weighing Goods.*" Basil Blackwell, Oxford, UK.

{% Only purpose is to point out a mistake that Lewis seems to have made. %}

Broome, John R. (1991) "Desire, Belief and Expectation," *Mind* 100, 265–267.

{% %}

Broome, John R. (1991) "Utility," *Economics and Philosophy* 7, 1–12.

{% %}

Broome, John R. (1991) "A Reply to Sen," *Economics and Philosophy* 7, 285–287.

{% **paternalism/Humean-view-of-preference**: Humean viewpoint: no preference can ever be criticized for being irrational. Moderate Humean viewpoint: only internal consistency conditions (such as transitivity) can be imposed, no other criteria for rationality. Broome argues that the moderate Humean viewpoint cannot be maintained in the sense that it must necessarily reduce to the Humean viewpoint, as follows.

Violations of internal consistency can always be avoided by remodeling, by "finer individuation" of alternatives (e.g., incorporating context-dependence in the description of the alternative). Such finer individuation cannot be criticized on the basis of internal consistency and must necessarily be discussed on external grounds.

I personally think that both the Humean and the moderate Humean viewpoint are untenable, and that external criteria have to be invoked in rationality. The viewpoint that only the consistency axioms, and not for instance medical knowledge, is required for rationality, is surely not fruitful in medical decision making!

Probably Broome thinks the same, see end of §1: "I hope this will diminish the appeal of the Humean view as a whole."

P. 58 (on a book-making reasoning): "It is as though you stole his shirt and then sold it back to him."

P. 65: "a person's practical preferences are causally affected by her nonpractical preferences" %}

Broome, John R. (1993) "Can a Humean Be Moderate?" *In* Raymond G. Frey & Christopher W. Morris (eds.) *Value, Welfare and Morality*. Cambridge University Press, Cambridge.

{% An abbreviated description of the ideas of Broome (1991), with implications for QALYs.

P. 150 2nd para: claims that EU is normative

intertemporal separability criticized: pp. 151–152

Pp. 153-154: **risky utility u = transform of strength of preference v**; states this point not for strength of preference but for intertemporal utility used in discounted utility.

Pp. 154-155: **risky utility u = transform of strength of preference v**; states this point not for strength of preference but for intertemporal utility versus a general cardinal index of utility, called "good" by the author.

Pp. 155 bottom: **risky utility u = transform of strength of preference v**; states this point not for strength of preference but for a general cardinal index of utility, called "good" by the author, versus EU utility.

P. 156 bottom suggests that intertemporal utility has more right to claim to be a cardinal index of goodness than risky EU utility. No argument is given, but the opinion is repeated three times or so.

P. 154 3rd para distinguishes cardinal in the mathematical sense from cardinal in the sense of index of goodness.

questionnaire versus choice utility: pp. 159-160 suggest that direct judgment may be better for measuring a normative index of goodness that eliciting preferences. %}

Broome, John R. (1993) "Qalys," *Journal of Public Economics* 50, 149–167.

{% %}

Broome, John R. (1993) "Goodness Is Reducible to Betterness: The Evil of Death Is the Value of Life," - Discussion Papers (University of Bristol, Department of Economics)

{% %}
Broome, John (1999) "*Ethics out of Economics.*" Cambridge University Press, Cambridge.

{% **risky utility u = strength of preference v (or other riskless cardinal utility, often called value)**: Broome believes so at the level of his degree of goodness (§§6 and 7); calls it the expectational concept. His argument is that this is most natural and that there is no natural alternative. He seems not to believe so at the level of rightness (§2), where he says that risk neutrality for rightness in goodness is not plausible. %}
Broome, John R. (2008) "Can There Be a Preference-Based Utilitarianism." *In* Maurice Salles & John Weymark (eds.) *Justice, Political Liberalism and Utilitarianism: Themes from Harsanyi and Rawls*, 221–238, Cambridge University Press, Cambridge.

{% **discounting normative**; extensively discuss whether or not we ought to discount. Have no strong position, but favor discounting. %}
Broome, John R. & David Ulph (1992) "Counting the Cost of Global Warming: A Report to the Economic and Social Research Council." White University Press, Cambridge.

{% Propose a measure for how much information about unknown subjective parameters to be measured a set of decision problems gives. Such measures are used in recent computer-based adaptive measurements where the new stimulus offered to the subject is chosen to give optimal info given previous choices of the subject, as for instance in Cavagnaro, Gonzalez, Myung, & Pitt (2013, Management Science). But now the criterion is simpler and more tractable, and does not depend on previous choices. I expect that tradeoff-method based measurements do well. They apply their method to the measurement of PT (they write CPT; I mean the 1992 version of their theory). They then use power utility and the 1-parameter Prelec probability weighting family. Pp. 265 ff. show that variations/errors in observations contribute to the DFD-DFE gap, because of positive skewness and the lower bound of 0.

They find, surprisingly, that the stimulus set deliberately chosen by Stott

(2006) in fact has more overlap of data estimation than a randomly constructed set by Erev et al. (2002) (p 268 bottom).

Unfortunately, this paper follows the bad terminology of some papers in DFE to let "diminishing sensitivity" refer only to utility curvature and even equate the two.

This paper finds, again, that estimations of loss aversion are not stable. The authors add an argument to the many existing: that there often are not many mixed lotteries and only those contribute to the estimation (p. 269 3rd para). %}

Broomell, Stephen B. & Sudeep Bhatia (2015) "Parameter Recovery for Decision Modeling Using Choice Data," *Decision* 1, 252–274.

{% Seem to find that the strategy method gives different results than posterior choice. %}

Brosig, Jeanette., Joachim Weimann, & Chun-Lei Yang (2003) "The Hot versus Cold Effect in a Simple Bargaining Experiment," *Experimental Economics* 6, 75–90.

{% They find endowment effect with 20 chimpanzees for objects of value. Unsurprisingly, there is no discrepancy for objects that are of no value anyhow. %}

Brosnan, Sarah F., Owen D. Jones, Molly Gardner, Susan P. Lambeth, & Steven J. Schapiro (2012) "Evolution and the Expression of Biases: Situational Value Changes the Endowment Effect in Chimpanzees," *Evolution and Human Behavior* 33, 378–386.

{% Big sample of Medicare patients. Default rules have large effects for low-income beneficiaries, even when involving clear large losses. (Ethical approvement of such an experiment is nontrivial.) %}

Brot-Goldberg, Zarek, Timothy Layton, Boris Vabson, & and Adelina Yanyue Wang (2023) "The Behavioral Foundations of Default Effects: Theory and Evidence from Medicare Part D," *American Economic Review* 113, 2718–2758. https://doi.org/10.1257/aer.20210013

{% %}

Brothers, Alan (1990) "An Empirical Investigation of Some Properties that are Relevant to Generalized Expected Utility Theory," doctoral dissertation, University of California, Irvine.

{% Replicate Plott & Zeiler (2005) but without anonymity, showing that familiarity with the procedures drives it rather than anonymity. %}
Brown, Alexander L. & Gregory Cohen (2015) "Does Anonymity Affect the Willingness to Accept and Willingness to Pay Gap? A Generalization of Plott and Zeiler," *Experimental Economics* 18, 173–184.

{% **random incentive system**: Test the random incentive system for choice lists with all choices on one page, and then each choice on a separate page. Take as gold standard, as is common, single choice. Then the separate presentation is not significantly different from the gold standard, but the one-page treatment is. However, the separate treatment gives more intransitivities, unsurprisingly, which I interpret as noise and deviation from true preference. The authors are more optimistic about the isolated treatment and claim that it is incentive compatible so that, as they claim, intransitivities must be true preference. %}
Brown, Alexander L. & Paul J. Healy (2018) "Separated Decisions," *European Economic Review* 101, 20–34.

{% An impressive meta-analysis on loss aversion. The mean found is 1.955, lower than 2.25 found by Tversky & Kahneman (1992) but higher than I thought. (And continue to think; oh well.) It does not correlate well with other variables.

P. 491 properly writes: "Notice that mixed prospects are necessary to identify loss aversion, since λ cancels out in the evaluation of pure loss prospects".

The authors provide many methodological discussions of meta-analyses.

The closing sentence is nice: "The old cliché "we encourage future research in these areas" now has empirical backing." %}
Brown, Alexander L., Taisuke Imai, Ferdinand M. Vieider, & Colin F. Camerer (2024) "Meta-Analysis of Empirical Estimates of Loss Aversion," *Journal of Economic Literature* 62, 485–516.

{% Test Epstein-Zin preferences. %}

Brown, Alexander L. & Hwagyun Kim (2014) "Do Individuals Have Preferences Used in Macro-Finance Models? An Experimental Investigation," *Management Science* 60, 939–958.

{% Consider DUU with real outcomes, so outcome-wise mixing. Consider risk measures, being functionals that satisfy translation invariance (= constant absolute risk aversion = homotheticity), convexity, and some other properties, and discuss many examples satisfying these conditions such as CEU (Choquet expected utility) with proper restrictions. %}

Brown, David B., Enrico De Giorgi, & Melvyn Sim (2012) "Aspirational Preferences and Their Representation by Risk Measures," *Management Science* 58, 2095–2113.

{% A generalization of more risk averse of Rotschild-Stiglitz, allowing for a sort of positive correlation between the noise-lottery added and the base lottery. %}

Brown, David P. (2017) New Characterizations of Increasing Risk," *Journal of Mathematical Economics* 69, 7–11.

{% Find evidence for rank dependence. %}

Brown, Gordon D.A., Jonathan Gardner, Andrew J. Oswald, & Jing Qian (2008) "Does Wage Rank Affect Employees' Well-Being?," *Industrial Relations* 47, 355–389.

{% Version of April '04:

inverse S: beginning has nice survey.

Paper discusses large and small probabilities without relating them to outcomes/rank-dependence.

Use range-frequency theory (RFT) of Parducci (1965, 1995) to explain inverse S probability weighing. According to RFT, we are extra sensitive to stimuli in regions where there are many observations/experiences, and insensitive in regions where there are few. Thus, if we more often encounter small and large probabilities, then we will be extra sensitive towards them. Difficulty is, what should we take as set of experiences? All probabilities we ever saw in our life, all probabilities occurring in the experiment we participate in so far, or only the probabilities occurring in the prospect now considered.

The theoretical discussion is nice, but testing these hypotheses empirically is not easy. The authors nevertheless try and, e.g., answer how frequent they think that probabilities appear. %}

Brown, Gordon D.A. & Jing Qian (2004) "The Origin of Probability Weighting: A Psychophysical Approach," University of Warwick.

{% P. 489 seems to argue for conditioning on ancillary statistic, and cite Fisher, Savage, Cox. %}

Brown, Lawrence D. (1990) "An Ancillarity Paradox Which Appears in Multiple Linear Regression" (including discussion), *Annals of Statistics* 18, 471–538.

{% **foundations of quantum mechanics** %}

Brown, Matthew J. (2009) "Relational Quantum Mechanics and the Determinacy Problem," *British Journal for the Philosophy of Science* 60, 679–695.

{% **updating: discussing conditional probability and/or updating** %}

Brown, Peter M. (1976) "Conditionalization and Expected Utility," *Philosophy of Science* 43, 415–419.

{% %}

Brown, Roger (1965) "*Social Psychology*." New York: Free Press.

{% There were 5 hypothetical risky decision questions (imagine your income would either double or …), used to measure risk attitudes. They are negatively related to their children's test scores and attending college post high scholes. %}

Brown, Sarah, Aurora Ortiz- Nuñez & Karl Taylor (2012) "Parental Risk Attitudes and Children's Academic Test Scores: Evidence from the US Panel Study of Income Dynamics," *Scottish Journal of Political Economy* 59, 47–70.

{% **Z&Z** %}

Browne, Mark J. & Helene I. Doerpinghaus (1993) "Information Asymmetries and Adverse Selection in the Market for Individual Medical Expense Insurance," *Journal of Risk and Insurance* 60, 300–312.

{% Use data from a portfolio of risks of a German insurer. Within-subject comparions give that people rather insure their bike than their house against floods. %}
Browne, Mark J., Christian Knoller, & Andreas Richter (2015) "Behavioral Bias and the Demand for Bicycle and Flood Insurance," *Journal of Risk and Uncertainty* 50, 141–160.

{% **foundations of statistics** %}
Browner, Warren S. & Thomas B. Newman (1987) "Are All Significant P values Created Equal? The Analogy between Diagnostic Tests and Clinical Research," *Journal of the American Medical Association* 257, 2459–2463.

{% **intertemporal separability criticized** %}
Browning, Martin (1991) "A Simple Nonadditive Preference Structure for Models of Household Behavior over Time," *Journal of Political Economy* 99, 6707–637.

{% Analyze data from the Canadian Family Expenditure Survey in 7 years between 1974 and 1992, assuming that households cannot be considered as one, but are composed of different individuals. Nicely, Slutsky symmetry, a necessary condition for utility maximization, is not rejected for singles (p. 1245), but is for general families. %}
Browning, Martin & Pierre-André Chiappori (1998) "Efficients Intra-Household Allocations: A General Characterization and Empirical Tests," *Econometrica* 66, 1241–1278.

{% %}
Browning, Martin & Thomas F. Crossley (2001) "The Life-Cycle Model of Consumption and Saving," *Journal of Economic Perspectives* 15, 3–22.

{% His first name, for friends, was Bertus. Full: Luitzen Egbertus Jan %}
Brouwer, Luitzen E.J. (1911) "Über Abbildung von Mannigfaltigkeiten," *Mathematische Annalen* 71, 97–115.

{% %}

Brouwer, Luitzen E.J. (1924) "Beweis das Jede Volle Funktion Gleichmässig Stetig Ist," *Proceedings KNAW* 27, 189–194.
Reprinted in Arend Heyting, (1975, ed.) "C*ollected Works*," Vol. I, 478–479. North-Holland, Amsterdam.

{% Complexity here refers to number of choice alternatives available, and number of attributes. It is not related to event splitting. %}
Bruce, Alistair C. & Johnnie E. V. Johnson (1996) "Decision-Making under Risk: The Effect of Complexity on Performance," *Psychological Reports* 79, 67–76.
https://doi.org/10.2466/pr0.1996.79.1.67

{% %}
Bruckner, Andrew M. (1962) "Tests for the Superadditivity of Functions," *Proceedings of the American Mathematical Society* 13, 126–130,

{% The paper studies local versions of superadditivity. The results suggest that superadditivity is a global property, quite disconnected from local properties. %}
Bruckner, Andrew M. (1964) "Some Relationships Between Locally Super-Additive Functions and Convex Functions," *Proceedings of the American Mathematical Society* 15, 61–65.
https://doi.org/10.2307/2034350

{% Uses real incentives for gains; **losses from prior endowment mechanism**;
Zurich 2003 179 subjects, 50 lotteries
Zurich 2006 118 subjects, 40 lotteries
Bejing Nov. 2005 151 subjects, 28 lotteries
Determine CEs (certainty equivalents) from choice lists, and fit PT. Do mixture models. Optimal result is with 2 groups, one (20%) doing EV and the other doing PT with all the patterns of T&K'92 confirmed
concave utility for gains, convex utility for losses;
inverse S; find it using Goldstein & Einhorn (1987) family.
risk averse for gains, risk seeking for losses
reflection at individual level for risk: It is in their data but they do not report it.

Have no mixed prospects and, hence, model and measure no loss aversion.

For gains, Chinese students are less pessimistic and more likelihood insensitive than Swiss students. They also have more concave utility and, because CE data may not separate utility well from probability weighting (collinearity), it was not clear to me to what extent the higher concavity of utility drives the lower probability weighting.

The authors are happy about each subject clearly falling into one of the two categories (w, probability weighting, linear or nonlinear). I did not understand what else could happen than these two. There are few subjects of the "ambiguous type" (between the two categories, with p = 0.4 of being one catefory and p = 0.6 of being the other, as an example they give) but I don't know if their probabilistic models give much space to such types in, say, randomly generated choices for instance. %}

Bruhin, Adrian, Helga Fehr-Duda, & Thomas Epper (2010) "Risk and Rationality: Uncovering Heterogeneity in Probability Distortion," *Econometrica* 78, 1375–1412.

{% The authors test 1992 new prospect theory (PT) against salience theory (ST), using Allais paradox stimuli where lotteries are either correlated or independent. PT predicts equally many violations in each case, ST predicts some violations in the case of independent lotteries but not if correlated. There have been studies into this before, but this paper is way more thorough. The authors apply finite mixture models, finding that 28% of subjects to EU, 38% to PT, and 34% do ST. They also find that subjects doing ST have more preference reversals than other subjects.

An important point is how stimuli were presented, collapsed or not, correlated or not, and with common outcomes saliently visible or not. It has been found in the literature, in the 1990s, that the common consequence condition (sure-thing principle) is not violated much if common outcomes are saliently presented. It has then been argued that subjects may then ignore common consequences, thus satisfying EU, not because this is by true preference, but only because it is an easy heuristic to simplify the task. Unfortunately, I cannot produce references for this now.

The authors are more positive about salience theory than I am. Their implementation is as much regret theory as salience theory. %}

Bruhin, Adrian, Maha Manai, & Luís Santos-Pinto (2022) "Risk and Rationality: The Relative Importance of Probability Weighting and Choice Set Dependence," *Journal of Risk and Uncertainty* 65, 139–184. https://doi.org/10.1007/s11166-022-09392-x

{% They study risky choices where the outcomes can depend on the skills of the agent. This is not easy to model with standard models, where truth of states of nature is outside the agent's influence, unlike with moral hazard and the like. %}

Bruhin, Adrian, Luis Santos-Pinto, & David Staublic (2018) "How Do Beliefs about Skill Affect Risky Decisions?," *Journal of Economic Behavior and Organization* 150, 350–371.

{% **inverse S:** Fifty-fifty is **principle of complete ignorance** is extreme case of inverse S. This paper conjectures, and finds confirmed, that more fifty-fifty reasoning occurs (a) for singular than for distributional formats (b) less controlable events (c) less numerate respondents (d) less educated respondents. (**cognitive ability related to likelihood insensitivity (= inverse S)**) (c) remains after correction for age and education. %}

Bruine de Bruin, Wändi, Baruch Fischhoff, Susan G. Millstein, & Bonnie L. Halpern-Felsher (2000) "Verbal and Numerical Expressions of Probability: 'It's a Fifty-Fifty Chance'," *Organizational Behavior and Human Decision Processes* 81, 115–131. https://doi.org/10.1006/obhd.1999.2868

{% Subjects can estimate probabilities in percentages. Those that estimate 0% get a refined scale for probabilities close to 0 and, obviously, many then go some above 0. %}

Bruine de Bruin, Wändi, Andrew M. Parker, & Jürgen Maurer (2011) "Assessing Small non-Zero Perceptions of Chance: The Case of H1N1 (Swine) Flu Risks," *Journal of Risk and Uncertainty* 42, 145–159.

{% (Algemeen Dagblad is a daily newspaper, with 300,000 copies per day, and is the 2nd largest newspaper in the Netherlands.) %}

Bruinsma, Gea & Peter P. Wakker (2017) "Ook naar het Strand Neem Ik Werk mee," *Algemeen Dagblad* 8 August 2017, Beurs 17.

Direct link to paper

{% People prefer to predict unknown result of toss of coin before toss to after toss. So, source dependence of information relates to timing, although it here always is known probability. It, hence, provides a case where known probability is not really one source. Introduction gives references to source preferences.

This paper argues that the difference between pre- and post-diction, usually ascribed to magical thinking, can have other causes, using open-ended questions to subjects to find out. The authors find many other causes, but point out a limitation to their study on p. 24 ℓ. 3: "Of course, we cannot rule out the possibility that some subjects might have been reluctant to disclose their belief in magic." %}

Brun, Wibecke & Karl H. Teigen (1990) "Prediction and Postdiction Preferences in Guessing," *Journal of Behavioral Decision Making* 3, 17–28.

{% If expected value can be increased by increasing probability or increasing outcome, then what will subjects prefer? The author tests it. %}

Bruner, David M. (2009) "Changing the Probability versus Changing the Reward," *Experimental Economics* 12, 367–385.

{% Shows that decision error decreases with risk aversion. %}

Bruner, David M. (2017) "Does Decision Error Decrease with Risk Aversion?," *Experimental Economics* 259–273.

https://doi.org/10.1007/s10683-016-9484-1

{% %}

Bruner, Jerome S. & Cecile C. Goodman (1947) "Value and Need as Organizing Factors in Perception," *Journal of Abnormal and Social Psychology* 42, 33–44.

{% Study risk aversion (measured through choice list of Holt & Laury 2002), and ambiguity aversion, choosing from known/unknown urn. Do it individually,

group process of unanimity rule, and group process of majority. Find increased risk aversion in group processes, but no significant differences for ambiguity attitude. The authors use the smooth model to analyze ambiguity through parameter s in Table 3, but I did not see specified how they chose the second-order probabilities.

correlation risk & ambiguity attitude: seem to find positive relation %}

Brunette, Marielle, Laure Cabantous, & Stéphane Couture (2015) "Are Individuals More Risk and Ambiguity Averse in a Group Environment or Alone? Results from an Experimental Study," *Theory and Decision* 78, 357–376. http://dx.doi.org/10.1007/s11238-014-9432-5

{% Use smooth model to analyze that, for instance, ambiguity aversion increases demand of insurance. They test particular theoretical inequalities in an experiment. %}

Brunette, Marielle, Laure Cabantous, Stéphane Couture, & Anne Stenger (2013) "The Impact of Governmental Assistance on Insurance Demand under Ambiguity: A Theoretical Model and an Experimental Test," *Theory and Decision* 75, 153–174.

{% **questionnaire versus choice utility** %}

Bruni, Luigino & Francesco Guala 2001) "Pareto and the Epistemological Foundations of Rational Choice," *History of Political Economy* 33, 21–49.

{% **questionnaire versus choice utility**

The authors discuss Pareto's views on utility, and connect them to modern issues, in particular Plott's discovered preference hypothesis. To cite someone opposed to Pareto, they often cite Pantaleoni.

On a few points I disagree with the authors:

1. They assume that behavioral economists do not accept the revealed-preference paradigm but want introspective psychological inputs. The same claim is made by Angner & Loewenstein (2010). I think that the link is less strong, and disagree with both these teams. Behavioral economists point out problems for revealed preference, are often close to psychologists, and their work gives support to abandoning revealed preference. But behavioral economics does not necessarily abandon revealed preference. It is still essentially within the revealed preference

paradigm, showing there are more problems there than thought but yet to be resolved. For example, virtually all papers by Kahneman & Tversky use only revealed preference inputs.

2. I disagree much with the suggestion, on p. 152 ff., that part of diminishing sensitivity correspond to reference dependence. State-dependent reference points is a research interest of Sugden (e.g. his 2003-JET paper), but he/they got carried away thinking that Edgeworth's diminishing marginal utility be that. On p. 153 the authors write: "it is surely significant that he [Edgeworth] was aware of the reference-dependence of preferences, .." It concerns the point that if I ate 2 apples each of the last 10 days, then I like an apple less today than if I didn't eat any for 10 days, an aspect of diminishing marginal utility put forward by Edworth. Contrary to the suggestions of Bruni & Sugden, this is not reference dependence. It is simply intertemporal dependence, dependence on PHYSICAL CIRCUMSTANCES. It is completely standard in economic analyses. Reference dependence concerns only framing situations, where the physical circumstances are the same but the PSYCHOLOGICAL PERCEPTION is different, something which is not standard in economic analyses.

§6 criticizes the discovered preference hypothesis, arguing that (1) if preference converge after learning the limit need not be true preference but may be ad-hoc learned heuristic (the shaping hypothesis); (2) many choices in our life must be made without chance to learn from repetition; (3.a) even if people learn preferences, these need not be consistent or context independent; (3.b) in substantive justification of consistency, amounting to assumption that people maximize some (objectively measurable) index such as happiness, how justify this measure? Probably requires resort to psychology, exactly the thing that Pareto and many economists don't want. %}

Bruni, Luigino & Robert Sugden (2007) "The Road not Taken: How Psychology Was Removed from Economics, and how It Might Be Brought Back," *Economic Journal* 117, 146–175.

{% If consumer is not certain to find optimal consumption bundle, then this can generate risk aversion for gains but risk seeking for losses, as posited by prospect theory. %}

Brunnermeier, Markus K. (2004) "Learning to Reoptimize Consumption at New Income Levels: A Rationale for Prospect Theory," *Journal of the European Economic Association* 2, 98–114.

{% **decreasing ARA/increasing RRA**: Find support for constant RRA (p. 714 4th para; p. 734) + inertia (p. 714 last para; p. 734), and against habit formation (p. 733 §III 1st para). Use household-level panel data from the Panel Study of Income Dynamics, covering a period of about 20 years (p. 714). %}

Brunnermeier, Markus K. & Stefan Nagel (2008) "Do Wealth Fluctuations Generate Time-Varying Risk Aversion? Micro-Evidence on Individuals' Asset Allocation," *American Economic Review* 98, 713–736.

{% In this paper, subjective probabilities (beliefs) can be chosen so as to maximize utility. For instance, in a prospect $100_{0.5}0$ you can believe that you get 100 with probability 1 and thus get the highest possible (expected) utility, so, this is what you then do. It is a Baron von Münchhausen way to get more utility. (He got himself out of a hole by very strongly, with his own hand, pulling his shoe leashes, thus lifting himself up, at least this is how his own story goes.) However, if decisions are to be taken then such misbeliefs can lead to suboptimal decisions. Then the optimal tradeoff between decision utility lost, and Baron-von-Münchhausen utility gained, has to be made. %}

Brunnermeier, Markus K. & Jonathan A. Parker (2005) "Optimal Expectations," *American Economic Review* 95, 1092–1118.

{% %}

Bruno, James E. & Arie Dirkzwager (1995) "Determining the Optimal Number of Alternatives to a Multiple-Choice Test Item: An Information Theoretic Perspective," *Educational and Psychological Measurement* 55, 959–966.

{% Does this paper contain the famous model? %}

Brunswik, Egon (1952) "The Conceptual Framework of Psychology." *In International Encyclopedia of Unified Science*, 1 (10), University Press of Chicago, Chicago.

{% The authors measure certainty equivalents of risky gambles with outcomes €5 and €25, or €15 and €20, and also of ambiguous gambles with those outcomes. Further, they play a complicated game, involving, to start, the following simple game:

	L	R
L	5^5	25^{20}
R	20^{25}	15^{15}

Each subject gets a role, say of row player. (This does not matter in the sense that the game is symmetric.) Then the subject has to choose between L and R, specify a belief, and choose two WTAs, one for L and one for R. Then the subject is paired with a randomly chosen other subject who gets the role of column player. Then the following, complex, payment follows.

(1) With probability 1/3 the simple game is played where the players receive the payment for their L/R choice made.

(2) With probability 1/3 the expressed belief is paid according to how close it is to the percentage of subjects who chose L, by a quadratic scoring rule, so that it is incentive compatible under expected value.

(3) With probability 1/3 a WTA is implemented. Then randomly WTA(L) or WTA(R) is chosen, say the former. Then a BDM implementation is done for this as CE of playing L in the simple game against what the other player chose of L or R.

The authors claim that, for *rational* (!) players, the choice of L or R is the same as playing the simple game. To me, who taught game theory for many years to master's students in economics and wants to be rational and Bayesian, this is not clear. I agree with the authors that my choice between L and R only affects MY payoff in Case (1) above, if the simple game is played. However, my opponent's choice of L and R impacts me differently, not only in (1) if the simple game is played, but also in (3), what I may get there. And, similarly, my choice between L and R impacts my opponent differently than only in the simple game. Thus, the payoffs are different than in the simple game, and I, experienced game theorist, find the game very complex to analyze. Comes to it that we should not see normatively how rational players should play this game, but empirically how real human beings play this game descriptively. These real human beings are assumed to not be ambiguity neutral, which greatly complicates the analysis of the above game, such as the conditioning on playing the simple game in (1). Further, the BDM mechanism is notoriously complex anyhow.

The authors claim to reveal how players play the simple game and also the certainty equivalents of the respective actions in that simple game, but I think it is way more complex, as explained above, and this is all unclear.

The authors claim, in particular p. 523 last para and p. 527 top, to be the first to separate strategic uncertainty and ambiguity (and risk). However, Li, Turmunkh, & Wakker (2020) also have such separations, with more sophisticated indexes.

The authors use a strange model where subjects derive direct utility from merely playing a game (may be negative). Thus, their utility can be above the maximum payoff in the game or below the minimum. The authors defend this on p. 533 2nd para by arguing for intrinsic utility, an argument used to justify many things in the literature. %}

Bruttel, Lisa, Muhammed Bulutay, Camille Cornand, Frank Heinemann, & Adam Zylbersztejn (2023) "Measuring Strategic-Uncertainty Attitudes," *Experimental Economics* 26, 522–549. https://doi.org/10.1007/s10683-022-09779-2

{% **real incentives/hypothetical choice**: compare them in the health domain and find no difference, supporting the use of hypothetical choice.

NB = 179 patients were asked hypothetical WTP for self-management equipment for testing blood for anticoagulation therapy. They did not know that later they got the change to really buy. The actual decisions were well consistent with the hypothetical declarations. %}

Bryan, Stirling & Sue Jowett (2010) "Hypothetical versus Real Preferences: Results from an Opportunistic Field Experiment," *Health Economics* 19, 1502–1509.

{% Updated for new releases of SPSS %}

Bryman, Alan & Duncan Cramer (1999) "*Quantitative Data Analysis with SPSS Release 8 for Windows*." Routledge, London.

{% %}

Brysbaert, Marc, Wim Fias, & Marie-Pascale Noël (1998) "The Whorfian Hypothesis and Numerical Cognition: Is "Twenty-Four" Processed in the Same Way as "Four-and-Twenty"?," *Cognition* 66, 51–77.

{% Nudge shows that *in some situations* behavioral economics (BE) *can* lead to improvements of decisions with no, or very minimal, paternalism. This is remarkable because it proves that behavioral economics can have some things to offer without commitment to paternalism. It, obviously, does not say that BE should do this in all situations, or that in all situations paternalism should be avoided. In many situations it can't. Li, Li, & Wakker (2014, Theory and Decision) argue for this point. The authors here discuss behavioral law economics (BLE), and seem to equate it with nudge. Then they go at great length to argue for the obvious: that nudge does not work in all situations, and that paternalism and optimization beyond nudge shouldn't always be avoided. %}

Bubb, Ryan & Richard H. Pildes (2014) "How Behavioral Economics Trims Its Sails and Why," *Harvard Law Review* 127, 1593–1678.

{% **information aversion**: Paper assumes RDU with probabilistic sophistication as normative, as in her other works, but points out that the argument holds in general. She then shows how nonEU can lead to aversion to info, and gives philosophical background. It would be nice if she would explicitly relate to the dynamic dec ision principles of Machina (1989 JEL), as in Brocas & Carrillo (2000) for instance. %}

Buchak, Lara (2012) "Instrumental Rationality, Epistemic Rationality, and Evidence-Gathering," *Philosophical Perspectives* 24, 85–120.

{% She defines faith as accepting something and not being willing to/not being nterested in searching for falsifying evidence. She justifies the latter by her work (2012 Philosophical Perspectives) on aversion to info which can happen under nonEU. (**information aversion**) %}

Buchak, Lara (2012) "Can It Be Rational to Have Faith?." *In* Jake Chandler & Victoria S. Harrison (eds.), *Probability in the Philosophy of Religion*, 225–247, Oxford University Press, New York.

{% **tradeoff method**: is used in axiomatizations.

Axiomatizes probabilistically sophisticated RDU under uncertainty; i.e., Quiggin's RDU for risk only now with the probabilities subjective, derived from acts. The author argues for this as a rational model. Many philosophic discussions on interpretations, normative status, and so on.

P. 81 points out that the author makes her claims only in situations where imprecise probabilities are no issue. Cases where (subjective) probabilities are felt to be imprecise, as in the Ellsberg paradox, are outside the scope of this book, as the author writes. %}

Buchak, Lara (2013) "*Risk and Rationality*." Oxford University Press, New York.

{% **free will/determinism**: Takes issue with Van Inwagen's rollback argument (see my comments at his paper). Argues that indeterminism can lead to free will in ways different than probability/chance. %}

Buchak, Lara (2013) "Free Acts and Chance: Why the Rollback Argument Fails," *Philosophical Quarterly* 63, 20–28.

{% On blaming and the necessity or not to use information beyond doubt (credence) or partial beliefs there. %}

Buchak, Lara (2014) "Belief, Credence, and Norms," *Philosophical Studies* 169, 285–311.
http://dx.doi.org/10.1007/s11098-013-0182-y

{% **tradeoff method**: Is used in axiomatizations. This paper discusses the author's preferred REU model, and its axioms. %}

Buchak, Lara (2014) "Risk and Tradeoffs," *Erkenntnis* 79, 1091–1117.

{% **Newcomb's problem**: there is quite a bit of this, with nuances on different kinds of causality and causal decision theory.

Discusses preference axiomatizations, their normative and descriptive status, but also their interpretive status. The latter means that we interpret, for instance, subjective probabilities and utilities derived from decisions as reflecting the state of the agent, and as genuine beliefs and happiness. If deviation from EU, the descriptive approach will simply turn to other model. The interpretive view will

not do so, because beliefs and happiness are taken to be as in EU (almost by definition). They will rather search for alternative interpretations such as taking outcomes more complex. The interpretive view says that preferences deviating from EU (or whatever is taken as the appropriate theory) do not really reflect the preferences of the agent. They search for an idealized version of the agent. I am sympathetic to this view. %}

Buchak, Lara (2016) "Decision Theory." *In* Alan Hájek & Christopher Hitchcock (2016, eds.) *Oxford Handbook of Probability and Philosophy*, 789–814 (Ch. 13), Oxford University Press, New York.

{% Seems to argue that if we take decisions on behalf of others, then we should optimize given their risk attitude if we know it, but if we don't know it, then we should go by the most risk averse attitude that is reasonably possible. Here risk attitude is to be taken in a rational sense which, according to the author, can involve rank-dependent utility. %}

Buchak, Lara (2016) "Why High-Risk, Non-Expected-Utility-Maximising Gambles can Be Rational and Beneficial: The Case of HIV Cure Studies," *Journal of Medical Ethics* 43, 90–95.

{% Seems to defend a position on equality between Rawls and Harsanyi. Seems to argue that if we take decisions on behalf of others, then we should optimize given their risk attitude if we know it, but if we don't know it, then we should go by the most risk averse attitude that is reasonably possible. Here risk attitude is to be taken in a rational sense which, according to the author, can involve rank-dependent utility. %}

Buchak, Lara (2017) "Taking Risks behind the Veil of Ignorance," *Ethics* 127, 610–644.

{% Seems to argue that if we take decisions on behalf of others, then we should optimize given their risk attitude if we know it, but if we don't know it, then we should go by the most risk averse attitude that is reasonably possible. Here risk attitude is to be taken in a rational sense which, according to the author, can involve rank-dependent utility. %}

Buchak, Lara (2019) “Weighing the Risks of Climate Change,” *The Monist* 102, 66–83.

{% **survey on nonEU**: the basic points. Given the philosophical background of the author, philosophical issues get a central place. %}

Buchak, Lara (2022) “Normative Theories of Rational Choice: Rivals to Expected Utility,” *The Stanford Encyclopedia of Philosophy* (Summer 2022 Edition), Edward N. Zalta (ed.), URL = <https://plato.stanford.edu/archives/sum2022/entries/rationality-normative-nonutility/>.

{% {% **tradeoff method**: is used in axiomatizations.

This paper proposes RAU (riskweighted ambiguity-resolved utility) theory. It is a special case of Choquet expected utility (CEU), so, prospect theory for gains. In CEU, a general nonadditive event weighting function W is used. This paper considers the special case where a subsigma-algebra exists where we have “local” probabilistic sophistication (i.e., where source theory holds), with a probability measure denoted small p. This is also assumed in the popular Anscombe-Aumann framework (AA). The author interprets these events as unambiguous. They can, for instance, be events with known objective probabilities. Unlike AA, the author also allows the unambiguous probabilities to be endogenous (subjective). However, unlike the AA framework, but like Sarin & Wakker (1992), this paper does not assume a two-stage framework, but allows any general framework. This is highly desirable, so as to avoid the problematic complications of nonEU in multistage optimization. Unlike AA and unlike Sarin & Wakker (1992), but like Sarin & Wakker (1994, in Machina & Munier (eds.)), the author does not assume EU for the unambiguous events, but Quiggin’s rank-dependent utility (RDU), called REU by her. It gives a probability weighting function applied to the unambiguous probabilities, usually denoted w. The author calls it a risk function and denotes it r. She then proposes the decomposition $W = r \circ v$, i.e., $v = r^{-1} \circ W$. She interprets r as risk attitude and v as ambiguity attitude.

The author can handle both risk and ambiguity/uncertainty together. This is not new but has been done before in prospect theory. Wakker (2010 p. 2) writes:

"At this moment of writing, 30 years after its invention, prospect theory is still the only theory that can deliver the full spectrum of what is required for decision under uncertainty, with a natural integration of risk and ambiguity." The novelty of the author is to give a precise place to risk and ambiguity, handling them in a unified manner but exactly separated and identified.

I disagree with the popular endogenous interpretations of unambiguity. But the author's concept can be taken as exogenous, as she writes, with objective probabilities. Then I agree with her composition and interpretation. Source theory in Baillon et al. (2025) studies the same decomposition $v = r^{-1} \circ W$ but only on subdomains where W is also probabilistically sophisticated. Wakker (2004) did consider the same decomposition, writing B for v, so $B = r^{-1} \circ W$ with W possibly not probabilistically sophisticated, and interpreted B as belief. B/v captures ambiguity attitude in full, and the general thinking in the field today (2025) is that that is more than belief. (My personal preference, not shown in my papers, is that all of ambiguity attitude is cognitive and is belief, coming from my collaboration with Tversky, but so be it.)

As written, I personally favor exogenous definitions of unambiguity. Many prefer endogenous definitions, and so does the author. Then there is a uniqueness problem that has plagued all endogenous definitions in the literature. There can be several sigma-algebras with probabilistic sophistication, but with different risk functions, say r and r´. Then also v in the composition is different, and there are different candidates for what risk and ambiguity attitudes are. The author has no real solution for it. Her §4 give two results that amount to all r's being the same, when, trivially, the problem does not arise. The author gives preference foundations. The author interprets the decision weights of the rank-dependent formula within a comon-cone derived from v (not W) as probabilities. They then depend on the comoncone and the author takes this as reflecting unknown probabilities, so, ambiguity. %}

Buchak, Lara (2025) "A Unified Treatment of Risk and Ambiguity within A Rank-Dependent Framework," working paper.

{% P. 116 (citation from Sen): “Rationality or irrationality as an attribute of the social group implies the imputation to that group of an organic existence apart from that of its individual components” %}

Buchanan, James M. (1954) “Social Choice, Democracy and Free Markets,” *Journal of Political Economy* 62, 114–123.

{% **utility elicitation** %}

Buckingham, Kenneth J. (1993) “Risks in Utility Assessment and Risks of Medical Interventions,” *Medical Decision Making* 13, 167–168.

{% **utility elicitation** %}

Buckingham, Kenneth J. (1993) “A Note on HYE (Healthy Years Equivalent),” *Journal of Health Economics* 11, 301–309.

{% $\alpha_E 0 \sim \alpha_p 0$, for $\alpha > 0$, defines objective probability p as the matching probability of event E. If a person does not do EU but weights probabilities, and does so the same way for objective and subjective probabilities, then the matching probability p still is the subjective probability of E. (P.s.: even, more generally, under all probabilistic sophistication.) However, if the weighting function is different for objective probabilities than for subjective ones (as in the source method of Abdellaoui et al. 2011 American Economic Review), then this is not so. This is what this paper points out. It calculates through many numerical examples with many weighting functions to illustrate this point again and again. This is what this paper does. %}

Budescu, David, Ali Abbas, & Lijuan Wu (2011) “Does Probability Weighting Matter in Probability Elicitation?,” *Journal of Mathematical Psychology* 55, 320–327.

{% **proper scoring rules**: Not really that, and rather scoring of exams in education, but with many related debates. For example, that even if two scoring rules are equivalent and only linear transformations of each other, one that uses loss scores may be perceived differently (p. 285). And points like if there is a critical level to pass, subjects may have to be risk seeking or risk averse (p. 283 ff.). And that it may be a burden to the subjects just to understand the strategic aspects of the scoring rule, and to be aware of their level of knowledge (p. 278 penultimate para and elsewhere). %}

Budescu, David V. & Maya Bar-Hillel (1993) "To Guess or not to Guess: A Decision-Theoretic View of Formula Scoring," *Journal of Educational Management* 4, 277–291.

{% Subjects choose under ambiguity for losses (**losses from prior endowment mechanism**), where ambiguity is generated by giving probability intervals. Some simple decision models are compared, but they do not allow for subjective parameters. %}

Budescu, David V., Stephen B. Broomell, Robert J. Lempert & Klaus Keller (2014) "Aided and Unaided Decisions with Imprecise Probabilities in the Domain of Losses," *EURO Journal on Decision Processes* 2, 31–62. https://doi.org/10.1007/s40070-013-0023-4

{% It is well known that in expert aggregation, it is sometimes better to combine the best and, say, the 3rd best expert, rather than the best and the 2nd best expert, because the latter two are too closely related to each other and don't add much to each other. This is the starting point of this paper. It proposes to select experts on the basis of how much their marginal contribution is to the rest of the group. Contribution can be measured, for instance, in terms of a proper scoring rule applied to some aggregation of the experts. The paper presents three data sets where their measure performs better than taking the best experts based on past performance. Topic for future research is to find out how general this superiority is or to what extent it was just because of the data sets chosen. Maybe some theoretical observations on when this approach is better than others and when not. Note that instead of marginal individual contribution, many other contribution indexses could be considered. Cooperative game theory has many proposals, such as the Shapley value. %}

Budescu, David V. & Eva Chen (2015) "Identifying Expertise to Extract the Wisdom of Crowds," *Management Science* 61, 267–280.

{% **dynamic consistency**: **test of RCLA** %}

Budescu, David V. & Ilan Fischer (2001) "The Same but Different: An Empirical Investigation of the Reducibility Principle," *Journal of Behavioral Decision Making* 14, 187–206.

{% Take lotteries with vague probabilities ("probability is between 0.03 and .07"), or with vague outcomes ("gain is between $45 and $105"; **ambiguous outcomes vs. ambiguous probabilities**). Common decision theories could take this as two-stage uncertainty, where the second stage is nonprobabilized. For vague outcomes, the authors evaluate the second stage not by $w_1U(x_1) + (1-w_1)U(x_2)$ etc. as common theories would do it, but by $U(w_1x_1 + (1-w_1)x_2)$. Could be interpreted as a very special case of Kreps & Porteus (1978). For vague probabilities they do a similar $w'_1p_1 + (1-w'_1)p_2$, where the w_1 and w_1' are indexes of optimism/pessimism. Could be rephrased as rank-dependent probability transformation. They ask for certainty equivalents. Probably because of scale compatibility, as the authors mention on some occasions but not on others, the subjects are thereby more sensitive towards vagueness in outcomes.

ambiguity seeking for losses: Subjects were ambiguity seeking for vague outcomes and probabilities for gains, and ambiguity averse for losses. This is hard to understand for me. %}

Budescu, David V., Kristine M. Kuhn, Karen M. Kramer, & Timothy R. Johnson (2002) "Modeling Certainty Equivalents for Imprecise Gambles," *Organizational Behavior and Human Decision Processes* 88, 748–768.

{% **inverse S** and **a-insensitivity**: Abstract: "As predicted, laypeople interpret IPCC statements as conveying probabilities closer to 50% than intended by the IPCC authors."

2nd column on 1st page concisely summarizes main findings on verbal probabilistic statements, including: "recipients of verbal forecasts interpret them as less extreme and more imprecise than intended by the communicators." 2nd column last para: "Responses [by readers assessing probabilities meant by authors] were highly regressive." Negative worded phrases were even more regressive. The authors propose an alternative presentation that gives more precise and less regressive understanding. P. 3 ℓ. –4 ascribes the inverse S phenomenon to cognitive factors (**cognitive ability related to likelihood insensitivity (= inverse S)**. %}

Budescu, David V., Han-Hui Por, Stephen B. Broomell, & Michael Smithson (2014) "The Interpretation of IPCC Probabilistic Statements around the World," *Nature Climate Change* 4, 508–512. https://doi.org/10.1038/nclimate2194

{% %}

Budescu, David V., Adrian K. Rantilla, Hsiu-Ting Yu, & Tzur M. Karelitz (2003) "The Effects of Asymmetry among Advisors on the Aggregation of Their Opinions," *Organizational Behavior and Human and Decision Processes* 90, 178–194.

{% P. 68: "This section is based primarily on our recent comprehensive review of the probability estimation literature (Wallsten & Budescu, 1983). In that review we claimed that subjective probability is an unobservable indivualized theoretical construct and that it must be evaluated by the same criteria that are usually applied to such psychometric and psychological constructs."

(**derived concepts in pref. axioms**)

Imprecise probabilities: Argue that upper and lower probabilities can be more natural than precise probability. Carefully use the term vague instead of the current ambiguous. Carefully argue that second-order probabilities should be considered as precise rather than vague probabilities. Nice citations, e.g. from American politicians. %}

Budescu, David V. & Thomas S. Wallsten (1987) "Subjective Estimation of Precise and Vague Uncertainties." *In* George Wright & Peter Ayton, *Judgmental Forecasting*, 63–82, Wiley, New York.

{% Makes reasonable assumptions about errors in probability judgments and then argues that these cannot account for much of overconfidence. %}

Budescu, David V., Thomas S. Wallsten, & Wing Tung Ali (1997) "On the Importance of Random Error in the Study of Probability Judgment. Part II: Applying the Stochastic Judgment Model to Detect Systematic Trends," *Journal of Behavioral Decision Making* 10, 173–188.

{% %}

Budescu, David V. & Thomas S. Wallsten (1995) "Processing Linguistic Probabilities: General Principles and Empirical Evidence." *In* Jerome R. Busemeyer, Reid Hastie, & Douglas L. Medin (eds.) *Decision Making from a Cognitive Perspective*. Academic Press, San Diego.

{% Argue, and I agree, that vagueness would be a better term than ambiguity. Some researchers have argued that people prefer verbal to numerical probabilities, but this paper finds no support for that. %}

Budescu, David V., Shalva Weinberg, & Thomas S. Wallsten (1988) "Decisions Based on Numerically and Verbally Expressed Uncertainties," *Journal of Experimental Psychology, Human Perception and Performance* 14, 281–294. https://doi.org/10.1037/0096-1523.14.2.281

{% **real incentives/hypothetical choice**: Use real incentives; each subjects plays some of the choices for real. They also said to the subjects that they'd really implement losses (pp. 187-188), but in reality manipulated their computer program to ensure that no subject lost (p. 190) (= **deception when implementing real incentives**)

Pity that only N = 22. But each choice was replicated 12 times, over different sessions!

Find support for reflection and the form of the value function of prospect theory, also through intransitivities. **concave utility for gains, convex utility for losses**: value function is indeed concave for gains, convex for losses, and exhibits loss aversion.

P. 190: different choices of one individual in the same session are not independent.

P. 193: more risk aversion for gains than risk seeking for losses.

reflection at individual level for risk: They beautifully support this, both with direct preferences and with negative correlations between risk aversion for gains and losses (p. 192). Also with intransitivities.

risk seeking for symmetric fifty-fifty gambles: Their last three prospects (j, k, m in Table 1) are of this kind, but are not directly compared to 0. They are compared to each other. Then there is massive aversion to increased variance (pp. 192-193). %}

Budescu, David V. & Wendy Weiss (1987) “Reflection of Transitive and Intransitive Preferences: A Test of Prospect Theory,” *Organizational Behavior and Human Decision Processes* 39, 184–202.

{% %}
Budescu, David V. & Hsiu-Ting Yu, (2006) “To Bayes or not to Bayes? A Comparison of Two Classes of Models of Information Aggregation,” *Decision Analysis* 3, 145–162.

{% %}
Budescu, David V. & Hsiu-Ting Yu (2007) “Aggregation of Opinions Based on Correlated Cues and Advisors,” *Journal of Behavioral Decision Making* 20, 153–177.

{% %}
Budescu, David V., Rami Zwick, Thomas S. Wallsten, & Ido Erev (1990) “Integration of Linguistic Probabilities,” *International Journal of Man-Machine Studies* 33, 607–724.

{% **natural-language-ambiguity**: Seems to give often-used questionnaire/scale to measure ambiguity aversion, and to argue that tolerance of ambiguity (in general natural-language sense) is truly related to individual personality traits rather than a situation-dependent/content-specific expression of psychological stress. %}
Budner, Stanley N.Y. (1962) “Intolerance of Ambiguity as a Personality Variable,” *Journal of Personality* 30, 29–50.

{% **Dutch book**, relates bets to preferences, weakens, I think, the requirement of betting for or against everything. Other than that, derives usual Dutch book from separating hyperplane. %}
Buehler, Robert J. (1976) “Coherent Preferences,” *Annals of Statistics* 4, 1051–1064.

{% **(very) small probabilities**: Seems to propose neglect of small probabilities so as to resolve the St. Petersburg paradox. Seems to take as example a probability of 1/10189 for a fifty-year old man to die within the next 24 hours, which, he says,

people perceive as zero.

Menger 1934, footnote 6, gives the following bibliographic info. %}

Buffon, (1777) “Essai d’Arithetique Morale,” supplement to Volume IV of the *Histoire Naturelle*, pp. 72 etc.

{% **real incentives/hypothetical choice**: for social preferences, it matters. %}

Bühren, Christoph & Thorben C. Kundt (2015) “Imagine Being a Nice Guy: A Note on Hypothetical vs. Incentivized Social Preferences,” *Judgement and Decision Making* 10, 185–190.

{% Survey on ambiguity, but from bibliographic perspective. The paper from the start focuses on ambiguity aversion. No consideration for insensitivity. The paper focuses on the three most popular ambiguity theories, claimed to be maxmin EU, Choquet expected utility, and the smooth model. Remarkable is that my favorite model of ambiguity, Tversky & Kahneman (1992), is not even mentioned, even though it is cited about twice as much as the most-cited paper considered in this review, Ellsberg (1961), and it shared the 2002 econ-prize in memory of Nobel. It is not even in §4.2 on sign dependence even though it is the only one having it. The next model to be considered would be α-maxmin.

Table 2, p. 503, lists the most-cited papers: Ellsberg (1961), Gilboa and Schmeidler (1989), Schmeidler (1989), Heath and Tversky (1991), Klibanoff et al (2005), Savage (1951 [1954]), Judge et al. (1999), Hansen and Sargent (2001), Chen and Epstein (2002), Ghirardato et al. (2004), Abdellaoui et al. (2011), Sutter et al. (2013). Table 3, p. 503, lists the most-cited authors: Ellsberg, Schmeidler, Gilboa, Marinacci, Epstein, Tversky, Klibanoff.

P. 507 makes a common mistake: to think that the nonadditive measure of Choquet expected utility reflects a set of priors.

P. 511, §4.2: **ambiguity seeking for losses**

P. 515: not many experimental studies because the theoretical models are complex.

P. 515: **ambiguity seeking for unlikely** %}

Bühren, Christophe, Fabian Meier, F., & Marco Plessner (2023) "Ambiguity Aversion: Bibliometric Analysis and Literature Review of the Last 60 Years," *Management Review Quarterly* 73, 1–31. https://doi.org/10.1007/s11301-021-00250-9

{% Proposition 2.5: that superadditive capacity has superadditive Choquet-integral. %}

Buja, Andreas (1984) "Simultaneously Least Favorable Experiments," *Zeitschrift für Warscheinlichkeitstheorie und Verwandte Gebiete* 65, 367–384.

{% %}

Bullen, Peter S. (2003) "Handbook of Means and Their Inequalities, Mathematics and Its Applications 560." Kluwer Academic Publishers, Dordrecht.

{% %}

Bult, Jan Roelft, Johanna L. Bosch, & Maria G.M. Hunink (1996) "Heterogeneity in the Relationship between the Standard Gamble Utility Measure and Health Status Dimensions," *Medical Decision Making* 16, 226–233.

{% **Z&Z** %}

Bundorf, Kate M. & Kosali I. Simon (2006) "The Effects of Rate Regulation on Demand for Supplemental Health Insurance," *American Economic Review, Papers and Proceedings* 96, 67–71.

{% **anonymity protection** %}

Bunge, John & Mark J. Fitzpatrick (1993) "Estimating the Number of Species: A Review," *Journal of the American Statistical Association* 88, 364–373.

{% %}

Bunge, Mario (1989) "The Bell Inequalities and All That," *Philosophia Naturalis* 26, 121–134.

{% **foundations of probability**; discusses to what extent probability is "subjective" %}

Bunge, Mario (1993) “Realism and Antirealism in Social Science,” *Theory and Decision* 35, 207–235.

{% **probability elicitation**; %}

Bunn, Derek W. (1980) “On the Calibration of Continuous Subjective Probability Distributions,” *R & D Management* 10(2), 87–90.

{% **Dutch book**: p. 24, last paragraph: de Finetti (1974) shows how an individual’s quantitative assessments on uncertainty *must* become effectively a probability distribution to avoid becoming a perpetual money-making machine.

Ch. 4 has didactical explanation of n-th order stochastic dominance.

simple decision analysis cases using EU: exercises Ch. 3 (p. 63 ff.) & Ch. 10 (p. 204 ff.) %}

Bunn, Derek W. (1984) “*Applied Decision Analysis*.” McGraw-Hill Book Company, New York.

{% %}

Bunn, Derek W. & Ahti A. Salo (1993) “Forecasting with Scenarios,” *European Journal of Operational Research* 68, 291–303.

{% **probability elicitation**

Test the BDM mechanism, and its complexity, for belief elicitation. %}

Burfurd, Ingrid & Tom Wilkening (2022) “Cognitive Heterogeneity and Complex Belief Elicitation,” *Experimental Economics* 25, 557–592.
https://doi.org/10.1007/s10683-021-09722-x

{% In the theoretical analysis the authors consider risk and intertemporal joined, with lotteries over outcome streams. In the experiment, though, they measure risk attitude and time attitude separately. They assume the Epstein-Zinn model, where the separate measurements are enough to give the entire attitude, but it is based on expected utility. In a large sample (N = 1153), they investigate the relation between these attitudes. %}

Burgaard, Johan & Mogens Steffensen (2020) “Eliciting Risk Preferences and Elasticity of Substitution,” *Decision Analysis* 17, 314–329.

https://doi.org/10.1287/deca.2020.0415

{% Measure introspective happiness of lottery players. Players derive extra happiness prior to the lottery realized, not if they gain small amounts. The authors argue for intrinsic utility of lottery playing. %}

Burger, Martijn J., Martijn Hendriks, Emma Pleeging, & Jan C. van Ours (2020) "The Joy of Lottery Play: Evidence from a Field Experiment," *Experimental Economics* 23, 1235–1256.
https://doi.org/10.1007/s10683-020-09649-9

{% **decreasing/increasing impatience**: find evidence against present bias. %}

Burger, Nicholas, Gary Charness, & John Lynham (2011) "Field and Online Experiments on Self-Control," *Journal of Economic Behavior and Organization* 77, 393–404.

{% **Newcomb's problem** %}

Burgess, Simon (2004) "The Newcomb Problem: An Unqualified Resolution," *Synthese* 136, 261–271.

{% This paper gives a simple, but appealing, decomposition of vNM independence into betweenness and a condition that can be interpreted as homotheticity. Betweenness requires that every indifference class is an indifference set of an EU model, so, is linear in probability. Homotheticity requires that indifference classes are parallel. The two conditions together are equivalent to independence. Note that, given homotheticity, it is enough to require that one indifference class is linear, which then implies that they all are, so that the two conditions have considerable overlap. In an experiment, 1/3 of subjects violated homotheticity, 1/3 satisfied homotheticity but violated EU (so, assuming the technical axioms (which is a nontrivial assumption), they violated betweenness), and 1/3 satisfied EU. The author cites many ideas related to homotheticity.

Fo RDU (and PT for gains), homotheticity is equivalent to the weighting function being a power function. Accordingly, it cannot accommodate the common inverse S. Now consider the 1/3 of subjects that satisfy homotheticity but violate EU. (The author's discussion section at the end is on this.) Can we

conclude that they must violate betweenness? Can we conclude that RDU with inverse S probability weighting is violated? May seem so at first sight. But is not really so. The reason is that the axioms of completeness and continuity interfere. If we say that subjects satisfy homotheticity, all we can claim is that in the finite set of observations made we did not find a violation. We do not know if the condition is satisfied everywhere. This problem is of a more serious mathematical nature than first meets the eye. To explain, it may well happen that a finite number of observed preference neither violate homotheticity nor betweenness, but there is no way to extend these preferences to a preference relation that satisfies these two conditions and also completeness and continuity. That is, it cannot satisfy EU. There exist finite sets of observed preferences that satisfy all cancellation axioms of order 100 and lower, but still violate higher-order cancellation axioms, so that they violate EU. These are violations of a very complex combinatorial nature, not captured by simple axioms such as betweenness or homotheticity or anything else that is simple. Such finite sets cannot be extended to preferences that satisfy completeness and continuity and low-order cancellation axioms. %}

Burghart, Daniel R. (2020) "The Two Faces of Independence: Betweenness and Homotheticity," *Theory and Decision* 88, 567–593. https://doi.org/10.1007/s11238-019-09735-2

{% A convenient tool for testing a revealed preference axiom for uncertainty (GARP). The paper considers two-outcome acts, so one event and its complement for each act, a given probability interval [p_ℓ, 1−p_h] for the event, and α-maxmin evaluation, called Partial Ignorance Expected Utility (PEU). Note that the set of priors is objectively given here and extensively manipulated, making the domain different than in most other experiments. The real probabilities selected from the probability intervals were actually determined by volunteers, inserted in sealed envelopes, unknown to the experimenters. In the subjects who can be classified, 48% were uncertainty averse, 22% were seeking and 30% was neutral. %}

Burghart, Daniel R., Thomas Epper, & Ernst Fehr (2020) "The Uncertainty Triangle – Uncovering Heterogeneity in Attitudes towards Uncertainty," *Journal of Risk and Uncertainty* 60, 125–156.

https://doi.org/10.1007/s11166-020-09331-8

{% Men's risk attitudes are not changed if getting alcohol, but women get more risk seeking from alcohol. %}
Burghart, Daniel R., Paul W. Glimcher, & Stephanie C. Lazzaro (2013) "An Expected Utility Maximizer Walks into a Bar," *Journal of Risk and Uncertainty* 46, 215–246.

{% %}
Burgos, Albert, Simon Grant, & Atsushi Kajii (2000) "Bargaining and Boldness," *Games and Economic Behavior*38, 28–51.

{% **real incentives/hypothetical choice**: Find a difference. Do an Allais paradox with (0.20:$5, 0.05:$5, 0.75:C) versus (0.20:$10, 0.05:$0, 0.75:C), for C = 0 and C = $5. Do real and hypothetical. In hypothetical there are 10 violations of EU (of n = 25), in real 3 (of n = 25). The consistent choices were virtually always choosing risky twice. In real incentives, both prospects are played, generating income effects that are extensively discussed. %}
Burke, Michael S., John R. Carter, Robert D. Gominiak, & Daniel F. Ohl (1996) "An Experimental Note on the Allais Paradox and Monetary Incentives," *Empirical Economics* 21, 617–632.

{% Reviewed by Skyrms (1980, Theory and Decision).|

"Alias" refers to Wakker(1999) http://personal.eur.nl/Wakker//pdf/alias.pdf .
a' is like (a) in Alias, but for uncertainty, "born as a grown-up"

(This edition is the third, thoroughly extended; earlier editions were published in 1963 and 1964. In particular, the marvelous material on dynamic choice under uncertainty, Ch. 5, had not been published before.)

I read this book, and made extensive hand-written comments on it, between August 19, 1981, and September 4, 1981; My handwritten notebook p. 61.

Ch. 5 is fascinating. It precedes Hammond (1988) and is well written.

Burks studies dynamic choice under uncertainty and derives sure-thing principle from dynamic principles. A person "marks" decision trees, i.e., indicates his moves at every decision node. He does so a priori, all is a priori.

Thus we can, strictly speaking, not discuss forgone-event independence and DC (dynamic consistency). However, Burks does show how a sort of combination of those plus some more implies the sure-thing principle. The sort of combination is invariance (Axiom IVA), saying that choices in subtrees should not be affected by what happens in the rest of the tree. It comprises most of forgone-event independence and DC (it is Alias (a') $\Rightarrow$ (c)). The little more of DC's implications that is required to derive sure-thing principle. Is provided by normal form equivalence which, given restriction to prior choices throughout, is quite weak (Alias (c) $\Rightarrow$ (e)) and then gives the sure-thing principle because it also implies **RCLA.** Let me repeat that I am automatically assuming the logical equivalence axiom restricted to single nodes. In fact, logical equivalence regarding collapsing of subsequent chance nodes also implies RCLA.

In summary, invariance IV(A) does most of the job (Alias (a') $\Rightarrow$ (c)), being all of forgone-event independence that is needed and part of DC, normal form equivalence does the rest (Alias (c) $\Rightarrow$ (e)), so, the rest of DC and RCLA.

Burks deserves priority for the derivation of the sure-thing principle from dynamic principles over Hammond and others. Argument against it could be that invariance IV(A) is strong and comprises most of sure-thing principle. However, I feel that the essence of dynamic principles is present here. A further argument is that Burks discusses posterior choice on p. 307/308 when he explains why he violates EU in Allais paradox. Here he makes clear that he wants to preserve forgone-event independence (interpreting it, informally, as invariance IV(A)) thus give up DC.

Burks' work on these delicate issues is also accurate and free from the ambiguities found in so many other works on these issues.

Now follow detailed comments.

==================

!!!

It is important to note that all is done a priori, i.e., before the tree really unfolds and uncertainties get resolved. So, it can be considered prior planning in the being-commited-to-it sense. That appears, e.g., from p. 255 second paragraph ("he does not know").

!!!

Preface has said that Chapter V is new in this edition. Footnote at p. 251 says the theory was developed in a first version in the early 1960s and benefited from discussions with Savage.

P. 213, §4.4: a clear statement of the **Dutch book** argument.

P. 270 discusses conditional ordering of uncertainties axiom, similar to Epstein & Le Breton.

Work does not assume state space a la Savage but statements and logic, because the main subject of the book is inductive logic. (p. 302/303 discusses more) Does not formalize the complete set (algebra?) of atomic statements. For the decision under uncertainty literature it would have been easier if the book had formally defined an underlying state space and had related the events to that. Another reason why it would have been preferable if a state space or a complete set of atomic statements had been formalized is the following. As it is now, it is not clear if at all an event in one tree can be identified with another event in another tree or that, differently, in the description of events would be contained the dynamic context (tree) in which it appears. From the context it becomes clear that it is the former. Events are atemporal and in themselves do not contain information on sequencing or ordering.

p. 254 ℓ. –5: “sequence of statements” is as a partition.

p. 255: second move by adverse opponent is unfortunate assumption. It better be hypothetical.

P. 256/257: details about impossible events are best skipped at first reading. (Subjects are not required to mark decision nodes off the optimal path.)

p. 257, bottom, shows that trees are atemporal (given that events are atemporal). “An act in the most general sense is an assignment of consequences to logically possible universes. A choice tree represents a set of acts. In marking a choice tree by the rule just stated, a subject chooses one or more acts from this set.” P. 273 ℓ. 10/11 will repeat that, adding “The assignments are explicit in a normal form tree, implicit in other trees.”

p. 258 defines normal form act expression, assigning to each event of a partition a consequence. They do not refer to the decision tree they come from because it can be inferred from the context that events do not contain ordering/time information.

p. 258 ℓ. – suggests that events do not contain ordering/time information: “many logically equivalent normal form expressions that represent the same act “

p. 259: tokens of subtrees: The assumed prior information is formulated separately! Only with the same prior information, there is therefore reason to treat them the same.

p. 260: Universe description is a set of atomic statements. I'm not sure if it's really the overall total or if it's just restricted to some context (p. 261 ℓ.7 suggests "choice basis" is a kind of context).

p. 260, 4th paragraph: As does Savage, it considers all acts, i.e., all mappings from events to consequences, "since any consequence can be assigned to any universe." The paragraph also suggests further that Burks has a Hammond model in mind where decision trees serve no other purpose than illustrate normal-form acts. See also p. 308, second paragraph: "Now the value of an act or strategy should depend only on its assignment of consequences to possible universes, not on how the content of a universe description is distributed along a path through the tree."

p. 261 wants to put limit to (length of) decision trees to be made for a "choice basis," does that informally.

p. 262, ℓ. 3 "complete sets of choice trees" is Hammond-like set of decision trees

p. 262, Section 5.3.1, 2nd sentence of second paragraph, suggests that the whole analysis would best be restricted to one complete choice set.

p. 263, logical equivalence axiom: Within one chance node, propositions can be combined according to logic and the prior information that the chance node is conditioned on. In the state of the worlds model it means collapsing of events with common outcome.

p. 265 shows that logical equivalence axiom encompasses RCLA (merging successive chance nodes).

It also encompasses merging successive choice nodes.

P. 264 ℓ. −6 to −3: Later texts will show that Burks means here only same tokens of a subtree conditioned on same information !!and within the same tree!!, so at the same choice node. See also p. 265 lines 10-14. It is very explicit in the first sentence of the 4th paragraph of p, 265 (The second part of the axiom applies to a single tree.) and the footnote on p. 268. The condition might be dropped because it will be implied by invariance IV(A).

P. 266, subset axiom is IIA.

p. 268, Invariance is two parts, IV(B) (ordinal state independence), and then, the most crucial of all axioms, invariance IV(A). The latter is Alias (a') ⇒ (c). It therefore probably entails forgone-event independence (though Burks here did not commit to anything in Alias (b)) and the main part of dynamic consistency. Following the condition Burks writes: "requires the subject's choices in a subtree to be invariant through ... changes in the rest of the tree of which it is a subtree."

p. 273 formulates normal form acts. The fourth paragraph goes through some trouble so as to choose exactly one of the many logically equivalent versions. Readers not interested in logical equivalence issues can skip.

Section 5.4.1 on normal form equivalence is just Alias (c) ⇒ (e), because all choices are taken prior. So, it only says that a strategy in en extensive tree, valued a priori, can be identified with the corresponding single-stage act.

Section 5.4.2 gives the main result of the analysis, i.e., it derives Savage's sure-thing principle ("the partial act theorem") from mainly invariance and the normal form equivalence axiom. The derivation is presented on p. 279.

P. 299 compares to Savage's discussion of the sure-thing principle. But the informal (P2i) is none too clear and neither is Burks' discussion thereof, mainly because the decision-interpretation of the antecedent in it is unclear.

p. 303, bottom, introduces the mathematically trivial but conceptually useful notion of potential coherence, which for a finite set of choices means they can be extended to a complete infinite set satisfying structural richnesses, in short, it can be represented by SEU. (**desirable to extend preferences while satisfying/maintaining conditions**)

dynamic consistency: **favors abandoning time consistency, so, favors sophisticated choice**: p. 307-308

Section 5.6.2, p. 307/308, is very crucial. It is the only place where Burks discusses posterior choice, i.e., after receipt of information. Here he discusses Alias (b). So, here we can see whether he would rather give up forgone-event independence or DC. Burks in fact favors deviation from EU in the common consequence Allais paradox; he prefers sophisticated choice, i.e., giving up DC.

Section 5.6.4, p. 320, is a confusing sentence: "The very idea of a strategy of plan of action is to make choices before one is forced by circumstances to do so, and this involves deciding how one whould act in various situations."

It shows, first, that choices are assumed a priori indeed, as I have interpreted it throughout. But then it suggests that the choices are !not! committed, which is not at all like my preferred viewpoint. It might be interpreted as planned choice that is not committed, a notion that I do not like. Then it combines particularly bad with his text on p. 307/308 which suggests that after resolution of uncertainty he would deviate from prior plan.

The text is less troublesome if one interprets Burks' sentence as sophisticated choice, and "make choices" means "plan choices."

P. 534, §8.4.2: Pierce's dispositional-frequency theory of probability ("would-be"); i.e., that it refers to hypothetical situations. %}

Burks, Arthur W. (1977) "*Chance, Cause, Reason (An Inquiry into the Nature of Scientific Evidence)*." The University of Chicago Press, Chicago.

{% **cognitive ability related to risk/ambiguity aversion**: Measure cognitive skills, and risk aversion (fitting EU with power utility), intertemporal choice (quasi-hyperbolic) and two game situations (repeated prisoner's dilemma and job attachment). There is positive correlation between high cognitive skill, low risk aversion for gains, low risk seeking for losses, and small impatience regarding both parameters of quasi-hyperbolic. (Similar things for the two game situations.) Thus, nice evidence supporting rationality of expected value maximization.

For risky choices random incentive system (not clear if/how they implemented losses).

real incentives/hypothetical choice, for time preferences: for intertemporal **random incentive system between-subjects** (paying only some subjects) %}

Burks, Stephen V., Jeffrey P. Carpenter, Lorenz Goette, & Aldo Rustichini (2009) "Cognitive Skills Affect Economic Preferences, Strategic Behavior, and Job Attachment," *Proceedings of the National Academy of Sciences* 106, 7745–7750.

{% Use their well-known data set on truck drivers. Test how β & δ from the quasi-hyperbolic model predict all kinds of behavior, and also two introspective questions (surveyed impatience and impulsivity). The latter do not do well, and β and δ fare better. Present biased (low β) subjects ar more likely to smoke, leave job, and wash out of training. Low discounting (high δ) means less smoking, better credit, and lower absence of work (p. 309 & pp. 314-315).

random incentive system between-subjects: p. 310

P. 311 bottom: they allow and get some $\beta > 1$, entailing violation of impatience.

P. 318 middle: Effect of β is improved if we correct for δ. Effects of δ get overstated (authors' interpretation) if not controlling for β. The authors, hence, argue for including both parameters in analysis, e.g. in last sentence of paper: "Further, our regression results suggest that it might also be the case that gathering just ı or ˇ is a mistake, we find that the prediction of outcomes is more robust when both measures are included." %}

Burks, Stephen V., Jeffrey P. Carpenter, Lorenz Goette, & Aldo Rustichini (2012) "Which Measures of Time Preference Best Predict Outcomes: Evidence from a Large-Scale Field Experiment," *Journal of Economic Behavior and Organization* 84, 308–320.

{% **Kirsten&I**; varies upon Diamond (1965) by deriving impatience under different continuity assumptions. %}

Burness, H. Stuart (1976) "Impatience and the Preference for Advancement in the Timing of Satisfactions," *Journal of Economic Theory* 6, 495–507.

{% %}

Burns, William J. & Robert T. Clemen (1993) "Covariance Structure Models and Influence Diagrams," *Management Science* 39, 816–834.

{% **ratio bias**: Find it, but for stimuli other than probabilities; show that $100 per month is weighted less than $1200 per year, because of denominator neglect (latter is nice term): People weigh the numerator more than the denominator. Thus, a chance of 10/100 at a good prize is preferred to a chance of 1/9. They cite many papers on it, and add two (hypothetical-choice) experiments demonstrating it. %}

Burson, Katherine A., Richard P. Larrick, & John G. Lynch, Jr. (2009) "Six of One, Half Dozen of the Other: Expanding and Contracting Numerical Dimensions Produces Preference Reversals," *Psychological Science* 20, 1074–1078.

{% Endowment effect occurs when people are endowed with a unit of something. When they are endowed with multiple units, it gets attenuated. So, 20 chocolates attenuates it, but one box with 20 chocolates does not. %}

Burson, Katherine, David Faro, & Yuval Rottenstreich (2013) "Multiple-Unit Holdings Yield Attenuated Endowment Effects," *Management Science* 59, 545–555.
http://dx.doi.org/10.1287/mnsc.1120.1562

{% In the debate whether to use quality-of-life assessments from the general public and hypothetical scenarios, or experiened assessments from patients, they, do my joy, deviate from the most common view that it should be the general public and instead go for patients. %}

Burström, Kristina, Sun Sun, Ulf-G. Gerdtham, Martin Henriksson, Magnus Johannesson, Lars-Ake Levin, & Niklas Zethraeus (2014) "Swedish Experience-Based Value Sets for EQ-5D Health States," *Quality of Life Research* 23, 431–442.
https://doi.org/10.1007/s11136-013-0496-4

{% Consider nonarbitrage if there is also ambiguity, and no as-if risk neutrality. Example 2.5, p. 1213, gives an example. There is friction with the buying price strictly above the selling price. Under convexity as common in finance, then often maxmin EU pricing holds. §3 is on the efficient market hypothesis. That is, common concepts are weakened to fit into ambiguity models. %}

Burzoni, Matteo, Frank Riedel, & H. Mete Soner (2021) "Viability and Arbitrage under Knightian Uncertainty," *Econometrica* 89, 1207–1234.

{% Considers some nonexpected utility models that use similarities between prospects. A similarity based on Euclidean distance works best. %}

Buschena, David E. & Joseph A. Atwood (2011) "Evaluation of Similarity Models for Expected utility Violations," *Journal of Econometrics* 162, 105–113.

{% %}

Buschena, David E. & David Zilberman (1995) "Predictive Value of Incentives, Decision Difficulty, and Expected Utility Theory for Risky Choices," Department of Agricultural Economics and Economics Staff Paper, 95–1, Montana State University.

{% **measure of similarity** %}
Buschena, David E. & David Zilberman (1999) "Testing the Effects of Similarity on Risky Choice: Implications for Violations of Expected Utility," *Theory and Decision* 46, 253–280.

{% **error theory for risky choice**;
Best core theory depends on error theory: find that. Call it the "path-dependence problem for model selection. %}
Buschena, David E. & David Zilberman (2000) "Generalized Expected Utility, Heteroscedastic Error, and Path Dependence in Risky Choice," *Journal of Risk and Uncertainty* 20, 67–88; erratum (2008) *Journal of Risk and Uncertainty* 36, 201.

{% Explain quantum decision theory. Seems that §9.1.2 accommodates Ellsberg, but can only get universal ambiguity aversion, neutrality, or seeking, and not insensitivity. %}
Busemeyer Jerome R. & Peter D. Bruza (2012) "*Quantum Models of Cognition and Decision*." Cambridge University Press, New York.

{% What title says. %}
Busemeyer, Jerome R. & Adele Diederich (2002) "Survey of Decision Field Theory," *Mathematical Social Sciences* 43, 345–370.

{% %}
Busemeyer, Jerome R., Reid Hastie, & Douglas L. Medin (1995, eds.) "*Decision Making from a Cognitive Perspective.*" Academic Press, San Diego.

{% **time preference**; %}
Busemeyer, Jerome R. & Amnon Rapoport, (1988) "Psychological Models of Deferred Decision Making," *Journal of Mathematical Psychology* 32, 91–134.

{% Introduced decision field theory. %}

Busemeyer, Jerome R., & James T. Townsend (1993) "Decision Field Theory: A Dynamic Cognition Approach to Decision Making," *Psychological Review* 100, 432–452.

{% **dynamic consistency**; test DC versus forgone-event independence (often called consequentialism; they call it consequential consistency). They find that dynamic consistency is violated but forgone-event independence not. For gains they take money, loss outcomes ("punishments") consist of solving arithmetic problems.

Their term strategic consistency is what Luce (2000) calls consequence monotonicity. %}

Busemeyer, Jerome R., Ethan Weg, Rachel Barkan, Xuyang Li, & Zhengping Ma (2000) "Dynamic and Consequential Consistency of Choices between Paths of Decision Trees," *Journal of Experimental Psychology: General* 129, 530–545.

{% **game theory for nonexpected utility**; **PT, applications** Analyzes bargaining under PT assuming various reference points. Many nice references to related papers. %}

Butler, Christopher K. (2007) "Prospect Theory and Coercive Bargaining," *Journal of Conflict Resolution* 51, 227–250.

{% Test error theories for preference reverals for DUR. The basic Fechner model assumes that the error in evaluating an option is independent of context (i.e., choice alternatives) which is not satisfactory if, for instance, there is a dominance relation between the options considered. A Blavatskyy (2009, 2011) error model that corrects for violations of dominance, and a random preference model (EU with CRRA) fare better. %}

Butler, David, Andrea Isoni, & Graham Loomes (2012) "Testing the 'Standard' Model of Stochastic Choice under Risk," *Journal of Risk and Uncertainty* 45, 191–213.
http://dx.doi.org/10.1007/s11166-012-9154-4

{% Use introspective strength of preference measurements in addition to risky choices to fit data. I regret that the authors only cite Butler & Loomes (2007) (B&L)

twice for details, and not as regards the fundamental issue. B&L not only used preference, but two categories:

(1) I definitely prefer lottery A;

(2) I think I prefer lottery A but I am not sure;

The pesent paper uses four categories:

(1) A is very much better

(2) A is much better

(3) A is better

(4) A is slightly better

(Can say eight categories, as in the authors' terminology, if you add the four where B is preferred.)

B&L consider choice imprecision/confidence. The present paper considers strength of preference. These concepts are closely related and subjects will perceive them as about the same. B&L indeed write that their choice confidence refers to an underlying concept of strength of preference (e.g. their p. 283 bottom). The methodological discussion of using these concepts in economic choice is the same.

The authors shows that their strengths of preferences are responsive in sense of becoming stronger if an outcome of the preferred lottery is increased, for instance. They discuss to what extent strength of preference is related to choice error and gives new insights into it. It can give further insights into violations of independence and preference reversals. As always, salience interferes. If one lottery is almost identical to another but has stochastic dominance, then utility difference is small but the preference is completely clear. %}

Butler, David, Andrea Isoni, Graham Loomes, & Kei Tsutsui (2013) "Beyond Choice: Investigating the Sensitivity and Validity of Measures of Strength of Preference," *Experimental Economics* 17, 537–563.

{% **random incentive system**: used this for choices, but not for their strength-of-preference questions. P. 286 suggests that the latter cannot be incentivized.

error theory for risky choice; **real incentives/hypothetical choice**: discussed on p. 293. The authors use much introspective kind-of strength of preference judgments, discussed at length on p. 293. Do traditional strength-of-preference stimuli where certainty equivalents are derived from choice-list like questions. At each choice the subject not only expresses preference, but also the introspective question of whether the preference is sure or only probable. Use random-preference explanations for preference reversals. P. 283 explicitly interprets this as strength of preference. %}

Butler, David J. & Graham C. Loomes (2007) "Imprecision as an Account of the Preference Reversal Phenomenon," *American Economic Review* 97, 277–297.

{% One sample is some 1600 customers of an Italian bank. The other is some 1300 students recruited online.

correlation risk & ambiguity attitude: they find a positive relation between ambiguity aversion and risk aversion.

They measure risk aversion in two ways. First, they ask an introspective general question. Then they use the Barsky et al. (1997) question. Ambiguity aversion is measured using the usual Ellsberg two-color urns, but it is hypothetical. They control for suspicion by letting subject choose winning color. They ask for introspective strength of preference. They also have a measure for how much subjects do intuitive rather than deliberate thinking. The intuitive thinkers are less risk and ambiguity averse. %}

Butler, Jeffrey V., Luigi Guiso, & Tullio Jappelli (2014) "The Role of Intuition and Reasoning in Driving Aversion to Risk and Ambiguity," *Theory and Decision* 77, 455–484.

{% The authors consider the Bohnet & Zeckhauser (BZ) betrayal aversion experiment: A principal can do a job herself ("distrust"), giving (10,10), where the first coordinate denotes the principal's payoff, and the second an agent's. Or can pass the job on to the agent ("trust"). The agent then chooses between the selfish (8,22) or the fair (15,15). They measure MAP (minimally acceptable probability) as do BZ. The authors add two treatments (between-subject). Those consider variations in case of the trust decision (measured beforehand, by the strategy method). In each of the two, there are 17 cards and the agent randomly chooses one. In each, the card chosen determines whether it is (8,22) or (15,15), but the agent does not know at all which card gives which. In one of the two treatments (AxD), the agent knows that the cards imply one of those two, only does not know which card gives which, and in the other treatment (Axx) the agent known nothing about the cards at all when choosing. The authors replicate BZ although not as strong, with Axx in between.

social risks > nature risks in coordination games (here it is competitive game but then hamstrung effect … see below) Strangely, the authors find that principals like AxD much more (so, lower MAP). P. 2792 puts forward a hamstrung effect explanation. It is that the agent can see the conflict of interest, and could desire for it, but has no possibility to enhance it. So, those desiring to be selfish will feel disappointment. May be the principal enjoys this idea. A replication finds the result again but much weaker.

I did not find number of subjects in the first experiment specified in the main text, but p. 2792 2nd column 2nd para writes that the result may be an artifact of sampling because of small sample size (40). For the new treatments, it can be discussed whether this is human intentional influence because all the choice options (17 cards) given to the agent are informationally identical. P. 2790 describes this as "essentially a human randomizing device."

P. 2793: The authors are enthusiastic about their finding and write: "Our findings have broad implications for contract design in situations where the presence of social risk is a choice variable."

P. 2794 footnote 10: The authors follow Bohnet & Zeckhauser by using an EU backward induction type of analysis, in particular by conditioning on p* in the footnote. Li, Turmunkh, & Wakker (2020) criticize this analysis for being normative and not descriptive. %}

Butler, Jeffrey Vincent & Joshua B. Miller (2018) "Social Risk and the Dimensionality of Intentions," *Management Science* 121, 1205–1246.

{% **gender differences in risk attitudes**: Women more risk averse than men. This paper is often cited. Pp. 369 is silly. The authors (in their second category) write that in prospect theory the risk attitude depends on the situation but not on the individual. This is not true and nonsensical. %}

Byrnes, James P., David C. Miller, & William D. Schafer (1999) "Gender Differences in Risk Taking: A Meta-Analysis," *Psychological Bulletin* 125, 367–383. https://doi.org/10.1037/0033-2909.125.3.367

{% %}

Cabanac, Michel (1971) “Physiological Role of Pleasure,” *Science* 173, 1103–1107.

{% **uncertainty amplifies risk: inverse S.** Finds that weighting function is more inverse S as ambiguity is bigger (supports **ambiguity seeking for unlikely**).
probability intervals: ambiguity is generated through probability intervals; **cognitive ability related to risk/ambiguity aversion** %}
Cabantous, Laure (2005) “Ambiguity and Ability to Discriminate between Probabilities; A Cognitive Explanation for Attitude towards Ambiguity,” presentation at SPUDM 2005.

{% Asks N = 78 professional actuaries for (hypothetical) prices for insurance they would charge, under ambiguity through imprecision (probability interval) and ambiguity through conflict (specialists giving different probability estimates). People have aversion to the conflict-info. Done for insurances against natural catastrophes etc. %}
Cabantous, Laure (2007) “Ambiguity Aversion in the Field of Insurance: Insurer’s Attitude to Imprecise and Conflicting Probability Estimates,” *Theory and Decision* 62, 219–240.

{% **foundations of statistics**; **foundations of statistics**: This paper discusses the socio-academic history of Bayesian decision analysis, with the period of Raiffa, Schlaifer, Ron Howard, and what happened after. It, for instance, uses ideas from STS (science, tewchnology, and society) and ANT (actor-network theory). Graphs of numbers of papers fluctuating over time, interviews with many people from the field. P. 443 bottom refers to Bayes for already having suggested equal prior probabilities if no info, like Laplace’s principle of insufficient reason.
P. 446: Bloor said that a theory is not accepted because it is true, but it is true because it is accepted.
P. 447: how ANT explains rise of concept of probability in 17th century.
P. 448 on debate Jeffreys-Fisher.
P. 451 lists all decision analysts interviewed.
P. 454: how term deision analysis came about. %}

Cabantous, Laure & Jean-Pascal Gond (2015) “The Resistible Rise of Bayesian Thinking in Management: Historical Lessons from Decision Analysis,” *Journal of Management* 41, 441–470.
http://dx.doi.org/10.1177/0149206314558092

(% Asks N = 84 professional insurers for (hypothetical) prices for insurance they would charge, under risk, ambiguity through imprecision (probability interval), and ambiguity through conflict (specialists giving different probability estimates). People have more aversion to the conflict-info for flood insurance but, surprisingly, less for the house fire insurance. Done for insurances against natural catastrophes etc.

Abstract writes that this is “the first experiment *in the United States*” …[italics added here]

The insurers are ambiguity averse with losses here, but this is natural because asymmetric information and moral hazard play a role. Also, they are professionals in dealing with uncertainty. Another complication is that the subjects may have their own knowledge and experience about the uncertainties (as well as whether there is conflict or imprecision) and may not pay much attention to the info provided by the experimenters. %}

Cabantous, Laure, Denis Hilton, Howard Kunreuther, & Erwann Michel-Kerjan (2011) “Is Imprecise Knowledge Better than Conflicting Expertise? Evidence from Insurers’ Decisions in the United States,” *Journal of Risk and Uncertainty* 42, 211–232.

{% **value of information**:
Consider a set of decision problems in which information structures can be completely ordered, and the ordering means that you always are willing to pay more for one than for the other. They assume expected utility. They assume no arbitrage, but still utility can be nonlinear, and it is between constant relative and constant absolute risk aversion. Ruin-aversion means $U(0) = -\infty$. They show that their ordering coincides with the entropy-ordering. Thus, this paper can be interpreted as a decision-theory axiomatization of entropy. (**anonymity protection**) %}

Cabrales, Antonio, Olivier Gossner, & Roberto Serrano (2013) "Entropy and the Value of Information for Investors," *American Economic Review* 103, 360–377.

{% %}
Cachon, Gérard P. & Colin F. Camerer (1996) "Loss-Avoidance and Forward Induction in Experimental Coordination Games," *Quarterly Journal of Economics* 111, 165–194.

{% **dynamic consistency**: the paper tests dynamic decision principles under ambiguity. Finds that many subjects satisfy dynamic consistency by being resolute or sophisticated.
real incentives/hypothetical choice: for hypo some more dynamic inconsistency.
The abstact ends with the trivial cliché claim of implications for policy. %}
Caferra, Rocco, John D. Hey, Andrea Morone, & Marco Santorsola (2023) "Dynamic Inconsistency under Ambiguity: An Experiment," *Journal of Risk and Uncertainty* 67, 215–238.
https://doi.org/10.1007/s11166-023-09418-y

{% **Prospect theory not cited**: The authors measure risk attitude from one choice list. They do not provide extensive references or priority there, and do not cite Holt & Laury (2002) for it, but only mention that it is similar to Dohmen et al. (2010), so, it is OK. They measure the effect of psychosocial stress on individual risk attitudes. (**decision under stress**) Psychosocial stress increases risk aversion among men; with women it does not get significant. As is fashionable today (2017), the conclusion then has long texts on important policy implications, poverty reduction, and much more. %}
Cahlıkova, Jana & Lubomır Cingl (2017) "Risk Preferences under Acute Stress," *Experimental Economics* 209–236.
https://doi.org/10.1007/s10683-016-9482-3

{% **dynamic consistency**; **DC = stationarity**; %}
Caillaud, Bernard & Bruno Jullien (2000) "Modelling Time-Inconsistent Preferences," *European Economic Review* 44, 1116–1124.

{% Opening sentence states that in horse races the term making a book is used for the bookmaker stating odds. This is not precisely the same term as bookmaking in decision theory but still is an interesting trace for the history of the term. %}
Cain, Michael, David Law, & Dennis V. Lindley (2000) "The Construction of a Simple Book," *Journal of Risk and Uncertainty* 20, 119–140.

{% **utility depends on probability**: seem to argue that in sports the utility of a result depends on its probability. %}
Cairns, John (1987) "Evaluating Changes in League Structure: The Reogainsation of the Scottish Football League," *Applied Economics* 19, 259–275.

{% %}
Cairns, John (1992) "Wealth and Time Preference," *Project Apprais* 7, 31–40.

{% **time preference** %}
Cairns, John & Marjan van der Pol (2000) "Valuing Future Private and Social Benefits: The Discounted Utility Model versus Hyperbolic Discounting Models," *Journal of Economic Psychology* 21, 191–205.

{% **time preference**;
questionnaire versus choice utility: p. 5 Ch. 2 points out that revealed preference is less imperative for health than for economics because there is no market for health. %}
Cairns, John & Marjan van der Pol (2000) "The Estimation of Marginal Time Preference in a UK-Wide Sample (TEMPUS) Project," *Health Technology Assessment* 4, 1–83.

{% **correlation risk & ambiguity attitude**: finds a positive relation
This paper considers a game with a safe row C giving $18 for sure, and two rows A and B giving $25 or $14, depending on the column player's choice. Under risk neutrality, (0.5:A, .5:B) strictly dominates C, and C cannot be. But under considerable risk or ambiguity aversion, C can be. The paper separately measures risk and ambiguity aversion, and correlates it with choice C. A nice

thing is that, whereas risk and ambiguity aversion are measured the usual way using choice lists and Ellsberg ambiguity, they are still (somewhat artificially) related to the game situation, increasing validity. The paper uses EU and log-power utility fitting to measure risk aversion. It uses the nice Epstein-Halevy (RESTUD) method to measure preference while staying somewhat away from indifference. This is probably the reason that he finds only 25% ambiguity aversion.

The paper finds a positive relation between risk/ambiguity aversion and the choice of C. Subjects who knew they faced ambiguity/risk neutral opponents, acted accordingly and chose proper optimum. %}

Calford, Evan M. (2020) “Uncertainty Aversion in Game Theory: Experimental Evidence,” *Journal of Economic Behavior and Organization* 176, 720–734.

{% Schmeidler’s (1989) uncertainty aversion implies a preference for randomization, heavily assuming the Anscombe-Aumann (AA) framework. However, preferences under risk are more pessimistic and risk averse and certainty seeking than the opposite, and this means preference against mixing, not captured by AA because it assumes EU for risk. This paper presents a model for games that reconciles the certainty effect with Schmeidler’s preference for randomization. %}

Calford, Evan M. (2021) “Mixed Strategies and Preference for Randomization in Games with Ambiguity Averse Agents,” *Journal of Economic Theory* 197, 105326.
https://doi.org/10.1016/j.jet.2021.105326

{% Apply ambiguity theory to enforcement, such as law enforcement, and reckon with source dependence of ambiguity attitudes. %}

Calford, Evan M. & Gregory DeAngelo (2023) “Ambiguity and Enforcement,” *Experimental Economics* 26, 304–338.
https://doi.org/10.1007/s10683-022-09755-w

{% **DC = stationarity**: intro first para and throughout.

If comparing constant discounters and hyperbolic discounters, the former can still be more impatient and, to the extent this is more irrational, thus be more irrational. The authors propose, comparing behavior and self-control problems, we should only do if the same degree of impatience in some average sense (“controlled comparison”). Difficulty is that this limits applicability. Also if people have different degrees of impatience, we can compare their degrees of DEVIATION from constant impatience and then (under time invariance) their vulnerability to control problems. Prelec (2004) and Bleichrodt, Rohde, & Wakker (2009 GEB) give such techniques.

Although time is continuous, it is not clear if consumption is discrete or continuous/spread-over-time. The authors do switch to discrete for quasi-hyperbolic. %}

Caliendo, Frank N. & T. Scott Findley (2014) “Discount Functions and Self-Control Problems,” *Economics Letters* 122, 416–419.

{% Vieider (2018 AER) criticizes this paper, showing that prospect theory with a plausible error theory can accommodate their findings well. The authors, indeed, ignore oceans of literature showing more risk aversion for probability equivalents than for certainty equivalents. See below.

real incentives/hypothetical choice: Did experiment in Afganistan. 1127 subjects (about half of the 2027 asked) filled out two hypothetical (real incentives with money carried around was too dangerous in Afganistan; p. 131) risky-choice matching tasks, giving q and q´ such that

$150 \sim 450_q0$ and (*)

$450_{½}150 \sim 450_q0$ (**)

Unit of payment is Afhani, and 450 is about three-day salary.

So, the first question is a probability equivalent (PE), also called standard gamble (SG). The second is a McCord-deNeufville (1986) variation (see Wakker 2010 §2.6, p. 59) with a 0.5 probability at 450 mixed in. They also do some priming of fear, and have info on exposure of subjects to violence. The main finding of the paper is that exposure to violence increases risk aversion. It is in itself a thin finding, but it is on a beautiful subject sample.

I consider risk questions more.

EU PREDICTION: q´ = ½+½q.

But the authors find that q´ is smaller, so, more risk aversion with the PE question, in agreement with the certainty effect. This is in agreement with the literature (not cited by the authors), which has found much risk aversion in PE, and also much trouble because PE questions usually perform poorly because of all kinds of biases. The keywords

PE doesn't do well and

PE higher than CE and

PE higher than others

in this file give such references. One difference is that most of this literature did direct matching, whereas the authors use a choice list, but the choice list will evoke part of the problems of matching. Bleichrodt (2002 HE) gives a good discussion.

The authors give a central role to the theory of utility of gambling (**utility of gambling**), also used in other Andreoni & Sprenger work, and which of course can accommodate the certainty effect well. Other theories with pessimism, such as Gul's disappointment aversion and RDU with convex w, can also accommodate the finding. PT *without loss aversion* and only inverse S probability weighting cannot. The certainty effect then overweights the lowest outcome similarly in both choices, but in the former effect the possibility effect is good for 450_q0, so that the prediction would be q´ bigger rather than smaller than the EU prediction. This is how the authors analyze PT. That they ignore loss aversion is stated in Footnote 10, in their words: "We abstract away from loss aversion …". Bleichrodt, Pinto, & Wakker (2001) did incorporate loss aversion, but with the difference that they considered matching rather than a choice list. Then they showed that PT does accommodate big risk aversion in PE. The choice list used here will to some extent work like matching, because the sure outcome is kept fixed and, hence, easily is taken as reference point.

The authors properly point out on p. 136 ff. that their data have great difficulties, with subjects not understanding. Thus, 63% of their subjects report q = q´ in Questions (*) and (**), which by transitivity gives150 ~ $450_{½}150$ violating stochastic dominance. It also explains why the authors find so much risk aversion in the question (*) with the sure option. %}

Callen, Michael, Mohammed Isaqzadeh, James D. Long, & Charles Sprenger (2014) "Violence and Risk Preferences: Artefactual and Experimental Evidence from Afghanistan," *American Economic Review* 104, 123–148.

{% Seems that they use high-quality data on Swedish households and find decreasing relative risk aversion. (**decreasing ARA/increasing RRA**) %}

Calvet, Laurent E., John Y. Campbell, & Paolo Sodini (2009) "Fight or Flight? Portfolio Rebalancing by Individual Investors," *Quarterly Journal of Economics* 124, 301–348.

{% Seems that they use high-quality data on Swedish households and find decreasing relative risk aversion. (**decreasing ARA/increasing RRA**) %}

Calvet, Laurent E., & Paolo Sodini (2014) "Twin Picks: Disentangling the Determinants of Risk-Taking in Household Portfolios," *Journal of Finance* 69, 867–906.

{% %}

Camacho, Antonio (1979) "On Cardinal Utility," *Theory and Decision* 10, 131–145.

{% %}

Camacho, Antonio (1979) "Maximizing Expected Utility and the Rule of Long Run Success." *In* Maurice Allais & Ole Hagen (eds.) *Expected Utility Hypotheses and the Allais Paradox*, 203–229, Reidel, Dordrecht.

{% %}

Camacho, Antonio (1980) "Approaches to Cardinal Utility," *Theory and Decision* 12, 359–379.

{% %}

Camacho, Antonio (1982) "*Societies and Social Decision Functions.*" Reidel, Dordrecht.

{% An SEU maximizer may, because of bounded rationality, deviate from SEU. %}

Camara, Modibo K. (2021) "Hadwiger Separability, or: Turing Meets von Neumann and Morgenstern," working paper.

{% **criticizing Knight (1921) for low quality**: This whole issue is on Keynes (1921) and Knight (1921), with several criticisims. %}

Cambridge Journal of Economics, volume: 45, issue: 5. 2021.

{% **SPT instead of OPT**: Pp. 74-75 really uses the right formula for 1979 prospect theory (Eqs. 17 and 18)! This is exceptional. Almost all other authors do this wrong, and instead do what is called separable prospect theory. The domain has only prospects with at most two nonzero outcomes, so, it is possible.

Paper tests gain- and loss prospects, but not mixed ones. For probability weighting, the paper allows for discontinuities at $p = 0$ and $p = 1$, capturing some insensitivity. In the interior, $0 < p < 1$, it only considers convex weighting functions, unfortunately (p. 75).

risk averse for gains, risk seeking for losses (p. 85, table 5 and p. 89); more subjects are risk averse for gains than risk seeking for losses.

real incentives/hypothetical choice: Done here (p. 81). Half of of the subjects were paid, half were not; no difference was found, neither in consistency, nor in risky choosing, nor in violations of independence. Discussed in §3.3 (p. 82 ff). P. 82 tests isolation of RIS by allowing subjects, after selection the choice to play for real, to change previously stated preference, with 80 subjects. Only 2 out of 80 subjects changed. They show that independence is massively violated, but isolation is not. This is a mild form of deception because experimental choices, announced to be consequential, in fact are not really so (**deception when implementing real incentivescrowding-out**).

losses from prior endowment mechanism: Said on p. 81; done for 96 subjects; p. 84/85 suggests that only part of subjects, not all, do isolation/integration of payment, but gives no very clear evidence on how many by using unclear overall tests.

P. 89: **risk averse for gains, risk seeking for losses** is found

P. 85 has nice discussion of within/between subjects and representative agent.

PT falsified: p. 94 describes dependence of probability weighting on outcomes in prospect theory. (**probability weighting depends on outcomes**)

reflection at individual level for risk: unfortunately the paper does not report this (Section 4.2). It only confirms reflection at average level (Section 4.1).

inconsistency in repeated risky choice: this paper has 31.6% %}

Camerer, Colin F. (1989) “An Experimental Test of Several Generalized Utility Theories,” *Journal of Risk and Uncertainty* 2, 61–104.

https://doi.org/10.1007/BF00055711

{% Conclusion: those who search for better descriptions of choices can learn from the data which directions have the most empirical promise (nonlinear weighting theories) and the least (betweenness-based theories). %}

Camerer, Colin F. (1992) "Recent Tests of Generalizations of Expected Utility Theory." *In* Ward Edwards (ed.) *Utility Theories: Measurement and Applications*, 207–251, Kluwer Academic Publishers, Dordrecht.

{% %}

Camerer, Colin F. (1992) "The Rationality of Prices and Volume in Experimental Markets," *Organizational Behavior and Human Decision Processes* 51, 237–272.

{% **survey on nonEU**; **time preference**;

P. 597: "methods for removing errors could be useful policy tools." Subjective fifty-percent intervals contain the true value about 30% of the time;

P. 603 refers to studies showing that mathematically sophisticated subjects, and also children who haven't yet learned the law of large numbers, are better at generating truly random numbers.

P. 619: **risky utility u = transform of strength of preference v**, haven't checked if he thinks that latter doesn't exist; Camerer is very explicit in his opinion on this issue.

P. 625, 2nd column, third line, makes the speculation that the value function in prospect theory was meant to be riskless. Although this interpretation seems to be a natural one and I like it, I think that, unfortunately, it cannot be found in any of the writings of Kahneman & Tversky, contrary to what Camerer suggests.

P. 627 points out that there is no clear way (I think, no way at all) to falsify the general Allais and Hagen risk theories.

P. 634 gives many refs on **real incentives/hypothetical choice**, several other places mention it. P. 635 seems to write: "The effect of paying subjects is likely to depend on the task they perform. In many domains, paid subjects probably do exert mental effort which improve their performance, but in my view choice over money gambles is not likely to be a domain in which effort will improve adherence to rational axoms."

P. 637 refers to several people who find that EU is not violated so much inside the probability triangle.

P. 637 says that nonlinear probabilities performance for many outcomes is empirical question;

is positive on future of nonadd. probability

P. 642 is, given Colin's disliking of EU, pessimistic on nonEU: "more general theories *fit* better than EU (since they have more degrees of freedom) but are no better in *predicting* new choices."

P. 643: "Maybe subjects do not induce divisions from preferences; instead, they regard money-splitting as akin to problem-solving and use a simple heuristic ... that generates allocations that are inconsistent with complete pairwise preferences."

Pp. 655-656 describes history of regret theory, where the inventors themselves later abandoned it because event splitting had driven their results, in positive terms: "The regret studies show the interplay of experimental studies, and the cumulation of discoveries, at its best. … This is a story of successful detective work."

P. 657: "Since ambiguity aversion is simply an application of the independence axiom,"

P. 659: "First, the BDM procedure only fails if independence is violated *and* reduction is obeyed." [italics from original] The sentence is not accurate, and should be: "First, the BDM procedure can be satisfied with independence violated but reduction also violated" where backward induction is satisfied.

P. 659 (on explanation of pref. reversal through BDM/nonEU): "the artifactual explanation may have received too much attention from talented researchers with better things to do."

P. 660 discusses several Loomes et al. papers that dispute the Tversky, Slovic & Kahneman (1990) explanation of pref. reversal as violation of procedure invariance rather than transitivity.

P. 661 supports the Slovic & Lichtenstein explanation of preference reversal that is often called contingent weighting.

P. 673: "suggest people use simple procedures to make choices, constructing their preferences from procedural rules rather than maximizing over well-formed preferences." %}

Camerer, Colin F. (1995) "Individual Decision Making." *In* John H. Kagel & Alvin E. Roth (eds.) *Handbook of Experimental Economics*, 587–703, Princeton University Press, Princeton, NJ.

{% Refers to movie "Groundhog Day" %}

Camerer, Colin F. (1996) “Rules or Experimenting in Psychology and Economics, and why They Differ.” *In* Wulf Albers, Werner Güth, & Eric van Damme, *Experimental Studies of Strategic Interaction: Essays in Honor of Reinhard Selten*, Springer, Berlin.

{% P. 174: D**C = stationarity**; Presented as addition to 1995 Handbook of Experimental Economics chapter. Text of leisurely lecture at Bonn. References not as extensive as 1995, but mostly through what Colin had heard casually. Opinions clear and not overly diplomatic. Pleas strongly for cumulative prospect theory against EU, and for hyperbolic discounting against exponential, criticizing economists for not using these things more. Nice sentences.

P. 163, on nonEU papers: “others merely featured an obligatory discussion of how their theory could explain the Allais paradox.”

P. 165, about Prelec’s intersection point at 1/e: “which has a nice scientific ring”

P. 166: “I should add that while various other theories have proved analytically intriguing and useful for some purposes (e.g., Machina’s local utility analysis, and betweenness-based theories), the full range of experimental evidence never seriously favored any of these alternative theories over cumulative prospect theory.” (**Prospect theory/Rank-Dependent Utility most popular for risk**)

P. 168 gives a table with nine phenomena known in economics, inconsistent with EU, consistent with cumulative prospect theory.

P. 169: “since, as Max Planck said, science progresses funeral by funeral.” %}

Camerer, Colin F. (1998) “Bounded Rationality in Individual Decision Making,” *Experimental Economics* 1, 163–183.

{% **PT, applications** %}

Camerer, Colin F. (2000) “Prospect Theory in the Wild: Evidence from the Field.” *In* Daniel Kahneman & Amos Tversky (eds.) *Choices, Values and Frames*. Cambridge University Press, New York.

{% %}

Camerer, Colin F. (2003) “*Behavioral Game Theory: Experiments in Strategic Interaction* (Roundtable Series in Behavioral Economics).” Princeton University Press, Princeton, NJ.

{% %}
Camerer, Colin F. (2003) "Strategizing in the Brain," *Science* 300, 1673–1674.

{% Neoclassical economists let utility represent introspective feeling of happiness. After the ordinal revolution, utility became related to revealed preference. Camerer studies currents in the brain. He equates, without further ado, the measurements of currents in the brain with the introspective feelings considered by the neoclassics. Thus, he comes to suggest that neuroeconomics can measure the introspective feelings (he sometimes calls it the black box) considered by neoclassical economists. Typical of this way of arguing is the last sentence on the first page, C26, continuing on p. C.27: "Pareto's view that psychology should be deliberately ignored was partly reflective of a pessimism of his time, about the ability to ever understand the brain well enough to use neural detail as a basis for individual economising."

Or p. C27, ℓ. 8: "The turn-of-the-century pessimism about understanding the brain … "

In neuroscience, the term "the hard problem" (Andreas Roepstorff) designates the big difficulty of relating objective measurements to subjective experiences. Camerer completely ignores this problem. The mind-body problem can't stop him either.

P. C27 brings up Friedman's positive economics, and criticizes its claim that a wrong theory A is OK if it gives right predictions P by assuming that the wrong assumptions must then have a hidden additional "repair" condition R. I disagree. It is well possible that wrong assumptions give right predictions without further assumptions. What is weak about Friedman's viewpoint is that we do not know, when using theory A, what predictions P' we want to derive from it in the future, and A being right on P does not exclude that it will be wrong on P'.

inverse S: pp. C33-C34, §3.3, refers to Hsu et al. (2005) for neuroeconomic evidence supporting inverse S probability weighting. P. C34 also explains the "three-valued logic" of probability weighting. %}
Camerer, Colin F. (2007) "Neuroeconomics: Using Neuroscience to Make Economic Predictions," *Economic Journal* 117, C26–C42.

{% A discussion of Levitt & List (2007, JEP). Camerer cites several people on the justified view that it is not clear whether, for predicting some field phenomenon, a lab experiment or another field experiment can serve better. Camerer several times argues that it is agreed among many experimental economists that external validity is not important for their studies, and this is hard to understand. For EVERY study it is important that finally external validity, with implications outside the walls of academia, will result. He may mean that some studies for a while focus on lab validity to first get things straight about lab findings, leaving external validity to others/later. He also raises an argument that experimental economics investigates general theories about links between factors and behavior, and from that concludes that "hence" external validity is not important. I do not understand. Some theory meant to be general may work well in the lab but not in the field, and this should always be a point of concern. He cites many studies that showed that lab findings usually extend to the field. Nicely, and no surprise for someone as broadly-read as Camerer, he cites psychological literature from the 1970s. I taught a module called quasi-experimental design to psychology students end of 1980s in Nijmegen in the Netherlands. Much of the discussions now going on in leading economic outlets on lab//field are discussed in better ways in first-year psychology textbooks of around the 1980s (e.g., Cook & Campbell 1979). %}

Camerer, Colin F. (2013) "The Promise and Success of Lab-Field Generalizability in Experimental Economics: A Critical Reply to Levitt and List,"

{% **PT, applications**: downward-sloping labor supply %}

Camerer, Colin F., Linda Babcock, George F. Loewenstein, & Richard H. Thaler (1997) "Labor Supply of New York City Cabdrivers: One Day at a Time," *Quarterly Journal of Economics* 112, 407–442.

{% The enthusiasm of the authors appears from the opening sentence: "The deepest trust in scientific knowledge comes from the ability to replicate empirical findings directly and independently." They apparently assume that scientific knowledge comes only from empirical findings, at least as far as deep trust is concerned, and then only from empirical findings that are replicable, excluding astronomy, archeology, macro-economic findings, and so on. It further appears from their sentence in the opening para: "Replication is now more important than ever."

They replicated all 18 experiments in AER and QJE of between-subject lab tests in 2011-2014, with always $\alpha = 0.05$ and power ≥ 0.90. They replicate about 70% of the findings, which, given publication bias, is a plausible finding. It is better than a similar study replicationg 100 psychological experiments, which found sme 40% replications. They advance as reasons that experimental economics has more rigor in view of real incentives and no deception. It is in general true that economics has more uniformity and less vagueness than psychology, which is broader and has less control. %}

Camerer, Colin F., Anna Dreber, Eskil Forsell, Teck-Hua Ho, Jürgen Huber, Magnus Johannesson, Michael Kirchler, Johan Almenberg, Adam Altmejd, Taizan Chan, Emma Heikensten, Felix Holzmeister, Taisuke Imai, Siri Isaksson, Gideon Nave, Thomas Pfeiffer, Michael Razen, Hang Wu (2016) "Evaluating Replicability of Laboratory Experiments in Economics," *Science* 10.1126/science.aaf0918, 1433–1436.

{% A small group of cooperative individuals can generate cooperative behavior in a group of mainly selfish individuals. Similarly, a small group of selfish individuals can generate selfish behavior in a group of mainly cooperative individuals. Bounded rationality plays a role here. %}

Camerer, Colin F. & Ernst Fehr (2006) "When Does "Economic Man" Dominate Social Behavior?," *Science* 311, 6 January, 47–52.

{% Finds that nonlinear probabilities explain choices better than betweenness; **decreasing ARA/increasing RRA**: footnote 22 finds better stability and fit for power utility; real incentives: **random incentive system between-subjects** (paying only some subjects) for one of every, about, fifty subjects

P. 168 adds to indirect evidence that the RCLA is a surprisingly poor descriptive axiom;

SPT instead of OPT: P. 185 uses the Edwards-type separate-probability transformation formula for prospect theory, but does not make the mistake of confusing them. They properly use a special term for it: Separable Prospect Theory (SPT). Their endnote 16 explicitly states that 79 prospect theory is different.

P. 186: argues for single-preference approach of representative agent

P. 188: **inverse S**; (on (parameter)-estimation of weighting functions: "These estimates are remarkably close to the estimate ... for PT," and Figure 7 (plotting the Tversky & Kahneman (92) function for the parameter found by Camerer & Ho)

p. 191: "and the similarity of the probability weighting estimates across eight studies suggest"

P. 191: "We think it is high time that theorists and others who use expected utility theory as a descriptive theory, should apply some of these functional forms -which add just one parameter to EU- and see if other kinds of anomalies can be explained by using the simple new forms instead of using EU." %}

Camerer, Colin F. & Teck-Hua Ho (1994) "Violations of the Betweenness Axiom and Nonlinearity in Probability," *Journal of Risk and Uncertainty* 8, 167–196. https://doi.org/10.1007/BF01065371

{% %}

Camerer, Colin F. & Teck-Hua Ho (1999) "Experience-Weighted Attraction Learning in Normal Form Games," *Econometrica* 67, 827–874.

{% **real incentives/hypothetical choice**: Paper considers, more broadly, effects of payment for achieving tasks such as probability matching, so, not just real incentives/hypothetical choice. I think, now in 2020 when writing this, that, in general, experimental economists exaggerate the importance of real incentives. This paper is balanced, i.e., in agreement with my views. ☺

Paper argues that, if real incentives are important, then other aspects such as give subjects right skills ("(cognitive) capital") should be equally important.

Abstract and p. 23: people are more risk averse under real incentives.

P. 8: "The extreme positions, that incentives make no difference at all, or always eliminate persistent irrationalities, are false. Organizing debates around those positions or using them to make editorial judgments is harmful and should stop."

P. 8: "In the kinds of tasks economists are most interested in, like trading in markets, bargaining in games and choosing among risky gambles, the overwhelming finding is that increased incentives do not change behavior substantially (although the variance of responses often decreases)."

Pp. 14-18 has Table 2 with references on use/effect of real incentives.

P. 11 mentions several other survey studies.

P. 21: effects result mostly from raising incentives from zero to small, not so much when raised from small to big.

P. 23: "It is worth noting that in many experiments, financial incentives might appear to have little effect because subjects are intrinsically motivated to perform well, so money adds little extra motivation. When subjects volunteer, for instance, they surely self-select for high intrinsic motivation." Then follows a warning about validity of volunteer-subjects results.

P. 24: "Overreporting purchase intention is quite familiar in marketing.":

P. 31: "For example, a search of the *American Economic Review* from 1970-97 did not turn up a single published experimental study in which subjects were not paid according to performance. Authors believe that referees will automatically reject a study which uses only hypothetical-payment data (and the authors are probably correct!)."

P. 34: "In … risky choices the most typical result is that incentives do not affect mean performance, but incentives reduce variance in responses."

P. 34 is, to my joy, harsh against people who dogmatically reject studies without real incentives.

P. 36: "Because …we do not know how earning money and losing mney differ." %}

Camerer, Colin F. & Robin M. Hogarth (1999) "The Effects of Financial Incentives in Experiments: A Review and Capital-Labor-Production Framework," *Journal of Risk and Uncertainty* 19, 7–42.

{% **paternalism/Humean-view-of-preference**: asymmetric paternalism: Paternalism by overruling individual decisions, or correcting for supposed biases, should never be such that rational individuals, who do satisfy normative theories, get harmed by it. Thus, if people on average overestimate utility of losses by a factor 2 in an irrational manner, then you cannot by way of best estimate divide all loss utilities by a factor 2, even if on average and for the majority of people you then get the best utility. The reason is that there will be some rational persons among the people concerned who did not overweight their loss utilities and who are harmed by this change. %}

Camerer, Colin F., Samuel Issacharoff, George F. Loewenstein, Ted O'Donoghue, & Matthew Rabin (2003) "Regulation for Conservatives: Behavioral Economics and the Case for "Asymmetric Paternalism "," *University of Pennsylvania Law Review* 151, 2111–1254.

{% %}

Camerer, Colin F. & Risto Karjalainen (1994) "Ambiguity-Aversion and Non-Additive Beliefs in Non-Cooperative Games: Experimental Evidence." *In* Bertrand R. Munier & Mark J. Machina (eds.) *Models and Experiments in Risk and Rationality*, Springer, Netherlands, 325–358.

{% %}

Camerer, Colin F. & Howard Kunreuther (1989) "Experimental Markets for Insurance," *Journal of Risk and Uncertainty* 2, 265–300.

{% %}

Camerer, Colin F. & Dan Lovallo (1999) "Overconfidence and Excess Entry: An Experimental Approach," *American Economic Review* 89, 306–318.

{% A discussion and survey of neuroeconomics. The paper is written in the enthusiastic style of Loewenstein. The opening sentence of the abstract: "Neuroeconomics uses knowledge about basic brain mechanism to inform economic theory." The authors claim in several places that neuroeconomics is the next step after the ordinal revolution; i.e., that neuroeconomics can measure the classical cardinal utility that economics has been looking for for over a century now. On p. 556, when they discuss Jevons, the 5th para starts with: "But Jevons was wrong. Feelings and thoughts *can* be measured directly now, because of recent breakthroughs in neuroscience. …" Or beginning of conclusion, on p. 572: "Economics parted company from psychology in the early twenthieth century … Neuroscience makes this measurement possible for the first time."

P. 559 brings up that we can learn a lot about human beings from studying primates, and then informs us that they share more than 98% of our genes.

P. 568: Footnote 7: the animal can be Bayesian if exchangeability does not hold.

P. 569 2nd para gives support for sign-dependence. %}

Camerer, Colin F., George F. Loewenstein, & Drazen Prelec (2004) "Neuroeconomics: Why Economics Needs Brains," *Scandinavian Journal of Economics* 106, 555–579.

{% P. 9: "This pessimism was expressed by William Jevons in 1987: "I hesitate to say that men will ever have the means of measuring directly the feelings of the human heart. It is from the quantitative effects of the feelings that we must estimate their comparative amounts." … But now neuroscience has proved Jevon's pessimistic prediction wrong: the study of the brain and nervous system is beginning to allow direct measurement of thoughts and feelings." That is, the authors ignore the so-called "hard problem" of neuroscience, that we do not know how currents or whatever we measure in brains are related to feelings. I discuss it more at Camerer's (2007) paper in the Scandinavian Journal of Economics.

Typical statements are:

P. 32: economics assumes that time-preference is context independent, but neuroscience can discover context dependencies.

P. 35: economics thinks that the utility of money is indirect (as means to buy things), neurostudies suggest that it can have intrinsic utility. %}

Camerer, Colin F., George F. Loewenstein, & Drazen Prelec (2005) "Neuroeconomics: How Neuroscience Can Inform Economics," *Journal of Economic Literature* 43, 5–60.

{% Show experimentally that if a better-informed agent should predict actions of a less-informed agent, then the better-informed agent acts too much as if the worse-informed had the extra info that the better-informed has but the less-informed does not. Theory of the mind is about such things. %}

Camerer, Colin F., George F. Loewenstein, & Martin Weber (1989) "The Curse of Insight in Economic Settings: An Experimental Analysis," *Journal of Political Economy* 97, 1232–1254.

{% **survey on nonEU**;

P. 326 is, unfortunately, not aware of the difference between objective probabilities given beforehand and available as primitive, and subjective probability that is not given beforehand and is not available as primitive and is typically inferred from choice: "In SEU the distinction between known and unknown probabilities is pointless, because subjective probabilities are never unknown—they are always known to the decision makers (or inferable from their choices)." Thus, the authors cannot discuss the subtle issue of whether probabilistic sophistication and SEU can be absence of or neutrality w.r.t. ambiguity. P. 329 top repeats it. (**SEU = risk**)

P. 341 top & p. 353 top: the studies that they reviewed (all included in this annotated bibliography) find that risk attitude and ambiguity attitude are uncorrelated (**correlation risk & ambiguity attitude**);

universal ambiguity aversion: §2.3 says that ambiguity is "scary," and suggests as if universal that people are averse to ambiguity; also end of §2.5 (though as antecedent). This will be repeated on p. 347 following Eq. 6, saying: "Outcome dependence is important because people are ambiguity-averse for *both* gain and loss gambles. Models like Fellner's (1961), in which ambiguous events simply have a lower probability weight, fail descriptively because they predict *preference* for ambiguous bets on losses." [italics from original] One problem here is that the state of the art today (June 2011) finds prevailing ambiguity seeking for losses (**ambiguity seeking for losses**).Another problem is that rank-dependent weighting can combine underweighting of small events with ambiguity aversion for both gains and losses if sign-independent—and the Sipos integral (= PT) if sign dependent.

Footnote 37 suggests that EU is not normative;

Footnote 38 is weird; they argue !in favor! of forgone-event independence (often called consequentialism) for the special case of indifference, but refer to Machina (1989) who I think did not accept forgone-event independence if indifference; accepting forgone-event independence if indifference is close to betweenness.

§3.4 is nice, with the title: "The difficulty of establishing equivalence of ambiguous and unambiguous probabilities." That an unknown probability of 0.1 due to skewness may be overestimated, even by SEU.

probability intervals: P. 346 bottom writes that with probability intervals it is true that one need not give precise probabilities, but one then has to give precise boundaries of probability, an argument also advanced by Lindley (1996).

ambiguity seeking for losses: §5.1 discusses ambiguity in health (which means losses). Problem in health is that ambiguity will suggest that the health outcomes are less known, and will decrease the value of the outcomes. Still they report less ambiguity aversion for health than for money. P. 354 bottom: "These medical and health studies are a little discouraging, because they show less ambiguity aversion, and less reliable measurement of ambiguity, than is observed or assumed in laboratory experiments (and in theory)."

P. 359, 2nd full paragraph points out that a **Dutch book** example discussed before requires “isolation” (~ additivity). The next paragraph describes the “Dutch book” commonly advanced against violation of DC (dynamic consistency), in the Raiffa (1961) answer to Ellsberg, and calls it “less slippery.”

P. 361 has a nice text on the discrepancy between empirical and theoretical workers on ambiguity, still relevant in the year I copy this text (2015):

“The differences in researchers’ purposes sometimes limit communication and crossfertilization. For example, psychologists are sometimes annoyed that decision theorists rely on unrealistic axioms. But theorists see more realistic axioms as inelegant and difficult to work with. A review like this is meant to promote cross-fertilization by telling people with different purposes about other kinds of research, so they can draw inspiration and ideas from others. Since psychologists and decision theorists are not as curious about market implications as economists, economists who find the psychology described here inspiring must figure out its market implications and test those using market data, themselves. Similarly, pyschologists who are curious about the descriptive validity of new axioms, and theories based on them, must conduct tests themselves since most decision theorists are more interested in the mathematical properties of axioms than in their descriptive validity.”

natural sources of ambiguity: p. 361: “There are diminishing returns to studying urns!” %}

Camerer, Colin F. & Martin Weber (1992) “Recent Developments in Modeling Preferences: Uncertainty and Ambiguity,” *Journal of Risk and Uncertainty* 5, 325–370.
https://doi.org/10.1007/BF00122575

{% **updating: testing Bayes’ formula** %}

Cameron, Trudy A. (2005) “Updating Subjective Risks in the Presence of Conflicting Information: An Application to Climate Change,” *Journal of Risk and Uncertainty* 30, 63–97.

{% **real incentives/hypothetical choice**: Compare 7 kinds of contingent valuation, including one real choice. Methods give same results with exception of direct matching, which gives lower values than binary-choice derived WTP. %}

Cameron, Trudy Ann, Gregory L. Poe, Robert G. Ethier, & William D. Schulze (2002) “Alternative Non-Market Value-Elicitation Methods: Are the Underlying Preferences the Same?,” *Journal of Environmental Economics and Management* 44, 391–425.

{% Review and discuss different definitions of subjective well-being (happiness) and quality of life, and the move from objective to subjective of the latter, and conclude that these concepts are about the same. %}

Camfield, Laura & Suzanne M. Skevington (2008) "On Subjective Well-Being and Quality of Life," *Journal of Health Psychology* 13, 764–775.

{% Find underweighting of rare events for DFE in the feedback treatments (repeated payments), but not in the sampling treatment. (**DFE-DFD gap but no reversal**:) %}

Camilleri, Adrian R. & Ben R. Newell (2010) "When and why Rare Events are Underweighted: A Direct Comparison of the Sampling, Partial Feedback, Full Feedback and Description Choice Paradigms," *Psychonomic Bulletin & Review* 18, 377–384.
https://link.springer.com/article/10.3758/s13423-010-0040-2

{% We often discretize and even dichotomize what in reality is a continuum for simplicity and for clarity of speech. But sometimes it better not be done. This paper argues that for the experienced versus descriptive debate nowadays (2005-2020), the dichotomy is oversimplistic. I agree!

Seems that, when presenting supposedly random samples to subjects, they in reality gave exactly representative samples (matching samples paradigm), which would comprise some deception (**deception**). They did this as variation of Ungemach et al. (2009). %}

Camilleri, Adrian R. & Ben R. Newell (2011) "Description- and Experience-Based Choice: Does Equivalent Information Equal Equivalent Choice?," *Acta Psychologica* 136, 276–284.

{% %}

Camille, Nathalie, Giorgio Coricelli, Jerome Sallet, Pascale Pradat-Diehl, Jean-René Duhamel, & Angela Sirigu (2004) "The Involvement of the Orbitofrontal Cortex in the Experience of Regret," *Science* 304, 1167–1170.

{% **value of information**: in welfare context. %}

Campbell, Colin (2004) "Blackwell's Ordering and Public Information," *Journal of Economic Theory* 114, 179–197.

{% **SIIA/IIIA**, social welfare function implementable only if Arrow IIA %}
Campbell, Donald E. (1992) "Implementation of Social Welfare Functions," *International Economic Review* 33, 525–533.

{% **SIIA/IIIA**, continuous-alternative-space extension of Arrow's impossibility theorem. %}
Campbell, Donald E. (1992) "Transitive Social Choice in Economic Environment," *International Economic Review* 33, 341–352.

{% **revealed preference**; that IIIA implies rationalizability even if all choice sets contain at least m elements. %}
Campbell, Donald E. (1994) "Arrow's Choice Axiom," *Economics Letters* 44, 381–384.

{% **utility elicitation**; seems to find that CRRA coefficient increases substantially if human wealth is included in wealth. Well, this in itself is a simple numerical fact, so I should recheck. %}
Campbell, John Y. (1996) "Understanding Risk and Return," *Journal of Political Economy* 104, 298–345.

{% %}
Campbell, John Y. & John H. Cochrane (2000) "Explaining the Poor Performance of Consumption-Based Asset Pricing Models," *Journal of Finance* 55, 2863–2878.

{% %}
Campbell, John Y. & Robert J. Shiller (1987) "Cointegration and Tests of Present Value Models," *Journal of Political Economy* 95, 1062–1088.

{% **free will/determinism** %}
Campbell, Joseph Keim (2007) "Free Will and the Necessity of the Past," *Analysis* 67, 105–111.

{% Committee Appointed by the British Association for the Advancement of Science, "Quantitative Estimates of Sensory Events" (1938), with Campbell in the committee. Campbell argued that no interval scales can be observed in the social science, here and in his 1938 work. %}

Campbell, Norman R. (1920) "*Physics: The Elements.*" Cambridge University Press, New York.

Reprinted in 1957 as "*Foundations of Science: The Philosophy of Theory and Experiment.*" Dover Publications, New York.

{% %}

Campbell, Norman R. (1920) "*An Account of the Principles of Measurement and Calculation*." Longmans, Green, London.

{% **Newcomb's problem** %}

Campbell, Richmond & Lanning Sowden (1985, eds.) "*Paradoxes of Rationality and Cooperation: Prisoners Dilemma and Newcomb's Problem.*" University of British Columbia Press, Vancouver.

{% **updating: discussing conditional probability and/or updating**: unexpected evidence %}

Campbell, Richmond & Thomas Vinci (1982) "Novel Confirmation," *British Journal for the Philosophy of Science* 34, 315–341.

{% Discussing claimed solutions to Hume's problem of induction through simple statistical formulas it seems. %}

Campbell, Scott & James Franklin (2004) "Randomness and the Justification of Induction," *Synthese* 138, 79–99.

{% **one-dimensional utility**: derive results for weak continuity. %}

Campión, María J., Juan C. Candeal and Esteban Induráin (2006) "The Existence of Utility Functions for Weakly Continuous Preferences On A Banach Space," *Journal of Mathematical Psychology* 51, 227–237.

{% February 2005: I couldn't find anything of this reference, and expect that there is something wrong about it.

Z&Z Say that 2/3 of the Dutch population has the compulsory ziekenfondsverzekering for health insurance. %}

Camps, Marielle, Ben Geurts, & Steef Kaatee (2000) "De Zorgverzekeringscombi," *Economisch Statistische Berichten* (3-11-2000), 873–875.

{% Shows relations between axioms in Debreu-type separability contexts, often leading to dictatorial solutions.

ordered vector space: Corollary 3.6 gives a funny way to characterize the dictatorial solution in welfare theory: Elements of $\mathbb{R}^n$ are welfare allocations over n individuals, and we study a preference relation over them. What I call de Finetti's additivity is called zero independence by the author. The multiplicative version (so, coordinate-dependent changes of scale should not affect preference) is called scale-independence by the author. The former condition implies the well-known linear representation of de Finetti, and the latter implies the same but after taking logarithms (handle negatives properly). These exclude each other, except if there is degeneracy of only one essential coordinate when the representations are just ordinal. This is exactly the dictatorial approach. Funny! %}

Candeal, Juan C. (2012) "Subgroup Independence Conditions on Preferences," *Social Choice and Welfare* 39, 847–853.

{% **ordered vector space**: Considers variations of the interesting Corollary 3.6 of Candeal (2012 SCW, cited as 2011 forthcoming.) where continuity is dropped. Then lexicographic things come in. %}

Candeal, Juan C. (2013) "Invariance Axioms for Preferences: Applications to Social Choice Theory," *Social Choice and Welfare* 41, 453–471.

{% **Dutch book**; **ordered vector space** %}

Candeal, Juan Carlos & Esteban Induráin (1995) "A Note on Linear Utility," *Economic Theory* 6, 519–522.

{% **one-dimensional utility**; this paper primarily considers extensive measurement. %}

Candeal, Juan Carlos, Juan R. de Miguel, & Esteban Induráin (1995) "Extensive Measurement: Continuous Additive Utility Functions on Semigroups".

{% **Dutch book**: Let ≽ be a weak order and + an operation. Assume the order topology. There exists an additive and continuous function representing ≽ whenever: (i) weak ordering; (ii) the order topology is connected; (iii) + is continuous. (iv) ≽ is ~- cancellative (the three equivalences x + y ~x + z, y + x ~ z + x, and y ~z are logically equivalent); (v) ≽ is ~- associative ((x + (y + z) ~ (x + y) + z). I like that apart from continuity, only ~ is considered. %}

Candeal, Juan Carlos, Juan R. de Miguel, & Esteban Induráin (2000) "Expected Utility from Additive Utility on Semigroups."

{% Eighteen economics students (acquainted with utility) were asked to give direct quantitative evaluations of three monetary outcomes and six lotteries over these, and three health states and six lotteries over these. From these, probability weighting was calculated under RDU. Probability weighting was less elevated for health than for money. %}

Canjels, Eugene & Hans J.M. Peters (1989) "Testing the Rank Order-Approach to Utility for Money and Health States," *Quantitatieve Methoden* 11, 53–64.

{% **Christiane, Veronika & I** %}

Cannon, Edmund & Gian Pietro Cipriano (2004) "Euro-Illusion: A Natural Experiment," Dept. of Economics, University of Bristol.

{% %}

Cantoni, Davide, David Y. Yang, Noam Yuchtman, & Y. Jane Zhang (2019) "Protests as Strategic Games: Experimental Evidence from Hong Kong's Antiauthoritarian Movement," *Quarterly Journal of Economics* 134, 1021–1077.

{% On forward induction in game theory, Mertens & Kohlberg (1986). %}

Catonini, Emiliano (2024) "Iterated Admissibility Does not Refine Extensive-Form Rationalizability," *Economic Journal* 134, 3017–3026.
https://doi.org/10.1093/ej/ueae032

{% **one-dimensional utility** %}
Cantor, Georg (1895) "Beiträge zur Begründung der Transfiniten Mengenlehre," §11, *Mathematische Annalen* 46, 481–512.
Reprinted in Georg Cantor (1932) Beiträge zur Begründung der Transfiniten Mengenlehre, *Gesammelte Abhandlungen Mathematischen und Philosophischen Inhalts*, 282–356, Springer, Berlin.

{% **information aversion**; prenatal diagnosis %}
Cantor Scott B. (1991) "A Decision Analytic Approach to Prenatal Diagnosis," Ph.D. Thesis in Decision Sciences, Harvard University, Boston, MA, USA.

{% **anonymity protection**: events with **(very) small probabilities** %}
Cantor Scott B., Richard D. Clover, & Robert F. Thompson (1993) "A Decision Analytic Approach to Postexposure Rabies Prophylaxis," University of Texas.

{% %}
Cao, H. Henry, Tan Wang, & Harold H. Zhang (2005) "Model Uncertainty, Limited Market Participation, and Asset Prices," *Review of Financial Studies* 18, 1219–1251.

{% %}
Capaldi, Elizabeth J., Daniel J. Miller, Suzan Alptekin (1989) "Multiple-Food-Unit-Incentive Effect: Nonconservation of Weight of Food Reward by Rats," *Journal of Experimental Psychology: Animal Behavior Processes* 15, 75–80.

{% Compares choice from multiple sets with ranking. Does a greater effort than preceding studies to make the two setups ceteris paribus. Uses binary choice as gold standard and finds no difference between (multiple) choice and ranking. Nice literature review on the topic restricted to environmental valuation. %}

Caparrós, Alejandro, José L. Oviedo, Pablo Campos (2008) "Would You Choose Your Preferred Option? Comparing Choice and Recoded Ranking Experiments," *American Journal of Agricultural Economics* 90, 1–13.

{% **linear utility for small stakes**: §3.3 beginning: "The amounts of money involved in experiments are too small to trigger risk aversion relevant to life cycle spending. For that reason, Barsky, Juster, Kimball, and Shapiro, 1997, constructed a stated preference question that placed enough wealth on the line to introduce significant wealth swings. It involved a switch of job with a potentially large change in income. With the advantage again of being able to place these on the HRS, this form of question is now widely used and related to portfolio choice." This text also pertains to **real incentives/hypothetical choice**.

Argues that for economists to work with data, they have to produce much of the data artificially by themselves, using theoies, having to do for one with the central role of counterfactuals in decisions. (**conservation of influence**) From economic data we usually cannot separate preferences (utilities) from beliefs. Does the consumer really prefer this product, or have wrong beliefs? Argues that economists also have to reckon with perceptions of consumers, and not just with what was objectively offered to the consumer. This is an input in the development of stochastic choice theories.

End of §4.3 discusses what is in fact only the observability problem of indifference; i.e., the difficulty to falsify indifference empirically. %}
Caplin, Andrew (2016) "Economic Data Engineering," working paper.

{% Provide some preference axioms for predicted and experienced reward, which they interpret as dopaminenergic, to reflect dopamine neurotransmitters. Their application to belief elicitations consists of a speculation that dopamine measurements can help elicit beliefs, with learning and addiction idem dito. In this way the authors aim to help bridge the conceptual gap between neuroscience and economics, as they write in their abstract. %}
Caplin, Andrew & Mark Dean (2008) "Dopamine, Reward Prediction Error, and Economics," *Quarterly Journal of Economics* 123, 663–701.

{% Theoretical decision-cost model; deriving that from revealed preference. %}

Caplin, Andrew & Mark Dean (2015) "Revealed Preference, Rational Inattention, and Costly Information Acquisition," *American Economic Review* 105, 2183–2203. http://dx.doi.org/10.1257/aer.20140117

{% %}

Caplin, Andrew, Mark Dean, & John Leahy (2022) "Rationally Inattentive Behavior: Characterizing and Generalizing Shannon Entropy," *Journal of Political Economy* 130, 1676–1715.

{% **value of information**: Different anxiety types have different needs for information. Let emotions such as anxiety enter as arguments into the utility function. Is a bit like the intrinsic **value of information** and early/late resolution of uncertainty. %}

Caplin, Andrew & John Leahy (1999) "The Supply of Information by a Concerned Expert," Dept. of Economics, New York University.

{% **conservation of influence;**

Agent receives physical prize z_1 in period 1, physical prize z_2 in period 2. There is uncertainty, so, probability distributions over prizes are involved. φ is a map that, at the end of period 1, maps the agent towards a psychological state. φ depends not only on z_1 but also on the lottery over the z_2's, and can reflect anxiety etc. There are decisions at both timepoints. This model generalizes Kreps & Porteus (1978) by permitting time inconsistency. Utility (from prior perspective) $V_1(y_1)$ is sum of expected utility $E(u_2)$ over second period and utility $u_1(\varphi(y_1))$ of psychological state $\varphi(y_1)$ at period 1, see Eq. (1) on p. 63. Decision making is assumed to be sophisticated, so, not resolute.

Under appropriate continuity, an optimal priori strategy exists if the set of options is compact. In several places, the authors state that anxiety will depend on possibility and will overestimate small probabilities (e.g. p. 56). §IV.B argues that what is often called risk aversion should have a dynamic aspect of anxiety and is not static.

The enthusiasm of the authors is reflected by sentences such as "More recently, these findings have moved out of the laboratory and into the field" (top of p. 60) or "One important advantage of our formulation over static nonexpected utility models is that the latter theories attempt to telescope a dynamic pattern of feelings into a single static utility function.” (p. 75) or the closing sentence of the paper.

information aversion: §II.B gives many refs where people, owing to anxiety etc., prefer not to receive info.

The model is general but, in return, it is not easy to see how to derive predictions from data. How can we measure its primitives from data? Are they identifiable? On p. 75 the authors explain that their model is very general indeed, incorporating everything relevant, with footnote 20 citing Machina on EU being normative then. As Machina added to this point, however, the problem then is that it is hard to derive predictions from data. %}

Caplin, Andrew & John Leahy (2001) “Psychological Expected Utility Theory and Anticipatory Feelings,” *Quarterly Journal of Economics* 116, 55–79.

{% **time preference**; **dynamic consistency**; point out that deciding social discount rate on basis of revealed preference means privileging the current agent at the cost of the future agent, which does not seem to be normative. They nicely discuss discounting of past consumption.

DC = stationarity: Their time consistency in Def. 1 p. 1261 is indeed time consistency; Eq. 1 implicitly implies stationarity. P. 1263 shows that they can characterize quasi-hyperbolic discounting. This paper is nice! %}

Caplin, Andrew & John Leahy (2004) “The Social Discount Rate,” *Journal of Political Economy* 112, 1257–1268.

{% **dynamic consistency**: They distinguish between recursive and subgame perfectness. The difference concerns indifferences. In the subgame-perfect solution, the posterior agent chooses arbitrarily, but in the recursive approach it is apparently permitted that the prior agent then choose. %}

Caplin, Andrew & John Leahy (2006) “The Recursive Approach to Time Inconsistency,” *Journal of Economic Theory* 131, 134–156.

{% Assume SEU with everything finite, state space, outcome set, act set. But additionally assume a perception function. It is unobservable, but is derived from

how subjective probabilities change. A “no improving action switches” (NIAS) condition is important. %}

Caplin, Andrew & Daniel Martin (2015) “A Testable Theory of Imperfect Perception,” *Economic Journal* 125, 184–202.

{% %}

Caplin, Andrew & Daniel Martin (2021) “Comparison of Decisions under Unknown Experiments,” *Journal of Political Economy* 131, 3185–320.

{% **Dutch book**: axiomatizations of concave and convex functionals with variations on Dutch books and incompleteness. %}

Capotorti, Andrea, Giulianella Coletti, & Barbara Vantaggi (2008) “Preferences Representable by a Lower Expectation: Some Characterizations,” *Theory and Decision* 64, 119–146.

{% Consider incoherent conditional probabilities, a distance measure (variation of proper scoring rule), and a way to correct the incoherence, maybe by taking the nearest coherent (I did not check). %}

Capotorti, Andrea, Giuliana Regoli, & Francesca Vattari (2010) “Correction of Incoherent Conditional Probability Assessments,” *International Journal of Approximate Reasoning* 51, 718–727.

{% DM-Subjects can distribute risky prospects over other subjects (and also if self involved) before the uncertainty of the risks are resolved. Next the uncertainties are resolved. Next the DM-subjects can redistribute. So, this is about the interaction of fairness and risk, in Harsanyi-type models.

They find that ex ante considerations remain dominant over ex post, but there are some redistributions. They redistribute much more the differences resulting from different luck, than differences resulting from different decisions. Although being stakeholder or not matters, the same fairness views underly both cases. %}

Cappelen, Alexander W., James Konow, Erik O. Sorensen, & Bertil Tungodden (2013) “Just Luck: An Experimental Study of Risk-Taking and Fairness,” *American Economic Review* 103, 1398–1413.

{% The authors examine sources, i.e., collections of disjoint events. They are like different partitions of a state space, as are sources as I use them, but a difference is that the union of all elements of a source need not be the same for each source here, and can in principle be unrelated to each other. For each source, acts map the atomic events to outcomes, asssumed real-valued here. It is similar to the experiments in §1.1.6.2 of Luce's 2000 book. The authors do not impose many restrictions, besides weak ordering, mostly continuity and monotonicity. Thus, all acts have certainty equivalents. Within one source, acts can be compared through their certainty equivalents. But certainty equivalents are not evaluated the same for different sources. Thus, nonlinear transformations relate certainty between sources and, then, by transitivity determine all preferences.

The authors allow for several acts and their outcomes to be received at the same time. They may specify n sources of uncertainty and n acts, and the outcome of each act is received, giving a portfolio of n outcomes. The n sources may, for instance, refer to n timepoints. Then the aggregation of these is another topic to study. It requires consideration of (non)separability across different sources, and stochastic (in)dependence of the events of different sources.

The source method of Abdellaoui et al. (2011) is different because there different sources concern partitions of the same Savagean state space. The authors point out that their approach can be related to one common state space by taking a product of the n sources. However, this product loses information. For instance, in Abdellaoui et al. a union of some events of some source may be a superset of a union of some events of another source, but such set-theoretic info is lost if the mentioned product space is taken. Further, Abdellaoui et al. (2011) have the receipt of only one outcome, and not a portfolio of different outcomes. %}

Cappelli, Veronica Roberta, Simone Cerreia-Vioglio, Fabio Maccheroni, Massimo Marinacci, & Stefania Minardi (2021) "Sources of Uncertainty and Subjective Prices," *Journal of the European Economic Association* 19, 872–912. https://doi.org/10.1093/jeea/jvaa013

{% **equity-versus-efficiency** %}

Capraro, Valerio (2020) "Gender Differences in the Trade-Off between Objective Equality and Efficiency," *Judgment and Decision Making* 15, 534–544.

{% **risk averse for gains, risk seeking for losses**: Seems to find risk seeking for bad outcomes, if some are below survival-minimum. This should be no surprise! %}

Caraco, Thomas (1981) "Energy Budgets, Risk and Foraging Preferences in Dark-Eyed Juncos (Junco Hyemalis)," *Behavioral Ecology and Sociobiology* 8, 213–217.

{% **dynamic consistency**: Finds violation of quasi-hyperbolic discounting. Does so in market setup with forward and spot market. Done with real incentives (**real incentives/hypothetical choice: for time preference**).

decreasing/increasing impatience: find counter-evidence against the commonly assumed decreasing impatience and/or present effect. %}

Carbone, Enrica (2008) "Temptations and Dynamic Consistency," *Theory and Decision* 64, 229–248.

{% The authors consider an allocation problem and then test some ambiguity theories. My views on ambiguity theories and their implementations deviate in many respects from the account given, for instance, in §2 here. The authors find that SEU performs well. %}

Carbone, Enrica, Xueqi Dong, & John Hey (2017) "Elicitation of Preferences under Ambiguity," *Journal of Risk and Uncertainty* 54, 87–102.

{% Seem to study intertemporal decisions on consumption and saving, with groups better in ambiguity and worse ini risk than individuals. %}

Carbone, Enrica, Konstantinos Georgalos, & Gerardo Infante (2019) "Individual vs. Group Decision-Making: An Experiment on Dynamic Choice under Risk and Ambiguity," *Theory and Decision* 87, 87–122. https://doi.org/10.1007/s11238-019-09694-8

{% P. 129 argues that inconsistency is partly irrational but partly also close-to-indifference, so, not totally irrational. %}

Carbone, Enrica & John D. Hey (1995) "A Comparison of the Estimates of Expected Utility and Non-Expected-Utility Preference Functionals," *Geneva Papers in Risk and Insurance Theory* 20, 111–133.

{% **Best core theory depends on error theory**: seems so. %}
Carbone, Enrica & John D. Hey (2000) "Which Error Story Is Best?," *Journal of Risk and Uncertainty* 20, 161–176.

{% **dynamic consistency**: e**mpirical test of backward induction** %}
Carbone, Enrica & John D. Hey (2001) "A Test of the Principle of Optimality," *Theory and Decision* 50, 263–281.

{% Theoretically examine the hypothesis of less tax for the poor because there are more poor to vote. %}
Carbonell-Nicolaua, Oriol & Efe A. Ok (2007) "Voting over Income Taxation," *Journal of Economic Theory* 134, 249–286.

{% **gender differences in risk attitudes**: women more risk averse than men. %}
Cardenas, Juan-Camilo, Anna Dreber, Emma von Essen, Eva Ranehill (2012) "Gender Differences in Competitiveness and Risk Taking: Comparing Children in Colombia and Sweden," *Journal of Economic Behavior and Organization* 83, 11–23.

{% Theorem 2 mentions (minus) the Pratt-Arrow index f´´//f´ as measure of convexity. %}
Cargo, Gerald T. (1965) "Comparable Means and Generalized Convexity," *Journal of Mathematical Analysis and Applications* 12, 387–392.

{% Considers concave functions of quantiles, which generalizes rank-dependent utility. %}
Carlier, Guillaume (2008) "Differentiability Properties of Rank-Linear Utilities," *Journal of Mathematical Economics* 44, 15–23.

{% Shows results, e.g. on differentiability, for usual thing that core of convex probability transformation is set of dominating measures, but in differentiable continuous-distribution context. %}

Carlier, Guillaume & Rose-Anna Dana (2003) “Core of Convex Distortions of a Probability,” *Journal of Economic Theory* 113, 199–222.

{% %}
Carlier, Guillaume & Rose-Anna Dana (2011) “Optimal Demand for Contingent Claims when Agents Have Law Invariant Utilities,” *Mathematical Finance* 21, 169–201.

{% Efficient risk sharing is characterized by a comonotonicity condition for univariate outcomes. For multivariate more complex because no direct extension of comonotonicity. %}
Carlier, Guillaume, Rose-Anna Dana, & Alfred Galichon (2011) “Pareto Efficiency for the Concave Order and Multivariate Comonotonicity,” *Journal of Economic Theory* 147, 71–92.

{% %}
Carlier, Guillaume, Rose Anne Dana, & Niousha Shahidi (2003) “Efficient Insurance Contracts under Epsilon-Contaminated Utilities,” *Geneva Papers on Risk and Insurance Theory* 28, 59–71.

{% Tests Allais paradox; gives no probabilities but numbers on wheel.
Greatly reduced effect, only 20 out of 142 exhibited effect, whereas 16 out of those 142 violated independence in other direction. %}
Carlin, Paul S. (1990) “Is the Allais Paradox Robust to a Seemingly Trivial Change of Frame?,” *Economics Letters* 34, 241–244.

{% P. 229: A version of the shaping hypothesis in the context of s.th.pr. tests:
“what could be called quasi-rational decision making. When the problem is too complex or the framing of the problem makes it appear that simple decision rules may work adequately and, perhaps, when not much is at stake, then people use non-expected utility decision programs or rules which are generated from previous experience and learning.”
He imposes it on the nonEU preferences, taking EU as right preferences. In this sense he does not defend the common consequence effect. %}

Carlin, Paul S. (1992) “Violations of the Reduction and Independence Axioms in Allais-Type and Common-Ratio Experiments,” *Journal of Economic Behavior and Organization* 19, 213–235.

{% Theorem 1 extends Hölder’s Lemma to non-Archimedean and incomplete. %}
Carlson, Erik (2011) “Non-Archimedean Extensive Measurement with Incomparability,” *Mathematical Social Sciences* 62, 71–76.

{% %}
Carlson, John A. (1998) “Risk Aversion, Foreign Exchange Speculation and Gambler’s Ruin,” *Economica* 65, 441–453.

{% Risk attitude is measured with as outcomes monthly lifetime income of grandchildren. In the inequality aversion formula (5), p. 379, I do not understand why utility depends only on the inequality index and, for instance, not on absolute level of utility. %}
Carlsson, Fredrik, Dinky Daruvala, & Olof Johansson-Stenman (2005) “Are People Inequality-Averse, or just Risk-Averse?,” *Economica* 72, 375–396.

{% %}
Carlsson, Fredrik, Olof Johansson-Stenman, & Peter Martinsson (2004) “Is Transport Safety More Valuable in the Air?,” *Journal of Risk and Uncertainty* 28, 147–163.

{% **time preference** in sense of value of waiting time %}
Carmon, Zvi, J. George Shanthikumar, & Tali F. Carmon (1995) “A Psychological Perspective on Service Segmentation Models: The Significance of Accounting for Consumers’ Perceptions of Waiting and Service,” *Management Science* 41, 1806–1815.

{% Seems to be a good reference on logical positivism. Good to cite, together with Popper’s (1935) notion of falsifiability, as basis of revealed preference. %}
Carnap, Rudolf (1923) “Über die Aufgabe der Physik und die Anwendung des Grundsatze der Einfachstkeit,” *Kant-Studien* 28, 90–107.

{% %}

Carnap, Rudolf (1950) "*Logical Foundations of Probability.*" University Press, Chicago. (2nd edn. 1962.)

{% %}

Carnap, Rudolf (1952) "*The Continuum of Inductive Methods.*" University Press, Chicago.

{% %}

Carnap, Rudolf (1980) "A Basic System of Inductive Logic, Part II." *In* Richard C. Jeffrey (ed.) *Studies in Inductive Logic and Probability,* Vol. II, 7–155, University of California Press, Berkeley.

{% %}

Carnap, Rudolf & Richard C. Jeffrey (1971, eds.) "S*tudies in Inductive Methods I*," University of California Press, Berkeley.

{% N = 140, students. Subjects three times had to choose one of six prospects to measure their risk attitude à la Binswanger (1981). The first six-tuple was fifty-fifty, in the second all prospects were equally ambiguous, and the third was as the first but with $50 subtracted from all payments leading to mixed prospects. (**losses from prior endowment mechanism**). They, unfortunately, implemented all three choices, generating income effects. What they call losses throughout the paper is mixed.

real incentives/hypothetical choice, for time preferences: 0, 1, or 2-month delays, testing stationarity, and paid using postal services. Here one payment through RIS (in addition to previous payments).

For fifty-fifty gains people are ambiguity averse, as usual.

Violations of stationarity: not significant.

risk averse for gains, risk seeking for losses: P. 242 & 244 reports more risk seeking for mixed (what they call losses) than for gains, going against the common hypothesis of loss aversion. Their implementation through prior endowment may have generated it, with too many subjects integrating.

For a gene called 7-repeat allele (having to do with dophamine) they seem to find ambiguity seeking (**ambiguity seeking**) (p. 245) and no impatience.

reflection at individual level for risk: they have the data but do not seem to report it. **%}**

Carpenter, Jeffrey P., Justin R. Garcia, & J. Koji Lum (2011) "Dopamine Receptor Genes Predict Risk Preferences, Time Preferences, and Related Economic Choices," *Journal of Risk and Uncertainty* 42, 233–261.

{% **gender differences in risk attitudes**: no difference %}

Carr, Priyanka B. & Claude M. Steele (2010) "Stereotype Threat Affects Financial Decision Making," *Psychological Science* 21, 1411–1416.
http://dx.doi.org/10.1177/0956797610384146

{% Seems to have argued for a role of group selection in evolution. Was sociologist pointing out that people living in small groups of primitive cultures avoided overpopulation by deliberately restraining fertility. Said that this was against selfish maximization of individual fertility and suggested that it must somehow be explained by group selection. %}

Carr-Saunders, Alexander M. (1922) "*The Population Problem: A Study in Human Evolution.*" Clarendon Press, Oxford.

{% **ubiquity fallacy**: §2.2: "Every specialist, owing to a well-known professional bias, believes that he understands the entire human being, while in reality he only grasps a tiny part of him." %}

Carrel, Alexis (1939) "*Man, the Unknown*." Harper & Brothers, New York.

{% They study what title says. Their novelty is not taking average person, but only new members who plan to start. For this group, financial incentives might have different effects. However, they find no effects. Essentially, they find H_0. %}

Carrera, Mariana, Heather Royer, Mark Stehr, & Justin Sydnord (2018) "Can Financial Incentives Help People Trying to Establish New Habits? Experimental Evidence with New Gym Members," *Journal of Health Economics* 58, 202–214.

{% **information aversion**; for the relation to Wakker (1988, JBDM 1) see my comments to Brocas & Carrillo (2000) %}

Carrillo, Juan-D. & Thomas Mariotti (2000) "Strategic Ignorance as a Self-Discipline Device," *Review of Economic Studies* 67, 529–544.

{% Uncertainty increases concavity of consumption function. %}
Carroll, Christopher D. & Miles S. Kimball (1996) "On the Concavity of the Consumption Function," *Econometrica* 64, 981–992.

{% In many situations, in particular under sufficient convexity, local incentive compatibility implies it globally. %}
Carroll, Gabriel (2012) "When Are Local Incentive Constraints Sufficient?," *Econometrica* 80, 661–686.

{% **measure of similarity** %}
Carroll, J. Douglas (1976) "Spatial, Nonspatial and Hybrid Models for Scaling," *Psychometrika* 41, 439–463.

{% " 'When *I* use a word,' Humpty Dumpty said in rather a scornful tone, 'it means just what I choose it to mean—neither more nor less.' " %}
Carroll, Lewis (1871) "*Alice through the Looking Glass.*" MacMillan, London. (1994, Puffin Books, London.)

{% One of three papers in an issue on contingent evaluation. Survey on contingent valuations and stated preferences, starting with history of Exxon Valdez. Concluding remarks (p. 40) argue in favor of contingent valuation because better than doing nothing. Carson is one of the main people working on contingent evaluation, and favoring it most. %}
Carson, Richard T. (2012) "Contingent Valuation: A Practical Alternative when Prices Aren't Available," *Journal of Economic Perspectives* 26, 27–42.

{% %}
Carson, Richard T., Robert C. Mitchell, W Michael Hanemann, Raimond J. Kopp, Stanley Presser, & Paul A. Ruud (1992) "*A Contingent Valuation Study of Lost Passive Use Values Resulting from the Exxon Valdez Oil Spill.*" Report to the

Attorney General of the State of Alaska, Natural Resource Damage Assessment Inc., La Jolla, California, November 10.

{% %}
Carter, Charles F. (1993) "George Shackle and Uncertainty: A Revolution still Awaited," Review *of Political Economy* 5, 127–137.

{% Cartesian dualism: res extensa versus res cogitans; there is the external world of things around us, and the internal world that we see when we close our eyes. %}
Cartesius

{% Presented at FUR-Oslo. End of §2 argues in favor of the lottery-equivalent method. On value of a statistical life through road safety: endnote 2 refers to surveys.
adaptive utility elicitation %}
Carthy, Trevor, Susan Chilton, Judith Covey, Lorraine Hopkins, Michael Jones-Lee, Graham Loomes, Nick Pidgeon, & Anne Spencer (1999) "On the Contingent Valuation of Safety and the Safety of Contingent Valuation: Part 2—The CV/SG "Chained" Approach," *Journal of Risk and Uncertainty* 17, 187–213.

{% Textbook on behavioral economics. %}
Cartwright, Edward (2018) "*Behavioral Economics*," (3rd ed.). Routledge, London.

{% **proper scoring rules**: Shows that proper scoring rules for an RDU maximizer elicit his weighting function if utility is linear or is corrected for, thus generalizing Kothiyal, Spinu, & Wakker (2011, J. Multi-Cr. DA) from binary outcomes to multiple outcomes and general proper scoring rules. It also extends Abdellaoui's (2000) elicitation method for decision weights, based on indifferences, to incentive compatible choices in proper scoring rule settings. %}
Carvalho, Arthur (2015) "Tailored Proper Scoring Rules Elicit Decision Weights," *Judgment and Decision Making* 10, 86–96.

{% Survey on **proper scoring rules**. Mostly, on the areas where there were publications and how many those publications were. %}

Carvalho, Arthur (2016) "An Overview of Applications of Proper Scoring Rules," *Decision Analysis* 13, 223–234.

{% **proper scoring rules** %}
Carvalho, Arthur, & Kate Larson (2010) "Sharing a Reward Based on Peer Evaluations." In *Proceedings of the 9th International Conference on Autonomous Agents and Multiagent Systems* (pp. 1455–1456).

{% **proper scoring rules** %}
Carvalho, Arthur & Kate Larson (2011) "A Truth Serum for Sharing Rewards." *In Proceedings of the 10th International Conference on Autonomous Agents and Multiagent Systems* (pp. 635–642).

{% **proper scoring rules** %}
Carvalho, Arthur, & Kate Larson (2012) "Sharing Rewards among Strangers Based on Peer Evaluations," *Decision Analysis* 9, 253–273.

{% **foundations of statistics** %}
Carver, Ronald P. (1978) "The Case against Statistical Significance Testing," *Harvard Educational Review* 48, 378–399.
Reprinted in Omar F. Hamouda & J.C. Robin Rowley (1997, eds.) "*Statistical Foundations for Econometrics.*" Edward Elgar, Cheltenham.

{% I think that the term behavioristic in this paper means trying to get away from teleological approach to social scienes (verstehen) and trying to use tehnique f natural sciences.
Author discusses behavioral influences in economics with many points debated as much still today. Writing style is phenomenal, as is often the case with papers written before the 1930s, and in itself is enough reason to read this paper. The paper points out that behaviorists look at different phenomena, where there is less rationality. Nice final sentence, about new groups of scholars as they behave throughout every discipline of science:

"But if they think that they have built up a complete system and can dispense with all that has gone before, they must be placed in the class with men in other fields, such as chemistry, physics,

medicine, or zöology, who, because of some new observations, hasten to announce that all previous work is of no account."

This sentence may also reflect the intergenerational battle where young people rather claim novelty than credit predecessors, and where older researchers complain that they have seen it all before. The author was 63 in 1918, after a long life with prominent positions. He was president of the American Economic Association in 1916. %}

Carver, Thomas N. (1918) "The Behavioristic Man," *Quarterly Journal of Economics* 33, 195–201.

{% **standard-sequence invariance**: don't really use invariance axiom, but do use standard sequences to get sequences of outcomes that are equally-spaced in utility units.

Use the Gul-independence version of bisymmetry on all two-outcome acts, to get CEU (Choquet expected utility) for all two-outcome acts (proved in Lemma A.5, p. 54) (could also have been done by means of a variation of standard-sequence invariance, or tradeoff consistency as I call it, the more so as they introduce this concept later). Then use standard sequences as in Krantz et al. (1971) to define outcome-mixtures of acts. Use that to adapt constant-act independence and uncertainty aversion of Schmeidler & Gilboa (1989) and of Chateauneuf (1991) to continuous instead of linear utility, in their constant-independence axiom 6. Thus, this paper is the first to axiomatize maxmin EU with continuous utility. A valuable result! %}

Casadesus-Masanell, Ramon, Peter Klibanoff, & Emre Ozdenoren (2000) "Maxmin Expected Utility over Savage Acts with a Set of priors," *Journal of Economic Theory* 92, 35–65.

{% Like their JET paper, but does uncertainty-aversion by mixing through B-event à la Gul-independence. Do need a generalized ethically-neutral event for it. Generalized in the sense that SEU should hold for binary acts depending on the event but, contrary to Ramsey (1931) and Faruk Gul (1992, JET), the event need not have probability 0.5 but can have any nondegenerate probability. %}

Casadesus-Masanell, Ramon, Peter Klibanoff, & Emre Ozdenoren (2000) "Maxmin Expected Utility through Statewise Combinations," *Economics Letters* 66, 49–54.

{% Subjects can choose to precommit or not. If the usual violation of stationarity is due to intertemporal preference, subjects will prefer to commit (under some assumptions), but if it is instead uncertainty about future outcomes (receiving new info in between) then they will not want to commit. They also get options to increase flexibility. This is tested. %}

Casari, Marco (2009) "Pre-Commitment and Flexibility in a Time Decision Experiment," *Journal of Risk and Uncertainty* 38, 117–141.

{% **DC = stationarity**: This paper carefully distinguishes the three concepts and tests them separately, in particular, employing the longitudinal data required for testing time consistency (also known as dynamic consistency). It is very similar to Halevy (2015), but the two studies were done independently and do not cite each other. The three preference conditions are nicely displayed in Figure 1, p. 128. This paper cites several predecessors in the intro and Section 1. It uses nice terms for the three conditions, being absence of static choice reversal (Halevy: stationarity), absence of dynamic choice reversal (Halevy: time consistency), and absence of calendar choice reversal (Halevy: time invariance). The end of Section 3 properly explains that stationarity and time consistency can be equated only if we assume time invariance, a result stated formally by Halevy.

Unfortunately, p. 122, 2nd sentence of §1, unlike rest of paper, does confuse stationarity and time consistency. (**DC = stationarity**:)

Prospects to choose from are losses: (1) Listen to 20 minutes of unpleasant noise now; (2) do it in 2 weeks; (3) do it in 4 weeks. Subjects are asked for their preferences now, and after two weeks are again asked for their preferences at that moment over the remaining prospects. The stimuli are really implemented (subjects get paid for it to make up). Subjects have to attend all three sessions anyhow, so, no savings of transaction costs in that sense. Under discounted utility, the preferences are determined solely by whether there is impatience (then postpose the unpleasant thing) or negative impatience (then do it as soon as possible). So, whether discounting is exponential or hyperbolic or otherwise plays no role.

losses from prior endowment mechanism: this they do. For money there is the usual problem that subjects may integrate the prior endowment with the loss and, hence, not perceive losses, which is why they do money only hypothetically, something that I agree with. For the outcomes here, listening to unpleasant music, such integration is less likely because it is not so easily integrated with the prior endowment OF MONEY (they are paid for the unpleasant listening). This makes this paper a convincing implementation of real incentives, similar to Abdellaoui & Kemel (2014).

Big problem of longitudinal choice is that the intertemporal conditions such as time consistency make a big ceteris paribus assumption: in the time between the decisions, nothing relevant should have changed, with no new info received for instance. In reality this is hard to get implemented. For instance, not now but in two weeks the subject knows if he has a headache then. There thus is, more or less endogenous, uncertainty about own preference. The authors nicely put this point very central using the term stochastic utility for it (a term elsewhere used mostly for the uncertainty of the analyst, rather than the subject, about preferences). Subjects have an option to pay some for flexibility, which means that in two weeks they get the chance to revise their time-0 choice. If they do pay, then probably there is stochastic utility. Buying flexibility is through an auction, which may encourage subjects to pay (too) much.

Calendar choice reversals (so, violations of time invariance) are usually due to factors other than time preference (which makes it understandable that many intertemporal choice studies assume it explicitly-- many do it implicitly). This paper finds it and has to draw the somewhat negative conclusion that other things are going on. As for me, I usually like to get extra things, whether good or bad, over with as fast as possible, simply because then I can forget and need not plan about them anymore. This, rather than negative impatience, can explain why most subjects wanted the noise listening to be done righ away, as people often want to take negative consumptions as soon as possible.

Another nice aspect of the paper is that the stimuli used, nonmonetary, avoid the problem of saving money or getting interest rates from the market, because the stimuli purely concern consumption that cannot be transferred in time. (**time preference, fungibility problem**) It is discussed, for instance, on p. 123 bottom.
%}

Casari, Marco & Davide Dragone (2015) "Choice Reversal without Temptation: A Dynamic Experiment on Time Preferences," *Journal of Risk and Uncertainty* 50, 119–140.
https://doi.org/10.1007/s11166-015-9211-x

{% Seem to write that body length is often taken as an index of quality of life. %}
Case, Anne, Angela Fertig, & Christina Paxson (2005) "The Lasting Impact of Childhood Health and Circumstance," *Journal of Health Economics* 24, 365–389.

{% **one-dimensional utility** %}
Caserta, Agata, Alfio Giarlotta, & Stephen Watson (2008) "Debreu-Like Properties of Utility Representations," *Journal of Mathematical Economics* 44, 1161–1079.

{% %}
Casey, Jeff T. (1991) "Reversal of the Preference Reversal Phenomenon," *Organizational Behavior and Human Decision Processes* 48, 224–251.

{% %}
Casey, Jeff T. (1995) "Predicting Buyer-Seller Pricing Disparities," *Management Science* 41, 979–999.

{% All hypothetical; **ambiguity seeking for losses**: they find this.
ambiguity seeking for unlikely: they find this for gains.
Vagueness in probabilities is compared to vagueness in outcomes.
reflection at individual level for ambiguity: they have within-individual data but do not report on this. %}
Casey, Jeff T. & John T. Scholz (1991) "Boundary Effects of Vague Risk Information on Taxpayer Decisions," *Organizational Behavior and Human Decision Processes* 50, 360–394.

{% Discussed positive versus negative feelings, and how they may not just be each others' opposites, and that negative feelings can get stronger than positive ones. I don't see a direct relevance of this text for prospect theory. %}

Cason, Hulsey (1930) "Pleasant and Unpleasant Feelings," *Psychological Review* 37, 227–240.

{% Subjects receive a card that is worth $2 (that they will later receive for it). Their subjective value of the card is then measured using BDM (Becker-DeGroot-Marschak). By any rationality standard, BDM should give the value $2. But this does not happen, and the measured value is usually higher. The authors argue that this is so fundamental that it should not be taken to reflect preference, but only that subjects do not understand the decision procedure. For the latter misunderstanding the authors use the strange term game form misconception. This term is strange because it suggests that the authors only think of game theory, and not of the many other preference situations. But so be it. This paper is part of a general direction of research by Plott, arguing that many biases found are too irrational to be taken as reflecting preference. The many biases such as framing are indeed of interest in decision making at low levels of rationality, as with marketing and consumers buying in supermarkets, which is what psychologists often study, but not if we are interested in higher-level preferences such as with financial traders, or if we have normative interests. In the same spirit as Plott, I usually study theories that satisfy transitivity, even if it is violated empirically.

Note that in the terminology of this paper, choice refers to descriptively revealed choice, and preference refers to some sort of true underling rational value system.

P. 1236 has a nice expression: "testing a scale by measuring a known weight."

P. 1237: "Many decision makers appear to confuse the second-price auction incentives of the BDM with a first-price auction."

The text is often verbose.

One problem I have with the experiment is that the amount, $2, is so small that subjects just for fun may deviate from the obvious. Another is that Fig. 2, p. 1244, may confuse subjects. Its left to says that subjects will sell the card, and have to name an offer price. This is suggesting to subjects that trading is to come. The bottom of the card explains the BDM payment system, but in no way makes clear that the suggestion of the upper left part will not happen at a later stage, and that this BDM payment is all there will be. The random prize has been determined beforehand, which is nice (the authors point out on p. 1244 that this excludes that the prize offered might depend on what the subjects do, which in fact excludes, in my terminology manipulation), and is tangible in the sense that it is below a covering card to be removed by the subjects, which is also nice. However, the randomization concerns the random prize only, and not the whole decision situation, which is a deviation from the Prince mechanism.

After a first round, subjects did it a second time. Subjects who in the first round had given a wrong value and lost because of it (the random prize between the stated and true value) did better in the second round, but not perfect.

The authors claim to exclude framing but their claim is incorrect. Subjects after a mistake in the first round usually improve their behavior in the 2nd round because of learning. The authors claim that framing would exclude such learning because the frame stays the same. This claim is incorrect. Nobody studying framing will think that learning cannot exist. %}

Cason, Timothy N. & Charles R. Plott (2014) "Misconceptions and Game Form Recognition: Challenges to Theories of Revealed Preference and Framing," *Journal of Political Economy* 122, 1235–1270.

{% risk aversion %}

Cass, David & Joseph E. Stiglitz (1972) "Risk Aversion and Wealth Effects on Portfolios with Many Assets," *Review of Economic Studies* 39, 331–354.

{% Seems to do de Finetti-like maths, playing much on **finite additivity**, in finance, incorporating correlatedness with market. %}

Cassese, Gianluca (2008) "Asset Pricing with No Exogenous Probability Measure," *Mathematical Finance* 18, 23–54.

{% %}

Castagnoli, Erio, Giacomo Cattelan, Fabio Maccheroni, Claudio Tebaldi, & Ruodu Wang (2022) "Star-Shaped Risk Measures," *Operations Research* 70, 2637–2654.

https://doi.org/10.1287/opre.2022.2303

{% Assume M and m are maximal and minimal outcome, utilities 1 and 0. Then the graph of the utility function can be interpreted as the distribution function of a "benchmark" random variable. The expected utility of a random variable then becomes the probability of the rv exceeding the benchmark rv (assuming stochastic independence). This is nice. Known properties such as concavity of utility are reformulated for the new interpretation. %}

Castagnoli, Erio & Marco LiCalzi (1996) "Expected Utility without Utility," *Theory and Decision* 41, 281–301.

{% This paper considers a remodeling of utility as the probability of attaining some goal. In f ≽ β, β is the goal to be attained and β can be a random variable, f is an act, and the preference f ≽ β means that the goal has been attained. Goals may be something like obtaining enough money to pay all bills each month, enough food to survive, producing offspring, etc.

Assume U on [a,b], normalized to U(a) = 0 and U(b) = 1. U(12) = 0.7 now means that the probability of achieving one's goal is 0.7 if the outcome received is 12. Taking as benchmark a random variable β with distribution function U, the probability of 12 achieving the goal of exceeding the benchmark β is indeed 0.7. This is the basic idea of the model. The benchmark β, and its probability distribution, are taken endogenously. This remodeling of utility is interesting. It was introduced in earlier papers by the authors, such as Castagnoli & LiCalzi (1996, *Theory and Decision*). For more references, see Abbas & Matheson (2009).

The contribution of the present paper is to establish the re-interpretation of utility in a number of commonly used preference representations, primarily additive decomposability of Debreu (1960) and several of its extensions. For infinite state spaces, a complication is that the reinterpretations of utilities as probabilities must be combined with traditional subjective probabilities established in the "overt" state space, and this requires the derivation of nonelementary measure-theory results on the extension of measures from non-algebras to algebras. The authors resolve this complication, with a useful summary of known results in Appendix A.

The material on measures on non-algebras in this paper is of special interest

for some recent developments in decision theory, by Zhang (1999, MSS) and Abdellaoui & Wakker (2005, *Theory and Decision*) %}

Castagnoli, Erio & Marco LiCalzi (2005) "Benchmarking Real-Valued Acts," *Games and Economic Behavior* 57, 236–253.

{% %}

Castagnoli, Erio & Fabio Maccheroni, & Massimo Marinacci (2000) "Restricting Independence to Convex Cones," *Journal of Mathematical Economics* 45, 535–558.

{% One frictionless asset in market with Choquet expectations as prices forces whole market to be frictionless. Because of this one frictionless asset, there can be no rank-dependent kinks in the weighting function. %}

Castagnoli, Erio, Fabio Maccheroni, & Massimo Marinacci (2004) "Choquet Insurance Pricing: A Caveat," *Mathematical Finance* 14, 481–485.

{% %}

Castaldo, Adriana, Fabio Maccheroni, & Massimo Marinacci (2004) "Random Sets and Their Distributions," *Sankhya (Series A)* 66, 409–427.

{% Consider reference dependence both regarding peers and aspiration. For poor people aspiration does most, and for rich people peers do. %}

Castilla, Carolina (2012) "Subjective Well-Being and Reference-Dependence: Insights from Mexico," *Journal of Economic Inequality* 10, 219–238.

{% %}

Castillo, Geoffrey (2020) "The Attraction Effect and Its Explanations," *Games and Economic Behavior* 119, 123–147.

{% %}

Castillo, Ismaël, Johannes Schmidt-Hieber, & Aad van der Vaart (2015) "Bayesian Linear Regression with Sparse Priors," *Annals of Statistics* 43, 1986–2018.

{% Present the Chew & Waller (1986) choices (tests of the common consequence effect as in Allais, but with common outcome passing from worst to middle to best rank) to 1275 8th grade children. Find that risk aversion correlates positively with fewer disciplinary referrals and completing high school. They find that EU as well fits choices as some nonEU theories, where for PT they unfortunately do not consider inverse S probability weighting but only convex and concave. As rationality index they take the minimum number of choices to change so as to satisfy EU (p. 71). They also assume an error theory (trembling hand) and emphasize its role much.

random incentive system between-subjects: do this. %}

Castillo, Marco, Jeffrey L. Jordan, & Ragan Petrie (2018) “Children’s Rationality, Risk Attitudes and Field Behavior,” *European Economic Review* 102, 62–81.

{% Didactical explanation of risk aversion under EU through concavity of utility and risk premium, with some real-world data on auto-insurance premiums loading and nice exercises with a practical touch. %}

Cather, David A. (2010) “A Gentle Introduction to Risk Aversion and Utility Theory,” *Risk Management and Insurance Review* 13, 127–145.

{% %}

Cattin, Philippe & Dick R. Wittink (1989) “Commercial Use of Conjoint Analysis: An Update,” *Journal of Marketing* 53, 91–96.

{% Try to replicate Dijksterhuis et al. (2004) but find the opposite. %}

Calvillo, Dustin P. & Alan Penaloza (2009) “Are Complex Decisions Better Left to the Unconscious? Further Failed Replications of the Deliberation-without-Attention Effect,” *Judgment and Decision Making* 4, 509–517.

{% Uses the statistically powerful adaptive technique to compare fit of several discount models. This is at the individual level. Unsurprisingly, quasi-hyperbolic and hyperbolic perform poorly because they cannot accommodate increasing impatience whereas this, even if minority, will still happens frequently and one can’t miss all those individuals. (P. 236: 25% of their subjects have increasing impatience.) Thus, the final sentence of the abstract writes: “specific properties of models, such as accommodating both increasing and decreasing impatience, that are mandatory to describe temporal discounting broadly."

P. 249: "Another significant result of the present study was the prevalence of increasing impatience (concavity of the discounting curve) in our sample. This phenomenon challenges the prevailing practice in the literature of modeling temporal discounting as exclusively non-increasing, while providing strong confirmation of the results from a small number of recent studies, notably by Attema et al. (2010); Abdellaoui et al. (2010); and Abdellaoui et al. (2013). Among the models we analyzed, only the Constant Sensitivity model can accommodate increasing impatience."

P. 250: "We believe the success of the Constant Sensitivity model demonstrates that increasing impatience and the extended present are likely to be relatively common behavioral variants, which reinforces the value of utilizing models that accommodate this behavior. The success of the neuroscience-inspired Double Exponential model … We anticipate that analysis of the unique characteristics of the Constant Sensitivity and Double Exponential models may yield important results in future studies. In addition, if increasing impatience, the extended present, and mixture are all important for describing discounting behavior, we propose that a mixture of Constant Sensitivity and Double Exponential would be a logical extension."

P. 250: "Several promising models have been developed in recent years that merit inclusion in future model comparison studies (Bleichrodt et al. 2009; Benhabib et al. 2010; Scholten and Read 2006, 2010)." It is useful to note here that the model of Bleichrodt et al. (2009) agrees with and extends Evert & Prelec's constant sensitivity model in the same way as negative powers extend positive powers for CRRA utility. Bleichrodt, Kothiyal, Prelec, & Wakker (2013) renamed the family "unit invariance." Bleichrodt et al. (2009) predicted, what this paper confirms, about their families: "They serve to flexibly fit various patterns of intertemporal choice better than hyperbolic and quasi-hyperbolic discounting can do, by allowing any degree of increasing or decreasing impatience. Thus, the CADI and CRDI [now called unit invariance] discount families are the first that can be used to fit data at the individual level."

P. 250: "In addition, it should be noted that all of the models tested assume linear utility, an assumption which has some support at the aggregate level, but could potentially introduce distortions if there is significant heterogeneity at the individual level (Abdellaoui et al. 2013). However, over the range of reward magnitudes involved in our experiment, any effect of nonlinear utility would likely be small." (**linear utility for small stakes**) %}

Cavagnaro, Daniel R., Gabriel J. Aranovich, Samuel M. McClure, Mark A. Pitt, & Jay I. Myung (2016) "On the Functional Form of Temporal Discounting: An Optimized Adaptive Test," *Journal of Risk and Uncertainty* 52, 233–254.

{% **SPT instead of OPT**: Really uses the right formula for 1979 prospect theory. This is exceptional.

A theoretical method for optimally designing (individual-dependent) an adaptive experiment to discriminate between decision theories. Illustrated in simulated data to discriminate EU, weighted utility, OPT, and PT (they write CPT). Big drawback is that different subjects face different stimuli. If all subjects get the same stimuli, one can see for each stimulus what is happening. This is not possible here. %}

Cavagnaro, Daniel R., Richard Gonzalez, Jay I. Myung, & Mark A. Pitt (2013) “Optimal Decision Stimuli for Risky Choice Experiments: An Adaptive Approach,” *Management Science* 59, 358–375. http://dx.doi.org/10.1287/mnsc.1120.1558

{% N = 19 subjects. Adaptive method for fitting probability weighting in probability triangle, with outcomes $25, $350, and $1000. Choices were hypothetical. At each question, the computer calculates what is the optimal next question to ask. The paper finds that two-parameter families work way better than one-parameter, especially because there are very optimistic subjects with high elevation which one-parameter families cannot capture (p. 281 para –2). The Prelec 2-parameter and linear-log-odds (Goldstein & Einhorn 1987) are about equally good, although Prelec 2-parameter is mostly better for the subjects with extremely high elevation. P. 281 2nd para: Prelec 2-parameter does not do very well primarily because universal subproportionality does not hold. %}

Cavagnaro, Daniel R., Mark A. Pitt, Richard Gonzalez, & Jay I. Myung (2013) “Discriminating among Probability Weighting Functions Using Adaptive Design Optimization,” *Journal of Risk and Uncertainty* 47, 255–289.

{% **questionnaire versus choice utility**: Present questionnaires to measure ambiguity attitudes, such as about aversion to novelty, complexity. Hypothetical Ellsberg choices are also included here. Relate them to incentivized Ellsberg choices to validate them. (**real incentives/hypothetical choice**). It is always hard to judge whether found correlations, if statistically significant, have much or little economic significance.

I was glad to see p. 75 top discuss a-insensitivity as an important component, because I work much on it myself. For simplicity reasons, the authors do not include it in their measurement.

They measure degree of ambiguity aversion by using sort of strength of preference, and also by matching probabilities. %}

Cavatorta, Elisa & David Schröder (2019) "Measuring Ambiguity Preferences: A New Ambiguity Preference Survey Module," *Journal of Risk and Uncertainty* 58, 71–100.

{% **information aversion**: give a model of anticipated regret for it, and find it confirmed in an experiment. %}

Cavlovic, Therese, Brandon C. Koford, & Lucas Rentschler (2024) "Information avoidance: An Experimental Test of Anticipated Regret," *Journal of Risk and Uncertainty* 69, :323–348. https://doi.org/10.1007/s11166-024-09447-1

{% %}

Cebul, Randall D. (1984) "A Look at the Chief Complaints Revisited: Current Obstacles and Opportunities for Decision Analysis," *Medical Decision Making* 4, 271–283.

{% **value of information**: shows how the Blackwell theorem, of more informative being equivalent to more increasing SEU, can be extended to maxmin EU. %}

Çelen, Bogaçhan (2012) "Informativeness of Experiments for Meu," *Journal of Mathematical Economics* 48, 404–406.

{% The authors propose a new risk model that assigns to $X = (p_1{:}x_1,\ldots,p_n{:}x_n)$ with expected value EV the value $EV + 2[\lambda E(X-EV)^+ + (1-\lambda)E(X-EV)^-]$. Here Y^- is defined as ≤ 0, as is often done in decision theory (especially if Y concerns nonquantitative losses for which $-Y$ is not defined) but not in mathematical probability theory or measure theory, where Y^- is usually taken ≥ 0. $\lambda = ½$ gives back EV. A pessimist will have $\lambda < ½$. I note that the model could have been rewritten as $EV + (2\lambda-1)E(|X\text{-}EV|)$, showing it's an analog to mean-variance. A behavioral foundation is in Blavatskyy (2010 Management Science), something the authors are not aware of.

They further generalize by replacing EV by $(g(p_1)x_1 + \cdots + g(p_n)x_n)/(g(p_1) + \cdots + g(p_n))$. Wakker (2010 Exercise 6.7.1) showed that this violates stochastic dominance whenever g is nonlinear. So, I would have preferred that the authors had cost-effectiveness done using rank-dependent probability weighting. The authors show how the model can accommodate all kinds of phenomena. They do not provide a behavioral foundation or empirical test.

Rieger (2017) comments, pointing out for instance that the model is close to Guls' (1992) disappointment aversion model, treating EV the way Gul treats certainty equivalents. %}

Cenci, Marisa, Massimiliano Corradini, Alberto Feduzi, Andrea Ghenoa (2015) "Half-Full or Half-Empty? A Model of Decision Making under Risk," *Journal of Mathematical Psychology* 68-69, 1–6.

{% For decision under uncertainty, the authors take stochastic independence as a primitive. It means that being informed about the true element of a partition does not impact preferences conditional on another partition. It follows up on Pfanzagl (1968; §12.5) for two-by-two partitions and by Mongin (2020). Those mostly focused in EU, showing that stochastic independence quickly implies EU. This paper considers relaxations for ambiguity theories, and their relations to dynamic consistency and consequentialism. %}

Ceron, Federica & Vassili Vergopoulos (2021) "On Stochastic Independence under Ambiguity," *Economic Theory* 71, 925–960.

{% r**eal incentives/hypothetical choice, for time preferences**: seems to be on it %}

Correia, Christopher J. & Carrie Little (2006) "Use of a Multiple-Choice Procedure with College Student Drinkers," *Psychology of Addictive Behaviors* 20, 445–452. https://doi.org/10.1037/0893-164X.20.4.445

{% Generalizes Gilboa, Maccheroni, Marinacci, & Schmeidler (2010). The objectively rational preference is still Bewley (1986, 2002)-type. The subjective one generalizes the maxmin-EU relation of Gilboa et al. (2010) to the general uncertainty averse (quasi-convex) preferences of Cerreia-Vioglio et al. (2011). So, the paper assumes the Anscombe-Aumann framework. It gives axioms implying that the sets of priors and utility functions of the objective and subjective preferences are the same. %}

Cerreia-Vioglio, Simone (2016) "Objective Rationality and Uncertainty Averse Preferences," *Theoretical Economics* 11, 523–545.

{% Non-Bayesian social learning in networks with heuristics-biases in non-linear opinion aggregation. (DeGroot linear updating: everyone's opinion today is a combination of neighbor's opinions yesterday.) Not yet much studied because of analytical difficulties, but these authors provide axiomatized models, considering wisdom of the crowd. The abtract ends with the nice sentence: Our framework bridges several models and phenomena in the non-Bayesian social learning literature, thereby providing a unifying approach to the field. %}

Cerreia-Vioglio, Simone, Roberto Corrao, & Giacomo Lanzani (2024) "Dynamic Opinion Aggregation: Long-Run Stability and Disagreement," *Review of Economic Studies* 91, 1406–1447.
https://doi.org/10.1093/restud/rdad072

{% **biseparable utility violated**;
The cautious expected utility model takes not one utility function, but a set $\mathcal{W}$ of such. Each lottery is evaluated by the, for that lottery, most risk averse utility function in $\mathcal{W}$ in expected utility. That is, the certainty equivalent CE of lottery x is $V(x) = \inf_{v \in \mathcal{W}} CE_v(x)$, where $CE_v(x)$ is the CE of x under EU with utility function v. It is dual to maxmin EU for uncertainty, with linearity in probability rather than in utility (maxmin EU has linear utility in the Anscombe-Aumann sense). Cautious EU can be risk averse if all functions in $\mathcal{W}$ are concave, and risk seeking if all those functions are convex. One can increase risk aversion by applying a concave transformation to all functions in $\mathcal{W}$, and increase risk seeking by applying a convex transformation. Thus, the model itself does not very directly speak to risk aversion. But what it adds to EU is entirely in the direction of risk aversion. For comparison, RDU can add risk aversion to EU by adding a convex probability weighting function to EU, but it has the flexibility of

adding other attitudes through other weighting functions.

One can readily formulate α maxmin generalizations of cautious EU. The model shares with Chew's (1983) weighted utility (and with the smooth ambiguity model although that is for ambiguity), the spirit of getting the action/variance-in-data from the outcomes, and will not work well to accommodate the fourfold pattern of risk attitude with risk aversion depending on the probabilities considered. (**event/outcome driven ambiguity model: outcome driven**, though here it is risk and not uncertainty). For instance, if we face an outcome interval where the utility functions in $\mathcal{W}$ differ much from each other, then the nonEU part of the formula will add much risk aversion. If we then go to another outcome interval where the utility functions are all equal, then there the formula satisfies EU. The outcomes we deal with, and not the events/probabilities, determine risk attitude. This is different for RDU or prospect theory, where the relevant probabilities determine how we deviate from EU.

The cautious model will not be very tractable for calculations, just as with maxmin EU, because for the very evaluation of a single lottery already a minimization problem, minimizing over a set of utility functions, must be carried out.

Whereas for most lotteries the model adds a layer of risk aversion, it does not do so for riskless lotteries. These get a kind of privileged treatment. Thus, a necessary axiom is negative certainty independence (NCI):

$$x \sim \alpha \;\Rightarrow\; \lambda x + (1-\lambda)c \succcurlyeq \lambda\alpha + (1-\lambda)c$$

for all lotteries x,c, sure outcomes α, and $0 < \lambda < 1$. A way to see this: If, in $\lambda x + (1-\lambda)c$, I could for x take the most aversive utility function for x, and for c the most aversive utility function for c, then I would have indifference. In reality I cannot minimize for both x and c at the same time. Putting NCI differently, and assuming RCLA, replacing any sublottery in a multistage lottery by its certainty equivalent always worsens the case. Put yet differently, and very nicely, any conditional CE (recommended to be used by McCord & de Neufville 1986) exceeds the unconditional CE. Thus, the model can be taken as a nice new insight into McCord & deNeufville: It characterizes when M&d ALWAYS find lower risk aversion. (This point gets a displayed elaboration below.) In combination with the RDU model the condition is very restrictive because it is imposed irrespective of the ranking of the outcomes and, indeed, it cannot be reconciled with RDU (unless EU). Loosely speaking, as soon as there is rank dependence, we can always arrange the conditional CE to come out relatively favorable but also relatively unfavorable and the latter violates NCI.

NCI implies convexity (also called quasi-convexity or quasi-concavity; it means:mixing with something good is always good) w.r.t. probabilistic mixing: if $x \sim y \sim \alpha$, then $\lambda x + (1-\lambda)y \succcurlyeq \lambda x + (1-\lambda)\alpha \succcurlyeq \lambda\alpha + (1-\lambda)\alpha \sim x$. That is, in $\lambda x + (1-l)y$ we twice substitute conditional CEs (p.697 footnote 8), each time worsening the lottery. So, there is a general preference for probabilistic mixing.

Theorem 1 p. 698 shows that under usual monotonicity/continuity/weak ordering, the condition (NCI) is not only necessary, but also sufficient, for cautious EU. Here is again the duality with maxmin EU, with convexity meaning that we have a minimum over dominating linear functions but a certainty independence needed extra because we have ordinal inputs. The negative certainty independence axiom of the authors nicely combines these two conditions. $\mathcal{W}$'s closed convex hull is unique up to redundant utilities (giving too high CEs to ever be minimum, as resulting for instance from any convex transform; they get some sort of Kannai-type minimally concave utilities); see §2.5 p. 701. It is a very, incredibly, appealing mathematical result connecting simple concepts in a way never noticed by anyone before. I elaborate on this point:

======================================

BEGINNING OF ELABORATION OF LAST SENTENCE

McCord & deNeufville (1986) had a nice idea. About utility measurement for EU under risk. Let M be the best outcome and m the worst. Normalize U(M) = 1, U(m) = 0. Then

x ~(p:M, 1-p:m)

implies U(x) = p, and was the common method. But M&d argued that such measurements are too much distorted by the certainty effect, and give too much risk aversion. They recommended mixing in another lottery C with weight (probability) 1-a, and use indifferences,

ax + (1-a)C ~ a(p:M, 1-p:m) + (1-a)C

to avoid the certainty effect and its excessive risk aversion. To me, this idea is about the same as negative certainty independence (NCI), the axiom that Dillenberger was the first to write. Nice idea.

Now for another nice idea: of multiple utility models.

Surprisingly, this paper shows that the two above nice ideas, that I have known longtime, are in fact the same. One axiomatizes the other. Nice surprise!

END OF ELABORATION OF LAST SENTENCE

==

I disagree with many empirical claims in the paper though.

(1) Pp. 694-695 mentions Quiggin's RDU and betweenness as the most popular alternatives to EU, overlooking the Nobel-awarded prospect theory whose 1979 introduction is the second-most cited paper ever in an economic journal. (**Prospect theory not cited**; although these authors are not experimental economists.) P. 712 writes that the NCI model, like betweenness and RDU, is not designed to distinguish between gains and losses. Here it is strange again that PT is not mentioned. Kahneman & Tversky's papers are only cited for particular empirical facts and in the definition of RDU it is just mentioned as comprising. Cautious utility can capture sign-dependence well in one way: It can let the set of utility functions for losses be very different than for gains. It cannot capture sign-dependence in the sense that its deviation from EU is always to take the minimal EU, both for gains and losses. A sign-dependent generalization could be to take the max for the loss-part, or do α maxmin with α different for losses than for gains.

(2) P. 695 claims "Third, our model is consistent with the main stylized facts of preferences under risk as surveyed in Camerer (1995) and Starmer (2000)." As most theoretically-oriented economists, the authors are not well aware of the common empirical finding of the fourfold pattern. They show no awareness of risk seeking for small-probability gains. They do explicitly point out that they do not seek to accommodate sign dependence (p. 712), and they do point out that they can accommodate risk seeking for losses (by having all utility functions in $\mathcal{W}$ convex for losses), but what their NCI adds for losses goes in a risk averse and I think wrong direction for losses. Whereas RDU adds layers to EU that can be risk averse or risk seeking and, importantly, can do so depending on probabilities considered, cautious EU only adds a layer of risk aversion to EU that is outcome-

oriented and not probability-oriented.

(2a) Problems for losses: People have a special aversion to sure losses, contra to NCI. The common finding is

$$-100_{½}0 \succ -50 \text{ (risk seeking)}$$

but, mixing it fifty-fifty with a sure 0, I predict

$$-100_{¼}0 \prec -50_{½}0$$

violating NCI.

(2b) Problems for low-likelihood gains: People will dislike certain outcomes if they compete with small-probability-high-gains (leading to inverse S under RDU). Thus, the common finding is

$$10^6{}_{10^{-6}}0 \succ 1 \text{ (risk seeking)}$$

but, mixing it fifty -fifty with a sure 10^6, I predict

$$10^6{}_{½+10^{-6}/2}0 \prec 10^6{}_{½}1$$

violating NCI.

NCI implies universal convexity of preference, but I expect it to be violated in many instances. Wakker (2010 Theorem 7.4.1) shows that under RDU (= PT for gains), convexity of preference ($p \sim q \Rightarrow \lambda p + (1-\lambda)q \succcurlyeq q$; a condition called quasi-concavity by Wakker) is equivalent to concavity of probability weighting. However, most empirical evidence suggests the opposite for gains: Convex probability weighting (under inverse S usually for moderate and high outcomes, although weak in the interior). This gives counterevidence to convexity of preference (modulated by violations of RDU). The authors mention this difference between their model and RDU in footnote 37, p. 713. I expect that neither convexity nor concavity of preference holds very generally (for gains or losses), depending on configurations of lotteries as with inverse S.

P. 713 suggests that betweenness is more restrictive (= parsimonious) than the NCI model, and that the latter is permissive (= less parsimonious), but then suggests that RDU is even more permissive (although staying vague by saying that "there are instances"). I see this differently. The set $\mathcal{W}$ of utility functions (also when modulo closed convex hull, redundant utilities, and affine transformations) is of higher dimensionality than RDU's (1 utility function + 1 weighting function). The NCI axiom, only imposing some inequalities and not symmetric in left- and right-hand side of preference, is more permissive than comonotonic independence or betweenness. The latter are symmetric in the left- and right-hand side of preference, amounting to invariant preferences and to preserving indifferences. This is the same as convexity being more permissive than linearity.

Related to the above point of cautious utility being permissive, elicitiation will be problematic. The elicitation discussed at the end of section 2 (p 702 bottom) confuses empirical observation with identifiability. It only shows how observations exclude some utility functions, and writes that if we know the whole preference relation than the set $\mathcal{W}$ must be identifiable (up to its degree of uniqueness of course). Such observations hold for every model satisfying the minimal requirement of identifiability, and give no clue on how much a finite number of observations narrows down the set $\mathcal{W}$. As always, one can do parametric fitting. But then one should not only restrict the utility functions considered, but also the *set of* utility functions considered. If this is done to a high degree, then cautious EU can become sufficiently parsimonious to be empirically tractable for data fitting and predicting. But it will take creativity to find empirically satisfactory parametric subfamilies.

P. 707 ℓ. −5 claims that RDU has a continuous (onto) weighting function, but this is not common because there is much interest in discontinuities at p = 0 and p = 1.

EVALUATION:

Cautious EU and its axiomatization are mathematically highly appealing and esthetic. In full generality the model is way more general (less parsimonous) than other models and, hence, less tractable. But more restricted (parsimonous) subfamilies can be developed and, in particular, the complexity of solving a minimization problem for every lottery to be evaluated can be made tractable this way.

Empirical problems are that, whereas RDU imposes an extra layer on EU that can give both extra risk aversion or extra risk seeking and, in particular, can have that depend on probabilities which is empirically and psychologically desirable, this model only imposes an extra risk aversion layer (cure: could easily be modified by α maxmin generalizations) that is outcome-oriented (no cure conceivable for this). %}

Cerreia-Vioglio, Simone, David Dillenberger, & Pietro Ortoleva (2015) “Cautious Expected Utility and the Certainty Effect,” *Econometrica* 83, 693–728.
https://doi.org/10.3982/ECTA11733

{% First I present a misleading reasoning that mispresents this paper, and then the correct reasoning. Imagine an implicit equation F(x) = G(x). I define H(x) = F(x) – G(x). Then x = $H^{-1}(0)$. Now didn’t I turn an implicit equation into an explicit one, using function inversion? Isn’t this trivially always possible if one can use function inversion? Of course, the above rewriting is trivial and not of any use. (As an aside, my little Pascal program, written 35 years ago, to obtain function inverses has helped me throughout my life to solve any equation I want, turning it into the most useful thing I ever did. I still use it today (2021) on my 20 year old computer - it doesn’t run on modern computers.)

A problem of Gul’s disappointment aversion model and, more generally, betweenness models, is that they only give implicit equations for functional values and certainty equivalents. This paper gives explicit rewritings of disappointment aversion and many other betweenness preferences using function inverses, but in particular useful manners that give good insights and facilitate computations (though they can remain difficult). They need the NCI preference condition for it, leading to infimum operations. The term explicit representation is to be taken in this sense. %}

Cerreia-Vioglio, Simone, David Dillenberger, & Pietro Ortoleva (2020) “An Explicit Representation of Disappointment Aversion and Other Betweenness Preferences,” *Theoretical Economics* 15, 1509–1546.

{% This paper introduces cautious utility, a new theory for decision under risk, or, a generalization of their 2015 theory. It generalizes the 2015 theory to multiattribute outcomes, and adds a central role to a reference point. The authors assume that the first attribute concerns money. The theory assumes a set of utility functions and then, for DUR, assigns the minimum expected utility to each lottery. This adds extra risk aversion (worse certainty equivalents), beyond expected utility. The pessimistic minimum taking already brings extra pessimism and loss aversion when choosing between riskless outcomes, cautiousness, which can better be interpreted as endowment effect, already bringing WTP-WTA discrepancy. More, extra, cautiousness, risk and loss aversion, can come when risk comes in. The model can thus deliver a distinction between a riskless endowment effect and risky loss aversion. Cautiousness is one factor jointly inducing extra endowment effect, extra loss aversion, and extra certainty effect (and other deviations from EU for risk). I interpret it as follows. Cautiousness is a new thing. One can distinguish some subcomponents of it, where one brings an *extra* CE effect, another brings *extra* endowment effect, and one brings *extra* loss aversion. Cautiousness gives a new way to add to those phenomena. Thus, it gives a new way to add to risk aversion. But it absolutely does not fully capture those phenomena, let be unify them.

The authors interpret cautious riskless preferences as uncertainty about what the proper tradeoffs are, processed in a very pessimistic way. For a mug and trading off the first attribute of money against the second attribute of mug, because of pessimism in WTP you take the lowest value of the mug, and in WTA the highest, giving WTA > WTP.

For multi-attribute outcomes, one can first specify a utility function that captures preference over all (riskless) outcomes, and from there on apply any risk model such as prospect theory. This is the more common approach and the one I am most familiar with. An alternative route is to do a sort of component-wise risk modeling. This is what cautious utility does, and it brings more novelty. Especially because it gives a new way to capture the endowment effect.

EXAMPLE [where cautious utility would not bring real novelty]. Under prospect theory, loss aversion is commonly modeled through an asymmetric utility function, steeper for losses than for gains with a kink at 0. Cautious utility theory can readily incorporate this by letting all functions in the set of utility functions be asymmetric and have the same kink at 0. □

Cautious utility has a way to capture extra loss aversion differently than in the example, and really new. That is, to bring in a new component to loss aversion. To maximally clearly bring out this novelty, the paper focuses on symmetric utility functions, so that prospect theory's way of modeling loss aversion is entirely ruled out.

P. 2072: "The most popular model to study our behaviors of interest is Cumulative Prospect Theory (Tversky and Kahneman (1992))" (**Prospect theory/Rank-Dependent Utility most popular for risk**).

The authors interpret cautious utility as a new theory distinct from prospect theory, capturing uncertainty about tradeoffs between attributes. Here is a way to bring back prospect theory: In cautious theory, there are two stages of uncertainty, one about the tradeoffs between attributes, and the other about the probabilistic risk through the lotteries. The uncertainty about tradeoffs between attributes is treated in a totally pessimistic manner, giving all weight to the worst case. I expect that modeling that stage of uncertainty using PT with loss aversion (yes: loss aversion!) will work better than the cautious model for what they call endowment effect. %}

Cerreia-Vioglio, Simone, David Dillenberger, & Pietro Ortoleva (2024) "Caution and Reference Effects," *Econometrica* 92, 2069–2103. https://doi.org/10.3982/ECTA21748

{% **quasi-concave so deliberate randomization**; This paper considers an interval [w,b] of monetary prizes and the set of lotteries over them (need not be simple). Subjects choose from finite sets A of lotteries, but they can randomize and thus choose from all probability distributions over A. It means that in fact they choose two-stage lotteries. Reduction of compound lotteries is assumed, meaning that in fact subjects choose from co(A), the convex hull of A. They assume single choices, so, if there is a set of indifferent best ones then one is selected one way or the other.

Theorem 1 gives two equivalent ways of describing the above model.

Randomization between indifferent optimal elements need not be "real" randomization, but just arbitrary selection. There is real randomization, roughly, if $\lambda p + (1-\lambda)q \succ r$ even though $p \prec r$ and $q \prec r$ (the paper does it a bit differently by bringing in stochastic dominance). Theorem 2 (p. 2432) shows that regularity is violated if and only if real randomization occurs, which holds if and only if there is some strict convexity of preference somewhere. Proposition 1 shows, under continuity, that this is equivalent to a violation of strict stochastic dominance. The intuition of Theorem 2 is explained on p. 2427: "Possibly the most well-known property of stochastic choice, widely used in the literature, is Regularity (also called Monotonicity): it posits that the probability of choosing p from a set cannot decrease if we remove elements from it. It is often seen as the stochastic equivalent of independence of irrelevant alternatives (IIA), and it is satisfied by many models in the literature, most prominently, models of Random Utility, albeit it is well known that it is often empirically violated. We show that our model of deliberate stochastic choice will necessarily lead to some violations of Regularity (unless the stochastic choice is degenerate, i.e., there is no stochasticity). Intuitively, our agent may choose from a set A two options that, together, allow her to "hedge." But this holds only if they are both chosen: they are complementary to each other. If either option is removed from A, the possibility of hedging may disappear and the agent no longer has incentive to pick the remaining one, which in turn generates a violation of Regularity. The key observation is that the agent considers all the elements chosen as a whole, for the general hedging they provide together. By contrast, Regularity is based on the assumption that the appeal of each option is independent from the other options present in the menu or in the choice."

Luce (1959) also had a probabilistic generalization of independence of irrelevant alternatives, but if I remember right it was more restrictive than regularity, imposing conditional probabilities (I am not sure).

Details:

- P. 2425 Footnote 2 writes that Tversky (1969) was the first to write on stochastic choice. But there is much preceding literature. For instance, in Luce, R. Duncan & Patrick Suppes (1965) "Preference, Utility, and Subjective Probability." In R. Duncan Luce, Robert R. Bush, & Eugene Galanter (eds.) *Handbook of Mathematical Psychology*, Vol. III, 249–410, Wiley, New York, Chs. 19.5-19.8, pp. 331-402 are on it.

- P. 2426 writes: "Crucially, convexity is a property shared by many existing models of decision making under risk, and it captures ambiguity aversion in the context of decision making under uncertainty." I view this differently. Convexity is an absolute property, reflecting pessimism. Ambiguity aversion is a relative property, reflecting more pessimism for ambiguity than for risk (Wakker 2010 §11.6).

P. 2429 Axiom 1: Unfortunately, the authors use the term "rational" for a mathematical property, amounting here to stochastic dominance. This is OK in math where one has much liberty to use everyday language to define abstract concepts and, for instance, is often done in theoretical game theory, but is unfortunate in economics where we want to use the word in its natural-language meaning. %}

Cerreia-Vioglio, Simone, David Dillenberger, Pietro Ortoleva, & Gil Riella (2019) "Deliberately Stochastic," *American Economic Review* 109, 2425–2445.

{% %}

Cerreia-Vioglio, Simone, Alfio Giarlotta, Salvatore Greco, Fabio Maccheroni, & Massimo Marinacci (2020) "Rational Preference and Rationalizable Choice," *Economic Theory* 69, 61–105.

{% **ambiguity attitude taken to be rational**: Rational means transitive and monotonic. Then there are in principle mathematical ways to relate preferences to sets of priors. They axiomatize the basic Anscombe-Aumann framework with representation I(u ∘ f) where f is an act, u a vNM utility function, and I a general functional, which will be by EU for risk plus monotonicity/backward induction. %}

Cerreia-Vioglio, Simone, Paolo Ghirardato, Fabio Maccheroni, Massimo Marinacci & Marciano Siniscalchi (2011) "Rational Preferences under Ambiguity," *Economic Theory* 48, 341–375.

{% Probabilistic choice. Study many relations between the weak axiom of revealed preference and its stochastic generalization in Luce (1959). They, thus, come to justify the term "rationality" in their title. %}

Cerreia-Vioglio, Simone, Per Olov Lindberg, Fabio Maccheroni, & Massimo Marinacci Aldo Rustichini (2021) "A Canon of Probabilistic Rationality," *Journal of Economic Theory* 196, 105289.

{% This paper illustrates how many representation theorems of Choquet integrals can be applied in finance.

In finance, we consider a finite state space $S = \{s_1,\ldots,s_n)$, and financial assets x are maps from S to $\mathbb{R}$. So, what Savage calls an act. V(x) is the market price of x, at which you can buy or sell x. Whereas economists usually take a preference relation $\succcurlyeq$ over acts as primitive, finance takes V as primitive, as does the risk measure field (and, for instance, production and price theory in economics also do). I assume, for simplicity, that all payments are done at one fixed time, say tomorrow. A call option at strike price k ($k \in \mathbb{R}$) is the asset $x \vee k$, giving k whenever $x(s) \le k$ and x(s) whenever $x(s) \ge k$. A put option at strike price k ($k \in \mathbb{R}$) is the asset $-(x \wedge k)$, giving $-k$ whenever $x(s) \ge k$ and $-x(s)$ whenever $x(s) \le k$. It readily follows that

$$x \vee k - (-(x \wedge k)) - k = x.$$

The put-call parity requires that the market price V, to avoid arbitrage, should respect this equality and satisfy

$$V(x \vee k) - V((-(x \wedge k))) - V(k) = V(x) \quad (*)$$

where it is understood that $V(k) = k$.

Avoiding arbitrage everywhere is equivalent to as-if risk neutral pricing, i.e., maximizing subjective expected value. This is the “fundamental theorem of finance.” It was essentially first proved by de Finetti (1931), in individual choice theory, not very well known in finance. In economic terms, it implies linear utility.

This paper considers the condition that arbitrage is not avoided everywhere, because of frictions, but that the put-call parity (*) is still satisfied. It shows that this holds, under regularity conditions, if and only if the market price is a Choquet integral. In economic terms, it still implies linear utility. It uses a theorem by Greco (1982) that provides most of the maths needed for this. As these annotations indicate at Greco’s paper, Anger (1977) preceded it with a more general theorem. As Anger (1977) is more general than Schmeidler (1986) and also preceded it. Hence, the axiomatization in this paper essentially follows from Anger. Wakker (1989 Fuzzy Sets and Systems) used Anger’s condition in a preference axiomatization and used the term maxmin relatedness for it. %}

Cerreia-Vioglio, Simone, Fabio Maccheroni, & Massimo Marinacci (2015) “Put-Call Parity and Market Frictions,” *Journal of Economic Theory* 157, 730–762. https://doi.org/10.1016/j.jet.2014.12.011

{% This paper revives the local utility analysis by Machina (1982), connecting it with the valuable generalization of vNM EU by allowing for incompleteness by: Baucells & Shapley (2008) and Dubra, Maccheroni, & Ok (2004) (two papers written independently and simultaneously, using sets of vNM utilities and unanimous agreement). It further shows that prospect theory with risk aversion and prudence must reduce to EU. I conjecture that pospect theory can be reconciled with risk aversion and prudence if prudence is taken in a comonotonic cosigned way, and not in the traditional way as done here. The authors define prudence in terms of the 3rd derivative of utility in EU, but this is just in that definition of EU and does not refer to the utility actually used, so, it does not require the utility actually used to be differentiable. %}

Cerreia-Vioglio, Simone, Fabio Maccheroni, & Massimo Marinacci (2017) "Stochastic Dominance Analysis without the Independence Axiom," *Management Science*, 62, 1097–1109. https://doi.org/10.1287/mnsc.2015.2388

{% Consider constant absolute and relative ambiguity aversion w.r.t. *wealth* changes, as opposed to utility changes as studied by Grant & Polak (2013) and others. %}

Cerreia-Vioglio, Simone, Fabio Maccheroni, & Massimo Marinacci (2022) "Ambiguity Aversion and Wealth Effects," *Journal of Economic Theory* 199, 104898.

{% Impose preference conditions that are variations of multiple-prior characterization, for generalized coherent risk measures. Using techniques of linear decision theory in finance interpretations, for coherent risk measures à la Artzner et al. Showing that sometimes convexity better be weakened to quasi-convexity to relate to diversification. %}

Cerreia-Vioglio, Simone, Fabio Maccheroni, Massimo Marinacci, & Luigi Montrucchio (2011) "Risk Measures: Rationality and Diversification," *Mathematical Finance* 21, 743–774.

{% This paper assumes the Anscombe-Aumann framework, with linearity of the vNM utility function. Then it gives a general representation for quasi-convex functionals; i.e., it characterizes quasi-convexity of preference, interpreted as uncertainty aversion. For the special case of RDU for uncertainty (also known as CEU), because utility is linear, their quasi-convexity will be equivalent to convexity of the weighting function.

To explain the model, I first discuss concave functionals. (It would be more convenient if the weakening of concavity, called quasi-convexity, were called quasi-concavity here, but I stick with the terminological conventions of this field.)

Assume the usual Anscombe-Aumann framework with n states of nature and prize set X. Take u(x), the vNM utility of prize x, as unit of outcome. Take a functional V that now is nothing but a function from $u(X)^n$ to $\mathbb{R}$. It is well known that V is concave if and only if it is the minimum of the dominating linear functions. In the presence of monotonicity and normalization, we can take those dominating linear functions as EV functionals determined by the subjective probabilities assigned to states. Because EV in u units is usually called expected utility in the Anscombe-Aumann framework, I will do so too henceforth. So, a functional then is concave if and only if it is a maxmin EU model, which is nice to know.

Gilboa & Schmeidler (1989) characterized maxmin EU by imposing concavity of preference (uncertainty aversion), which amounts to quasi-convexity, rather than concavity, of the representing functional. They mainly added certainty independence to go from quasi-convex to concave.

The present paper drops concavity of the functional (and certainty independence), imposing only quasi-convexity. Then the functional is not the minimum of a set of dominating EU functionals, but of a quasi-concave G transform of those EU functionals. Here G depends not only on its u(x) input, but it can also entirely depend on the EU functional; i.e., on the subjective probabilities p chosen on the state space. Its quasi-convexity concerns both mixing in u(x) and in p. We need not consider a subset of dominating EU functionals, but can just use all EU functionals, by letting G take value infinite for all the EU functionals to be ignored. The functional is of course general, depending on all subjective probabilities over S. But it is a convenient way to unify many models.

The paper describes for many models what they mean in terms of their G function, such as the variational model (G is additively decomposable), the Chateauneuf-Faro (2009) model (G is multiplicatively decomposable), the smooth model (for φ concave), and probabilistic sophistication.

P. 1284 $\ell\ell$. 3-4 below Proposition 6 writes: "The function G can thus be properly interpreted as an *index of uncertainty aversion*." [italics from original] The authors here only mean that the partial pointwise-dominance ordering of G is compatible with the Epstein-Ghirardato-Marinacci definition of more ambiguity averse than, because this is all that Proposition 6 shows. It does not mean that other orderings derivable from G would reflect more ambiguity aversion.

biseparable utility violated %}

Cerreia-Vioglio, Simone, Fabio Maccheroni, Massimo Marinacci, & Luigi Montrucchio (2011) "Uncertainty Averse Preferences," *Journal of Economic Theory* 146, 1275–1330.

{% Assume Anscombe-Aumann framework.

P. 271, footnote 2 writes that probabilistic sophistication was introduced by Machina & Schmeidler (1992). However, it existed long before. M&S were the first to axiomatize it. Cohen, Jaffray, & Said (1987, first step on p. 1) describe it, for instance.

They take uncertainty aversion in the Schmeidler sense, of quasi-concavity w.r.t. probabilistic mixing. Then they use techniques such as in their 2011 JET paper for the case of probabilistic sophistication. %}

Cerreia-Vioglio, Simone, Fabio Maccheroni, Massimo Marinacci, & Luigi Montrucchio (2012) "Probabilistic Sophistication, Second Order Stochastic Dominance and Uncertainty Aversion," *Journal of Mathematical Economics* 48, 271–283.

{% %}

Cerreia-Vioglio, Simone, Fabio Maccheroni, Massimo Marinacci, & Luigi Montrucchio (2012) "Signed Integral Representations of Comonotonic Additive Functionals," *Journal of Mathematical Analysis and Applications* 385, 895–912.

{% The authors define a statistics model, and a common decision theory model, which assumes Anscombe-Aumann. They define a mechanism to relate the statistical model to the decision theory model, and then show how all kinds of ambiguity models can be related to statistical techniques.

Theorem 6 characterizes the smooth model, but has the two-stage setup exogenous. (See footnote 31.) %}

Cerreia-Vioglio, Simone, Fabio Maccheroni, Massimo Marinacci, & Luigi Montrucchio (2013) "Ambiguity and Robust Statistics," *Journal of Economic Theory* 148, 974–1049.

{% The authors take Savage's SEU model, with state space S and subjective probability P, as point of departure. They assume an additional set M, interpreted as possible models of which we do not know which one is true, and apparently taken to be a set of subjective probability measures m on S. The beginning of the paper carefully explains that S is outcome relevant, and M is only instrumental. They assume that P is a μ weighted average over M, so, μ is the 2nd-order distribution over S. As a Bayesian I am happy to see that the authors are exemplary Bayesians here! P. 6755 middle of 2nd column writes: "The first issue to consider in our !!normative!! approach" [exclamation marks added], suggesting that the authors consider their approach to be normative.

A necessary and sufficient condition for P to be derivable from M is that if $m(A) = m(B)$ for all $m \in M$ then $1_A 0 \sim 1_B 0$ ($1_A 0$: get $1 under A and $0 otherwise) (p. 6756 Proposition 1).

A question addressed in this paper is when the 2nd stage μ can be recovered from P. Without further info about M it obviously cannot. The main case is if all in M is orthogonal (with which the authors indicate disjoint supports) or, more generally, if the elements of M are linearly independent. The authors cite Teicher (1963) for this result on p. 6756 1st para following Proposition 1. Note that this is an extreme case, where the different models considered are completely different. The authors add results referring to supports and absolute continuity. They give a mathematical intertemporal example, stationary and ergodic, where the condition is satisfied.

It is encouraging for theoreticians that PNAS took this mathematical paper. The authors relate to many important ideas, such as Hansen & Sargent's robust approach, Wald, Marschak, model uncertainty, with much knowledge of history. %}

Cerreia-Vioglio, Simone, Fabio Maccheroni, Massimo Marinacci, & Luigi Montrucchio (2013) "Classical Subjective Expected Utility," *Proceedings of the National Academy of Sciences* 110, 6754–6759.

{% %}

Cerreia-Vioglio, Simone, Fabio Maccheroni, Massimo Marinacci, & Luigi Montrucchio (2015) "Choquet Integration on Riesz Spaces and Dual

Comonotonicity,” *Transactions of the American Mathematical Society* 367, 8521–8542.

{% %}

Cerreia-Vioglio, Simone, Fabio Maccheroni, Massimo Marinacci, & Luigi Montrucchio (2016) “Ergodic Theorems for Lower Probabilities,” *Proceedings of the American Mathematical Society* 144, 3381–3396.

{% %}

Cerreia-Vioglio, Simone, Fabio Maccheroni, Massimo Marinacci, & Luigi Montrucchio (2018) “Commutativity, Comonotonicity, and Choquet Integration of Self-adjoint Operators,” *Reviews in Mathematical Physics* 30, 10, 1850016.

{% %}

Cerreia-Vioglio, Simone, Fabio Maccheroni, Massimo Marinacci & Aldo Rustichini (2014) “Niveloids and Their Extensions: Risk Measures on Small Domains,” *Journal of Mathematical Analysis and Applications* 413, 343–360. http://dx.doi.org/10.1016/j.jmaa.2013.11.034

{% The variational model has a cost function c(p) for lottery p. This paper analyses uniqueness, concerning the set of all c-functions that represent preference. It shows that there are a lower c* and an upper d*, and that c can be iff it is between c* and d*. The introductory paper of the variational model, Maccheroni et al. (2006), had an unboundness assumption making d* infinite/redundant. This paper interprets c* as degree of ambiguity aversion and d* as degree of ambiguity, but is is unclear to me how this can be defended. %}

Cerreia-Vioglio, Simone, Fabio Maccheroni, Massimo Marinacci & Aldo Rustichini (2015) “The Structure of Variational Preferences,” *Journal of Mathematical Economics* 57, 12–19.

{% Consider consumer theory, but take demand stoxhastic, and show that law of demand for normal goods continues to hold on average. It is nice that Luce’s (1959) famous consistency condition for probabilistic choice turns into

independence of irrelevant alteratives, the weakening of the WARP axiom, when choice is deterministic. %}

Cerreia-Vioglio, Simone, Fabio Maccheroni, Massimo Marinacci, Aldo Rustichini (2022) “Law of Demand and Stochastic Choice,” *Theory and Decision* 92, 513–529.
https://doi.org/10.1007/s11238-021-09844-x

{% For every binary relation over lotteries they define kind of the largest subrelation satisfying transitivity and independence, or at least relation close to the original binary relation in some sense. %}

Cerreia-Vioglio, Simone & Efe A. Ok (2018) “The Rational Core of Preference Relations,” working paper.

{% Investigate several stock market indices for period of ‘97 to ’99, finding that daily returns are nonnormal and autocorrelated, but weekly returns and longer-term returns are normally distributed and independent. %}

Cesari, Riccardo & David Cremonini (2003) “Benchmarking, Portfolio Insurance and Technical Analysis: A Monte Carlo Comparison of Dynamic Strategies of Asset Allocation,” *Journal of Economic Dynamics and Control* 27, 987–1011.

{% Study 11,000 (!) Swedish twins. Ask them many simple questions to test for loss aversion, discounting, and so on. Find that loss aversion and ambiguity aversion (and several other anomalies) are partly explained genetically, with some 20% of variance explained this way. Impatience is not genetically related. %}

Cesarini, David, Magnus Johannesson, Patrik K. E. Magnusson, & Björn Wallace (2012) “The Behavioral Genetics of Behavioral Anomalies,” *Management Science* 58, 21–34.

{% The paper finds way more preference for justice (≈ fairness ≈ equity) under certainty than under uncertainty. A novelty is the variation of levels of uncertainty. %}

Cettolin, Elena & Arno Riedl (2017) “Justice under Uncertainty,” *Management Science* 63, 3739–3759.

https://doi.org/10.1287/mnsc.2016.2535

{% The authors reveal incomplete preferences for choice under ambiguity in their Experiment 1 (§3.1). To this effect, they measure a matching probability of an ambiguous Ellberg 2-color bet, using choice lists (prizes €15 and €0). But, in each choice in the choice lists the authors have a third option, besides the risky or ambiguous bet, and that option is described as "I am indifferent between the two urns." to the subjects, and called option mix in the paper. Then a 50-50 lottery would choose the option for subjects. By classical theories, if a subject is not indifferent between the two bets, she should surely choose the one preferred. If she is indifferent, she may choose the mix, but need not, and may as well choose any of the two options. Hence, there will at most be few indifferences. And, by stochastic dominance and transitivity, each subject will in each single choice list have at most one indifference. The data show the opposite. Many subjects choose indifference, and even several times in single choice lists: 40% does it for the most critical choices. 23% never chooses mix, 29% chooses it exactly once, 13% twice, and 35% three or more times (p. 555; replicated pp. 557-558).

Several explanations other than incompleteness of preference under ambiguity can be considered. But the authors have a nice second experiment (§4) to halfway counter. Here they replace the ambiguous bet by a sure €7.5, so that they measure the probability equivalent. And here they find only few indifference choices. This does not fully rule out the alternative explanations, but at least gives a good counter. The alternative explanations will have to distinguish ambiguity from risk.

I think that a plausible explanation (not contradicting incompleteness, but giving it background) is that people want to avoid responsibility for a choice. The authors do not discuss this, although p. 582 in the appendix shows that subjects could choose an explanation "I don't like to have the responsibility of handling a situation that requires a lot of thinking" among 31 other ones. This may only happen for complex decisions involving ambiguity, and not for more clearcut decisions such as involving only risk.

A plausible explanation that is alternative is experimenter demand: The subjects think that the indifference option hasn't been put there for no reason, so the experimenters must be hoping that they will use them and, then, so they do. An alternative explanation can also be trembling hand, if stronger for ambiguity than for risk (the latter counters the authors' counterargument on p. 560). Such alternative explanations are hard to ever rule out.

The authors in the middle of p. 551 point out that they avoid connotations of incomplete preference or randomization to subjects, but are too optimistic in suggesting that, therefore, there could be no experimenter demand.

Some nonEU theories for risk allow strict preference for mixing lotteries. (**quasi-concave so deliberate randomization**) That is, if P ~ Q, then still 0.5P + 0.5Q can be strictly preferred to both P and Q, a violation of betweenness. For instance, this happens under RDU with concave (optimistic) probability weighting. Something similar could happen when ambiguity is present (violating certainty independence). This would then be an explanation alternative to incompleteness. But I do not believe that such singlestage preferences play any role here, because such things are too complex to be conceived by subjects. §5 (pp. 556-559) describes an experiment to see if subjects were willing to pay a positive amount (0.05€) so as to mix, to see if there is a strict preference for mixing. No very clear results come, with some willing to pay and some not. The conclusion (p. 560), hence, says that 30% may prefer randomization and 50% may be incomplete.

P. 551 1st para: ambiguity was implemented by letting a colleague compose the urns.

P. 551 (**suspicion under ambiguity**): they let subjects choose the winning colors.

P. 552 bottom: The authors apply RIS to each separate experiment. But, to my regret, they do several payments to each subject, one for each task. Empirically this will not matter much, but strictly speaking one does get income effects and one looses the theoretical incentive compatibility of RIS.

P. 554 2nd para: The "identifying assumption" entails that choosing indifference (mix) means indecisiveness, i.e., incompleteness. Subjects use whole regions of indifference but only when ambiguity is involved. %}

Cettolin, Elena & Arno Riedl (2019) “Revealed Preference under Uncertainty: Incomplete Preferences and Preferences for Randomization,” *Journal of Economic Theory* 181, 547–585.

{% Find that difference in chess performance of men and women can be explained entirely by fewer women playing chess. %}
Chabris, Christopher F. & Mark E. Glickman (2006) “Sex Differences in Intellectual Performance: Analysis of a Large Cohort of Competitive Chess Players,” *Psychological Science* 17, 1040–1045.

{% Seem to find no relation between risk aversion and impatience. %}
Chabris, Christopher F., David Laibson, Carrie L. Morris, Jonathon P. Schuldt & Dmitry Taubinsky (2008) “Individual Laboratory-Measured Discount Rates Predict Field Behavior,” *Journal of Risk and Uncertainty* 37, 237–269.

{% **value of information** %}
Chade, Hector & Edward Schlee (2003) “Another Look at the Radner-Stiglitz Nonconcavity in the Value of Information,” *Journal of Economic Theory* 107, 421–452.

{% %}
Chade, Hector, Jan Eeckhout, & Lones Smith (2017) “Sorting through Search and Matching Models in Economics,” *Journal of Economic Literature* 55, 493–544.

{% **R.C. Jeffrey model** %}
Chai, Junyi, Chen Li, Peter P. Wakker, Tong V. Wang, & Jingni Yang (2016) “Reconciling Savage’s and Luce’s Modeling of Uncertainty: The Best of Both Worlds,” *Journal of Mathematical Psychology* 75, 10–18.
http://dx.doi.org/10.1016/j.jmp.2015.10.007
Direct link to paper

{% Weak present bias:0: if $(0{:}0{:}\sigma) \preccurlyeq (l{:}0{:}\lambda)$, then $(t{:}0{:}\sigma) \preccurlyeq (\ell+t{:}0{:}\lambda)$ for every $t \geq 0$. Together with natural conditions such as impatience, this condition holds if and only if (t:x) $\mapsto$ $\min_{U\in\mathcal{U}}\{\delta^t U(x)\}$ represents preference, where $\mathcal{U}$ is a set of utility functions satisfying natural conditions. The representation is extended to outcome streams by adding separability over disjoint time sets and monotonicity w.r.t. single nonzero timed outcomes, leading to an additive representation $(t_0{:}x_0,\ldots,t_T{:}x_T) \mapsto \sum_{t=0}^{T} V(\min_{U\in\mathcal{U}}\{\delta^{t_j}U(x_j)\})$. %}

Chakraborty, Anujit (2021) "Present Bias," *Econometrica* 89, 1921–1961.

{% They reanalyze the data of Andreoni & Sprenger (2012 American Economic Review 3333-3356) and Augenblick et al. (QJE 2015). They find many violations of elementary WARP and monotonicity, almost exclusively with subjects who did not always make boundary choices. They point out that this is a serious confound. %}

Chakraborty, Anujit, Evan M. Calford, Guidon Fenig, & Yoram Halevy (2017) "External and Internal Consistency of Choices Made in Convex Time Budgets," *Experimental Economics* 20, 687–706.

{% %}

Chakravartty, Anjan (2007) "*A Metaphysics for Scientific Realism*." Cambridge: Cambridge University Press.

{% %}

Chakravartty, Anjan (2017) "Scientific Realism." *In* Edward N. Zalta (ed.) *The Stanford Encyclopedia of Philosophy*, Metaphysics Research Lab, Stanford University, Stanford, CA; https://plato.stanford.edu/archives/sum2017/entries/scientific-realism/

{% %}

Chakravarty, Sugato, Robert Wood, & Robert A. Van Ness (2004) "Decimals and Liquidity: A Study of the NYSE," *Journal of Financial Research* 27, 75–94.

{% Risk sharing when different individuals have different ambiguity attitudes, analyzed using RDU for uncertainty. They may not want to share risks for extreme events, something also seen with no-insurance for extreme events. %}

Chakravarty, Surajeet & David Kelsey (2015) "Sharing Ambiguous Risks," *Journal of Mathematical Economics* 56, 1–8.

{% %}

Chakravarty, Surajeet & David Kelsey (2017) "Ambiguity and Accident Law," *Journal of Public Economic Theory* 19, 97–120. https://doi.org/10.1111/jpet.12160

{% **losses from prior endowment mechanism**; RIS for each individual. N = 85; very bright students; use 4 choice list, for gains, losses, known and unknown probabilities (Ellsberg urns), always first with known probabilities, so order effects can be (p. 206 bottom).

They consider the smooth model, with a risky $x_{0.5}0$ equivalent to an ambiguous 100_E0, and the 2nd order probability of E is 0.5. Under the smooth model this implies

$\varphi(0.5U(x)) = 0.5\varphi\big(U(100)\big)$. (*)

Unfortunately, as a colleague pointed out to me, the paper uses a different, incorrect, equation:

$0.5U(x) = 0.5\varphi\big(U(100)\big)$. (**)

That Eq. ** cannot be correct can for instance be seen directly because replacing φ by $\varphi/2$ should not affect preference, which goes wrong in Eq. **.

The authors are not clear and do not write Eq. ** explicitly, but still it can be seen that they use it because:0: (1) it is suggested on p. 204 top; (2) a colleague of mine could exactly reproduce their Table 2 using Eq. **, and not using Eq. *. (3) their repeated claims that risk attitude cancels when measuring ambiguity attitude (assuming that U and φ are power functions) only follows from the incorrect Eq. **, and not from the correct Eq. *.

suspicion under ambiguity: subjects can choose color to gamble on, controlling for suspicion.

risk averse for gains, risk seeking for losses & convex utility for losses & ambiguity seeking for losses: They find risk aversion for gains, risk seeking for losses, ambiguity neutrality for gains, and weak ambiguity seeking for losses. Importantly, note that ambiguity is what is MORE than risk attitude, so that weak ambiguity seeking for losses means somewhat MORE under ambiguity than under risk (**uncertainty amplifies risk**). Find risk and ambiguity aversion positively correlated for gains, but unrelated for losses (p. 214) **correlation risk & ambiguity attitude**).

reflection at individual level for ambiguity & **reflection at individual level for risk**: They find the opposite, both for risk- and for ambiguity attitudes. Subjects risk averse for gains are also mostly risk averse for losses, and risk seeking for gains then mostly so for losses. Subjects ambiguity averse for gains are also mostly ambiguity averse for losses, and ambiguity seeking for gains then mostly so for losses. Unfortunately, they only report preference patterns and no correlations (of utility parameters that can serve as risk/ambiguity aversion parameters). They also find no relation between reflection for risk and reflection for ambiguity at the individual level, but it is not very clear.

They use the KMM (Klibanoff, Marinacci, & Mukerji) model. In their theory, they also allow for "subjective probability" at the extreme outcome as a subjective variable, which amounts to **biseparable utility.** In their data analysis they, however, do not do this and just take subjective probabilities as 50-50 (pp. 215-216). %}

Chakravarty, Sujoy & Jaideep Roy (2009) "Recursive Expected Utility and the Separation of Attitudes towards Risk and Ambiguity: An Experimental Study," *Theory and Decision* 66, 199–228.

{% Assumes a set of priors, and does all kinds of maxmin regret things etc. Focuses on predictive distributions. %}

Chamberlain, Gary (2000) "Econometrics and Decision Theory," *Journal of Econometrics* 95, 255–283.

{% Is RDU for uncertainty when nondegeneracy is violated, i.e., there is no more than one nonnull state (no two disjoint nonnull events if state space is infinite) in every comonotonic subset. %}

Chambers, Christopher P. (2007) "Ordinal Aggregation and Quantiles," *Journal of Economic Theory* 137, 416–431.

{% **proper scoring rules** %}

Chambers, Christopher P. (2008) "Proper Scoring Rules for General Decision Models," *Games and Economic Behavior* 42, 32–40.

{% Study preference aggregation when, in particular, individuals may have different discount rates. Their axioms can give utilitarianism, maxmin, or multi-utilitarian, depending on the between-individual comparability of utility that is assumed. These are all quasilinear multi-utility models where one way to go is weighted mean, another is minimum of utility, and a third is minimum of evaluating functional. %}

Chambers, Christopher P. & Federico Echenique (2018) "On Multiple Discount Rates," *Econometrica* 86, 1325–1346.

{% I like the basic philosophy underlying this paper, as several others by these authors, that we should develop results assuming finitely many choice observations. The result of this paper is mathematical. The authors assume a finite number of observations of binary choices. Under continuity, if the domain is not too large (mainly, compact), then, if the finite set of choices is large and dense enough, we can infer the true preference relation from it to any desired degree of precision. A version is given for deterministic choice and for stochastic choice. This is the result of this paper. It is intuitively self-evident, but takes maths to get exact. They only consider cases where the finite set of choice situations has been randomly drawn (p. 1637).

criticizing the dangerous role of technical axioms such as continuity: This paper does the opposite, and uses bluff whenever the issue arises. For instance, end of Footnote 4: "continuity is a necessary regularity condition; without it, no meaningful inferences can be made with any finite amount of data." This latter claim is, of course, very incorrect. Most that the authors can say is that their approach cannot be used without continuity. Bear in mind that continuity means absolutely nothing without restrictions on the topology specified. Assumption 1 (1639), making topological assumptions, continues in the same style, when the authors write, below it: "Assumption 1 puts a necessary structure on the set of alternatives." Again, "necessary" can mean no more than that the authors need it for their approach, but the authors write ambiguously as if it is general. Same style at Assumption 3, below which the authors write: "The importance of having a dense set of alternatives is clear: without it, the characteristics of the preference remain unobservable on an open set, and for general classes of preferences, knowledge of the preference outside this set does not suffice to infer those unobservable characteristics." Here they seek to exploit the ambiguity of the term "general." In the para below Corollary 2, p. 1645, the authors themselves gives a counterexample, where knowing EU preferences on a small subdomain can determine them on the whole domain. %}

Chambers, Christopher P., Federico Echenique, & Nicolas S. Lambert (2021) "Recovering Preferences from Finite Data," *Econometrica* 89, 1633–1664.

{% This paper assumes that the empirical content of a theory is (at most) what it can predict for a finite data set (p. 2304 penultimate para). UNCAF (universal negation of conjunctions of atomic formula) axioms such as the weak axiom of revealed preference and transitivity are falsifiable and UNCAF, but continuity is not (**criticizing the dangerous role of technical axioms such as continuity**:a bit but not really) and completeness, under some assumptions about choice, neither is. The paper introduces formal terminology and results for the assumption, referring to mathematical logic and model theory.

P. 2305 has nice citation from Carl Sagan; "Absence of evidence is not evidence of absence."

P. 2308: two theories are observationally equivalent (Thom Bezembinder used the term data equivalent) if they have the same implications for finite data sets.

P. 2308: "The empirical content of a theory is the most permissive observationally equivalent weakening of the theory." It is next formalized in Definition 3.

The authors say on p. 2311 2nd para that decision theorists often call continuity technical. I discussed the dangers of continuity, of not just being technical, on several occasions, such as Wakker (1988 JMP pp. 432-433). This was also argued by Adams et al. (1970) and Pfanzagl (1966), and it is nice to see that the authors cite these works (on p. 2314). (**criticizing the dangerous role of technical axioms such as continuity**)

While not formalized, I used similar criteria of observability/empirical content in some works. I use it for instance to point out the dangerous empirical status of completeness. My book Wakker (2010 p. 38 penultimate para) writes: "A third argument against completeness concerns the richness of the models assumed, that constitute continuums, with choices between all prospect pairs assumed observable. We will never observe infinitely many data, let alone continuums (Davidson & Suppes 1956). Here completeness is an idealization that we make to facilitate our analyses. Although it has sometimes been suggested that completeness and continuity for a continuum-domain are innocuous assumptions (Arrow 1971 p. 48; Drèze 1987 p. 12), several authors have pointed out that these assumptions do add empirical (behavioral) implications to other assumptions. It is, unfortunately, usually unclear what exactly those added implications are (Ghirardato & Marinacci 2001b; Krantz et al. 1971 §9.1; Pfanzagl 1968 §6.6; Schmeidler 1971; Suppes 1974 §2; Wakker 1988)." The topic is central in Wakker (1988 JMP p. 422 and Example 7.3 and what follows), Köbberling & Wakker (2003 p. 410 last three paras." Further references criticizing continuity for not properly separating observable and non-observable conditions include Fuhrken & Richter (1991, p. 94) and Luce et al. (1990 p. 49).

P. 2315 2nd para presents Samuelson's counter to Friedman, where Samuelson very strictly separates falsifiable and nonfalsifiable. If the readers can bear another self-reference, Wakker (2010 p. 3 middle) counters in an opposite direction, by arguing that usually we do not know what will be falsifiable and what not.

It seems that this paper discusses in detail that we can never really falsify indifference from revealed preference unless we add assumptions such as nonsatiation. Wakker (1989 §1.1.5) discussed this calling it the preliminary choice problem. %}

Chambers, Christopher P., Federico Echenique, & Eran Shmaya (2014) "The Axiomatic Structure of Empirical Content," *American Economic Review* 104, 2303–2319.

{% **ordered vector space**: Maths seems to be related to de Finetti's additive representation but more complex because it involves Scitovsky sets (weakly dominating allocations) and gets a probability distribution over prize vectors. An axiom that joining two societies (they consider populations of variable sizes) should respect separate orderings is close to additivity axiom of de Finetti or independence axiom of vNM. %}

Chambers, Christopher P. & Takashi Hayashi (2012) "Money-Metric Utilitarianism," *Social Choice and Welfare* 39, 809–831.

{% They consider proper scoring rules for very general preferences, mainly assuming continuity. They define an indirect utility and use that as their main tool. Show that for EU maximizers with CARA or CRRA utility we can elicit their subjective probabilities and utility functions. They generalize Grünwald & Dawid (2004), who allowed for ambiguity attitude but had risk neutrality, by dropping most of risk neutrality. %}

Chambers, Christopher P., Paul J. Healy, & Nicolas S. Lambert (2019) "Proper Scoring Rules with General Preferences: A Dual Characterization of Optimal Reports," *Games and Economic Behavior* 117, 322–341.

{% **proper scoring rules**: the authors develop incentive compatible belief elicitation, but not for just static belief, but capturing whole dynamic situations of updating. (**updating: discussing conditional probability and/or updating**) %}

Chambers, Christopher P. & Nicolas S. Lambert (2021) "Dynamic Belief Elicitation," *Econometrica* 89, 375–414.

{% "Matching" refers to Roth's matching markets with contracts. %}

Chambers, Christopher P. & M. Bumin Yenmez (2017) "Choice and Matching," *American Economic Journal: Microeconomics* 9, 126–147.

{% Propose a generalization of mean-variance where the combination of mean and variance can be anything monotonic (so, only weak separability in the two) and, the main contribution, it goes for uncertainty/ambiguity rather than for risk. Assume Anscombe-Aumann, although as often these days they just take a mixture space (p. 616). They mention Anscombe-Aumann as one case, but explicitly also consider the case of monetary outcomes and linear utility, referring to "finance applications" for its interest. Assuming the Anscombe-Aumann framework, the mean is mean Anscombe-Aumann-EU. Instead of variance they take a generalized dispersion measure, satisfying conditions specified below.

A probability measure π on the state space S is derived subjectively à la Savage (or Anscombe-Aumann). The model is very general and encompasses Siniscalchi's (2009) vector utility, variational, multiplier, and many other models. The authors share with Siniscalchi (2009) a complementarity axiom (here taken objectively rather than subjectively as by Siniscalchi: P. 619 footnote 8) that rules out likelihood insensitivity/inverse S, slo that I think the model will not be suited to fit empirical ambiguity attitudes. There may be interest in finance though, and the paper is targeted to that. They generalize Grant & Polak (2013) JET mainly by giving up the additive decomposability in mean and dispersion, but only have weak separability and some other (in)equalities there (complementarity independence, common-mean certainty independence, and common-mean uncertainty aversion).

P. 613: a measure of dispersion is the subjective EU an agent would be willing to give up to achieve constant EU over the state space.

P. 613: they argue that ambiguity aversion need not always be constant as in Grant & Polak (2013), which motivates the generalization.

P. 614: the general form is

$V(f) = \varphi\big(E_\pi(U \circ f)\ ),\ \rho(U \circ f)\big)$ where φ is bivariately weakly separable, $E_\pi(U \circ f)$ denotes the subjective Anscombe-Aumann EU, ρ captures dispersion about $E_\pi(U \circ f)$, and $\varphi(y,0) = y$. P. 615: $\varphi(\mu,0) - \varphi(\mu,\rho)$ is the absolute uncertainty premium in utils.

P. 617b lists axioms, including subadditivity $\big($3(b)$\big)$ and symmetry $\big($3(d)$\big)$, each ruling out likelihood insensitivity. Symmetry is captured by Axiom A5, complementarity independence (p. 619). Axiom A.6 (p. 620) is common-mean uncertainty aversion and also rules out likelihood insensitivity. Axiom A.7 (p. 620) is common-mean certainty independence, imposed only for acts f and g that have a common “mean” (π-EU). Axioms A.1-A.7 are necessary and sufficient for their model (Theorem 2, p. 621).

P. 623 penultimate para: their A.7 is not weaker than weak certainty independence of Maccheroni et al. (2006 JET), but common-mean translation invariance is weaker than the translation invariance property implied by weak independence.

Pp. 625-626: they can handle Machina’s examples. Pp. 627: relations to CAPM. %}

Chambers, Robert G., Simon Grant, Ben Polak, & John Quiggin (2014) “A Two-Parameter Model of Dispersion Aversion,” *Journal of Economic Theory* 150, 611–641.

{% Take beliefs as sets of probabilities. These can be described by their tangents. Results on approximations are given. The authors add interpretations in terms of beliefs. %}

Chambers, Robert G. & Tigran Melkonyan (2008) "Eliciting Beliefs," *Theory and Decision* 65, 271–284.

{% **Dutch book**: consider restrictions on arbitrage. %}

Chambers, Robert G. & John Quiggin (2008) "Narrowing the No-Arbitrage Bounds," *Journal of Mathematical Economics* 44, 1–14.

{% %}

Chandler, Jesse J. & Emily Pronin (2012) "Fast Thought Speed Induces Risk Taking," *Psychological Science* 23, 370–374.

{% This paper is a rewritten version of the working paper Frick, Iijima, & Le Yaouanq (2019) "Boolean Representations of Preferences under Ambiguity."

The authors assume the Anscombe-Aumann framework.

Any sufficiently smooth function (absolutely continuous/bounded variation) can be written as a sum of a strictly increasing and strictly decreasing function. In the same spirit, one can, by properly combining max and min, generate almost every function, in a similar way as one can generate almost every kind of set by properly combining union and intersection. This is, if I understand well, underlying several papers by Efe Ok, e.g., the appealing Hara, Ok, & Riella (2019), cited in this paper. This paper presents a result in this spirit in the Anscombe-Aumann framework.

We throughout assume Axioms 1-4 (weak ordering, monotonicity, nondegeneracy, and Archimedeanity w.r.t. probabilistic mixing, and Axiom 11 (mixture independence, i.e., expected utility for lotteries). Theorem 4, p. 1048, shows that in this almost complete generality the representing functional W can be written as resulting from a maxmin operation:

$$W(f) \;=\; \max_{G\in\mathcal{G}}\inf_{\mu\in\Delta(S)}G\big(\mathrm{Exp}_{\mu}[u(f)],\mu\big)$$

where u is the EU ("vNM") utility function, $\Delta(S)$ the set of all probability distributions (called beliefs) over the finite ("horse") state space S, G from $\mathbb{R}$ ×

$\Delta(S) \to \mathbb{R}\cup\infty$ increasing (don't know if they mean strictly increasing or nondecreasing) in first argument and $\mathcal{G}$ a set of functions G that are quasiconvex and such that W(a) = a for all constant functions f with f(s) = a for all s. It reminds me not only of the general Hara, Ok, & Riella (2019), but also of the very general functional in Cerreia-Vioglio, Maccheroni, Marinacci, & Montrucchio (2011, JET).

Theorem 3 specifies the preceding result by reinforcing independence for lottery mixtures to weak certainty independence, which amounts to constant absolute ambiguity aversion in utility units. Then the representation specifies the function G and becomes

$$W(f) = \max_{c\in\mathcal{C}}\inf_{\mu\in\Delta(S)}\big(\mathrm{Exp}_{\mu}[u(f)] + c(\mu)\big)$$

$\mathcal{C}$ denotes a set of convex cost functions c: $\Delta(S) \to \mathbb{R} \cup \infty$.

Theorem 2 specifies Theorem 3 further by reinforcing weak certainty independence into full-force certainty independence, which amounts to adding constant relative ambiguity aversion in utility units. Then the representation is further specified into the dual-self expected utility model (DSEU) (called Boolean expected utility in their 2019 working paper) assigns to act f the value

$$W(f) = \max_{P\in\mathcal{P}}\min_{\mu\in P}\mathrm{Exp}_{\mu}[u(f)]$$

where P is a usual set of priors over the state space (horse race) of the Anscombe-Aumann framework, and $\mathcal{P}$ is a collection of sets of priors. This model is put central by the authors. It satisfies Savage's P4 (**event/outcome driven ambiguity model: event driven**).

In all the above, the same class of models results if we interchange max/sup and min/inf. The model can be interpreted as a zero-sum game between a maximizating and a minimizing agent, so, between an optimist and a pessimist.

The DSEU model had been considered before, by Ghirardato, Maccheroni, & Marinacci (2004; invariant biseparable), as the paper points out in the abstract and intro.

As nonadditive measures in Choquet expected utility have too high cardinality to be very useful in general, thus sets of priors in multiple prior models have even more (Basu & Echenique 2020) too high cardinality to be very useful in general. The above model has yet drastically higher generality, because the set $\mathcal{P}$ has very high cardinality, indeed, leading to an almost completely general model. But this general model is useful in appealingly organizing and unifying models, and providing starting points for specifications. The model readily captures general preferences and hence, readily represents basic preference properties.

If $\mathcal{P}$ has exactly one element (surely no power for the maximizing agent), then the model is maxmin EU. If all P are one-element (surely no power for the minimizing agent), then the model is maxmax. Schmeidler's uncertainty aversion, i.e., preference for probabilistic mixing, i.e., preference for all hedges, holds iff all options available to the optimist are identical (up to irrelevant changes) so that the optimist is powerless. The sets available to the optimist have nonempty intersection if and only if there is preference for complete hedges (mixtures that give a lottery for sure). One can readily see that the pessimist always has an element of the nonempty intersection available, she can just always choose that and hence can do expected utility and be uncertainty neutral. So, there is an EU upper bound to her evaluation. It implies (I don't know how to prove but the authors do) that her real preference relation then in fact satisfies preference for complete hedging.

The authors consider k-ambiguity aversion: If $f_1 \sim \cdots \sim f_k$ then every convex probabilistic mixture $\lambda_1 f_1 + \cdots + \lambda_k f_k$ that is a complete hedge $p \in \Delta(S)$ is preferred to them. It means, roughly, that all unions of elements of k-fold partitions are relatively underweighted. 2-ambiguity aversion gives source dispreference relative to SEU: For every event E we can take convex weights α, $1-\alpha$ such that, denoting outcomes in utility units, $f_1 = \alpha_E 0 \sim 0_E(1-\alpha) = f_2$ and then $(1-\alpha)f_1 + \alpha f_2$ gives the preferred complete hedge that under rank-dependent utility implies $W(E) + W(E^c) \leq 1$. For k ambiguity aversion, I focus on a k-fold partition $E_1,\ldots,E_k$ that is uniform, i.e., with all events exchangeable, so that we have local probabilistic sophistication, and I assume rank-dependent utility for ambiguity, i.e., Choquet expected utility, with weighting function W. Then k-ambiguity aversion holds here if and only if $W(iE) \leq i/k$ for every disjoint union of i elements of the partition. (We can take 1/k probabilistic mixes of k such events giving a complete hedge with the sure outcome utility i/k.) Proposition 3 (p. 1040) shows that k-ambiguity aversion is equivalent to every k-tuple of collections for the optimist being nonempty. It implies that for every k-tuple of acts and every assignment of a choice set to each act by the optimist, the pessimist has an SEU representation available. In α maxmin, k-ambiguity aversion is equivalent to $\alpha \geq 1-1/k$.

Insensitivity gives overweighting of unlikely events. If in the aforementioned k-fold partition each single event is overweighted, then k-ambiguity aversion cannot hold. In this sense, the model can accommodate insensitivity by not imposing k-ambiguity aversion for large k. It is crucial here that DSEU is event driven. (**event/outcome driven ambiguity model: event driven**)

k-ambiguity aversion, or its exclusion, do not come close to insensitivity because the characteristic property of insensitivity is overweighting of unlikely events *together with* underweighting of likely events. k-ambiguity aversion concerns underweighting of all events involved, likely as much as unlikely.

For a fixed event E, we have source preference of SEU over $\{E,E^c\}$ i.e., with M denoting matching probability, $M(E) + M(E^c) \leq 1$ (local ambiguity aversion), if and only if for every pair of collections that the optimist can choose the pessimist can choose from that pair such that the same P(E) results. So, there is a dominating SEU available to the pessimist regarding $\{E,E^c\}$. Under α maxmin this holds iff $\alpha \geq 0.5$. The DSEU model can accommodate local ambiguity aversion together with local ambiguity seeking by letting the sets of priors and their collections behave differently for different sources of uncertainty. The α maxmin model cannot accommodate it. The end of §3.1 (p. 1043) points out that the smooth model neither can.

The authors also propose formulas for updating and relate them to the DSEU model (**updating under ambiguity**). %}

Chandrasekher, Madhav, Mira Frick, Ryota Iijima, & Yves Le Yaouanq (2022) "Dual-Self Representations of Ambiguity Preferences," *Econometrica* 90, 1029–1061.

{% %}

Chandrasekhar, Pammi V.S., C. Monica Capra, Sara Moore, Charles Noussair, & Gregory S Berns (2008) "Neurobiological Regret and Rejoice Functions for Aversive Outcomes," *Neuroimage* 39, 1472–1484.

{% %}

Chandy, Rajesh, Glen Dowell, Colin Mayer, Erica Plambeck, George Serafeim, Michael Toffel, Beril Toktay, & Elke Weber (2019) "Management Science—Special Issue on Business and Climate Change," *Management Science* 65, 3447 – 3448.
https://doi.org/10.1287/mnsc.2019.3415

{% Test the DUU theory of Chichilnisky. Use **tradeoff method** to measure utility and probability weighting. Test the uncertainty theory of Chichilnisky (2009). Problem is that in the experiment extremity of an event is generated by its outcome, whereas in the theory an event is to be extreme irrespective of the outcome. %}
Chanel, Olivier & Graciela Chichilnisky (2009) "The Influence of Fear in Decisions: Experimental Evidence," *Journal of Risk and Uncertainty* 39, 271–298.

{% **decreasing ARA/increasing RRA**: Subjects' risk aversion is measured before and after a change of wealth derived from a task they carried out. Their change is both absolute in the sense of just getting an extra positive or negative payment for their work, but also relative in the sense of getting more or less than the average of what other subjects get. Risk aversion is measured by fitting EU with log-power (CRRA) utility. Because of several things going on such as perception of inequality it is not easy to interpret the results. %}
Chao, Hong, Chun-Yu Ho, & Xiangdong Qin (2017) "Risk Taking after Absolute and Relative Wealth Changes: The Role of Reference Point Adaptation," *Journal of Risk and Uncertainty* 54, 157–186.

{% **PT, applications**: shows that for nonexpected utility models, including rank dependence and prospect theory, with first-order risk aversion, heterogeneity can lead to extra deviations from the representative agent model. %}
Chapman, David A. & Valery Polkovnichenko (2009) "First-Order Risk Aversion, Heterogeneity, and Asset Market Outcomes," *Journal of Finance* 64, 1863–1887.

{% Explain that reference dependence as solution to Rabin's paradox is very inconvenient for finance. Propose to assume Rabin's small-scale risk aversion in a restricted number of choice situations, in which the calibration does not go

through and no paradoxes result for large-scale risks.

Seems to show that individual stocks and underdiversified portfolios have positive skewness, and discuss first-order risk aversion. %}

Chapman, David A. & Valery Polkovnichenko (2011) "Risk Attitudes toward Small and Large Bets in the Presence of Background Risk," *Review of Finance* 15, 909–927.

{% **time preference**; in experiment 3, she measured utility under risk (using one gain-choice to fit power-utility for gains and one loss-choice to fit power-utility for losses) and used this measurement to measure discounting of utility rather than of money. Seems to have been the first to have done so for money, although for health it had been done before (Redelmeier & Heller 1993 MDM; Stiggelbout et al. 1994 MDM). %}

Chapman, Gretchen B. (1996) "Temporal Discounting and Utility for Health and Money," *Journal of Experimental Psychology: Learning, Memory, and Cognition* 22, 771–791.

{% **time preference**; argues that people do not always prefer increasing sequences, but instead the kind of sequences that they are used to, for example, decreasing for health. %}

Chapman, Gretchen B. (1996) "Expectations and Preferences for Sequences of Health and Money," *Organizational Behavior and Human Decision Processes* 67, 59–75.

{% **time preference**; extends on Chapman (1996). %}

Chapman, Gretchen B. (2000) "Preferences for Improving and Declining Sequences of Health Outcomes," *Journal of Behavioral Decision Making* 13, 203–218.

{% %}

Chapman, Gretchen B. & Arthur S. Elstein (1995) "Valuing the Future: Temporal Discounting of Health and Money," *Medical Decision Making* 15, 373–386.

{% Measure usual behavioral attitudes, 21 in total, for representative sample of 1000 people. There are 8 indexes of social behavior, 9 of risk/uncertainty, 3 of overconfidence, and 1 of time preference. Principal components analysis reveals six factors: generosity, punishment (impulsivity), inequality/WTP (inequality aversion & bit risk aversion), WTA (risk aversion), uncertainty (ambiguity aversion and RCLA)

correlation risk & ambiguity attitude: they find unrelated.

They find a high relation between violations of RCLA and ambiguity aversion.

They find a negative relation between loss aversion and the endowment effect, which is strange because one would expect it positive. Well, the endowment effect, difference between WTP and WTA, has components other than loss aversion, such as bargaining (mis)perception.

cognitive ability related to risk/ambiguity aversion: there is a positive relation between cognitive ability and both risk and ambiguity aversion, significant but very weak (0.03 or so). %}

Chapman, Jonathan, Mark Dean, Pietro Ortoleva, Erik Snowberg, & Colin F. Camerer (2018) "Econographics," working paper.

{% %}

Chapman, Jonathan, Mark Dean, Pietro Ortoleva, Erik Snowberg, & Colin Camerer (2022) "On the Relation between Willingness to Accept and Willingness to Pay," working paper.

{% Version of 4 Sept 2018:

RIS: They pay each subject TWO randomly chosen choices. I regret that they did not do only one (say for double stakes), losing all the good theoretical properties, and I think also confusing subjects.

They measure preferences where computer program, after each choice of an individual, determines which next choice stimuli will be most informative. So, indidivually dependent adaptive. Pro is that the esatimation per individual is more efficient, but con is that the stimuli are different for every subject so that we cannot do within-stimulus-between-subject analyses. A similar technique was used by Cavagnaro and co-authors in various papers, e.g., Cavagnaro, Pitt, Gonzalez, & Myung (2013). If I understand right, DOSE has extra facilities of correcting mistaken choices in the beginning of the experiment.

The authors take a representative (N = 2000) US sample. Choices are between

(0.5:x, 0.5:-x) and 0 or between (0.5:2x, 0.5:0) and x. The authors assume loss aversion but no probability weighting. The use the gain questions to estimate utility curvature with power utility and the same power for gains as for losses (finding average power 0.69), and then the mixed choices to estimate loss aversion. Because of symmetry of utility about 0, utility curvature will not affect loss aversion much. They also estimate a discount factor for each subject, where the present effect plays no role in their stimuli and is found not to play a role in the results. They use the risky utility function in analyzing discounting. For the gain choices the authors use WTP and WTA formulations, which may generate rerference dependence and perceptions of losses.

Their DOSE performs well in having little noise, good stability (they replicated within-subject half a year later), and better relations with other variables. They find on average no loss aversion, even a bit of gain seeking. There is, surprisingly, a positive relation between cognitive ability and loss aversion (**cognitive ability related to risk/ambiguity aversion**). I conjecture that this is because low cognition subjects are not less loss averse, but have something like joy of gambling.

Men/young people and stock owners are most loss averse. There is a weak positive relation between cognitive ability and doing expected value maximization (**cognitive ability related to risk/ambiguity aversion**).

Strangely enough, the authors find that loss aversion is as stable over time as utility curvature. I conjecture that this may be because the WTA/WTP formulations of gains generate reference dependence and loss aversion. %}

Chapman, Jonathan, Erik Snowberg, Stephanie Wang, & Colin F. Camerer (2018) “Dynamically Optimized Sequential Experimentation (DOSE) for Estimating Economic Preference Parameters,” working paper.

{% In big representative samples (in total, N = 3000), they find that half the subjects are the opposite of loss aversion, what I often call gain seeking and what the authors call loss tolerant. This goes contrary to may other studies that report prevailing loss aversion. The authors suggest that this may be because most studies used student subjects, and that loss aversion occurs only for students but not for representative samples.

I have a different opinion. I think that in general loss aversion is prevailing

and is one of the strongest phenomena regarding risk attitudes. But at the same time it is very volatile and hard to predict, and changing one word may as well double it or rule it out entirely. Thus, different studies find different things.

What may play a role here is that the authors use many 50-50 lotteries, where the opposite of loss aversion and risk aversion is often found. See the keyword "**risk seeking for symmetric fifty-fifty gambles**" in this bibliography, giving many such findings.

The authors also find no correlation between loss aversion and the endowment effect. Again, I belief that those will be positively related. An explanation for the mentioned finding can be that this is H0 due to noise. There can be expected to be much noise here. Thus, the authors do find a relation for subjects with good cognitive ability (**cognitive ability related to risk/ambiguity aversion**). An impressive data set Gächter, Johnson, & Herrmann (2022) also found a positive relation. %}

Chapman, Jonathan, Erik Snowberg, Stephanie Wang, & Colin F. Camerer (2024) "Looming Large or Seeming Small? Attitudes towards Losses in a Representative Sample," *Review of Economic Studies*, rdae093, forthcoming. https://doi.org/10.1093/restud/rdae093

{% **marginal utility is diminishing**: Discusses many "local" deviations due to last penny needed to buy a house etc. Does not discuss loss aversion, contrary to what may be suggested by footnote 4 on p. 673 of Robertson (1954) %}

Chapman, Sydney (1913) "The Utility of Income and Progressive Taxation," *Economic Journal* 22, 25–35.

{% %}

Chareka, Patrick (2009) "The Central Limit Theorem for Capacities," *Statistics & Probability Letters* 79, 1456–1462.

{% **social risks > nature risks in coordination games**

Measure CEs (certainty equivalents) in game situations. CEs are higher in coordination game (which is cooperative) than in matching pennies (which is competitive). These things are moderated if "opponent" is random computer. Neuroimaging is used to find correlations with brain activities.

A difficulty is that the measurement of the CEs in this paper interferes with the games. What happens is, first, players are asked what they play if they have to play a game. Next, some players are given the choice to either play the game, or instead get a sure outcome for themselves (and then the same sure amount for their opponent). This impacts the game by forward induction. If your opponent had the choice between the game and the sure amount, and chose the game, then this signals that she wants to get more money from the game than the sure money amount, which for instance may rule out some equilibria. In the coordination game it makes it extra safe to also enter there and go for a high amount. Thus, it makes coordination games extra attractive. %}

Chark, Robin & Chew Soo Hong (2015) "A Neuroimaging Study of Preference for Strategic Uncertainty," *Journal of Risk and Uncertainty* 50, 209–227. https://doi.org/10.1007/s11166-015-9220-9

{% Use real incentives.

Use front-end delay: Choices between receiving money after 2 or 9 days (proximate), after 31 and 38 days later (intermediate), and after 301 versus 308 days (remote). They find decreasing impatience when going from proximate to intermediate, but not when going from intermediata to remote. %}

Chark, Robin, Soo Hong Chew & Songfa Zhong (2015) "Extended Present Bias: A Direct Experimental Test," *Theory and Decision* 79, 151–165. https://doi.org/10.1007/s11238-014-9462-z

{% **(very) small probabilities**: This paper provides an original data set on an often discussed but never yet thoroughly investigated topic: risk attitudes for very small probabilities. A pretty design (Figure 1, p. 1010) allows for testing many hypotheses, leading to rich results. In particular, they can consider extremely small probabilities, 10^{-5}, and extremely big winning amounts, $\$10^6$. A new finding is that for very small probabilities with very large outcomes, people become risk averse again. This may be because then utility becomes very concave. There are more specific predictions involving outcome and probability scaling, but these depend on parametric assumptions made. %}

Chark, Robin, Chew Soo Hong, & Songfa Zhong (2020) "Individual Preference for Longshots," *Journal of the European Economic Association* 18, 1009–1039. https://doi.org/10.1093/jeea/jvz004

{% As in preceding works by some of these authors, I have always liked the direct way in which they use EU to capture source preference, avoiding any multistage complication but just as direct as can. They relate to genes, adding to separating ambiguity aversion from (un)familiarity. %}

Chark, Robin, Songfa Zhong, Shui Ying Tsang, Chiea Chuen Khor, Richard P. Ebstein, Hong Xue, & Chew Soo Hong (2022) "A Gene–Brain–Behavior Basis for Familiarity Bias in Source Preference," *Theory and Decision* 92, 531–567. https://doi.org/10.1007/s11238-022-09871-2

{% %}

Charles-Cadogan, Godfrey (2016) "Expected Utility Theory and Inner and Outer Measures of Loss Aversion," *Journal of Mathematical Economics* 63, 10–20.

{% Shows that the Born rule innovation of quantum probability theory (QPT) can be replaced by a weak harmonic transitivity axiom in classic probability, involving a complex-valued harmonic probability weighting function that satisfies Born rule. %}

Charles-Cadogan, Godfrey (2018) "Probability Interference in Expected Utility Theory," *Journal of Mathematical Economics* 78, 163–175.

{% %}

Charnes, Abraham & William W. Cooper (1959) "Chance-Constrained Programming," *Management Science* 5, 197–207.

{% %}

Charness, Gary (2004) "Attribution and Reciprocity in an Experimental Labor Market," *Journal of Labor Economics* 22, 665–688.

{% Subjects do immediate risky choices, or risky choices after having done many hypothetical choices to learn. Men become less risk averse, and women do not

change much.

It is well-known that it is good to first, in an experiment, let subjects practice with the stimuli to get to know them. This is one argument put forward by the authors. It is also well-known that subjects, after many risky choices and the corresponding learning, move closer to expected value maximization. I co-authored a paper on it, among many other people: van de Kuilen & Wakker (2006 JRU). Section 2.1: **Prospect theory not cited**. %}

Charness, Gary, Nir Chemaya, & Dario Trujano-Ochoa (2023) "Learning Your Own Risk Preferences," *Journal of Risk and Uncertainty* 67, 1–19. https://doi.org/10.1007/s11166-023-09413-3

{% This paper reports an experiment with a big representative sample from the Dutch population (N = 1122), using the LISS panel. They use several standard ways to measure risk aversion: Ordered lottery selection as Eckel & Grossman (2008), choice lists as Holt & Laury (2002) (and many preceding them …), and further choice lists (Tanaka et al.). I regret that they did not consider insensitivity, i.e., inverse S. They then see how these are related to actual real-life financial decisions. They find no relations, leading to pessimistic conclusions. This is in the spirit of Dohmen, Falk, Huffman, et al. (2011 *Journal of the European Economic Association*) and Pedroni, Frey, Bruhin, et al. (2017 *Nature Human Behaviour*), both cited, who also find negative results. My reply is here as always: The risk attitude concepts are normatively imposed on us. (E.g., propect theory is for me primarily an attempt to get the normative utility function of EU while correcting for empirical problems.) Getting them as good as possible is essential for making good decisions. %}

Charness, Gary, Thomas Garcia, Theo Offerman, & Marie Claire Villeval (2020) "Do Measures of Risk Attitude in the Laboratory Predict Behavior under Risk in and outside of the Laboratory?," *Journal of Risk and Uncertainty* 60, 99–123. https://doi.org/10.1007/s11166-020-09325-6

{% Paying people for doing exercise enhances them doing it. %}

Charness, Gary & Uri Gneezy (2009) "Incentives to Exercise," *Econometrica* 77, 909–931.

{% **gender differences in risk attitudes**: women more risk averse than men. They investigate illusion of control, ambiguity aversion, and myopic loss aversion. In direct choices people behave as usual, preferring to have control and to choose unambiguous. But they do not pay small amounts for their preferences, and do not invest more, suggesting that the effects found are very weak.

P. 137: in Ellsberg subjects can choose the winning color, so, control for suspicion. (This can create illusion of control, as is central in Berger & Tymula 2022)

They investigate illusion of control for simple risky choices between-subjects so that there is no contrast effect, and find none (p. 138).

correlation risk & ambiguity attitude: seem to find positive correlation (p. 139)

P. 139: In Ellsberg, they find no direct ambiguity aversion. However, in a treatment (T8) where subjects can either invest in the ambiguous urn or the unambiguous, but have to pay some for the latter, the appreciation of the former is HIGHER than in the other treatments. This can be explained by the contrast effect known from marketing, where appreciation of an option is increased by adding an irrelevant inferior option (Tversky & Simonson 1993).

P. 141 quotes Albert Einstein, "everything should be as simple as it is, but not simpler." %}

Charness, Gary & Uri Gneezy (2010) "Portfolio Choice and Risk Attitudes: An Experiment," *Economic Inquiry* 48, 133–146.

{% **random incentive system between-subjects**: the authors are positive about it. %}

Charness, Gary, Uri Gneezy, & Brianna N. Halladay (2016), "Experimental Methods: Pay One or Pay All," *Journal of Economic Behavior and Organization* 131, 141–150.
https://doi.org/10.1016/j.jebo.2016.08.010

{% **survey on nonEU**: survey a few methods of measuring risk attitudes, mostly from close researchers, pointing out that they do not seek completeness. They present a section "the multiple price list" as a method, citing some papers that elicited indifferences through what I would call price list rather than multiple price list. %}

Charness, Gary, Uri Gneezy, & Alex Imas (2013) "Experimental Methods: Eliciting Risk Preferences," *Journal of Economic Behavior and Organization* 87, 43–51.

{% Survey belief measurements. Adding my opinion: the results of introspective measurements are hard to interpret, especially for use in normatively justified decisions. What the authors call simple methods pay probability estimates according to whether they are close to true probabilities, but, then, can only be used in the uninteresting case where the experimenter already knows the true probability distribution. %}

Charness, Gary, Uri Gneezy, & Vlastimil Rasocha (2021) "Experimental Methods: Eliciting Beliefs," *Journal of Economic Behavior and Organization* 189, 234–256.

{% **updating: testing Bayes' formula**: a refinement of the Charness & Levin (2005) design gives violations of stochastic dominance. The larger the groups to decide and the more transparent the stimuli, the fewer the violations of stochastic dominance. %}

Charness, Gary, Edi Karni, & Dan Levin (2007) "Individual and Group Decision Making under Risk: An Experimental Study of Bayesian Updating and Violations of First-Order Stochastic Dominance," *Journal of Risk and Uncertainty* 35, 129–148.

{% They study the Linda conjunction fallacy of Kahneman & Tversky (1983). In the replication they find 58% rather than the 85% (note the reversal of digits …; typo!?) that K&T did; here subjects received a flat $2 payment. Then they redid, telling the subjects that there was a correct answer, and paying $4 to who gave the correct answer. This reduced the error rate to 33% (**real incentives/hypothetical choice**; p. 554). They also let groups of 2 and also of 3 answer. The groups, especially of 3, had much lower error rates, both with answer-contingent payment and with flat payment.

Note that paying for the correct answer versus flat is a way of rewarding different than the real-hypothetical decisions distinction. Here it is not a decision

the outcome of which is real or hypothetical, but just a different payment for an effort. In the hypothetical treatment there is no reference to any hypothetical payment. %}

Charness, Gary, Edi Karni, & Dan Levin (2010) "On the Conjunction Fallacy in Probability Judgment: New Experimental Evidence Regarding Linda," *Games and Economic Behavior* 68, 551–556.

{% Consider three-color Ellsberg urn with 36 balls (slips in envelope but I write balls), with a known number X of red balls, and 36−X black and yellow balls in unknown proportion. They find the switching value X, which is similar to matching probability but not the same because the number of black/yellow also changes. Subjects who switch between 11 and 13 are ambiguity neutral. Then choosing known or unknown for X = 12 are both taken as ambiguity neutral. The latter is for 60% (n = 164) of their subjects. Subjects who for X = 12 choose risky are categorized as ambiguity averse in most other studies but as neutral in this study; if there are many such subjects, it explains much of their finding. Further, 20% is inconsistent, 12% is ambiguity seeking, and only 8% is ambiguity averse **(ambiguity seeking**). Strange that so few of the latter. One might conjecture that many subjects are very weakly ambiguity averse, choosing red in classical Ellsberg experiments and also here when X = 12, in which case the majority of the subjects categorized as ambiguity neutral would choose to bet on red. This did not happen. Footnote 15 (p. 11) points out that only 50% of these subjects (82 of 164) chose red. Given the outstanding nature of red versus the other two colors, this can be taken as roughly ambiguity neutral.

suspicion under ambiguity: §2 discusses an experiment where they did not control for suspicion, then finding 25% ambiguity aversion. In the beginning of the paper the authors suggest that they deviate from most other studies, and find less ambiguity aversion than those others, because they, supposedly unlike the others, control for suspicion. However, as my keyword shows, most other studies have controlled for suspicion also in the past.

They also study subjects who try to convince each other of their preferences, with an incentive for them to convince each other. Ambiguity neutral subjects can convince ambiguity seeking and inconsistent, but less so ambiguity averse.

For both the first part, individual choice, and the second part (convince others), one choice was paid for real, which entails a mild income effect.

P. 20: "ambiguity aversion by no means seems as prevalent as some studies have suggested." %}

Charness, Gary, Edi Karni, & Dan Levin (2013) "Ambiguity Attitudes and Social Interactions: An Experimental Investigation," *Journal of Risk and Uncertainty* 46, 1–25.

{% **updating: testing Bayes' formula**: Considers case where Bayesian updating means CHANGING successful strategy, so that the former can be distinguished from heuristic-like continuation of strategies that were successful in the past, more or less a myopic version of CBDT, as follows. A coin has been flipped, giving H or T, unknown to an agent. There are an upper and lower urn, containing B and W balls, where the distribution of H will always be more extreme than of the lower. One ball will be drawn from an urn, where B gives a valuable prize and W not, and sometimes you can choose from which urn this is to be done, upper or lower. H is more favorable because, if H, then the upper urn contains 6 B balls and 0 W balls, and the lower urn contains 4 B and 2 W, whereas if T then the upper urn contains 0 B balls and 6 W balls, and the lower urn contains 2 B and 4 W.

H	T
{B,B,B,B,B,B}	{W,W,W,W,W,W}
{B,B,B,B,W,W}	{B,B,W,W,W,W}

A first draw is done from the lower urn, and the agent sees its result. The agent can then choose from which urn the second and last draw should be made. If the first draw from lower is favorable and gives B, then Bayesian updating recommends to switch and 2nd draw should be from the upper urn. If the first draw is unfavorable and gives W, then Bayesian updating recommends not to switch and 2nd draw should again be from the lower urn. Myopic continuation of successful strategy, and changing of bad strategy, would suggest opposite.

In experiment the authors find about fifty-fifty of the two strategies. No payment in first draw reduces error rate. Error rates are also reduced if higher prizes, presence of affect for first draw (if they know before first draw whether B or W will be favorable) and being male do so too (**gender differences in risk attitudes; gender differences in ambiguity attitudes**). %}

Charness, Gary & Dan Levin (2005) "When Optimal Choices Feel Wrong: A Laboratory Study of Bayesian Updating, Complexity, and Affect," *American Economic Review* 95, 1300–1309.

{% %}

Charness, Gary & Matthew Rabin (2000) "Social Preferences: Some Simple Tests and a New Model."

{% **equity-versus-efficiency**: seems to be on it. %}

Charness, Gary & Matthew Rabin (2002) "Understanding Social Preferences with Simple Tests," *Quarterly Journal of Economics* 117, 817–869.

{% In games people behave differently if felt to be part of group, watched by them, than if not. %}

Charness, Gary, Luca Rigotti & Aldo Rustichini (2007) "Individual Behavior and Group Membership," *American Economic Review* 97, 1340–1352.

{% Survey among economists and students about deception. An argument why deception is more problematic for economics than for other disciplines I did not find mentioned in this paper. It is that for economics incentives, and how they motivate subjects, are often crucial, and here it is often detrimental if subjects do not trust these. Table 1 (pp. 394-395) is interesting because it presents seven cases of partial deception, to be discussed and judged by the subjects. %}

Charness, Gary, Anya Samek, & Jeroen van de Ven (2022) "What is Considered Deception in Experimental Economics?," *Experimental Economics* 25, 385–412. https://doi.org/10.1007/s10683-021-09726-7

{% Seem to find that seniors are more risk averse, and more cooperative, than juniors. %}

Charness, Gary & Marie-Claire Villeval (2009) "Cooperation and Competition in Intergenerational Experiments in the Field and the Laboratory," *American Economic Review* 99, 956–978.

{% Use Machina's local utility. For multivariate outcomes, aversion to multivariate mean preserving increases in risk is equivalent to the concavity of the local utility functions (Machina showed this only for univariate, i.e., money. They apply it to rank-dependent utility. %}

Charpentier, Arthur, Alfred Galichon, & Marc Henry (2016) "Local Utility and Multivariate Risk Aversion," *Mathematics of Operations Research* 41, 466–476. https://doi.org/10.1287/moor.2015.0736

{% **gender differences in risk attitudes**: several results

inverse S (= likelihood insensitivity) related to emotions

Measure probability weighting w. Relate it to the five-factor model of psychology. Use hypothetical choice. Use the Tversky & Kahneman (1992) stimuli except mixed. Find that emotional balance moves w towards EU, both regarding likelihood insensitivity and regarding optimism. Also being male rather than female does so. The one-parameter Prelec family does best, then the one-parameter T&K'92, then the two-parameter Prelec family (compound invariance), and, finally, Goldstein & Einhorn (1987). They test reflection and find it confirmed. For gains, gender matters with men less likelihood insensitive than women. For losses, emotional balance leads to closer conformity with EU both for less likelihood insensitivity and pessimism. Emotional intelligence (**cognitive ability related to risk/ambiguity aversion**) does more for gains, and emotional balance for losses. Seems that losses are treated more emotionally and less cognitively than gains. Several times no significance was reached. %}

Charupat, Narat, Richard Deaves, Travis Derouin, Marcelo Klotzle, & Peter Miu (2013) "Emotional Balance and Probability Weighting," *Theory and Decision* 75, 17–41.
https://doi.org/10.1007/s11238-012-9348-x

{% **value of information**; Paper considers maxmin EU. "Revising info" is called the info that reduces the number of probability measures to be included in the set of prior probabilities. "Focusing" is, if I understand right, the traditional thing of receiving info about event. %}

Chassagnon, Arnold & Jean-Christophe Vergnaud (1999) "A Positive Value of Information for a Non-Bayesian Decision-Maker,"

{% **ordering of subsets**: This paper gives necessary and sufficient conditions, in full generality, for existence of probability measure representing qualitative probability relation. The ultimate result!

Assume that $\succcurlyeq$ is a preference relation on an algebra of events (subsets of a state space S, also called universal event). We call P *agreeing* if P is a finitely additive probability measure on the algebra, and

$E \succcurlyeq F \Rightarrow P(E) \geq P(F)$.

$E \succ F \Rightarrow P(E) > P(F)$.

This amounts to the usual $E \succcurlyeq F \Leftrightarrow P(E) \geq P(F)$ if and only if $\succcurlyeq$ is a weak order, but it is nicer because it also covers the practically realistic case of incomplete observations. 1_E denotes indicator function. The condition necessary and sufficient for comparative probability (existence of agreeing probability) is, besides well boundedness ($S \succ \varnothing$ and $S \succcurlyeq E \succcurlyeq \varnothing$ for all E):

For all $A \succ B$ there exists $\varepsilon > 0$ such that:

$E_j \succcurlyeq F_j$, $j = 1,\ldots,n$, $m > 0$, $k \geq 0$

&

$$m \times 1_A + \Sigma 1_{E_j} + k1_\varnothing = m \times 1_B + \Sigma 1_{F_j} + k1_S$$

& $k \leq m\varepsilon$

cannot be.

For finite S the condition is equivalent to excluding $k \leq 0$ (or, $\varepsilon = 0$) and was demonstrated by Kraft, Pratt, & Seidenberg (1959). It then amounts to the well-known necessary and sufficient condition for solving linear inequalities. The general way of turning this into preference conditions was explained beautifully by Scott (1964). For infinite S we have to ensure Archimedeanity, and the ε condition ensures it. Substitution of P shows that ε reflects $P(A) - P(B)$. %}

Chateauneuf, Alain (1985) "On the Existence of a Probability Measure Compatible with a Total Preorder on a Boolean Algebra," *Journal of Mathematical Economics* 14, 43–52.

https://doi.org/10.1016/0304-4068(85)90025-4

{% %}
Chateauneuf, Alain (1987) "Continuous Representation of a Preference Relation on a Connected Topological Space," *Journal of Mathematical Economics* 16, 139–146.

{% The fundamental lemma characterizes maxmin EU. %}
Chateauneuf, Alain (1988) "Uncertainty Aversion and Risk Aversion in Models with Nonadditive Probabilities." *In* Bertrand R. Munier (ed.) *Risk, Decision and Rationality*, 615–629, Reidel, Dordrecht.

{% Axiom A5.1 can be used to imply proportionality of additive value functions. Published in JME 32 1999. %}
Chateauneuf, Alain (1990) "On the Use of Comonotonicity in the Axiomatization of EURDP Theory for Arbitrary Consequences," CERMSEM, University of Paris I; extended abstract presented at Fifth International Conference on the Foundations and Applications of Utility, Risk and Decision Theory (FUR-90).

{% Theorem 2 characterizes the maxmin EU model just as Gilboa & Schmeidler (1989, JME) did, but with linearity of utility referring to money-addition and not to the mixing of probabilities as in G&S. Chateauneuf and Gilboa & Schmeidler obtained their results independently, although at a late stage Gilboa helped Chateauneuf to correct a mistake in Chateauneuf's theorem, acknowledged in Footnote 9 of Chateauneuf's paper. The "fundamental lemma" on p. 623 of Chateauneuf (1988) stated the same result. Although it referred to a 1986 working paper of Gilboa & Schmeidler's 1989 paper, the results were obtained independently.

Theorem 1 provides an alternative to Schmeidler (1989), again with monetary outcomes and linear utility. It uses a nice weakening of comonotonic independence building on Anger (1977). Chateauneuf uses mixing independence and not addition independence.

biseparable utility %}
Chateauneuf, Alain (1991) "On the Use of Capacities in Modeling Uncertainty Aversion and Risk Aversion," *Journal of Mathematical Economics* 20, 343–369.

https://doi.org/10.1016/0304-4068(91)90036-S

{% %}

Chateauneuf, Alain (1994) "Combination of Compatible Belief Functions and Relation of Specificity." *In* Ronald R. Yager, Janusz Kacprzyk, & Mario Fedrizzi (eds.) *Advances in the Dempster-Shafer Theory of Evidence*, 97–114, Wiley, New York.

{% This paper surves mainly axiomatizations of RDU with linear utility, as in Chatenauneuf (1991). %}

Chateauneuf, Alain (1994) "Modeling Attitudes towards Uncertainty and Risk through the Use of Choquet Integral," *Annals of Operations Research* 52, 1–20.

{% Not all decomposable capacities are distorted probabilities, but many are. There may be some vague similarity with sources of uniform ambiguity. %}

Chateauneuf, Alain (1996) "Decomposable Capacities, Distorted Probabilities and Concave Capacities," *Mathematical Social Sciences* 31, 19–37.

{% **tradeoff method**: Axiom A4 is a weakened version of tradeoff consistency (if the latter were imposed on all events and not just states of nature). It is used jointly with something like tail independence, and suffices to imply proportionality of the additive value functions.

A4 says for, say, outcomes always ordered from best to worst, so, a ≽ c and b ≽ d:

(1) (p_1:x_1, p_2:a, p_3:a) ~ (p_1:y_1, p_2:b, p_3:b) and

(2) (p_1:x_1, p_2:c, p_3:c) ~ (p_1:y_1, p_2:d, p_3:d) imply

(3) (p_1:x_1, p_2:a, p_3:c) ~ (p_1:y_1, p_2:b, p_3:d).

(1) and (2) imply ab $\sim^*_c$ cd, and so do (1) and (3). So, this is a nice weakening of tradeoff consistency. It kind of implies, loosely speaking, that V_{p1+p2} is proportional to V_{p2}. A reformulation: if replacing the tradeoff ab by the tradeoff cd on an event A does not affect indifference, then neither should it do on any subset of A.

Additionally nice is that it also is a weakening of vNM-probability-mix independence. %}

Chateauneuf, Alain (1999) "Comonotonicity Axioms and Rank-Dependent Expected Utility Theory for Arbitrary Consequences," *Journal of Mathematical Economics* 32, 21–45.

{% Corollary 2 on p. 86 shows that risk aversion can hold under rank-dependent utility with a nonconcave (even strictly convex) utility function, as soon as the probability weighting function is sufficiently convex. For example, if $U(x) = x^n$, n > 1, then $f(p) \leq p^n$ will do (is actually necessary and sufficient). %}

Chateauneuf, Alain & Michèle Cohen (1994) "Risk Seeking with Diminishing Marginal Utility in a Non-Expected Utility Model," *Journal of Risk and Uncertainty* 9, 77–91.

{% %}

Chateauneuf, Alain & Michèle Cohen (2000) "A New Approach to Individual Behavior under Uncertainty and to Social Welfare." *In* Michel Grabisch, Toshiaki Murofushi & Michio Sugeno (eds.) *Fuzzy Measures and Integrals: Theory and Applications* 40, 289–313, Physica-Verlag, Berlin.

{% This paper contains a sketch of the proof of Savage's (1954) SEU theorem, based on notes that Jaffray used. During one of my first visits to him, when I was a young researcher, end of the 1980s, he showed me his handwritten notes. Good to now see that they are public. %}

Chateauneuf, Alain, Michèle Cohen, & Jean-Yves Jaffray (2006) "Decision under Uncertainty: The Classical Models." *In* Denis Bouyssou, Didier Dubois, Henri Prade, & Marc Pilot (eds.) *Decision-Making Process: Concepts and Methods*, Ch. 9, 385–400, Wiley, New York.

{% %}

Chateauneuf, Alain & Michèle Cohen, & Robert Kast (1997) "Comonotone Random Variables in Economics: A Review of Some Results," CERMSEM, CEM, University of Paris I.

{% %}

Chateauneuf, Alain, Michèle Cohen, & Isaac Meilijson (1997) "New Tools to Better Model Behavior under Risk and Uncertainty: An Overview," *Finance* 18, 25–46.

{% %}

Chateauneuf, Alain, Michèle Cohen, & Isaac Meilijson (2004) "Four Notions of Mean-Preserving Increase in Risk, Risk Attitudes and Applications to the Rank-Dependent Expected Utility Model," *Journal of Mathematical Economics* 40, 547–571.

{% %}

Chateauneuf, Alain, Michèle Cohen, & Isaac Meilijson (2001) "Comonotonicity-Based Stochastic Orders Generated by Single Crossings of Distributions, with Applications to Attitudes to Risk in the Rank-Dependent Expected Utility Model," CERMSEM, CEM, University of Paris I.

{% %}

Chateauneuf, Alain, Michèle Cohen, & Isaac Meilijson (2004) "More Pessimism than Greediness: A Characterization of Monotone Risk Aversion in the Rank-Dependent Expected Utility Model," *Economic Theory* 25, 649–667.

{% Arrow (1965) showed that optimal insurance often involves some deductible. This paper extends it to left-monotone risk aversion, which is empirically worthwile. It brings extra under RDU (not EU), adding to the interest of EU. %}

Chateauneuf, Alain, Michèle Cohen, & Mina Mostoufi (2022) "Optimality of Deductible: A Characterization, with Application to Yaari's Dual Theory," *Theory and Decision* 92, 569–580. https://doi.org/10.1007/s11238-022-09880-1

{% A characterization of convex Choquet integrals. They do not use a comonotonic-additivity like axiom. General characterizations of not-necessarily convex Choquet integrals are in Wakker (1993 MOR). %}

Chateauneuf, Alain & Bernard Cornet (2018) "Choquet Representability of Submodular Functions," *Mathematical Programming B* 168, 615–629.

{% %}

Chateauneuf, Alain, Rose-Anna Dana, & Jean-Marc Tallon (2001) "Optimal Risk-Sharing Rules and Equilibria with Choquet-Expected-Utility," *Journal of Mathematical Economics* 34, 191–214.

{% Use Anscombe-Aumann setup as did Schmeidler (1989), and simplify his axioms somewhat. %}

Chateauneuf, Alain, Jürgen Eichberger, & Simon Grant (2003) "A Simple Axiomatization and Constructive Representation Proof for Choquet Expected Utility," *Economic Theory* 22, 907–915.

{% **event/outcome driven ambiguity model: event driven**

Neo-additive means: non-extreme-outcome additive.

The simplest and most well-known version of the neo-additive model is **EU+a*sup+b*inf**. (My 2010 book defines it this way, explaining in Footnote 3, p. 319 that details about null events are ignored.) The authors write it as (1−δ)EU + αδsup + (1−α)δinf. The authors consider somewhat more general models, first explained intuitively: A subjective probability measure P is given. All events E with positive probability P(E) > 0 are possible and P-nonnull. However, there may be nonempty P-null events E with P(E) = 0 that are still considered to be possible. "Possible" thus is an additional category, broader than P-nonnull. A person maximizes EU w.r.t. P but assigns some extra weight to the infimum and the supremum POSSIBLE outcomes. Given P (in fact, for each P), the maximal set of possible events that can be considered is all nonempty events, leading to the aforementioned well-known model **EU+a*sup+b*inf**. Given P, the minimal set of possible events that can be considered is only all P-nonnull events. This leads to the RDU model with W(.) = w(P(.)) with w a neo-additive probability weighting function (w linear on (0,1) under the most common case of a ≥ 0 and a+b ≤ 1). This is the probabilistically sophisticated version of the neo-additive model. The authors allow for intermediate cases between these two extremes. In the notation of the authors, the weight for the supremum possible outcome is αδ, and the weight for the infimum possible outcome is (1−α)δ. δ indexes distrust in the beliefs P, α designates optimism beyond EU, and 1−α designates pessimism beyond EU.

Both α and δ are from [0,1], and are allowed to take the extreme values 0 or 1. $\delta = 1$ and $\alpha = 0$ indicate maximal pessimism, going by the infimum possible outcome (most extreme is if all nonempty events are possible, when acts are evaluated by their infimum outcomes, as in the opening formula above).

We can infer possibility from preferences. Event E is possible if and only if $x_Ey \nsim y$ for some outcomes x,y. x_Ey denotes the binary act in the usual way. There is a small inaccuracy in the paper regarding null/possible events, explained later. I first explain the paper's terminology and some other things. The paper uses the term null for impossible, which, as explained, is broader than P-null. Hence, nonnull is possible (including both what the authors call universal and what they call essential). They denote the set of null events by $\mathcal{N}$.

For the preference foundation, the authors use a subjective midpoint operation defined by Ghirardato, Maccheroni, Marinacci, & Siniscalchi (2003). This is somewhat complex to observe, especially because it needs many certainty equivalents, but it is possible. The authors, properly, do it only for 50-50 mixtures which, as just explained, are reasonably well observable. They do not use general mixtures as GMMS do and which is not really observable (for instance for a 1/3-2/3 mixture GMMS need infinitely many observations).

P. 544: They interpret δ as index of confidence in the EU probability, $\alpha\delta$ as index of optimism, and $(1-\alpha)\delta$ as index of pessimism (the authors there confuse optimism and pessimism). The authors do not explicitly commit to risk attitudes, but their interpretation of δ as disconfidence in P strongly suggests that they assign all deviations from EU to ambiguity and assume EU for risk. If this assumption does not hold, then their parameters reflect a general uncertainty attitude that captures both ambiguity and (part of) risk.

§4.1 shows how neo-additive can accommodate the coexistence of gambling and insurance, deviating from EU under risk.

nonadditive measures are too general: they may argue for this, but I am not sure if they do.

EXPLANATION WHY NULL EVENTS ARE NOT TREATED COMPLETELY CORRECTLY, FORMALLY (end indicated by open box □)

Given monotonicity, E is possible if and only if:

===================

[either

there exist outcomes $x > y$ with $x_E y \succ y$ (betting on E) (*)

or

there exist outcomes $x < y$ with $x_E y \prec y$ (betting against E) (**)]

In the neo-additive model,

===================

Given $\alpha > 0$, (*) is necessary and sufficient for possibility.

Given $\alpha < 1$, (**) is necessary and sufficient for possibility.

Given $0 < \alpha < 1$, (*) and (**) are equivalent.

In their preference condition on p. 548 ℓ. −6, the authors, unfortunately, relate the nullness of events only to bets on events (Eq. *), and not to bets against events (Eq. **). This is incorrect for the pessimistic case of $\alpha = 0$. Relatedly, the Hurwicz capacity in Definition 3.2 need not be exactly congruent for $\alpha = 0$ (then nonnull events may still have capacity 0), contrary to what the authors claim. In Theorem 5.1, null event consistency (Axiom 6) is not a necessary condition for the representation, contrary to what is claimed there. For instance, assume $\delta = 1$, $\alpha = 0$, and $\varnothing$ is the only null event. Thus, acts are evaluated by their infimum outcome (which is the minimal outcome in the paper because all acts are assumed simple there), implying the most extreme pessimism there is. The weighting function/capacity, which I denote W, has $W(E) = 0$ for all events except the universal event S. W is not exact because $W(E) = 0$ for many nonnull events. For each $\varnothing \neq E \neq S$ and $x \succ y$ we have $x_E y \sim y$, which according to the definition on p. 548 ℓ. −6 would mean that E is null. By Axiom 6 (null event consistency) it should imply $y_E x \sim x$, but this is not so, because $y_E x \sim y \prec x$. So, the representation does not imply null event consistency, contrary to what Theorem 5.1 claims. Their preferential definition of null and universal events (p. 548) does not imply that the latter are complements of the former, contrary to what is assumed throughout the paper. In the proof the authors incorrectly claim sufficiency of all their conditions on p. 565, not giving a proof.

It often happens under RDU that researchers relate likelihood interpretations only to the weighting function W (= capacity). Under RDU, likelihood is better related to the rank also and is better assigned to ranked events (as, you guessed it, in my 2010 book). In the neo-additive model, the best and the worst ranks play special roles, and besides best-ranked events the authors should also have considered worst-ranked events. □ (END OF EXPLANATION) %}

Chateauneuf, Alain, Jürgen Eichberger, & Simon Grant (2007) "Choice under Uncertainty with the Best and Worst in Mind: NEO-Additive Capacities," *Journal of Economic Theory* 137, 538–567. https://doi.org/10.1016/j.jet.2007.01.017

{% **biseparable utility violated;**

This paper provides the multiplicative analog of the variational model of Maccheroni, Marinacci, & Rustichini (2006, Econometrica). The latter generalized maxmin EU by imposing only the additive part of certainty independence (constant absolute ambiguity aversion in utility units) and not the multiplicative part (constant relative ambiguity aversion in utility units), leading to an extra term c(p) depending on the prior probability p. The present paper takes only the multiplicative part and thus generalizes maxmin EU by adding a nonnegative factor 1/φ(p) depending on prior probability p. Both generalizations have their pros and cons. P. 541 discusses the variational model but only in general terms, not referring to the additive/multiplicative analogy. Seems plausible that factor 1/φ(p) added to maxmin is attitude.

This paper writes the representation first in a more complex manner, with a threshold α_0 added, in the beginning, but φ can always be redefined to get rid of this α (Corollary 5). More preference for certainty à la Yaari (1969; the authors refer to Ghirardato & Marinacci for an interpretation as ambiguity aversion) is equivalent to pointwise domination by φ, but only if identical utility and set of priors.

To take the multiplicative part of certainty independence, the paper needs a zero point, and for this a worst consequence x_* is assumed, in their axiom 5 (worst independence). $u(x_*)$ will be 0. %}

Chateauneuf, Alain & José H. Faro (2009) "Ambiguity through Confidence Functions," *Journal of Mathematical Economics* 45, 535–558.

{% Take agent as consisting of two persons, whose convex combination gives the alpha maxmin model. %}

Chateauneuf, Alain, José Heleno Faro, Jean-Marc Tallon, & Vassili Vergopoulos (2024) “Alpha-Maxmin as an Aggregation of Two Selves,” *Journal of Mathematical Economics* 113, 103006. https://doi.org/10.1016/j.jmateco.2024.103006

{% %}

Chateauneuf, Alain, Thibault Gajdos, & Pierre-Henry Wilthien (2002) “The Principle of Strong Diminishing Transfer,” *Journal of Economic Theory* 103, 311–333.

{% They characterize the maximization of the Sugeno integral. %}

Chateauneuf, Alain, Michel Grabisch, & Agnès Rico (2008) “Modeling Attitudes toward Uncertainty through the Use of the Sugeno Integral,” *Journal of Mathematical Economics* 44, 1084–1099.

{% %}

Chateauneuf, Alain & Jean-Yves Jaffray (1984) “Archimedean Qualitative Probabilities,” *Journal of Mathematical Psychology* 28, 191–204.

{% %}

Chateauneuf, Alain & Jean-Yves Jaffray (1987) “Some Characterizations of Lower Probabilities and Other Monotone Capacities through the Use of Möbius Inversion.” *In* Bernadette Bouchon & Ronald R. Yager (eds.) *Uncertainty in Knowledge-Based Systems*. Lecture Notes in Computer Science, Vol. 286, 95–102, Springer, Berlin.

{% %}

Chateauneuf, Alain & Jean-Yves Jaffray (1989) “Some Characterizations of Lower Probabilities and Other Monotone Capacities through the Use of Möbius Inversion,” *Mathematical Social Sciences* 17, 263–283.

{% %}

Chateauneuf, Alain & Jean-Yves Jaffray (1994) "Combination of Compatible Belief Functions and Relation of Specificity." *In* Ronald R. Yager, Janusz Kacprzyk, & Mario Fedrizzi (eds.) *Advances in the Dempster-Shafer Theory of Evidence*, Wiley, New York.

{% Random variables are comonotonic iff covariance nonnegative for all probability distributions. %}

Chateauneuf, Alain & Robert Kast, & André Lapied (1994) "Market Preferences Revealed by Prices: Nonlinear Pricing in Slack Markets." *In* Bertrand R. Munier & Mark J. Machina (eds.) *Models and Experiments in Risk and Rationality*, 289–306, Kluwer Academic Publishers, Dordrecht.

{% This paper considers a pricing functional on assets in a financial market, imposes on it the usual axioms that characterize the Choquet integral, mainly comonotonic additivity, and then gets it as a Choquet integral. It discusses some properties that may interest finance researchers. %}

Chateauneuf, Alain, Robert Kast, & André Lapied (1996) "Choquet Pricing for Financial Markets with Frictions," *Mathematical Finance* 6, 323–330. https://doi.org/10.1111/j.1467-9965.1996.tb00119.x

{% %}

Chateauneuf, Alain, Robert Kast, & André Lapied (2001) "Conditioning Capacities and Choquet Integrals: The Role of Comonotony," *Theory and Decision* 51, 367–386.

{% Preference for sure diversification: If a set of equivalent prospects (random variables with given probabilities but related to underlying states of nature) can be outcome-mixed to give a sure outcome, then that sure outcome is preferred to the prospects. The authors show that this condition, under usual monotonicity and continuity, is equivalent to weak risk aversion (preference for expected value). %}

Chateauneuf, Alain & Ghizlane Lakhnati (2007) "From Sure to Strong Diversification," *Economic Theory* 32, 511–522.

{% %}

Chateauneuf, Alain & Ghizlane Lakhnati (2015) Increases in Risk and Demand for a Risky Asset," *Mathematical Social Sciences* 75, 44–48.

{% %}

Chateauneuf, Alain & Jean-Philippe Lefort (2008) "Some Fubini Theorems on Product σ-Algebras for Non-Additive Measures," *International Journal of Approximate Reasoning* 48, 686–696.

{% Characterize countable additivity and nonatomicity of all priors in maxmin EU. %}

Chateauneuf, Alain, Fabio Maccheroni, Massimo Marinacci, & Jean-Marc Tallon (2004) "Monotone Continuous Multiple Priors," *Economic Theory* 26, 973–982.

{% My annotations below concern the version of mid 2020.

The authors present variations of theorems as in Köbberling & Wakker (2003 *Mathematics of Operations Research*). All results below remain valid if the domain is a comoncone rather than a whole product set, and all results extend to biseparable utility, so that many ambiguity theories are covered.

K&W used tradeoff consistency conditions. Those imply the sure-thing principle, and the hexagon condition for two dimensions, giving additive representation $V_1 + \cdots + V_n$. To get EU, the V_js should be proportional. Tradeoff consistency gets that by implying consistency of orderings of utility differences across states. These results can be generalized by imposing the sure-thing principle separately, and then weaker conditions to give proportionality. This paper does so. The latter weaker condition is a consistency, across events, of a tradeoff-based endogenous utility midpoint operation, imposed only on binary acts. The latter implies the hexagon condition, so that also the case of two states gives additive representability and, hence is covered. Thus, whereas TO consistency has all ideas into one, this paper separates them, with all the pros and cons.

Two results underlie this paper:

(1) It can be seen that if one has additive representability, and EU on all or

sufficiently many two-dimensional subsets (with EU entirely depending on that subset), then one gets EU on the whole domain, so that EU must be independent of the subsets after all.

(2) If for three or more states, and everything nonnull, one has SEU (= CEU) on every comoncone, then one gets CEU overall. Main reason is that comoncones have intersections of dimension two or more, so that the representations on those overlaps are cardinal. It implies same utility functions and agreeing weighting functions on common events, so that it can all be patched together consistently into one overall representation. If there are only two states, then the comoncones (there are only two such) have a one-dimensional overlap, with the representation only ordinal there, and then the representations can really have different utility functions, and no overal CEU representation exists, as examples in this paper show. %}

Chateauneuf, Alain J., Fabio A. Maccheroni, & Horst Zank (2021) "On the Separation of Utility and Beliefs," working paper.

{% Present a beautiful result under CEU (Choquet expected utility): Preferences are convex (w.r.t. outcome mixing) if and only if utility is concave and the capacity convex. This beautiful result is somewhat "hidden," and follows from equivalence of (i) and (iv) in Theorem 1 (Choquet functional is concave iff it is quasi-concave which is iff U concave and W convex) plus Proposition 1.

They also show that preference for sure diversification (the same as convexity, only restricted to the case where the mix of acts is a constant act) implies a nonempty core, and is equivalent to that nonemptiness under concave utility.

They also show that convexity of preference restricted to comonotonic sets of acts is equivalent to concave utility. For the special case of SEU this result has been known before, but has not been well known.

Unfortunately, they only obtain their results under the assumption of differentiable utility. %}

Chateauneuf, Alain & Jean-Marc Tallon (2002) "Diversification, Convex Preferences and Non-Empty Core," *Economic Theory* 19, 509–523.

{% Show, under RDU for uncertainty, that no-trade interval iff U concave and W superadditive. Some other results, such as regarding perfect hedging, are given. %}

Chateauneuf, Alain & Carolina Ventura (2010) “The No-Trade Interval of Dow and Werlang: Some Clarifications,” *Mathematical Social Sciences* 59, 1–14.

{% This paper examines Choquet integral representations over sequences, interpreted as income profiles (intertemporal). The sequences are assumed bounded. What the paper calls impatience is a kind of continuity, requiring that for every $\varepsilon > 0$ extra payment there is a period n such that receiving ε up to n is worth giving up everything after n. So, the far remote future’s importance tends to 0. Myopia refers to a similar kind of continuity. This paper examines the similarities and differences between these concepts. %}

Chateauneuf, Alain & Caroline Ventura (2013) “Continuity, Impatience and Myopia for Choquet Multi-Period Utilities,” *Journal of Mathematical Economics* 49, 97–105.

{% %}

Chateauneuf, Alain & Peter P. Wakker (1993) “From Local to Global Additive Representation,” *Journal of Mathematical Economics* 22, 523–545.
https://doi.org/10.1016/0304-4068(93)90002-3
Direct link to paper

{% **tradeoff method** %}

Chateauneuf, Alain & Peter P. Wakker (1999) “An Axiomatization of Cumulative Prospect Theory for Decision under Risk,” *Journal of Risk and Uncertainty* 18, 137–145.
https://doi.org/10.1023/A:1007886529870
Direct link to paper

{% Lived 1706 - 1749. **conservation of influence**: Leibnitz introduced kinetic energy, calling it the living force (vis viva). Émilie introduced potential energy, so as to make conservation of energy hold. %}

du Châtelet, Émilie

{% Show effectively that a general concave functional over probability-contingent prospects can be obtained as the lower envelope of EU functionals. To get that precise one has to add Lipschitz conditions and all that, and this paper does that. It relates it to Machina (1982). This is also a big step in the direction to maxmin EU, something not discussed in this paper. %}

Chatterjee, Kalyan & R. Vijay Krishna (2011) "A Nonsmooth Approach to Nonexpected Utility Theory under Risk," *Mathematical Social Sciences* 62, 166–175.

{% Uses linear-space techniques to give preference foundation for vNM EU (although they only do linearity and not integral-form of a utility function). Their sure-thing principle for lotteries concerns common conditional part, so, general infinitely many common outcomes as Savage (1954) also does, and not its restriction to one (so, finitely many) common outcomes. Pity they use topology and metric on outcomes, getting functional that is continuous in outcomes. %}

Chatterjee, Kalyan & R. Vijay Krishna (2008) "A Geometric Approach to Continuous Expected Utility," *Economics Letters* 98, 89–94.

{% **(very) small probabilities**: They investigate risk attitudes for small-probability catastrophic events. Doing broad bracketing, i.e., presenting risks compounded over long times, has the potential to improve, but does not cure. Deciding from experience instead of description does not help. %}

Chaudhry, Shereen J., Michael Hand, & Howard Kunreuther (2020) "Broad Bracketing for Low Probability Events," *Journal of Risk and Uncertainty* 61, 211–244.

{% **revealed preference** %}

Chavas, Jean-Paul & Thomas L. Cox (1993) "On Generalized Revealed Preference Analysis," *Quarterly Journal of Economics* 108, 493–506.

{% When inspecting the Pareto-optimal points in a convex set, e.g., in welfare (I think Wald for uncertainty is the same), all PO points result from maximizing a linear aggregation of the criteria with nonnegative weights, but not vice versa. More or less conversely, all maximizations of a linear aggregation of the criteria with positive weights are PO, but not vice versa. Intermediate limiting results have long been known. This paper advances on the topic, with some necessary and sufficient results. %}

Che, Yeon-Koo, Jinwoo Kim, Fuhito Kojima, & Christopher Thomas Ryan (2024) " "Near" Weighted Utilitarian Characterizations of Pareto Optima," *Econometrica* Vol. 92, 141–165. https://doi.org/10.3982/ECTA18930

{% Propose exp(–s(1–p)^b/p^b), the exponential odds model, as probability weighting family. %}

Chechile, Richard A. & Daniel H. Barch (2013) "Using Logarithmic Derivative Models for Assessing the Risky Weighting Function for Binary Gambles," *Journal of Mathematical Psychology* 57, 15–28.

{% There is a serious flaw in the design, corrected in their 2003 study. %}

Chechile, Richard A. & Susan F. Butler (2000) "Is "Generic Utility" a Suitable Theory of Choice with Mixed Gains and Losses?," *Journal of Risk and Uncertainty* 20, 189–211.

{% Corrects the Chechile & Butler (2000) flaw. %}

Chechile, Richard A. & Susan F. Butler (2003) "Reassessing the Testing of Generic Utility Models for Mixed Gambles," *Journal of Risk and Uncertainty* 26, 55–76.

{% Test Miyamoto's generic utility; i.e., **biseparable utility. A**s several have pointed out (Traub, Seidl, Schmidt, & Grösche 1999, Chechile & Luce 1999) the experimental design is seriously flawed. For example, EV indifferences are impossible to state for subjects in many questions. They do not refer to Tversky & Kahneman (1992), give an acknowledgment to Luce, and ascribe the introduction of rank-dependent utility to Luce (1988). "Normed" probability weighting (kind of Karmarkar family but bit different, I think **inverse S**) plus power utility give best fit. %}

Chechile, Richard A. & Alan D.J. Cooke (1997) “An Experimental Test of a General Class of Utility Models: Evidence for Context Dependence,” *Journal of Risk and Uncertainty* 14, 75–93. Correction: Richard A. Chechile & R. Duncan Luce (1999) “Reanalysis of the Chechile-Cooke Experiment: Correction for Mismatched Gambles,” *Journal of Risk and Uncertainty* 18, 321–325.

{% %}
Chechile, Richard A. & R. Duncan Luce (1999) “Reanalysis of the Chechile-Cooke Experiment: Correction for Mismatched Gambles,” *Journal of Risk and Uncertainty* 18, 321–325.

{% Do Ellsberg two-color experiment in traditional treatment, where there is asymmetric information with the experimenter knowing the composition of the unknown urn but the subjects not, but then also in a treatment where the composition of the unknown urn was determined by other subjects in the experiment, and not by the experimenter, so that there is no as ymmetric info (we can ignore the knowledge of the composing subject). There they find no ambiguity aversion but rather a tendency even for ambiguity seeking (**ambiguity seeking**). %}
Chen, Daniel L. (2024) “Is Ambiguity Aversion a Preference? Ambiguity Aversion without Asymmetric Information,” *Journal of Behavioral and Experimental Economics* 111, 102218.
https://doi.org/10.1016/j.socec.2024.102218

{% Test the Machina (2009) paradox, finding the same preferences as l’Haridon & Placido (2010), again going against Machina’s predictions. %}
Chen, Daniel L. & Martin Schonger (2016) “Testing Axiomatizations of Ambiguity Aversion.”

{% **game theory for nonexpected utility** %}
Chen, Ho-Chyuan & William S. Neilson (1999) “Pure-Strategy Equilibria with Non-Expected Utility Players,” *Theory and Decision* 46, 199–200.

{% Study effects of risk and ambiguity aversion on mortality-linked securities, using the smooth model. Find that ambiguity aversion has less effect than risk aversion. %}

Chen, Hua, Michael Sherris, Tao Sun, & Wenge Zhu (2013) "Living with Ambiguity: Pricing Mortality-Linked Securities with Smooth Ambiguity Preferences," *Journal of Risk and Insurance* 80, 705–732.

{% **updating under ambiguity** %}

Chen, Jaden Yang (2022) "Biased Learning under Ambiguous Information," *Journal of Economic Theory* 203, 105492.

{% Considers languages that do not (Chinese), sometimes (weak-FTR; e.g. Dutch), or always (strong-FTR; e.g. English) use future tenses for future actions. Sometimes is called weak, always is called strong. Empirically examines how this impacts saving and other intertemporal actions, using data of 76 countries. Finds strong effects with weak-FTR 31% more likely to have saved in a given year, 31% more savings at retirement, 24% less likely to smoke, and so on (p. 692 top). Incredibly strong results. One may worry that these effects are generated by confouding factors other than the linguistic cause considered. But the author controls for cultural values, even for "deep" cultural values as he pompuously calls it. This daunting task is implemented by one and only one control question, being how important people think it is to teach children to save. It did take me some thinking to see in which sense this one question be controlling for "deep cultural values" or other confounds. The author's reasonings, and claims of causality as derived from this one question (no lack of optimismm here), are typically stated in the 2nd para of the conclusion:

> "One important issue in interpreting these results is the possibility that language is not causing but rather reflecting deeper differences that drive savings behavior. These available data provide preliminary evidence that much of the measured effects I find are causal, for several reasons that I have outlined in the paper. Mainly, selfreported measures of savings as a cultural value appear to drive savings behavior, yet are completely uncorrelated with the effect of language on savings. That is to say, while both language and cultural values appear to drive savings behavior,

these measured effects do not appear to interact with each other in a way you would expect if they were both markers of some common causal factor."

The author has collected an impressive data set, where he must have consulted the linguistic literature a lot, which is the more impressive as it is a single-author paper.

One explanation offered is about time perception: People not using future tense will distinguish less between present and future and, hence, discount the future less, which then enhances rationality. This has some plausibility.

A second explanation offered is about beliefs. Although the author is not explicit, when analyzing beliefs he assumes probability distributions over waiting time for one reward. A formal proposition is provided. Imagine one reward R is received at some timepoint t, and the timepoint is risky, with distributions $F_W(t)$ for weak-FTR and $F_S(t)$ for strong-FTR. Weak-FTR will have more uncertainty, less precision, about timings. P. 697 writes: "we might expect $F_W(t)$ to be a mean-preserving spread of $F_S(t)$." Because time is valued by discount functions that are usually convex, people will (assuming EU and, crucially, $U(R) > 0$) be risk seeking regarding delay-time and prefer future more under $F_W(t)$ than under $F_S(t)$. (Makes sense because sure receipt of reward in one year and a day is preferred less than fifty-fifty either tomorrow or in 2 years and a day.) The author cites Kacelnik & Bateson (1996) and Redelmeier & Heller (1993) for similar risk seeking.

There is a mathematical mistake here in Chen's analysis. U(R), a factor in a multiplication, is a ratio scale and it matters whether it is negative, 0, or positive. The more so as in intertemporal choice, with the normalization $D(0) = 1$, the total weight distributed over all timepoints is not constant (unlike with probability), further showing that utility is not cardinal but is a ratio scale. The neutrality level of utility is empirically meaningful. If D(T) is convex, then D(T)U(R) will be convex for $U(R) > 0$, but the opposite, concave, for $U(R) < 0$. Because of this, Chen misinterprets the literature. Redelmeier & Heller find a small majority of common positive discounting and convex discounting D(T), but they have this for aversive outcomes (health impairements), being worse than neutral. Hence, they have risk aversion rather than risk seeking. I did not check Kacelnikov & Bateson on positive or negative outcomes. There is a nice study on risk about delays with gains, being Onay & Öncüler (2007), but they find the opposite of Chen's claim, being risk aversion. In O&O this gives the paradoxical implication of concave discounting. O&O nicely point out that the risk aversion found should probably be ascribed to probability weighting rather than to concave utility (= discount function), pointing out that the EU assumption in Chen's analysis is also problematic.

The author's claim "we might expect $F_W(t)$ to be a mean-preserving spread of $F_S(t)$" (p. 697) set me thinking. Why are $F_W(t)$ and $F_S(t)$ the same regarding expectation of waiting time t (arithmetic mean) and not of ln(t) (geometric mean) or of exp(t), or of anything other? Another complication is infinite waiting time (not getting the object). $F_S(t)$ may be sure to receive reward R in one year, and to never receive reward R´ ($t = \infty$). $F_W(t)$ may think that for both R and R´ it is fifty-fifty: Either receive them in one year or never. Here we have infinity coming in and the usual maths does not work. $F_S(t)$ is not a mean-preserving spread of $F_W(t)$. Another complication in this analysis is that intertemporal utility may be cardinally different from cardinal risky utility, being a nonlinear transform; risk attitude may be different than what intertemporal utility suggests under EU. A third complication is that if $F_S(t)$ has different beliefs over t than $F_W(t)$, then this will affect the discount function and it cannot be assumed the same.

P. 720 2nd chunck of text: I did not understand how the described similar development paths exclude innate cognitive or early cultural differences, a claim central in the 3rd para of the conclusion (p. 721). Pp. 720-721 discuss the grand topic of why similarly-situated societies differ so greatly in economic development and health, illustrating the broadness of the author. P. 721 gives three causes: (1) geography and (2) climate (which are apparently not included in "similarly situated "), and, (3) ecology of animal domestication. Then some more are discussed later. For cause (3) would have been good to indicate that this holds for mankind many thousands of years ago, but not today. %}

Chen, M. Keith (2013) "The Effect of Language on Economic Behavior: Evidence from Savings Rates, Health Behaviors, and Retirement Assets," *American Economic Review* 103, 690–731.

{% N = 5 capuchin-monkeys were given tokens, and learned that they could trade them with experimenters in exchange for apples, at rates different for different experimenters. First it was verified that the monkeys satisfy elementary versions of GARP (generalized axiom of revealed preference).

Then the monkeys were in two treatments. In treatment one, one apple was displayed, the monkey could pay tokens, and then either received the one apple displayed or that one with one added (a bonus), so, two apples. Essentially, they received a fifty-fifty prospect yielding one or two apples. In treatment two, two apples were displayed, the monkey could pay tokens, and then either received the two apples displayed or one was removed and only one apple was received (a loss). Essentially, they received a fifty-fifty prospect yielding one or two apples, as in treatment one. In each treatment, the monkeys spent some time doing repeated choices, until their choices stabilized.

The monkeys exhibited loss aversion in trading more in treatment one, and preferring treatment one to treatment two if they could choose. The authors conclude that loss aversion is innate and not learned, because these monkeys had no chance to learn it from others.

The authors next used a parametric model, with linear utility with a kink at zero (loss aversion), and developed a probabilistic-choice model and regression to fit the data. They got the best fit if they take loss aversion parameter 2.7. %}

Chen, M. Keith, Venkat Lakshminarayanan, & Laurie Santos (2006) "How Basic Are Behavioral Biases? Evidence from Capuchin Monkey Trade," *Journal of Political Economy* 114, 517–537.

{% %}

Chen, Shu-Heng & Ya-Chi Huang (2007) "Relative Risk Aversion and Wealth Dynamics," *Information Sciences* 177, 1222–1229.

{% **nonconstant discount = nonlinear time perception**

By cognitive load, *perception* of time duration becomes shorter (apparently), giving more patience. The authors discuss problems of causal relations and otherwise in §4.3.

They did both convex time budget and choice list, in latter eliciting time-tradeoff sequences of Attema et al. (2010 Management Science). %}

Chen, Xiu & Xiaojian Zhao (2024) "How Time Flies: Time Perception and Intertemporal Choice," *Journal of Behavioral and Experimental Economics* 109, 102160.
https://doi.org/10.1016/j.socec.2023.102160

{% Ambiguity in the bidder's evaluations is investigated in a theoretical analysis, and then an experiment. The experiment suggests ambiguity seeking (**ambiguity seeking**). Each bidder faces one other bidder, with the probability distribution of the type of the opponent either F1 or F2, with F1 stochastically dominating F2 (F1 always bids higher, so, is more unfavorable). As far as I understand, α maxmin here is simply SEU with α times the unfavorable F2 and $1-\alpha$ times the favorable F1. %}

Chen, Yan, Peter Katušcák, & Emre Ozdenoren (2007) "Sealed Bid Auctions with Ambiguity: Theory and Experiments," *Journal of Economic Theory* 136, 513–535.

{% Show that if we can only observe actual choices of players in a game situation, then the choices can always be accommodated by EU if they satisfy some minimal monotonicity (with the naive name "rationalizability," a term used by fields in immature states). The authors cite many related recent results. Although I did not study the paper enough to be sure, it seems to me to be close to the Wald (1950) observation, famous in my youth, that a Pareto optimal choice can always be accommodated by EU with subjective probabilities. %}

Chen, Yi-Chun & Xiao Luo (2012) "An Indistinguishability Result on Rationalizability under General Preferences," *Economic Theory* 51, 1–12.

{% **natural sources of ambiguity**: the authors do so. They use the source method, with a-neutral probabilities for each source and a source-dependent probability weighting function (what I call the source function).

Subjects do real-effort task where they only get paid for it conditional on some natural uncertainty event, bringing in ambiguity. The natural events concern a digit of a stockprice in the future, so that there is symmetry and the a-neutral probabilities are readily available, similarly as they are in unknown Ellsberg urns, and no elicitation of a-neutral probabilities is required. They consider a-neutral probabilities 0.1, 0.5, and 0.9. There are familiar stocks and unfamiliar ones. Such experiments with digits have the interesting feature that probabilities are not really unknown and that emotions other than unknown probabilities are driving the differences.

They find natural things such as source preference for familiar sources. They also confirm the gain-part of the fourfold pattern of Trautmann & van de Kuilen (2015), i.e., more insensitivity for unfamiliar sources. %}

Chen, Yiting & Songfa Zhong (2024) "Source Dependence in Effort Provision," *International Economic Review* 65, 1499–1517. https://doi.org/10.1111/iere.12698

{% In an online experiment, there are six numbered boxes, where n contain a high prize h (say h = $30) and 6-n a low prize $\ell < h$ (say $\ell = \$10$). Subjects know n, h, and ℓ, but not which of the six boxes contain which prize. One of the six boxes, randomly chosen independently of everything else, receives an extra amount, say $4. Next I describe the acts to be done by the subjects, and which info they have at their act. Subjects first choose a number between 1 and 6 at their choice, and then write it on a piece of paper unverifiable by the experimenter or anybody else. They do not know which boxes contain h or which one contains the extra $4 at that stage and in this sense they have no reason to prefer any of the six boxes. Then they get informed about which box has the extra $4. Then, knowing this, but not knowing which boxes contain h and which contain ℓ, subjects should make public which number between 1 and 6 they chose. The content of that box they will get, as they know. They can now lie or tell truth here. For any single subject one cannot know if he lied or not. But much more than 1/6 report the box with the extra $4, so that we can statistically, significantly, prove that many must be lying. The main finding of this paper is that, if there is uncertainty about the boxes ($0 < n < 6$), then subjects lie less than if there is no uncertainty (n = 0 or n = 6). A plausible explanation is magical thinking, where subjects think that the risk about h versus ℓ will work out unfavorably if they lie (this may also be suspicion about the experiment), or quasi-magical thinking where they do not express magical-thinking beliefs but still behave as if. (Karmareasoning.) There are several treatments precluding several alternative explanations.

Remarkable is that, with subjects prefering not to lie if the sure outcome $h + 4$ versus h is involved ($n = 6$), so $h \succ h + 4 + \text{lying}$, and also if the sure outcome $\ell + 4$ versus ℓ is involved ($n = 0$), so $\ell \succ \ell + 4 + \text{lying}$, they still prefer the opposite if there is uncertainty ($0 < n < 6$), which can be taken as a violation of stochastic dominance if we take the four outcomes h, $h + 4 + \text{lying}$, ℓ, $\ell + 4 + \text{lying}$ as sure outcomes.

The finding can have many implications such as in cheating with banks, tax, auditing. %}

Chen, Yiting & Songfa Zhong (2024) "Uncertainty Motivates Morality," *Econometrica*, forthcoming.

{% Does multiple priors (I assume maxmin EU) in continuous time. Derives risk premium and ambiguity prmium. %}

Chen, Zengjing & Larry Epstein (2002) "Ambiguity, Risk, and Asset Returns in Continuous Time," *Econometrica* 70, 1403–1443. https://doi.org/10.1111/1468-0262.00337

{% Test menu-dependent risk attitudes. Adding extreme (but inferior, strategically irrelevant) options to choice set does not alter risk attitude. This result comes from an accepted H_0, as the authors point out, but they have good power. Seems to go against Parducci's well-known range-frequency model, a model not cited. As they write, the find no violations of traditional prospect theory or expected utility. It is also supportive of IIA (independence of irrelevant alternatives).

The authors use lotteries with three (or even four?) outcomes but seem to give nice visual displays, not making the common mistake of using angles in circles to indicate probabilities. They only test hypotheses related to risk aversion. I always like if people pay attention to insensitivity but it is not done here.

§5.2 suggests little overweighting of small probabilities. (**risk seeking for small-probability gains**)

The authors pay much attention to salience theory, although their data find no support. All they say about salience theory as much holds for regret theory, a theory not even mentioned, which I regret (pun unforeseen). %}

Chen, Zhuo, Russell Golman, & Jason Somerville (2024) “Menu-Dependent Risk Attitudes: Theory and Evidence,” *Journal of Risk and Uncertainty* 68, 77–105. https://doi.org/10.1007/s11166-023-09423-1

{% Consider implications of ambiguity aversion being decreasing in wealth, and α maxmin and the smooth model. %}
Cherbonnier, Frédéric & Christian Gollier (2015) “Decreasing Aversion under Ambiguity,” *Journal of Economic Theory* 157, 606–623.

{% **revealed preference**: necessary and sufficient condition for finitely many observations of choice function to be represented by a convex weak order. %}
Cherchye, Laurens, Thomas Demuynck, & Bram de Rock (2014) “Revealed Preference Analysis for Convex Rationalizations on Nonlinear Budget Sets,” *Journal of Economic Theory* 152, 224–236.

{% **revealed preference**: Consider revealed preference in the context of consumer demand. Give necessary and sufficient conditions for the set of budget sets considered so that WARP does imply SARP. SARP is quite equivalent to transitivity of preference, so it shows when and when not transitivity adds to WARP. %}
Cherchye, Laurens, Thomas Demuynck, & Bram De Rock (2018) “Transitivity of Preferences: When Does It Matter?,” *Theoretical Economics* 13, 1043–1076.

{% **criticism of monotonicity in Anscombe-Aumann (1963) for ambiguity**: they point out that it implies a kind a separability (they use the term sure-thing principle). %}
Cheridito, Patrick, Freddy Delbaen, Samuel Drapeau, & Michael Kupper (2015) “Stochastic Order-Monotone Uncertainty-Averse Preferences,” working paper.

{% %}
Cherkes, Martin, Jacob Sagi, & Richard H. Stanton (2006) “A Liquidity-Based Theory of Closed-End Funds?,” *Review of Financial Studies*, submitted.

{% %}
Chern, Shiing-Shen & Philip Griffiths (1977) "Linearization of Webs of Codimension One and Maximum Rank." *In Proc. of the Int. Symp. on Alg. Geom.*, Kyoto, Japan, 85–91.

{% Seems to have demonstrated that Savage's maxmin regret violates independence of irrelevant alternatives. Arrow (1951) cites him for that.

Seems to have done something Anscombe-Aumann-like, seems state-dependent-like; that is, according to Arrow, Econometrica 1951 %}
Chernoff, Herman (1949) "Remarks on a Rational Selection of a Decision Function" (hectographed), Cowles Commission Discussion Papers: No. 326 and 326A, January 1949; 346 and 346A, April 1950.

{% Nothing of particular interest. Announces two-state-half-half probability SEU. %}
Chernoff, Herman (1950) "Remarks on a Rational Selection of a Decision Function" (abstract), *Econometrica* 18, 183.

{% His first para describes the modern (2025) framework of Anscombe-Aumann, with their first probabilistic stage omitted, and only the two stages (1) horses (2) lotteries. It is used in his paper. He cites Wald (1939) for it, but Wald was only a special case: statistical inference, where only the first-stage events (the horses) are outcome-relevant and not the roulette-events.

His theorems are similar to Anscombe & Aumann (1963). However, unfortunately, he assumes vNM utilities given and uses them explicitly in his axioms. For example, for independence he mixes the vNM utilities. Big pity! Could be changed by replacing vNM utilities by probability equivalents. %}
Chernoff, Herman (1954) "Rational Selection of Decision Functions," *Econometrica* 22, 422–443.
https://doi.org/10.2307/1907435

{% Show that if a subject is first put in a market-type environment enhancing rational behavior (by arbitrage), then this spills over to other tasks in an experiment. They do this for preference reversals, which are reduced by the prior exposure to market. Interestingly, people adjust their evaluation of the high-risk lottery. They

do not adjust their evaluation of the low-risk lottery, or their choice. This suggests that the evaluation of the high-risk lottery is the culprit, in agreement with scale compatibility. %}

Cherry, Todd L., Thomas D. Crocker, & Jason F. Shogren (2003) "Rationality Spillovers," *Journal of Environmental Economics and Management* 45, 63–84.

{% N = 266 businesses answered questionnaires with hypothetical choices on ambiguity for losses (storm), generated by diverging expert judgments, and choices with uncertainty (with known probabilities, so, risk) about timing delay (also studied by Onay & Öncüler 2007). It was kind of matching: subjects first chose between two initial prospects, and then were asked to indicate an indifference value.

ambiguity seeking for losses: Table III shows it, with 73 ambiguity seeking and 57 ambiguity averse.

risk averse for gains, risk seeking for losses: Table III (p. 63) shows prevailing risk seeking for losses (outcome is time delay), with 98 preferring risk and 44 preferring safety.

correlation risk & ambiguity attitude: find strong positive relation between ambiguity aversion for losses and risk aversion (regarding delay of outcome). %}

Chesson, Harrell W. & W. Kip Viscusi (2003) "Commonalities in Time and Ambiguity Aversion for Long-Term Risks," *Theory and Decision* 54, 57–71.

{% Considers, within EU, relative risk aversion parameter. Relates it to labor supply, where, if risk aversion were very big, wage elasticity would be unrealistically small because people would derive too little extra utility from extra income. Controls contrary phenomenon where more consumption would make work much easier to do. Seems that data on labor supply support relative risk aversion not exceeding 2. %}

Chetty, Raj (2006) "A New Method of Estimating Risk Aversion," *American Economic Review* 96, 1821–1834.

{% Discusses policy implications of behavioral economics. %}

Chetty, Raj (2015) "Behavioral Economics and Public Policy: A Pragmatic Perspective," *American Economic Review: Papers & Proceedings*, 105, 1–33.

{% %}

Cheung, Ka Chun (2008) “Characterization of Comonotonicity Using Convex Order,” *Insurance: Mathematics and Economics* 43, 403–406.

{% If sum of variables is comonotonic sum, then variables must be comonotonic. Several variations and generalizations are given. %}

Cheung, Ka Chun (2010) “Characterizing a Comonotonic Random Vector by the Distribution of the Sum of Its Components,” *Insurance: Mathematics and Economics* 47, 130–136.

{% %}

Cheung, Ka Chun, Sheung Chi Phillip Yam, Fei Lung Yuen, & Yiying Zhang (2020) “Concave Distortion Risk Minimizing Reinsurance Design under Adverse Selection,” *Insurance: Mathematics and Economics* 91, 155–165.

{% **restrictiveness of monotonicity/weak separability**: This paper replicates experiments by Andreoni & Sprenger (2012) and Andersen et al. (2008) for choices that are both risky and intertemporal. When dealing with time and risk, A&S implicitly first aggregated over timepoints (conditioning on risky events). This implies a sort of weak separability, i.e., separability of each single risky event which, in particular, precludes hedging considerations across different timepoints. It also requires correlated lotteries for different timepoints, and A&S’s mistake was that in their experiment they instead implemented the lotteries stochastically independently.

This paper changes correlations/dependencies to correct for hedging possibilities, and also considers choice lists instead of the convex choice sets of A&S. Then differences in utility curvature are reduced or disappear. It implies that this paper uses EU to analyze risky choice (p. 2249b 3rd para says it implicitly), which is empirically problematic. Epper, Fehr-Duda, & Bruhin (2011) used PT for this purpose. Several papers by Ayse Öncüler also considered interactions between intertemporal and risk, showing that the effects of either are reduced in the context of the other.

Related comments were made by Epper & Fehr-Duda (2015 AER) and Miao & Zhong (AER 2015). %}

Cheung, Stephen L. (2015) "Risk Preferences Are not Time Preferences: On the Elicitation of Time Preference under Conditions of Risk: Comment," *American Economic Review* 105, 2242–2260.

{% **real incentives/hypothetical choice, explicitly ignoring hypothetical literature**: states that he does so in footnote 3. %}

Cheung, Stephen L. (2016) "Recent Developments in the Experimental Elicitation of Time Preference," *Journal of Behavioral and Experimental Finance* 11, 1–8.

{% One choice list for risky choice, and six choice lists for intertemporal preference, were presented to N = 122 student subjects. EU (expected utility) and RDU (rank-dependent utility) with utility and probability weighting as free parameters are used to fit risky choice, and DU (discounted utility) with utility and discounting as free parameters is used to fit intertemporal choice. CRRA utility is always used. For risk, probabilities and not outcomes were varied in the choice list, and for time, timepoints and not outcomes were varied in the choice list.

Although it should be trivially obvious that one can directly measure utility of DU from intertemporal choices, there has been confusion in the field, mainly by the confused paper Andersen et al. (2008 Econometrica), that this might not be possible (or not desirable?). Fortunately, in the mean time there have been some papers doing it, and so does this paper. The author overstates the case on p. 494 when writing: "Unfortunately, until quite recently there were essentially no known methods to elicit the curvature of utility outside the domain of risk." Not only I, but many people have known this as standard knowledge for many decades. Here, and in other places, the author is too much focused on the confused Andersen et al. (2008 Econometrica).

The main question considered here is whether utility for risky and intertemporal choice is the same or not. The paper finds more concave utility for risk (**risky utility u = strength of preference v (or other riskless cardinal utility, often called value)**).

I am puzzled that only one choice list is considered for risky choice, essentially giving only one indifference there. It is not only problematic for reliability, but even for identifiability. P. 515, §3.7, writes: "Since there is only a single risk preference choice list, it is not possible to estimate probability weighting parameters at an individual level." So it is! You can't get two parameters (probability weighting and utility) from one data point! Most of the paper uses a representative-agent analysis, but then I think the same problem remains, contrary to what the paper suggests. The computer will generate output, but it is problematic. Therefore, I have difficulties with the risky utility estimated here.

Section 3.4 considers the interesing joint estimation of risky and intertemporal choices. It only does so when assuming a common utility function and, unfortunately, gives no statistics on how allowing different utility functions compares to not doing so.

Section 3.5 considers the interesting discounted incremental utility model of Blavatskyy, and finds that it better fits data than regular discounted utility. %}

Cheung, Stephen L. (2020) "Eliciting Utility Curvature in Time Preference," *Experimental Economics* 23, 493–525. https://doi.org/10.1007/s10683-019-09621-2

{% They test time consistency, using quasi-hyperbolic discounting, to find present bias with 697 low-income Chinese students finds, for money, healthy food, and unhealthy food, with moderate correlations between them. A proper test of time consistency should be longitudinal, and that is what this paper does. The paper provides arguments against fungibility of money. (**time preference, fungibility problem**) %}

Cheung, Stephen L., Agnieszka Tymula, & Xueting Wang (2022) "Present Bias for Monetary and Dietary Rewards," *Experimental Economics* 25, 1202–1233. https://doi.org/10.1007/s10683-022-09749-8

{% **biseparable utility violated**: his weighted utility violates it.

event/outcome driven ambiguity model: outcome driven: although this paper is on risk and not uncertainty, weighted utility does have the spirit of being outcome driven.

This paper axiomatizes weighted utility. This paper explains how the mathematical theory of generalized means (quasilinear means), part of functional equations, can be applied to decision under risk by letting certainty equivalents be such generalized means. P. 1066 end of 1st para: "In general, the received expected utility hypothesis is equivalent to adopting the quasilinear mean as a model of certainty equivalence."

It then characterizes the certainty equivalent of weighted utility.

P. 1068 Property 3 shows that vNM independence (in the form of substitution), the condition of decision theory, is essentially the same as quasilinearity of functional equations, as indicated in the last lines of p. 1068.

P. 1070 propagates continuity just by restating its definition.

Theorem 1 axiomatizes the quasilinear mean, being the certainty equivalent of EU, citing Hardy, Littlewood, & Polya (1934) for it. It is sloppy in not stating any continuity (axiom 4) of the functional. Continuity is restrictive because it refers is continuity in distribution, which imposes restrictions both in the probability dimension and in the outcome dimension.

P. 1077 2/3: quasilinear mean well defined iff utility (often denoted U; denoted φ in this paper) is bounded.

P. 1080 1/5 nicely cites Hardy, Littlewood, & Polya as preceding Pratt on more risk aversion iff utility is convex transformation. %}

Chew, Soo Hong (1983) "A Generalization of the Quasilinear Mean with Applications to the Measurement of Income Inequality and Decision Theory Resolving the Allais Paradox," *Econometrica* 51, 1065–1092. https://doi.org/10.2307/1912052

{% %}

Chew, Soo Hong (1985) "An Axiomatization of the Rank-Dependent Quasilinear Mean Generalizing the Gini Mean and the Quasilinear Mean," Economics Working paper # 156, Johns Hopkins University.

{% In this paper, increasing is strictly increasing.

P. 3 ℓ. 10: convergence is not easy to see if F has no compact support.

P. 8 ℓℓ. 5-6: This claim is not at all obvious. Requires some establishing of φ(α) = 1/2, will have to invoke weak commutativity. plus α as solution to Eq. 4.1. Problem will be that Eq. 4.1 has only been shown for that x,y there.

P. 9: I do not know Theorem O.

P. 9 Theorem 1: Isn't finite support required?

P. 12 middle: why does the limit not depend on the choice of $\{K_n\}$?

P. 14 ℓ. 4: what if $v'(x) = 0$? Problems can arise if v is not absolutely continuous.

%}

Chew, Soo Hong (1989) "An Axiomatization of the Rank-Dependent Quasilinear Mean Generalizing the Gini Mean and the Quasilinear Mean," unpublished manuscript, Johns Hopkins University and Tulane University.

Rewritten version of

Chew, Soo Hong (1985) "An Axiomatization of the Rank-Dependent Quasilinear Mean Generalizing the Gini Mean and the Quasilinear Mean," Economics Working paper # 156, Johns Hopkins University.

http://personal.eur.nl/Wakker/refs//pdf/chew(1989).pdf

{% %}

Chew, Soo Hong (1989) "The Rank-Dependent Quasilinear Mean," Unpublished manuscript, Department of Economics, University of California, Irvine, USA.

Yet another rewritten version of (the 1989 version of)

Chew, Soo Hong (1985) "An Axiomatization of the Rank-Dependent Quasilinear Mean Generalizing the Gini Mean and the Quasilinear Mean," Economics Working paper # 156, Johns Hopkins University.

{% %}

Chew, Soo Hong (1989) "Axiomatic Utility Theories with the Betweenness Property," *Annals of Operations Research* 19, 273–298.

{% **suspicion under ambiguity**: although the paper is not clear and explicit about it, it looks like subjects could choose the color or odd/even to gamble on.

Used N = 325 Beijing students. Could gamble on known vs. unkown Ellsberg urn (deck in fact), but unknown urn paid 20% more. 49.4% still chose known urn. They could also gamble on some digit in temperature being odd or even, either for their familiar Beijing temperature or for the less familiar Tokyo temperature (**natural sources of ambiguity**). Again, the unfamiliar Tokyo temperature paid 20% more. 39.6% chose Beijing temperature still. Women are more ambiguity averse and prone to familiarity bias than men (**gender differences in ambiguity attitudes**). They took blood from subjects to measure genotype. They find a

serotin transporter polymorphism to be associated with familiarity bias, and the dopamine D5 receptor gene and estrogen receptor beta gene are associated with ambiguity aversion only among women. %}

Chew, Soo Hong, Richard P. Ebstein, & Songfa Zhong (2012) "Ambiguity Aversion and Familiarity Bias: Evidence from Behavioral and Gene Association Studies," *Journal of Risk and Uncertainty* 44, 1–18. https://doi.org/10.1007/s11166-011-9134-0

{% %}

Chew, Soo Hong, Richard P. Ebstein, & Songfa Zhong (2013) "Sex-Hormone Genes and Gender Difference in Ultimatum Game: Experimental Evidence from China and Israel," *Journal of Economic Behavior and Organization* 9, 28–42. https://doi.org/10.1016/j.jebo.2013.03.008

{% %}

Chew, Soo Hong & Larry G. Epstein (1989) "Axiomatic Rank-Dependent Means," *Annals of Operations Research* 19, 299–309.

{% **dynamic consistency**

(It is best to take all conditions of this paper given a fixed first-period consumption c. Nothing in the paper considers variations in that first-period consumption.)

dynamic consistency: favors abandoning RCLA when time is physical: p. 108: "It is, after all, perfectly "rational" for an individual to prefer early or later resolution of uncertainty." They give example where consumption of information seems to be the reason. %}

Chew, Soo Hong & Larry G. Epstein (1989) "The Structure of Preferences and Attitudes towards the Timing of the Resolution of Uncertainty," *International Economic Review* 30, 103–117.

{% %}

Chew, Soo Hong & Larry G. Epstein (1989) "A Unifying Approach to Axiomatic Non-Expected Utility Theories," *Journal of Economic Theory* 49, 207–240.

{% **dynamic consistency**: **favors abandoning time consistency, so, favors sophisticated choice**; well, they at least study this approach.

dynamic consistency; **DC = stationarity** ? (according to Ahlbrecht & Weber, ZWS 115); seem to weaken what Machina (1989) calls dynamic consistency.

Clearly distinguish the thee deviations from EU through either giving up RCLA or doing precommitment or doing sophisticated (or myopic). Show how these three imply EU but do not refer to Machina (1989) or Hammond (1988) even though these works were well known to the authors.

Seem to use stationarity plus DC to get forgone-branch independence.

On basis of modeling risk aversion their axioms favor RDU over betweenness.

Give some references to old literature on intergenerational etc. %}

Chew, Soo Hong & Larry G. Epstein (1990) "Nonexpected Utility Preferences in a Temporal Framework with an Application to Consumption-Savings Behavior," *Journal of Economic Theory* 50, 54–81.

{% **dynamic consistency**; %}

Chew, Soo Hong & Larry G. Epstein (1991) "Recursive Utility under Uncertainty." *In* M. Ali Khan & Nicolas C. Yannelis (eds.) *Equilibrium Theory in Infinite Dimensional Spaces*, 352–369, Springer, Berlin.

{% **biseparable utility violated** %}

Chew, Soo Hong, Larry G. Epstein, & Uzi Segal (1991) "Mixture Symmetric and Quadratic Utility," *Econometrica* 59, 139–163.

{% %}

Chew, Soo Hong, Larry G. Epstein, & Uzi Segal (1994) "The Projective Independence Axiom," *Economic Theory* 4, 189–215.

{% **restricting representations to subsets** %}

Chew, Soo Hong, Larry G. Epstein, & Peter P. Wakker (1993) "A Unifying Approach to Axiomatic Non-Expected Utility Theories: Correction and Comment," *Journal of Economic Theory* 59, 183–188.

https://doi.org/10.1006/jeth.1993.1011

Direct link to paper

{% **dynamic consistency: favors abandoning RCLA when time is physical. Se**em to use Kreps & Porteus (1978) but in a nonEU version. %}

Chew, Soo Hong & Joanna L. Ho (1994) "Hope: An Empirical Study of Attitude toward the Timing of Uncertainty Resolution," *Journal of Risk and Uncertainty* 8, 267–288.

{% %}

Chew, Soo Hong, Wei Huang, & Xiaojian Zhao (2020) "Motivated False Memory," *Journal of Political Economy* 128, 3913–3939. https://doi.org/10.1086/709971

{% They assume different sources of uncertainty. For each source, they assume (subjective!?) expected utility maximization, but different sources use different utility functions. There is source preference for a first source over a second if and only if the second has a more concave utility function.

The model doesn't stay as simple as just written. The authors assume that the probabilities (that need not be objective so I will call them subjective) for each source are given, available, and can be used as primitives, which I find an unfortunate assumption for subjective probabilities. They thus use them to define mixture operations. $x\lambda_s y$ is a mixture of x and y, interpreted as follows. One receives x under event E and y otherwise, where E is an event from source s (the authors denote a source by a small s) with subjective probability λ_s. The result of this mixture depends on source s. They justify EU by assuming the Hernstein-Milnor (1953) axioms, which uses the subjective probabilities as inputs.

Something that complicates things is that x and y in the mixture $x\lambda_s y$ need not just be riskless outcomes but can be any act or gamble available in the domain. We thus get multistage gambles, n-stage gambles for every $n \in \mathbb{N}$. The authors assume recursive CE substitution. If the mixtures in several stages all involve the same source then we have EU and RCLA also holds. If the several stages involve the same source then in applications for subjective probabilities I expect learning to take place, but the authors do not assume that and assume that the subjective probabilities remain the same and are not impacted by learning. (Same as in Luce, 2000, who in the footnote

on p. 10 acknowledges me for pointing this learning out to him in a similar multistage setup.) %}

Chew, Soo Hong, Gavin Kader, & Wang Wenqian (2024) "Source Recursive Expected Utility on Rich Mixture Sets," working paper.

{% %}

Chew, Soo Hong & Edi Karni (1994) "Choquet Expected Utility with a Finite State Space: Commutativity and Act-Independence," *Journal of Economic Theory* 62, 469–479.
https://doi.org/10.1006/jeth.1994.1026

{% Show that, under RDU, aversion to mean-preserving spreads holds iff U concave and w convex (they use dual probability weighting, which then is concave). They assume differentiability in this. Ebert (2004) generalizes this result by not assuming differentiability but only continuity. %}

Chew, Soo Hong, Edi Karni, & Zvi Safra (1987) "Risk Aversion in the Theory of Expected Utility with Rank Dependent Probabilities," *Journal of Economic Theory* 42, 370–381.
https://doi.org/10.1016/0022-0531(87)90093-7

{% Point out that Ellsberg's ambiguity aversion is a special case of source preference. Abstract, very erroneously, writes that rank-dependent utility (= CEU for uncertainty), PT, and multiple priors satisfy probabilistic sophistication. Would imply that these models cannot accommodate Ellsberg, which of course is completely untrue. If extended to the Anscombe-Aumann framework and imposed on the whole framework there, it would imply full subjective expected utility there, thus negating the existence of Schmeidler (1989) for instance.

Paper lets subjects bet on whether a digit for some source is odd or even (suspicion is avoided because subjects can themselves choose to gamble on odd or even), and find source preference for the best-known source. (**natural sources of ambiguity**) Because the probabilities about digits can be taken as objective, this in fact is: **violation of risk/objective probability = one source**

Very very unfortunately, do ranking from bottom to top and not from top to bottom for the RDU-functional definition.

event/outcome driven ambiguity model: outcome driven:

source-dependent utility (pp. 186-187): This paper most clearly has this idea. It proposes a SDEU (source-dependent expected utility) model where they have expected utility within each source, but different utility functions. This is much in the spirit of KMM, but without the multistage complications of KMM.

losses from prior endowment mechanism: Random incentive system but for gains and losses both so that there can be income effect. Find source preference for both, and related differences in neural activities.

reflection at individual level for ambiguity: Although they have within-subject data, they do not report it in the main paper. Because they have N = 16 and there can be expected to be few ambiguity seekers for gains, the data will not give much info on it anyway. %}

Chew, Soo Hong, King King Li, Robin Chark, & Songfa Zhong (2008) "Source Preference and Ambiguity Aversion: Models and Evidence from Behavioral and Neuroimaging Experiments." *In* Daniel Houser & Kevin McCabe (eds.) *Neuroeconomics (Advances in Health Economics and Health Services Research* 20), 179–201, JAI Press, Emerald Group Publishing Limited, Bingley, UK.

{% %}

Chew, Soo Hong & Kenneth. R. MacCrimmon (1979) "Alpha-Nu Choice Theory: An Axiomatization of Expected Utility," University of British Columbia Faculty of Commerce working paper #669, July 1979.

Link to paper

{% %}

Chew, Soo Hong & Kenneth. R. MacCrimmon (1979) "Alpha Utility Theory, Lottery Composition and the Allais Paradox," University of British Columbia Faculty of Commerce working paper #686, September 1979.

Link to paper

{% This paper deserves to be a classic, with many valuable results on mean-preserving spreads. I conjecture that the, then young, Chew wanted this to be his master piece and so it is.

Their Theorem 2 (p.415) shows that, under continuity, elementary risk aversion is equivalent to aversion to mean-preserving spreads. A useful result! Elementary risk aversion concerns only simple equally-likely lotteries ($1/n{:}x_1$, …, $1/n{:}x_n$). It says that moving a small amount espsilon from a "high" outcome to its lower neighbor, without affecting their ranking, always is an improvement. It is obviously weaker than aversion to mean-preserving spreads, and also than outcome-convexity. Table II (p.418) displays that, for RDU, this is equivalent to convex w and concave U. (The paper writes g instead of w for probability weighing. Unfortunately, it does bottom-up integration for RDU rather than the nowadays (1992-2023) common top-down integration, so, it uses probability weighting in a dual manner, and its concavity is equivalent to modern convexity.)

Unfortunately, the paper does not make well clear what differentiability assumption is made in Table II. The introduction p. 404 suggests Gateaux differentiability (which under RDU is equivalent to differentiable w). P. 418 ℓ. 2-3 suggests that for RDU not any smoothness is assumed. However, the derivations on occasions assume marginal rates of substitution that are not infinite and that need ratios with denominators > 0 (p. 416 the formula between Eqs. 4.8 & 4.9), and that there are points p where the derivative g´(p) is > 0 (p. 429 last line of displayed formula in the RDU proof). This need not hold for a continuous strictly increasing continuous g (which is almost everywhere differentiable but may have derivative 0 whenever it is defined, if it is not absolutely continuous; Paradís, Viader, & Bibiloni, 2001 Theorem 3.1 give an example.), contrary to frequent confusions in the literature.

Ebert (2004, Theorem 2), unaware of this paper, with the principle of progressive transfer the same as elementary risk aversion, proved the above result for RDU without assuming any smoothness. This completely generalizes Chew, Karni, & Safra (1987) to the nonsmooth case. %}

Chew, Soo Hong & Mei-Hui Mao (1995) "A Schur-Concave Characterization of Risk Aversion for Non-Expected Utility Preferences," *Journal of Economic Theory* 67, 402–435.
https://doi.org/10.1006/jeth.1995.1079

{% Considers multiple-switching behavior (MSB) in choice-list experiment. "Irregular" ones more violate stochastic dominance, but "regular" ones more reflect nonEU and deliberate randomization. %}

Chew, Soo Hong, Bin Miao, Qiang Shen, & Songfa Zhong (2022) "Multiple-Switching Behavior in Choice-List Elicitation of Risk Preference," *Journal of Economic Theory* 204, 105510.
https://doi.org/10.1016/j.jet.2022.105510

{% This paper considers multiple priors in three ways. The set of priors, with a deck of 100 cards, and n describing number or red (winning) cards, so that objective probabilities are multiples of j/100: (1) interval ambiguity: [50-n, 50+n]; (2) disjoint ambiguity: [0,n] u [100–n,100]; (3) two-point: {n, 100–n}. Subjects consider bets on such events and, using price lists, certainty equivalents are elicited. This means that all bets considered have at most one nonzero outcome. I haven't seen implementations of multiple priors with nonconvex sets of priors before, and this is a useful phenomenon to investigate.

They also do the same stimuli but with 2nd order uniform objective probabilities given over them, which is risk and RCLA to be tested. Figure 2, p. 1251, is best to see the results.

They find strong correlations between ambiguity attitudes and RCLA violations. This comes as no surprise because the two kinds of stimuli are similar. In general, multiple prior implementations of ambiguity are a kind of two-stage already (may I add: unlike natural ambiguities), which explains much of the correlations found in the literature.

It is not easy to draw inferences about existing ambiguity models because most have no clear predictions. The only clear finding comes from the smooth ambiguity model together with ambiguity aversion (concave 2nd-order utility transformation function φ), if it is assumed that the 2-stage decomposition exogenously specified by the experimenters is the subjective one of the smooth model—but this assumption is made in all tests of the smooth model that I am aware of. The authors use the term "recursive EU" for it. Anyway, then the stimuli of this experiment are targeted so much towards this model, that predictions can come. Here they seem to find a violation: key Finding 1 (p. 1242) goes against the smooth model (recursive EU) to the favor of recursive rank-dependent utility (always assuming ambiguity aversion), as mentioned in ℓ. –7 of §1 when coupled with the common assumption of ambiguity aversion. This Key

Finding 1 is: aversion to increasing number of possible compositions for interval and disjoint ambiguity, and aversion to increasing spread in two-point ambiguity except near the end-point.

No predictions for existing (general) models:

(1) Choquet expected utility (CEU-I will use this term the authors' term (introduced by Wakker 1990, Theory & Decision) instead of my own preference, RDU) is (too) general because nonadditive measures can accommodate anything here.

(2) Multiple priors with α maxmin (needed empirically because maxmin EU is too pessimistic) is also (too) general. The authors, by the way, do not mention α maxmin and only maxmin EU but do not analyze it, grouping it with CEU instead.

(3) Source dependence is also too general because it is only one completely general idea, and not a theory.

(4) Recursive RDU is considerably more general than recursive EU and there are, again, (too) many nonadditive weighting functions.

Hence, the authors add assumptions to the theories, but their assumptions are, unfortunately, not empirically plausible (e.g., van de Kuilen & Trautmann 2015). Whereas on p. 1246 2nd para the authors point out that CEU in general ("Savagian [Savagean] domain") gives no predictions, they throughout assume that CEU is coupled with the Anscombe-Aumann framework. For example, see p. 1241 3rd para, using vague implicit words. I think that this is unfortunate and empirically invalid (e.g. my Wakker (2010) book §10.7.3). Comes to it that they then add the assumption of RCLA, which drives most of their predictions, but even under the EU assumption of Anscombe-Aumann RCLA need not hold. Anscombe-Aumann assumes backward induction which, if anything, goes against RCLA when deviations from EU are desirable. (Backward induction + RCLA imply vNM independence.) This point becomes especially problematic if combined with the authors' unfounded claim on p. 1247 top, that two-stage models would not distinguish between objective and subjective stage-1 priors.

Whereas on p. 1258 bottom they cite evidence for ambiguity seeking for unlikely (they call it preference for skewness), for all models they throughout assume ambiguity aversion. Van de Kuilen & Trautmann's (2015) survey cites violations, as does the keyword **ambiguity seeking** in this bibliography.

In their discussion of empirical performance they only consider fit and not parsimony; i.e., they do not correct for number of parameters. Thus, the "source perspective" as the authors call it is a general property (rather than a model; it is similar to commodity dependence of utility) that can accommodate any finding, which is why it comes out positively in Table IV on p. 1256.

Note also that, contrary to what is sometimes weakly and sometimes strongly suggested (p. 1241 middle: "Multiple prior models such as Choquet expected utility"), Choquet expected utility (CEU) is different than multiple priors—these two models only have overlap, but are not nested. It is true that for the stimuli considered here, bets with only one nonzero outcome, CEU and α maxmin coincide.

correlation risk & ambiguity attitude: find strongly positive relation but this is because both are coupled with a similar two-stage structure.

P. 1240 footnote 3: contrary to the claim there, source preference was first axiomatized by Tversky & Wakker (1995, Econometrica, §7).

P. 1244 top: subjects can choose winning color so as to avoid suspicion. (**suspicion under ambiguity**)

P. 1246 $\ell\ell$. 3-5 equate convexity of nonadditive measure with ambiguity aversion, which only holds if EU is assumed for risk. Without that, empirically failing, assumption, I qualified it as a historical accident in Wakker (2010 p. 328 penultimate para).

P. 1247 top claims that two-stage models do not distinguish between objective and subjective stage-1 priors. I am not aware of this point, only knowing the explicit deviation of it by the smooth model (which the authors mention in footnote 10). The claim is repeated on p. 1258 top.

As I wrote above, CEU is too general, as are most other existing theories. Developing good specifications is desirable. Unsurprisingly, I like Abdellaoui, Baillon, Placido, & Wakker's (2011) specification of the source method. We can consider a recursive version here. It would be like the recursive RDU considered in this paper, only the weighting function of the prior stage would capture ambiguity. However, for empirical purposes it would be desirable to take inverse S weighting functions rather than the convex weighting functions considered by the authors, because inverse S is empirically better. It would fit the data well. For instance, for two-point ambiguity with n = 0 we'd just have risk transformation of 0.5, giving the high 0.8 in Figure 2 (left), and for n = 50 we'd only have uncertainty of the prior stage, i.e., ambiguity transformation of 0.5, being lower than the 0.8 of risk. For n = 25 we'd have transformations at both stages, giving the worst result. As for transformation in the 2nd stage, the probability 0.75 is underweighted by the certainty effect and the probability 0.25 is a bit overweighed by the possibility effect but the latter is much less.

testing color symmetry in Ellsberg urn: they seem to confirm it.

I next discuss the reference Wakker (1987) on p. 1246.

It is downloadable from

https://personal.eur.nl/Wakker/pdf/nonaddprobs_der.str.prfs1987.pdf

In those days, Chew and I, young, were among the very few to know about maths of nonEU. He was almost the only human being I could communicate with on many topics. The paper cited there was finished as first draft on Dec. 31, 1986, and I consider it one of the best I ever wrote. I then sent it to Chew and Yaari, asking for comments. Chew and I communicated frequently, stayed in each others' houses, where he conquered my heart by taking me to Vietnamese restaurants in Toronto and later in Los Angeles, and so on. It is nice to see that Chew still remembers it. My paper has been taken apart and rewritten into several different papers after, and my 2010 book is close to it but, à la, more up to date.

☺ ==========================%}

Chew, Soo Hong, Bin Miao, & Songfa Zhong (2017) "Partial Ambiguity," *Econometrica*, 85, 1239–1260.
https://doi.org/10.3982/ECTA13239

{% They compare ambiguity aversion/source preference for Ellsberg known urns, RCLA, and trailing digit of foreign vs. home city being odd or even ("natural uncertainty"), finding strong relations between all. N ≥ 2000 subjects!

Funny start of paper: "The proverbial urn …"

Footnote 3 criticizes Smith (1969) who suggested that utility for the known Ellsberg be higher than for the unknown, arguing that both functions are interval scales so that their absolute levels are meaningless. I disagree with the authors' criticism. The two functions will be unique up to a joint unit and scale, so that Smith's comparisons are meaningful still. I do not find Smith's idea very valuable, e.g. when applied to constant acts, but it is meaningful.

P. 1140, as usual in many papers, treats KMM's smooth model as recursive expected utility. %}

Chew, Soo Hong, Bin Miao, & Songfa Zhong (2023) "Ellsberg Meets Keynes at an Urn," *Quantitative Economics* 14, 1133–1162.
https://doi.org/10.3982/QE2253

{% %}

Chew, Soo Hong & Naoko Nishimura (1992) "Differentiability, Comparative Statics and Non-Expected Utility Preferences," *Journal of Economic Theory* 56, 294–312.

{% N = 3,583 subjects collected online. This paper presents Ellsberg 2-urn choices in a somewhat complex manner, using matrices. It uses a test question to see if subjects understand the matrices. Those who do, exhibit the usual ambiguity aversion. Those who don't, are close to fifty-fifty. A naïve interpretation would be to say that not-understanding subjects are less ambiguity averse and, maybe, even more rational. This is of course an incorrect interpretation. The not-understanding subjects are just behaving randomly. Their data is not ambiguity neutrality but mere noise. Funny.

The authors also distinguish between ambiguity-minded subjects, reluctant to assign probabilities to the unknown urn, and probability minded, who are willing to. The former are extremely ambiguity averse (84%!) and the latter not at all (31%). Remarkably, the ambiguity-minded are younger, and more educated, analytic, and reflective, suggesting that they are more rational which would be bad news for Bayesians like me. But my interpretations are very different. Being ambiguity minded or probability minded is measured through the following questions Qk and Qu:

"Qk- the subject is asked to quantify the probability of drawing a red card from 'Deck no. 1', which contains exactly ten red cards and ten black cards. The six available response alternatives include: 0%, 25%, 50%, 75%, 100%, and 'Cannot be determined'. The only satisfactory response is '50%'.

Qu– the subject is asked to quantify the probability of drawing a red card from 'Deck no. 2', which contains exactly twenty *red* [cards] with an unknown mix of red and black cards. The six available response alternatives are the same as in Qk. Satisfactory responses are '50%' or 'Cannot be determined'." [italics added here and is a typo]

Answer 50% to question Qu means probability minded and answer "Cannot be determined" is ambiguity minded. Main problem is that the authors' term probability here makes subjects think of objective probability related to composition of urn. I as 100% Bayesian would answer "Cannot be determined" because I think the experimenters have in mind not my subjective probability but an objective one. The more so as the multiple choice framing suggests that there may exist a correct objective answer, and subjective probabilities can deviate from the categories offered (e.g. if I (think to) know about experimenters' color preferences). So, subjects categorized as ambiguity minded need not at all be so. A second problem is that these questions prime subjects to dislike unknown objective probabilities, generating false ambiguity aversion. This explains the extreme 84% ambiguity aversion found among the ambiguity minded. %}

Chew, Soo Hong, Mark Ratchford, & Jacob S. Sagi (2018) "You Need to Recognise Ambiguity to Avoid It," *Economic Journal* 128, 2480–2506. https://doi.org/10.1111/ecoj.12541

{% The original 2003 working paper contained nice ideas about **small worlds**—what Tversky would call sources of uncertainty—and their comparisons. Unfortunately, Econometrica had the authors take out these interesting ideas, reducing the paper to a, nice indeed, definition of exchangeability, but other than that a technical generalization of probabilistic sophistication to the case of no stochastic dominance and with continuity weakened somewhat by replacing it by solvability, along the well-known techniques of Krantz et al. (1971). The move from continuity to solvability is discussed in more detail by Wakker (1988, Journal of Mathematical Psychology). Econometrica let the authors take out the most valuable idea, and made the main theorem and the main intuition become disconnected! The second part of the paper, with the valuable idea of variable source, thus only appeared in their 2008 JET paper.

Basically, the authors define two events as equally likely if they are exchangeable in the sense that their outcomes can be switched without affecting preference. Monotonicity need not be brought in separately because it automatically follows from set-inclusion. Thus, an event is more likely than another if the former contains a subset exchangeable with the latter. The general idea of using the set-theoretic structure on the state space because it is automatically there is discussed in more detail by Abdellaoui & Wakker (2005, Theory and Decision). %}

Chew, Soo Hong & Jacob Sagi (2006) "Event Exchangeability: Probabilistic Sophistication without Continuity or Monotonicity," *Econometrica* 74, 771–786. https://doi.org/10.1111/j.1468-0262.2006.00682.x

First version (which was later split up into the above paper and their 2008 JET paper): Chew, Soo Hong & Jacob Sagi (2003) "Small Worlds: Modeling Attitudes towards Sources of Uncertainty," Haas School of Business, University of California, Berkeley, CA.

{% %}

Chew, Soo Hong & Jacob Sagi (2006) "Small Worlds: Modeling Attitudes towards Sources of Uncertainty," Haas School of Business, University of California, Berkeley, CA; version of June 2006.

{% They consider subdomains of the event space, sources, the concept first advanced by Amos Tversky, with which Tversky influenced not only me but also Chew (and Craig Fox) in the early 1990s (see Chew & Tversky 1990). So, this is a paper in the right spirit and I like it much!

I think that Savage's **small worlds** is too much a different idea than source so that I disagree with the authors linking with small worlds. Savage's small worlds serve for cases where the grand-world is too complex, and then the agent takes a small world, the best modeling of reality he can. So, there is only one small world. If different small worlds then Savage surely would not want inconsistent probability assessments between them, but he would treat the small world as consistent with the grand world. Savage wants whatever can be considered to consistently satisfy his axioms.

The authors take sources not as partitions of the whole state space, but as partitions of subevents of the state space, taking the overall subevent as a conditioning event. They call it conditional small world event domain. I regret this move because it confounds the source concept with issues of conditioning and dynamic decisions. (Even if conditioning is important, one does not want to mix it in with every static concept.) Probably the authors made this move so as to have something easy to say on the Ellsberg's 3-color paradox.

They also define a collection of events as a conditional small world event domain only if probabilistic sophistication holds there. On their conditioned events they call probabilistic sophistication homogeneous, where Wakker (2008, New Palgrave) used the term uniform for the unconditioned-source concept of probabilistic sophistication.

They derive their representation of probabilistic sophistication on λ-systems, which is more general than the conventional algebras. Abdellaoui & Wakker (2005, Theorem 5.5) derive probabilistic sophistication for the more general mosaics of events, like Chew & Sagi using also solvability instead of the more restrictive continuity. Chew & Sagi are more general in considering conditionings and in relaxing monotonicity.

In §4 they call events of (homogeneous) conditional small world event domains EB-unambigous, where EB abbreviates exchangeability-based. Argue that if there are more EB unambiguous sources, as in the Ellsberg 2-color paradox, then we need extraneous info to determine what is really unambiguous, so that EB unambiguous need not really be unambiguity. (I think that we ALWAYS need such extraneous info.) I regret, if it is not unambiguous, that the authors still use this term unambiguous. In §4 they have to spend much space on discussing the, I think wrong, definition of Epstein & Zhang.

Unfortunately, the authors ascribe source dependence to risk attitude, and write that the risk attitude depends on the source of ambiguity, which is something like a contradictio in terminis. Abdellaoui et al. (2011 American Economic Review) used a source function to reflect ambiguity attitude. %}

Chew, Soo Hong & Jacob S. Sagi (2008) "Small Worlds: Modeling Attitudes toward Sources of Uncertainty," *Journal of Economic Theory* 139, 1–24. https://doi.org/10.1016/j.jet.2007.07.004

{% Consider inequality with risk, and one-parameter extension of the generalized Gini mean, with a quadratic term for inter-personal correlations (in spirit of

quadratic utility of Chew, Epstein, & Segal 1991), accommodating “shared destiny,” preference for probabilistic mixtures over unfair allocations, and for fairnes “for sure” over fairness in expectation. They essentially use an Anscombe-Aumann framework, reinterpreting the horses in a horse race as people in society. %}

Chew, Soo Hong & Jacob S. Sagi (2012) “An Inequality Measure for Stochastic Allocations,” *Journal of Economic Theory* 147, 1517–1544. https://doi.org/10.1016/j.jet.2011.05.002

{% %}

Chew, Soo Hong & Jacob S. Sagi (2022) “A Critical Look at the Aumann-Serrano and Foster-Hart Measures of Riskiness,” *Economic Theory* 74, 397–422. https://doi.org/10.1007/s00199-022-01451-3

{% Use Chew’s weighted utility, instead of RDU or PT, to model the coexistence of gambling and insurance. Analyze economic implications and refer to experimental findings.

§1, p. 1011, top para, suggests that RDU (Called RDEU here) cannot accommodate longshot preference behavior under tractable functional forms (“we have not been able to …”). I am puzzled about this claim. All common functional forms, such as in Tversky & Kahneman (1992), were primarily developed to do so, and can qualify as tractable. The same para, and also §2.3 (including footnote 6) point out that RDU cannot combine global risk aversion for small stakes with some risk seeking for large stakes. This is very true. There is empirical evidence for risk seeking (fourfold pattern). Now, had the authors also had empirical evidence for global risk aversion for small stakes, then they had had a point. But they don’t mention any such evidence. When choosing between 1 cent for sure, or a 1/1000 chance at $10, will people be risk seeking? Problem is that the choice options are too small to be of interest to anyone. There may be risk seeking for joy of gambling.

For limits as in Chew & Tan’s p. 1016, it is well known that the probability-weighting function of T&K’92 does not exhibit the desirable subproportionality. Tversky was enthusiastic about the families developed by Prelec that can satisfy this. %}

Chew, Soo Hong & Guofu Tan (2005) "The Market for Sweepstakes," *Review of Economic Studies* 72, 1009–1029.
https://doi.org/10.1111/0034-6527.00359

{% Presented by Tversky at FUR, 1990; never finished because of mathematical problems in the main axiom, which is too strong. Its problem is as follows. It is a sign-dependent bisymmetry axiom also used by

Chew, Soo Hong (1989) "An Axiomatization of the Rank-Dependent Quasilinear Mean Generalizing the Gini Mean and the Quasilinear Mean," unpublished manuscript, Johns Hopkins University and Tulane University.

This condition essentially uses certainty-equivalent substitution. However, for mixed prospects it will lead to either positive of negative certainty equivalents, in both cases not restricting to either only gains or either only losses. Hence, unlike "my" tradeoff consistency, it cannot easily handle sign dependence. %}
Chew, Soo Hong & Amos Tversky (1990) "Cumulative Prospect Theory: Reference-Dependent Axiomatization of Decision under Uncertainty." In preparation (never completed), Stanford University; presented by Tversky at the 5th Foundations of Utility and Risk (FUR) conference, Duke University, Durham NC, 1990.

{% Greco, Matarazzo, & Giove (2011) will independently reinvent the functional of this paper for linear utility. %}
Chew, Soo Hong & Peter P. Wakker (1996) "The Comonotonic Sure-Thing Principle," *Journal of Risk and Uncertainty* 12, 5–27.
https://doi.org/10.1007/BF00353328
Direct link to paper

{% Harless & Camerer (1994, p. 1273) argues that nonexpected theories other than weighted utility explain the data better.

inverse S: as explained by Wakker (2001, Econometrica), the data of this paper, if analyzed through new (1992) prospect, support inverse S probability weighting.

real incentives: not used, flat payment. %}

Chew, Soo Hong & William S. Waller (1986) "Empirical Tests of Weighted Utility Theory," *Journal of Mathematical Psychology* 30, 55–72. https://doi.org/10.1016/0022-2496(86)90042-8

{% Under the state-dependent generalization of Savage's (1954) SEU, subjective probabilities are nonidentifiable, as is well known. This readily extends to general betweenness nonEU models. For the extension to rank-dependent models, a delicate question is how one takes the rank-ordering of outcomes, at least if outcomes are money. By their utilities or by the money amounts? This paper only considers the latter, without discussing it. Chiu (1996, *Geneva Papers on Risk and Insurance Theory* 21) did it the other way, getting real generalizations. This paper shows that we cannot do the linear rescaling of utility/probability underlying the nonidentifiability in SEU in rank dependence. So, in that sense state-dependence is not possible under rank-dependence. However, more general forms of state-dependent utility with nonidentifiable weighting functions are possible, as for instance in Chew & Wakker (1996 JRU). They have a state-dependent utility or, equivalently, an outcome-dependent weighting function. %}

Chew, Soo Hong & Wenqian Wang (2020) "On the Robustness of Indeterminacy in Subjective Probability," *Economics Letters* 188, 108939.

{% **cognitive ability related to discounting**: higher school education gives less impatience and less time inconsistency

cognitive ability related to risk/ambiguity aversion: High school education gives, paradoxically, more Allais paradox and more ambiguity aversion than with dropouts. But less risk aversion. Use 70 Chinese twins in this experiment. Unfortunately, whereas most other choices were incentivized, those on the Allais paradox, longshot choices, and intertemporal were not due to practical limitations. This could give a contrast effect, with the nonincentivized not taken seriously.

Longshot was by lottery tickets with winning probability 1/100,000 and smaller.

Ambiguity: subjects could bet whether temperature in Bejing would be odd or even, and whether temperature in Tokyo would be odd or even. %}

Chew, Soo Hong, Junjian Yi, Junsen Zhang, & Songfa Zhong (2016) "Education and Anomalies in Decision Making: Experimental Evidence from Chinese Adult Twins," *Journal of Risk and Uncertainty* 53, 163–200. https://doi.org/10.1007/s11166-016-9246-7

{% %}

Chew, Soo Hong, Junjia Yi, Junsen Zhang, & Songfa Zhong (2018) "Risk Aversion and Son Preference: Experimental Evidence from Chinese Twin Parents," *Management Science* 64, 3896–3910. https://doi.org/10.1287/mnsc.2017.2779

{% %}

Chew, Soo Hong & Itzhak Zilcha (1990) "Invariance of the Efficient Set when the Expected Utility Hypothesis Is Relaxed," *Journal of Economic Behavior and Organization* 13, 125–132.

{% **Z&Z** %}

Chiappori, Pierre-André, Frank Durand, & Pierre-Yves Geoffard (1998) "Moral Hazard and the Demand for Physician Services: First Lessons from a French Natural Experiment," *European Economic Review* 42, 499–511.

{% %}

Chiappori, Pierre-André, Amit Gandhi, Bernard Salanié, & Francois Salanié (2009) "Identifying Preferences under Risk from Discrete Choices," *American Economic Review, Papers and Proceedings* 99, 356–362.

{% Empirical data on penalty kicks, their scores, direction, etc. %}

Chiappori, Pierre-André, Steven D. Levitt, & Tim Groseclose (2002) "Testing Mixed-Strategy Equilibria when Players Are Heterogeneous: The Case of Penalty Kicks in Soccer," *American Economic Review* 92, 1138–1151.

{% They show that distributions of individual risk attitudes can be recovered from market data, more precisely, horse race betting, without individual data needed, if enough assumptions: That sufficiently many market equilibria can be observed (sufficiently many probabilities and corresponding odds), that individual risk attitudes satisfy a single-crossing condition, that individuals bet a fixed amount (p. 22), that they satisfy the rational expectations assumption (p. 12) of going by true probabilities (even if in reality they don't know them), and that they do not change between different markets. They apply their technique to a dataset of 25,000 races. The abstract writes: "We estimate the model on data from U.S. races. Specifications based on expected utility fit the data very poorly. Our results stress the crucial importance of nonlinear probability weighting."

P. 2: under risk neutrality, betting odds would be proportional to winning probabilities.

P. 4: besides rank-dependent utility (RDU) - the authors write the inefficient RDEU - also something called NEU works well, but the authors never define what NEU means.

P. 12: "We could also incorporate ambiguity-aversion in the "exponential tilting" form introduced by Hansen and Sargent (e.g., in their 2007 book, or Hansen (2007)). However, in our very simple choice problems with static decision-making, it is observationally equivalent to increased risk-aversion." This is useful for the source method!

P. 24: they do not even commit to the very general HARA family because it predicts a fanning out not holding in the data.

P. 28: unfortunately, the authors follow the tradition of finance of letting "preference" refer to utility.

P. 30: "We could, of course, resort to parametric specifications, but this is precisely what we have tried to avoid in this paper." I guess that they take every point in the domain as a separate parameter? Not clear to me. %}

Chiappori, Pierre-André, Bernard Salanié, François Salanié, & Amit Gandhi (2019) "From Aggregate Betting Data to Individual Risk Preferences," *Econometrica* 87, 1–36.

{% Savage (1954) (casually, just to simplify maths) and de Finetti (1974) (very deliberately), used finitely additive and not countably additive probabilities in expected utility. By Yosida & Hewitt (1952), the finitely additive probability can be decomposed into a countably additive measure, and a purely finitely additive measure. For example, the latter can be ℕ (natural numbers) with every finite set having measure 0 but yet ℕ having measure 1. For the latter measure, all mass

seems to have escaped to infinity.

The author of this paper considers models as just described. She refers only to Arrow (1971), who gave an adaptation of Savage (1954) with countable additivity. She then presents the finitely additive case of de Finetti and Savage as different than Arrow, but presents it as new, unaware that de Finetti and Savage already did **finite additivity**. She interprets the purely finitely additive part as extreme event. Problem is that an extreme event is to be qualified by an exteme *outcome*, obviously depending on the act chosen, and this is not captured by the model of the author. %}

Chichilnisky, Graciela (2000) "An Axiomatic Approach to Choice under Uncertainty with Catastrophic Risks," *Resource and Energy Economics* 22, 221–231.

{% %}

Chichilnisky, Graciela (2009) "The Influence of Fear in Decisions: Experimental Evidence," *Journal of Risk and Uncertainty* 39, 271–298.

{% Applies her 2000 model to foundations of statistics. The rare events, captured by strictly finitely additive measures, are called black swans. As in the 2000 model, they are not related to the outcomes that they generate and those need not be bad or good or extreme. %}

Chichilnisky, Graciela (2009) "The Foundations of Statistics with Black Swans," *Mathematical Social Sciences* 59, 184–192.

{% %}

Chick, Stephen, Martin Forster, & Paolo Pertile (2017) "A Bayesian Decision Theoretic Model of Sequential Experimentation with Delayed Response," *Journal of the Royal Statistical Society, Ser. B* 79, 1439–1462.

{% **game theory can/cannot be viewed as decision under uncertainty**:

I read a preliminary version of January 2018.

This paper follows up on Heinemann, Nagel, & Ockenfels (2009 RESTUD), HNO henceforth, and Nagel, Brovelli, Heinemann, & Coricelli (2018), NBHC henceforth. They consider a stag hunt game, an entry game, and risky lotteries determining their certainty equivalents (CEs), as described in my annotations of

NBHC. In addition, and this is the novelty relative to NBHC, they measure a CE for an ambiguous lottery, coming from an Ellsberg urn generated by a two-stage lottery after the first stage has been implemented but not revealed. They find that the CEs of stag hunt are highest, then risk, then ex aequo ambiguity and entry game. As did NBHC, they find more choice switches in the (unconventional) choice lists for the entry game. In the version that I read, they did not report correlations or regressions and based their conclusions solely on compared CEs. %}

Chierchia, Gabriele, Rosemarie Nagel, and Giorgio Coricelli (2018) "Betting 'on Nature' or 'Betting on Others': Anti-Coordination Induces Uniquely High Levels of Entropy," *Scientific Reports* 8, 3514. https://doi.org/10.1038/s41598-018-21962-1

{% %}

Childs, Andrew M. (2010) "On the Relationship between Continuous- and Discrete-Time Quantum Walk," *Communications in Mathematical Physics* 294, 581–603.

{% Pp. 3-4 summarizes explanations of WTP/WTA discrepancies. In my terminology, the 1st (p. 3 2nd para) is the rational basic utility (fitting within neoclassical theory), the 2nd (p. 3 3rd para) is the irrational framing/loss aversion of prospect theory, and the 3rd (p. 3 4th and last para) is a bargaining attitude of the subjects when answering.

4th (p. 4 1st para): subjects may guess favorable market prices rather than their value. (I add: if you do not buy for a given price, can always buy it 5 minutes later in the next store.)

This paper really addresses the interesting question whether utility is really kinked at the reference point, or only in general is very concave. This is not very relevant to the main question claimed in the paper. If utility is not kinked but still very concave about the reference point, then still the MRS (marginal rate of substitution) between money and life years changes much around the reference point and we have no clear MRS.

P. 4 last para suggests that marginal utility of wealth can be assumed constant for the small stakes they consider. But then how can the WTA/WTP ratio still change as stakes get smaller?

They use the nice Cherry et al. (2003) idea of first making subjects rational in an (incentivized) experiment, hoping for spillover to their real experiment.

The negative weights in Table 7 are hard to understand. Do they support the claimed weight 1? %}

Chilton, Susan, Michael Jones-Lee, Rebecca McDonald, & Hugh Metcalf (2012) "Does the WTA/WTP Ratio Diminish as the Severity of a Health Complaint Is Reduced? Testing for Smoothness of the Underlying Utility of Wealth Function," *Journal of Risk and Uncertainty* 45, 1–24.

{% **PE doesn't do well. %**}

Chilton, Susan & Anne Spencer (2001) "Empirical Evidence of Inconsistency in Standard Gamble Choices under Direct and Indirect Elicitation Methods," *Swiss Journal of Economics* 137, 65–86.

{% Gotten from Stefan in Feb'05. Discusses biases/heuristics à la representativeness and anchoring, illustrate them through some examples such as earthquake, and in the appendix develop a formal model for finance that incorporates heuristic **updating under ambiguity** %}

Chiodo, Abbigail J., Massimo Guidolin, Michael T. Owyang, & Makoto Shimoji (2004) "Subjective Probabilities: Psychological Theories and Economic Applications," *Federal Reserve Bank of St. Louis Review* 86, 33–47.

{% Considers lexicographic EU. %}

Chipman, John S. (1960) "The Foundations of Utility," *Econometrica* 28, 193–224.

{% The first two pages discuss in detail that probabilities are often unknown. However, the author does not use it to show that Savage's (1954) subjective expected utility, and its axioms, are violated. He only uses it to argue that choices are not deterministic but probabilistic. He does an experiment, with 10 subjects and real incentives, with unknown probabilities but only to test stochastic choice and stochastic choice he also analyzes mathematically in some detail.

ambiguity seeking for unlikely: Subjects can gamble on an event with known probability p and on event with unknown probability but with observed relative frequency of p. For p ≥ 0.5 they prefer the known distribution but for p < 0.5 they

prefer the unknown event. Note that this finding need !not! designate ambiguity seeking and in fact can be explained by SEU because the subjective probability depends not only on the observed relative frequency but also on the belief prior to the observed frequency.

It was real payment with the possibility of losses. If paricipants lost too much then they were offered favorable gambles. This procedure constitutes a mild form of deceiving subjects. (**deception when implementing real incentives**) Funnily, p. 80 writes that if subjects had won an "unduly large amount of money," unfavorable gambles were presented to them.

Pp. 87-88: the two paras there, under the heading "bias towards one-half," write briefly, interestingly, about ambiguity attitudes. P. 87 writes,: "One of the most striking features shown by the data is a tendency for individuals to bias unknown probabilities towards one-half." (**inverse S & uncertainty amplifies risk**) It also describes ambiguity aversion for events that are revealed-as -likely as their complement. %}

Chipman, John S. (1960) "Stochastic Choice and Subjective Probability." *In* Dorothy Willner (ed.) *Decisions, Values and Groups Vol. 1*, 70–95. Pergamon Press, New York.
http://personal.eur.nl/Wakker/refs//pdf/chipman(1960).pdf

{% %}

Chipman, John S. (1971) "On the Lexicographic Representation of Preference Orderings." *In* John S. Chipman, Leonid Hurwicz, Marcel K. Richter, & Hugo F. Sonnenschein (eds.) "*Preferences, Utility, and Demand,*" 276–288, Hartcourt, New York.

{% **revealed preference** %}

Chipman, John S., Leonid Hurwicz, Marcel K. Richter, & Hugo F. Sonnenschein (1971, eds.) "*Preferences, Utility, and Demand.*" Hartcourt, New York.

{% %}

Chipman, John S., Daniel L. McFadden, & Marcel K. Richter (1990, eds.) "*Preferences, Uncertainty, and Optimality.*" Westview Press, Boulder CO.

{% **survey on nonEU** %}
Chiu, Andrew & George Wu (2010) “Prospect Theory.” *In* James J. Cochran (ed.), *Wiley Encyclopedia of Operations Research and Management Science*, 1–9 (electronic), Wiley, New York.

{% Lets rank-ordering be according to state-dependent U(x,s) of outcome x at state s (Chew & Wakker (1996) use the alternative method, rank-ordering according to the outcomes themselves), does not give a preference axiomatization. %}
Chiu, W. Henry (1996) “Risk Aversion with State-Dependent Preferences in the Rank-Dependent Expected Utility Theory,” *Geneva Papers on Risk and Insurance Theory* 21, 159–177.

{% Extends results of Pratt-Arrow and Ross. %}
Chiu, W. Henry (2005) “Skewness Preference, Risk Aversion, and the Precedence Relations on Stochastic Changes,” *Management Science* 51, 1816–1828.

{% Formulates conditions implying that preferences depend only on 1st, 2nd, and 3rd moments of distributions (the latter through prudence). Uses a well-known result of van Zwet (1964) about convex transformations of distribution functions.
Eq. 1 p. 115 gives, for two prospects, a decomposition into only the expectation-difference, only a 2nd moment difference, and only a 3rd moment difference. %}
Chiu, W. Henry (2010) “Skewness Preference, Risk Taking and Expected Utility Maximisation,” *Geneva Risk and Insurance Review* 35, 108–129.

{% Alternative preference conditions to characterize signs of nth derivatives of utility. %}
Chiu, W. Henry, Louis Eeckhoudt, & Beatrice Rey (2012) “On Relative and Partial Risk Attitudes: Theory and Implications,” *Economic Theory* 50, 151–167.

{% %}
Chiu, W. Henri & Edi Karni (1998) “Endogenous Adverse Selection and Unemployment Insurance,” *Journal of Political Economy* 106, 806–827.

{% Find violations of RDU. %}

Cho, Younghee & R. Duncan Luce (1995) "Tests of Hypotheses about Certainty Equivalents and Joint Receipt of Gambles," *Organizational Behavior and Human Decision Processes* 64, 229–248.

{% %}

Cho, Younghee, R. Duncan Luce, & Detlof von Winterfeldt (1994) "Tests of Assumptions about the Joint Receipt of Gambles in Rank- and Sign-Dependent Utility Theory," *Journal of Experimental Psychology: Human Perception and Performance* 20, 931–943.

{% The paper considers intertemporal choice with a special aversion to decreases. It is modeled taking consumption at the previous time as reference point and then loss aversion. It reminds me of Gilboa (1989 Econometrica) who modeled the same thing using rank dependence. Relatedly, Wakker (2010, Example 9.3.2) pointed out that first-order risk aversion, often put forward as a virtue of rank dependence, may rather be loss aversion.

This paper analyzes optimization of consumption/portfolio. %}

Choi, Kyoung Jin, Junkee Jeon, & Hyeng Keun Koo (2022) "Intertemporal Preference with Loss Aversion: Consumption and Risk-Attitude," *Journal of Economic Theory* 200, 105380.

{% %}

Choi, Sungyong, Andrzej Ruszczynski, & Yao Zhao (2011) "A Multiproduct Risk-Averse Newsvendor with Law-Invariant Coherent Measures of Risk," *Operations Research* 59, 346–364.

{% Study choice between two-outcome prospects, not binary choice, but from a budget set, taking one commodity as payment under one state and other as payment under the other state. Subjects can thus choose from budget sets using a mouse (**revealed preference**). Giving money to subjects to invest optimally in a project consisting of an event-contingent payment has been done before, by Frans van Winden for one. But the way presented in this paper, as choices from budget sets, is new in decision under uncertainty/risk. It is easy to present to subjects and each choice of a subject gives much information. They test revealed preference axioms (i.e., whether choices are generated by a transitive preference relation), something which they do more elaborately in their follow-up paper in American Economic Review.

They write, in Eq. (1) (p. 1929) and elsewhere, that they do Gul's disappointment aversion theory. However, in reality it is **biseparable utility**, agreeing with virtually any nonEU theory presently existing, including RDU and prospect theory. Indifference curves have a kink at the certain (safe) prospect.

Boundary choice is if subjects maximize outcome for one state, taking it 0 at the other. Safe choice is if taking same payment under both states. Intermediate choice is any other. Under expected value subjects would always choose boundary (or be completely indifferent). Under biseparable utility there will be quite some at the kink of safe choice. Under virtually all theories there will be little intermediate choice. I expect (too) many such because of the compromise effect: subjects think that the truth is in the middle and, likewise, that the optimal choice will be somewhere in the middle.

I wonder if the few extreme choices found in this paper could be due to EV + error.

error theory for risky choice: §IV.E notices that maximum likelihood gives implausible results, but least squares gives plausible results.

In a paper with a new methodology it is often difficult to get much novelty otherwise. The paper has no empirical findings of particular interest. The authors put forward as "striking fact" (p. 1921 end) that they find heterogeneity among subjects, but this is the common finding. Their term loss aversion is rank dependence (kink at safety).

In their references to measurements of CRRA they exclusively refer to experimental economics studies (p. 1922 2nd column), and in American Economic Review this narrow scope is, unfortunately, considered to be acceptable.

(**Prospect theory not cited**)

They take objective probabilities 1/3, 1/2, and 2/3. I wonder if subjects treated probabilities 1/3 and 2/3 just as 1/2, as this sometimes happens, but I could not find out. %}

Choi, Syngjoo, Raymond Fisman, Douglas Gale, & Shachar Kariv (2007) "Consistency and Heterogeneity of Individual Behavior under Uncertainty," *American Economic Review* 97, 1921–1938.

{% **revealed preference** %}

Choi, Syngjoo, Raymond Fisman, Douglas Gale & Shachar Kariv (2007) "Revealing Preferences Graphically: An Old Method Gets a New Tool Kit," *American Economic Review, Papers and Proceedings* 97, 153–158.

{% **revealed preference**: Measure violations of GARP from CenTER panel, the large representative sample from the Netherlands. Consider risky choices using the budget-framing that they used in preceding studies (Choi et al. 2007). Here two equally likely states of nature, with fifty-fifty probabilities, are specified, with (x_1,x_2) the usual act. Subjects are offered randomly determined budget sets. (I don't know why they are determined randomly.) So, on the Pareto line there is a fixed exchange rate between the two states, where it is natural to take the highest payoff under the cheapest state. Expected value maximizers will just take the highest payoff under the cheapest state. The more people invest in the most expensive state of nature, so, the more they move to the riskless diagonal, the more risk averse they are.

Use RIS. They pay in points, where one point is €0.25.

GARP is equivalent to transitivity. So, it does not test EU or other particular theories. They measure violations of GARP through Afriat's (1972) Critical Cost Efficiency Index (CCEI) which is roughly how much money a person must be overpaying in a situation involved in a GARP violation, and the maximum of that in the data of a person.

There are many methodological discussions. Because GARP is equivalent to transitivity and does not involve anything else, the authors call CCEI a practical, portable, quantifiable, and economically interpretable measure (p. 1519 3rd para). The 4th para continues and the 5th then comes with the authors offering a new approach to the methodological challenges they listed before, where the paper later explains that CCEI brings all that. P. 1527: "A key advantage of the CCEI is its tight connection to economic theory. This connection makes the CCEI economically quantifiable and interpretable. Moreover, the same economic theory that inspires the measure also tells us when we have enough data to make it statistically useful. Thus, this theoretically grounded measure of decision-making quality helps us design and interpret the experiments in several ways."

P. 1530 footnote 9: As so many studies they only have two-outcome prospects and, hence, most nonEU theories agree there, where the term biseparable utility is used to express this. Or, better Miyamoto's (1988) generic utility. Strangely enough, as seems to be a convention in this field, they only cite Gul's disappointment aversion theory as a case, and not for instance the more popular Nobel-awarded prospect theory.

Violations of GARP are negatively related to wealth, education, being male, and positive to age. The correlation of violations of GARP with the trembling parameter is 0.178 (p. 1542). Find a correlation of about 0.2 between Frederic's cognitive ability index and violations of GARP (p. 1543). Derive many conclusions about "important real-world outcomes." For instance, p. 1521 end of 2nd para is none too pessimistic on relation with wealth: "We interpret the economically large, statistically significant, and quantitatively robust relationship between decision-making quality in the experiment—the consistency of the experimental data with the utility maximization model—and household wealth as evidence of decision-making ability that applies across choice domains and affects important real-world outcomes." %}

Choi, Syngjoo, Shachar Kariv, Wieland Müller, & Dan Silverman (2014) "Who Is (More) Rational?, *American Economic Review* 104, 1518–1550. http://dx.doi.org/10.1257/aer.104.6.1518

{% The paper measures certainty equivalents for five lotteries and fits 1992 prospect theory with power utility and the Goldstein-Einhorn two-parameter probability weighting. They relate these estimates to cognitive ability. They find that likelihood insensitivity is strongly negatively correlated with cognitive ability, but that pessimism is unrelated. (**cognitive ability related to likelihood insensitivity (= inverse S)**). This wonderfully supports the cognitive interpretation of likelihood insensitivity. They correct for many variables including choice error. They have two samples of about 300 subjects, where the first sample has an exceptionally wide variation in cognitive ability, and for the second they did within-subject manipulation of time pressure. %}

Choi, Syngjoo, Jeongbin Kim, Eungik Lee, & Jungmin Lee (2022) "Probability Weighting and Cognitive Ability," *Management Science* 68, 5201–5215. https://doi.org/10.1287/mnsc.2021.4146

{% Credited as an initiator of the cognitive revolution. Around 2010 there was a related debate with Peter Norvig (director of Google) on AI versus machine learning. Norvig's favored machine learning is like Skinner's behaviorism, input-output-statistics without abstract concepts, and Chomsky is more sympathetic to cognitive speculations, abstractions, introspection, homeomorphic modeling, and so on. %}
Chomsky, Noam (1959) "A Review of B.F. Skinner's Verbal Behavior," *Language* 35, 26–58.

{% Investigate to what extent finding H_0 reduces value of a finding. %}
Chopra, Felix, Ingar Haaland, Christopher Roth, & Andreas Stegmann (2024) "The Null Result Penalty," *Economic Journal* 134, 193–219. https://doi.org/10.1093/ej/uead060

{% %}
Choquet, Gustave (1953-4) "Theory of Capacities," *Annales de l'Institut Fourier* 5 (Grenoble), 131–295.

{% (in French); describes his discovery of capacity theory, and that term "capacity" comes from electrostatic capacity. %}
Choquet, Gustave (1986) "La Naissance de la Théorie des Capacités: Réflexion sur une Expérience Personelle," La Vie des Sciences, *Comptes Rendus, Série Générale* 3, 385–397.

{% Thorough study of Ellsberg paradox, following up on Fox & Tversky (1995, QJE). Fox & Tversky found that ambiguous urn receives on average the same price as unambiguous if interpersonal and suggest that intrapersonal difference may stem from contrast effect and not from ambiguity aversion. Chow & Sarin find in-between-result. Ambiguity aversion persists when studied intrapersonally, but less extremely.

Unfortunately, some of the nice experiments in early working paper versions were taken out from the published version. C&S further found in the working paper: The contrast effect accentuates the difference by decreasing the price of the ambiguous urn but as well, and maybe even stronger, by increasing the price of the known urn. The effects for the unknowable case (where it is clear that no one knows the “true” probabilities; for example, colors of M&M candies in an unopened bag or sees in an apple) is between the known and the unknown case. Contrast effects occur similarly if the known/unknown urns go to different persons but they know of each other that that happens. %}

Chow, Clare C. & Rakesh K. Sarin (2001) “Comparative Ignorance and the Ellsberg Paradox,” *Journal of Risk and Uncertainty* 22, 129–139.

{% %}

Chow, Clare C. & Rakesh K. Sarin (2002) “Known, Unknown, and Unknowable Unertainties,” *Theory and Decision* 52, 127–138.

{% P. 54: motto from 1932 till 1952 was Lord Kelvin’s maxim “science is measurement.” Then it was changed into “Theory and Measurement.” %}

Christ, Carl F. (1994) “The Cowles Commission’s Contributions to Econometrics at Chicago, 1939-1955,” *Journal of Economic Literature* 32, 30–59.

{% Does what title says, with both utility and the measure of the state space allowed to be unbounded. Characterizing conditions then always require tails to be sufficiently thin, and this paper provides proper versions. It applies them to robust ambiguity models and Epstein-Zinn preferences. %}

Christensen, Timothy M. (2022) “Existence and Uniqueness of Recursive Utilities without Boundedness,” *Journal of Economic Theory* 200, 105413.

{% Fear for dentist-effect; **dynamic consistency** (Prelec & Loewenstein, 1991, footnote 2, describe it as instationarity); **time preference** %}

Christensen-Szalanski, Jay J.J. (1984) “Discount Functions and the Measurement of Patients’ Values; Woman’s Decisions During Childbirth,” *Medical Decision Making* 4, 47–58.

{% %}

Christensen-Szalanski, Jay J.J., & Cynthia F. Willham (1989) "The Hindsight Bias: A Meta-Analysis," *Organizational Behavior and Human Decision Processes* 48, 147–168.

{% %}

Chu, Francis C. & Joseph Y. Halpern (2001) "A Decision-Theoretic Approach to Reliable Message Delivery," *Distributed Computing* 14, 1–16.

{% A follow-up paper on their 2008-Theory-and-Decision paper. This one is at a higher level of abstraction which makes it farther remote from decision-theory applications. %}

Chu, Francis C. & Joseph Y. Halpern (2004) "Great Expectations. Part II: Generalized Expected Utility as a Universal Decision Rule," *Artificial Intelligence* 59, 207–229.

{% Theorem 3.1 states a completely general representation theorem for general binary relations and decision under uncertainty. One may think, as I did when first seeing, that such a result must be of no value because it is not falsifiable. However, this result is nice because it gives a common departure for all representation theorems. It even shaped some my general thinking. It is always in the back of my mind: all representation theorems can be assumed to have been derived from this one by adding identifiers.
Link to an explanation. %}

Chu, Francis C. & Joseph Y. Halpern (2008) "Great Expectations. Part I: On the Customizability of Generalized Expected Utility," *Theory and Decision* 64, 1–36.

{% %}

Chu, Yun-Peng & Ruey-Ling Chu (1990) "The Subsidence of Preference Reversals in Simplified and Marketlike Experimental Settings: A Note," *American Economic Review* 80, 902–911.

{% %}

Chu, Po-Young, Herbert Moskowitz, & Richard T. Wong (1989) “Robust Interactive Decision-Analysis (RID): Concepts, Methodology, and System Principles,” *Proceedings of the Twenty-Second Annual Hawaii International Conference on System Sciences. Volume III: Decision Support and Knowledge Based Systems Track*,” Vol. 3, 255–261 Kailua-Kona, HI, USA.

{% Collected 10-year data in rural Paraguay. Social-preference *survey* measurements are stable, but those of risk, time, or social preferences are not. %}

Chuang, Yating & Laura Schechter (2015) “Stability of Experimental and Survey Measures of Risk, Time, and Social Preferences: A Review and Some New Results,” *Journal of Development Economics* 117, 151–170. https://doi.org/10.1016/j.jdeveco.2015.07.008

{% Consider a lottery x_py, with $0 < p < 1$ and $x > y$ monetary. The *buying price* B = $B(x_py)$ and *selling price* S = $S(x_py)$ are defined by

$(x-B)_p(y-B) \sim 0 \sim (S-y)_{1-p}(S-x)$. (*)

(So, no prior endowments. If selling, you are not first endowed with the lottery.) We assume them existing and unique. *Complementary symmetry* holds:

$B(x_py) + S(x_{1-p}y) = x + y$. (**)

Note here the switch of probabilities.

PROOF. $(S-y)_p(S-x) = (x-B+k)_p(y-B+k)$ for $k = S-y-x+B$. By uniqueness, $k = 0$. (**) follows.

The paper gives the result in Theorem 2.1. It gives a more complex proof, but this is because the paper presents further results. %}

Chudziak, Jacek (2020) “On Complementary Symmetry under Cumulative Prospect Theory,” *Journal of Mathematical Psychology* 95, 102312.

{% This paper considers RDU. It shows that for binary gambles, a particulary defined bidding price is the expected value if and only if the weighting function is of the Goldstein-Einhorn family and utility is power utility family, with relations between the parameters of the two families. %}

Chudziak, Jacek (2020) “On a Derivation of the Goldstein–Einhorn Probability Weighting,” *Aequationes Mathematicae* 94, 749–759.

https://doi.org/10.1007/s00010-020-00704-7

{% Study secretary-type problems under ambiguity, with maxmin EU. Use backward induction. %}

Chudjakow, Tatjana & Frank Riedel (2013) "The Best Choice Problem under Ambiguity," *Economic Theory* 54, 77–97.

{% Analyzes separability in bargaining, which is satisfied by the **Nash bargaining solution** but not the Kalai-Smorodinsky solution, and refers to earlier works on the condition. %}

Chun, Youngsub (2005) "The Separability Principle in Bargaining," *Economic Theory* 26, 227–235.

{% Wakker (2022, AEJ, Microeconomics) comments on this paper and argues that the authors take ordinal utilit for choices between commodity bundles as cardinal. If one takes it as ordinal then all inconsistencies disappear and one can have one consistent utility for both risky and riskless choice.

A widespread misunderstanding about Tversky & Kahneman (1992) is that their paper would only concern risk. This is not so. Their paper writes again and again that it handles both risk and uncertainty. The present Chung et al. paper cites T&K on p. 34: " … we presented a model of choice, called prospect theory, which explained the major violations of expected utility theory in choices between risky prospects with a small number of outcomes." which might suggest otherwise. However, the words on the dots are "Some time ago" and T&K were only referring to their 1979 paper for it.

risky utility u = transform of strength of preference v:

I refer to this paper as CGT. CGT compares the utility function of prospect theory, denoted U here, with a riskless utility function capturing choices over commodity bundles (x_1,x_2) denoted V here. Assuming stochastic dominance, we then have U = φ∘V for a strictly increasing φ. Unfortunately, the authors throughout overlook the essential role of φ. Thus, they come to conclude that their empirical findings about V are inconsistent with those of U, but this is not so because φ can fix everything. Details are in Wakker (2019). I add further details here.

P. 34 ℓ. -5: The text cited by T&K92 is a bit misleading because, contrary to what is suggested, it does not refer to the situation of 1992. The words on the dots omitted are: "Some time ago". T&K refer there to the situation from the past. Big change in 1992 is that they also handle uncertainty, as emphasized throughout their paper. But this is irrelevant for CGT, so I understand that they avoid it.

P. 35 middle: the first paper usually praised for extending prospect theory to riskless choice is Thaler (1980), although I must say that I do not find this in itself a very big deal.

P. 37 ℓ. 3: one of the popular clichés in the modern literature is to call any experiment "novel," and so it happens here.

A problem throughout pp. 38-40, first part of Section I, is that the authors assign meanings to (diminishing) marginal utility, concave utility, (sign of) second derivative of utility, even though utility is only ordinal, and these concepts often are not meaningful. Proposition 1 seems to come from Arrow & Enthoven (1961), and uses the second derivative of utility U, but I trust that it is correct still. Probably, even though the second derivative itself is not meaningful, the sign of its combination with partial derivatives as written there still is. There are serious problems with Assumption 1 though, which does not pass the ordinality test. The assumption amounts to saying that it is reasonable to assume that the second partial derivatives of $U(x_1,x_2)$ pragmatically determine whether rates of substitution between the two goods satisfy quasi-convexity. But this is too "non-ordinal." Given that quasi-convexity of preference is the common and most plausible case, the critical part in Assumption 1 is part (ii), and this is violated by the risky U in Wakker (2019). But the authors do not discuss it, and only discuss the less critical Part (i) in the preceding text (using nonordinal concepts), probably to suggest that Part (ii) would be the same. But it is not. To show that Assumption 1 does not pass the ordinality test, note that it is satisfied by V in Wakker (2019), but not by its ordinal transform U. On p. 39 the authors qualify utility functions that do not satisfy Assumption 1.i as "monomaniacal." If they also qualify violations of Assumption 1.ii as such, then U of Wakker (2019) is monomaniacal, but its ordinal transform V is not, showing that the authors' monomaniacality is not an ordinal property.

Similarly as above, p. 40 Proposition 2 statement (ii) is just not meaningful for the ordinal indifference curves, and V, U of Wakker (2019) show it again. And, similarly as above, p. 54 3rd para last sentence discusses meaningless convexity/concavity of riskless utility, and so does p. 57 ℓ. -4/-3.

P. 41 penultimate para: contrary to what the authors write, loss aversion has much impact on risk aversion and is, I think, the main component of risk aversion.

P. 47 middle: The authors keep one good of (x_1,x_2) at level 1, and then measure the utility function of the other. Contrary to what they write, they thus do not take complementarities between the goods into account.

P. 58 ℓ. -7 refers to utils, which are meaningless for ordinal utility, but then the bottom of the page states this.

P. 60 1st para italicizes a sentence that refers to marginal utility for ordinal utility.

P. 60 2/3 writes: "The principle of decreasing marginal utility as well as the definitions of complementarity and substitution between the goods are not unique up to positive affine transformations and, hence, are meaningless under ordinal utility." It is not clear to me what it means that the mentioned concepts are "not unique up to positive affine transformations," or what that would have to do with ordinality. But the sentence suggests that the authors have some awareness of meaningfulness restrictions under ordinal utility. They don't seem to understand that complementarity and substitution do have meaning under ordinal utility. %}

Chung, Hui-Kuan, Paul Glimcher, & Agnieszka Tymula (2019) "An Experimental Comparison of Risky and Riskless Choice—Limitations of Prospect Theory and Expected Utility Theory," *American Economic Journal: Microeconomics* 11, 34–67.

{% %}

Chung, Kee H., Charlie Charoenwong, & David Ding (2004) "Penny Pricing and the Components of Spread and Depth Changes," *Journal of Banking and Finance* 28, 2981–3007.

{% **time preference**: Seem to have been the first to observe hyperbolic discounting. Did it in animal behavior. Or was it only in their 1967 paper? %}

Chung, Shin-Ho & Richard J. Herrnstein (1961) "Relative and Absolute Strengths of Responses as a Function of Frequency of Reinforcement," *Journal of the Experimental Analysis of Behavior* 4, 267–272.

{% **time preference**; may have introduced hyperbolic discounting %}

Chung, Shin-Ho & Richard J. Herrnstein (1967) "Choice and Delay of Reinforcement," *Journal of the Experimental Analysis of Behavior* 10, 67–74.

{% **utility elicitation**; use data about households' decision to buy insurance against telephone line trouble. Probability is about .005 per month, expected cost per month $0.262, premium per month $0.45. Their parametric family for utility, Eq. (7) ($U(W) = a_1(W+a_2)^L$, seems to be only power and hyperbolic, not general HARA as they suggest. L depends on the monthly bill.

Eq. (3) uses as probability weighting function:

$G(p)/\big(1–G(p)\big) = (p/(1–p))^{a_1}\big(p_0/(1–p_0)\big)^{1–a_1}$ (or equivalently, $\ln\big(G(p)/(1–G(p))\big) = c_1 + c_2.\ln\big(p/(1–p)\big)$)

inverse S: They write that they do not find big overestimation of probability but footnote 15, using more restricted parametric family for probability transformation, writes "This suggests that consumers overestimate the mean probability to a degree that is small in absolute terms but large in percentage terms." Logit of weight is affine transform of logit of true probability

They find concave utility with decreasing absolute risk aversion. They find that a_2 in Eq. (7) is significantly different from zero, which rejects power utility. (P.s.: if a_2 could be interpreted as status quo ...)

Their estimations are quite complex, I understand it's a logit analysis. My main problem is that the argument of their utility does not seem to be money but !money per month!, and probability likewise. Then things are quite different. I did not understand the analysis regarding this point. It seems to me that only info about whether customers do or don't buy this insurance can never distinguish between utility curvature and probability weighting. %}

Cicchetti, Charless J. & Jeffrey A. Dubin (1994) "A Microeconometric Analysis of Risk Aversion and the Decision to Self-Insure," *Journal of Political Economy* 102, 169–186.

{% %}

Cifarelli, Donato M. & Eugenio Regazzini (1996) "De Finetti's Contribution to Probability and Statistics," *Statistical Science* 11, 253–282.

{% This paper on the sleeping beauty paradox argues for p = 1/2, whereas I think that it is p = 1/3. The paper surveys much literature the topic. Sleeping beauty is a strange creature, in a way can be two different creatures with split-mind, and traditional Savage-type-states-of-nature or traditional probability-space analyses, I do not see how they can be applied to her. For instance, the "event" of her being woken up is not an event in the sense of either happening or not, because it can happen twice. Conditioning on it, I do not know how it can be done in any traditional modeling way. This paper tries to do it, but I do not understand.

P. 328 middle: Time t is hard to understand for me. Does t = 2016 mean it is 2016 years after Jesus Christ was born (calendar time) or 2016 years after sleeping beauty was woken up (stopwatch time, and then Monday or Tuesday, or both?). I guess it is the latter in some sense. Then strange that on Tuesday it happens twice. The analysis on p. 328 ff. is from the Sunday perspective (p. 328 ℓ. −3), but then C_{xMt} (sleeping beauty perceives perceptions x on Monday on time t) and C_{xUt} (sleeping beauty perceives perceptions x on Tuesday on time t) are the same event (I assume only one possible perception x: Being woken up and being asked), one happening if and only if the other does and event C_{xt} (sleeping beauty perceives x at time t after having been woken up, without it being specified if it is Monday or Tuesday) is not an event in any formal sense that I can understand. Thus, I do not understand Eq. 1, specifying a probability from the Sunday perspective of event C_{xt}. And I do not understand the rest of the analysis. One can take events C_{xMt} (sleeping beauty perceives perceptions x on Monday on time t) and C_{xUt} as disjoint events from the perspective of sleeping beauty who has just been woken up, but this is a different creature than sleeping beauty on Sunday, or maybe I should say two different creatures. %}

Cisewski, Jessi, Joseph B. Kadane, Mark J. Schervish, Teddy Seidenfeld, & Rafael Stern (2016) "Sleeping Beauty's Credences," *Philosophy of Science* 83, 324–347.

{% **time preference**: **dominance violation by pref. for increasing income**: seems to find it. %}

Clark, Andrew E. (1999) "Are Wages Habit-Forming? Evidence from Micro Data," *Journal of Economic Behavior and Organization* 39, 179–200.

{% That there should be a relative component in utility related to others (social comparison) in society and to the past (habituation). Discuss relation between happiness and utility. %}

Clark, Andrew E., Paul Frijters, & Michael A. Shields (2008) "Relative Income, Happiness, and Utility: An Explanation for the Easterlin Paradox and Other Puzzles," *Journal of Economic Literature* 46, 95–144.

{% %}

Clark, Andrew E. & Andrew J. Oswald (1994) "Unhappiness and Unemployment," *Economic Journal* 104, 648–659.

{% Argues that economics should use more ideas from psychology. Note that is in the period when the ordinal revolution was taking place.

P.4. Section II: "Why Economist Should Study Psychology"

P. 4: "The economist may atempt to ignore psychology, but it is a sheer impossibility for him to ignore human nature."

P. 7: "We used to think that we sought things because they gave us pleasure; now we are told that things give us pleasure because we seek them."

P. 9: "what to do with misplaced instincts." In my teaching preference conditions and what we can learn from inconsistencies, I often discuss misplaced instincts.

cognitive ability related to likelihood insensitivity (= inverse S): "Now that man has developed powers of intellect capable of discriminating between the requirements of different crises more flexibly than animals can, he is confronted with the need of finding harmless outlets for his left-over impulses." The text does not refer to inverse S, but still to general discriminatory power.

P 12: "Every idea is in its nature dynamic" Not this author, but other authors working on intertemporal choice, may misuse this for [**ubiquity fallacy**]. Clark only refers to ideas here.

P. 23, Section VII: "Effort of Decision—An Important Cost" (**utility of gambling**.) %}

Clark, John Maurice (1918) "Economics and Modern Psychology. I," *Journal of Political Economy* 26, 1–30.

{% %}

Clark, John Maurice (1918) "Economics and Modern Psychology. II. Constructive Statement: Outline of the Theory of Economic Guidance," *Journal of Political Economy* 26, 136–166.

{% **Newcomb's problem** %}

Clark, Michael & Nicholas Shackel (2006) "The Dr. Psycho Paradox and Newcombs Problem," *Erkenntnis* 64, 85–100.

{% %}

Clark, Russell D., Walter H. Crockett, & Richard L. Archer (1971) "Risk-as-Value Hypothesis: The Relationship between Perception of Self, Others, and the Risky Shift," *Journal of Personality and Social Psychology 20,* 425–429.

{% %}

Clark, Stephen A. (1985) "Consistent Choice under Uncertainty," *Journal of Mathematical Economics* 14, 169–185.

{% %}

Clark, Stephen A. (1988) "An Extension Theorem for Rational Choice Functions," *Review of Economic Studies* 55, 485–492.

{% **revealed preference** %}

Clark, Stephen A. (1988) "Revealed Independence and Quasi-Linear Choice," *Oxford Economic Papers* 40, 550–559.

{% **revealed preference**; **Dutch book**s; linearity of utility is for convex set, which may refer to probability mixtures. %}

Clark, Stephen A. (1993) "Revealed Preference and Linear Utility," *Theory and Decision* 34, 21–45.

{% **Dutch book**; **ordered vector space**; **qualitative probability** %}

Clark, Stephen A. (2000) "The Measurement of Qualitative Probability," *Journal of Mathematical Psychology* 44, 464–479.

{% **free will/determinism**: Discuss whether all causation is substance causation. Counterfactual dependence is discussed, agents acting purposively, agents possessing causal power,

P. 78: "A reductive analysis of agent causation, in its restricted sense—as what we have when an agent exercises a capacity to act purposively—would have to provide necessary and sufficient conditions for action, without resort to an unanalyzed notion of agency or agent causation, that would rule out deviant causation of the problematic sort. It is a contested matter whether any such analysis is possible."

P. 80: "Robert Kane, for example, characterizes agent-causation (hyphenated) as "the causation of action by a thing or substance (the self or agent) that cannot be explained as the causation of occurrences or events by other occurrences or events (i.e., by 'states' or 'changes')" (1996: 120)"

P. 82, principle SR: "If an agent S freely decides at time t to A, then S settles at t whether that decision is made then." %}

Clarke, Randolph (2019) "Free Will, Agent Causation, and "Disappearing Agents"," *Nous* 53, 76–96.
https://doi.org/10.1111/nous.12206

{% Use Eckel and Grossman's (2008) variation of Binswanger's (1981) risk measurement (and trust game). Compare representative students' sample with self-selected sample for lab. Find no differences. %}

Cleave, Blair L., Nikos Nikiforakis, & Robert Slonim (2013) "Is there Selection Bias in Laboratory Experiments? The Case of Social and Risk Preferences," *Experimental Economics* 16, 349–371.

{% %}

Clemen, Robert T. (1989) "Combining Forecasts: A Review and Annotated Bibliography," *International Journal of Forecasting* 5, 559–583.

{% Book introduces decision analysis very carefully and slowly, elaborately discussing and explaining many qualitative aspects. Many modeling exercises.
simple decision analysis cases using EU: the whole book is full of them. %}
Clemen, Robert T. (1991) "*Making Hard Decisions: An Introduction to Decision Analysis*." PWS-Kent, Boston, MA.

{% Nice discussion of risk tolerance, as traditionally measured assuming EU but then also what happens if subjects do PT. %}
Clemen, Robert T. (2004) "Assessing Risk Tolerance," *Decision Analysis Newsletter* 23, March 2004, 4–5.

{% **proper scoring rules-correction**: **paternalism/Humean-view-of-preference**; **proper scoring rules**; Propose statistical techniques for estimating to what extent **probability elicitation**s are not well calibrated. (Argue that estimation for one expert can be based on results from other experts.) Propose that these be used to correct new probability elicitations. Use the term ex ante adjustment for approaches that try to help experts avoid overconfidence etc., and the term ex post adjustment for approaches that let the experts do overconfidence as usual, and then correct the data based on estimations of the extent of overconfidence. P. 13 cites some works that point out that ex post adjustment may require much data. %}
Clemen, Robert T. & Kenneth C. Lichtendahl (2005) "Debiasing Expert Overconfidence: A Bayesian Calibration Model," Fuqua School of Business, Duke University, Durham, NC, USA.

{% %}
Clemen, Robert T. & Terry Reilly (2001) "*Making Hard Decisions with Decision Tools*." Thomson, Duxbury.

{% %}
Clemen, Robert T. & Fred Rolle (2001) "In Theory … in Practice," *Decision Analysis Newsletter* 20, no. 1, 3.

{% **EU+a*sup+b*inf**: Present a model, a variation of Fox & Rottenstreich (2003), where subjects (say experts) give subjective probabilities dependent on their partition of the state space in combination with the support they have. In this new model, however, interior additivity is satisfied, and only at the boundary there are violations. Test it empirically. End with a proposal for debiasing: Measure probabilities only over binary partitions, and derive probabilities of intermediate events only as differences of measured probabilities. Then the distortion generated by boundary will drop. %}

Clemen, Robert T. & Canan Ulu (2008) "Interior Additivity and Subjective Probability Assessment of Continuous Variables," *Management Science* 54, 835–851.

{% %}

Clemen, Robert T. & Robert L. Winkler (1986) "Combining Economic Forecasts," *Journal of Business & Economic Statistics* 4, 39–46.

{% Useful survey paper on expert aggregation. %}

Clemen, Robert T. & Robert L. Winkler (1999) "Combining Probability Distributions from Experts in Risk Analysis," *Risk Analysis* 19, 187–203.

{% %}

Cleveland, William S. (1993) "*Visualizing Data*" Hobart Press, Summit, NJ.

{% **foundations of quantum mechanics** %}

Clifton, Robert K., Jeremy N. Butterfield, & Michael L.G. Redhead (1990) "Nonlocal Influences and Possible Worlds. A Stapp in the Wrong Direction," followed by comments by Stapp, *British Journal for the Philosophy of Science* 41, 5–58.

{% %}

Clotfelter, Charles T. & Philip J. Cook (1994) "The "Gambler's Fallacy" in Lottery Play," *Management Science* 39, 1521–1525.

{% %}

Clots-Figueras, Irma, Roberto Hernán González, & Praveen Kujal (2016) "Trust and Trustworthiness under Information Asymmetry and Ambiguity," *Economics Letters* 147 (2016) 168–170.

{% Seems to write extremely positively about the value of axiomatizations of economic theories. %}
Clower, Robert W. (1995) "Axiomatics in Economics," *Southern Economic Journal* 62, 307–319.

{% Brings the famous Coase theorem. %}
Coase, Ronald H. (1960) "The Problem of Social Cost," *Journal of Law and Economics* 3, 1–44.

{% The ratio in the title has something to do with relative length of fourth finger. It predicts success in highly competitive sports (shown elsewhere). This study shows it predicts success in high-frequency trading in financial markets. %}
Coates, John M., Mark Gurnell, & Aldo Rustichini (2009) "Second-to-Fourth Digit Ratio Predicts Success among High-Frequency Financial Traders," *Proceedings of the National Academy of Sciences* 106, 623–628.

{% Test the Kreps-Porteus (1978) model, in a different version though. At each timepoint there is direct consumption, whereas in KP it is only at the end. What they call KP is a recursive formula. They strongly reject the classical discounted expected utility in favor of KP. I wish they would have written more about their finding than this thin and negative point.

source-dependent utility: p. 69: They estimate the elasticity of interteremporal substitution (EIS), which measures the curvature of utility across consumption at different timepoints, and the discount factor. Classical discounted utility equates EIS with risk attitude (**risky utility u = strength of preference v (or other riskless cardinal utility, often called value)**. %}
Coble, Keith H. & Jayson L. Lusk (2010) "At the Nexus of Risk and Time Preferences: An Experimental Investigation," *Journal of Risk and Uncertainty* 40, 67–79.

{% %}

Coes, Donald V. (1977) "Firm Output and Changes in Uncertainty," *American Economic Review* 67, 249–251.

{% %}

Coffey Scott F., Gregory D. Gudleski, Michael E. Saladin, & Kathleen T. Brady (2003) "Impulsivity and Rapid Discounting of Delayed Hypothetical Rewards in Cocaine-Dependent Individuals," *Experimental and Clinical Psychopharmacology*11, 18–25.

{% **foundations of statistics**

I read the intro. The main purpose of "pre-analysis" (i.e., making your hypotheses and tests known before seeing the data) is to avoid cheating on claimed prior hypotheses/tests that in reality were conceived/chosen only after, rather than to avoid the publication bias (called file drawer problem in this paper).

The authors' suggesion to have a journal on replication studies, or with negative findings, has no chance. Such a journal will not be read or sold. It should be an archive, which will only be consulted by interested specialized researchers. If top journals require authors to cite replications, these journals may lose their top status.

In several sentences I did not understand how the concepts there could be connected. %}

Coffman, Lucas C. & Muriel Niederle (2015) "Pre-Analysis Plans Have Limited Upside, Especially where Replications Are Feasible," *Journal of Economic Perspectives* 29, 81–98.

{% %}

Cogley, Timothy & Thomas J. Sargent (2008) "Anticipated Utility and Rational Expectations as Approximations of Bayesian Decision Making," *International Economic Review* 49, 185–222.

{% Decision under complete ignorance à la Cohen & Jaffray (1980), Milnor (1954), Pattanaik, and others. Cite these classics properly. Some preference conditions such as duplication-of-states and strict transitivity imply that only maximax, maximin, or the combination of the two can be. %}

Cognar, Ronan & François Maniquet (2010) "A Trichotomy of Attitudes for Decision-Making under Complete Ignorance," *Mathematical Social Sciences* 59, 15–25.

{% Consider choice of deductible (a rather clean index of risk aversion) from more than 100,000 Israelian individuals. Women are more risk averse than men (**gender differences in risk attitudes**), and r.av. depends on age through a U shape (**relation age-risk attitude**). Use EU and absolute risk aversion index. Stake concerns loss of $100. Average subject is indifferent between losing $56 for sure, and 50-50 lottery of losing $100 or $0. Pp. 746-747 erroneously think that the Rabin criticism of EU does not apply because they only consider one wealth level per subject. (Such as: If our data are too poor to detect violations of EU then we may assume that there are no violations of EU. Or, if we don't investigate the patient then we may assume the patient is not ill.) Big point in paper is that they can analyze heterogeneity in risk situation and also in risk attitude.

Pp. 761-762 find positive relation between risk aversion and proxies for wealth. This is amazing and is opposite to the common hypothesis of decreasing absolute risk aversion, even if it is based on between-person comparisons. Thus, they have very strongly decreasing RRA (**decreasing ARA/increasing RRA**;).

P. 764 footnote b to table, very correctly, specifies that for index of absolute risk aversion they take $\$^{-1}$ as unit. Median value is 0.0019 (p. 764).

P. 765 takes annual income as current wealth. %}

Cohen, Alma & Liran Einav (2007) "Estimating Risk Preferences from Deductible Choice," *American Economic Review* 97, 745–788. https://doi.org/10.1257/aer.97.3.745

{% %}

Cohen, Brian J. (1996) "Is Expected Utility Theory Normative for Medical Decision Making?," *Medical Decision Making* 16, 1–6. (7–13 discussions by Jonathan Baron, George Wu, John Douard, and Louis Eeckhoudt, 14 reply by Cohen.)

{% **risky utility u = transform of strength of preference v**: central in this paper %}
Cohen, Brian J. (1996) "Assigning Values to Intermediate Health States for Cost-Utility Analysis: Theory and Practice," *Medical Decision Making* 16, 376–385.

{% %}
Cohen, I. Bernard (1980) "*The Newtonian Revolution.*" Cambridge University Press, Cambridge.

{% Seems to write that a correlation exceeding 0.7 is "high." %}
Cohen, Jacob (1988) "*Statistical Power Analysis for the Behavioral Sciences*"; 2nd edn. Lawrence Earlbaum, Mahwah, NJ.

{% **foundations of statistics**. Discusses H_0 testing, gives many nice references but does not really understand things. Thinks that confidence intervals and meta-analyses can solve the problems. Nice relation of H_0 testing to modes tollens.
Seems to often argue that no model or equality holds perfectly well, and that everything depends on everything to some small degree. %}
Cohen, Jacob (1994) "The Earth Is Round (p < .05)," *American Psychologist* 49, 997–1003.

{% **time preference**: Survey on intertemporal choice, paying much attention to the fungibility problem (**time preference, fungibility problem**). I enjoyed that this paper gives a balanced account of this issue, as well as other issues, and does not try to push dogmatic views. MEL abbreviates "money earlier or later" studies, so, studies that take money as outcome. One argument favoring money as outcome, despite the fungibility problem, is that discounting is of most interest for this outcome. (In another domain, health, life duration is also important.) Further, for any consumption taken as outcome, there will be much time-dependence of the utility of those outcomes, confounding (measurement of) discounting. See, e.g., p. 332 on thirsty subjects. P. 338 (in the Conclusion): "On the other hand, consumption-based analyses still require assumptions/inferences/controls regarding the curvature of the instantaneous utility function and the nature of intertemporal substitution"
For what follows, I take as the common terminology in the literature what

Halevy (2015) used. It is not entirely what I would have chosen if I could, but we should stick with it to have consensus and that is quite happening, fortunately. The term stationarity has always, also before 2015, been used in the same unambiguous manner. It is unfortunate and disappointing that the authors of this paper will still use this term differently; see below.

The usual ambiguity in time-preference conditions also applies to some statements in this paper (**time consistency stated ambiguously**). To prepare, if you want to maintain an equality $a + b = c$, but want to change one of the three inputs, then you have to specify which of the other two inputs changes. Further, one can distinguish between calendar time (this paper calls that absolute time) and stopwatch time (the paper calls that relative time). Now to time preference. I now let “current time” refer to calendar time t. Further, $t + \tau_1$ and $t + \tau_2$ are some future calendar times, and τ_1 and τ_2 are differences, which in some contexts can be called stopwatch time. Many authors define a preference condition by claiming that changes in t don’t matter, or in τ_1 and/or τ_2. A first ambiguity then is, does that change concern decision time or consumption time, or both? A second ambiguity relates to the above a+b=c. Thus, if for instance t is changed, then are stopwatch times τ_1 and τ_2 kept constant so that calendar times $t + \tau_1$ and $t + \tau_2$ change, or are those calendar times kept constant so that the stopwatch times τ_1 and τ_2 change? With this, see Footnote 1 (p. 300): “Preferences are dynamically consistent if and only if all the state-contingent preferences held at time t agree with the state-contingent preferences held at time $t + \tau$ for all values of t and τ.” Here “state-contingent” is a term that will be explained only later (p. 303) and only vaguely, but can be ignored. The footnote makes clear that decision-time changes, but not wheether calendar-time or stopwatch time of consumption is to be kept constant. In the former case, it is what the literature indeed calls dynamic consistency or time consistency. In the latter case it is what the literature calls time invariance. In this paper, it will be the former. The latter will just be made throughout this paper, as can be read on p. 303. The paper uses both the terms time consistency and dynamic consistency, apparently interchangeably, but never says so.

A drawback is that the paper is quite outdated. P. 302 Figure 1 writes that the literature search was done August 2014. Several references that have appeared by long, are still cited as working papers.

DC = stationarity: The authors do not really commit this confusion, but throughout assume time invariance which makes the two equivalent. Footnote 6 on p. 305 makes explicit that without time invariance (what they call stationarity) DC can be different. P. 303 §2.1 introduces notation but, unfortunately, deviates from standard terminology. It uses the term stationarity for what is usually called time invariance: Preferences remain the same if the calendar time of preference is changed from t into $t+\varepsilon$, and the calendar times of consumption are also increased by ε, so that all distances between consumption time and decision time remain the same. And this for all t and ε. This allows using stopwatch time. It also allows putting the decision time always at t=0. This paper will not always do so, for instance on p. 305 below Eq. 7 when discussing time consistency. Given the assumed time invariance, stationarity and time consistency become logically equivalent. And, thus, they can claim that constant discounting is equivalent to time consistency.

P. 310 nicely writes: "To date, heuristic-based models in the domain of intertemporal choice have primarily been descriptive and difficult to generalize. They would not typically be used for welfare or policy evaluation. In other words, these heuristic models are primarily positive and not normative in scope."

The authors in most of the paper discuss models with economic flesh, such as self-control or multiple selfs or temptation or all kinds of heuristics, monetary versus nonmonetary outcomes, field versus lab, binary choice versus matching versus choice lists. §4 discusses the more conventional studies that use monetary outcomes. They also discuss real versus hypothetical choice (§4.3), using balanced terms. P. 327 in §4.3 writes: "Because of such logistical challenges, the desirability of using real payments in a MEL task, as opposed to hypothetical rewards, is open to debate."

P. 321 considers measurements of discounting that need not assume linear utility and that need no utility curvature, but only cites a five-year old unpublished working paper co-authored by one of them, being Ericson & Noor (2015). It will be no surprise that I would have liked citation of Attema, Bleichrodt, Rohde, & Wakker (2010 *Management Science*), and/or Attema, Bleichrodt, Gao, Huang, & Wakker (2016 *American Economic Review*). %}

Cohen, Jonathan, Keith Marzilli Ericson, David Laibson, & John Myles White (2020) "Measuring Time Preferences," *Journal of Economic Literature* 2020, 58, 299–347.
https://doi.org/10.1257/jel.20191074

{% %}
Cohen, Joshua (1997) "Utility: A Real Thing: A Study of Utility's Ontological Status," Ph.D. dissertation, Economics Department, University of Amsterdam, Tinbergen #173.

{% **foundations of probability**; reviewed by Howard A. Harriot in History and Philosophy of Logic 11, 1990 %}
Cohen, L. Jonathan (1989) "*An Introduction to the Philosophy of Induction and Probability*." University Press, Oxford.

{% **EU+a*sup+b*inf** %}
Cohen, Michèle (1992) "Security Level, Potential Level, Expected Utility: A Three-Criteria Decision Model under Risk," *Theory and Decision* 33, 101–134.

{% **survey on nonEU** %}
Cohen, Michèle (1995) "Risk Aversion Concepts in Expected- and Non-Expected-Utility Models," *Geneva Papers on Risk and Insurance Theory* 20, 73–91.

{% **updating under ambiguity with sampling**; **dynamic consistency**: seems that they find that dynamic consistency is violated. %}
Cohen, Michèle, Itzhak Gilboa, Jean-Yves Jaffray, & David Schmeidler (2000) "An Experimental Study of Updating Ambiguous Beliefs," *Risk, Decision, and Policy* 5, 123–133.

{% **principle of complete ignorance**: Characterize and discuss model of complete ignorance where f is preferred to g if both max and min of range of f are at least as good as of g, in a way that is not complete but also, deliberately, intransitive. They prefer giving up transitivity to giving up dominance. End of §2.1.5 says that indifference may be partly caused by incomparability. %}

Cohen, Michèle & Jean-Yves Jaffray (1980) "Rational Behavior under Complete Ignorance," *Econometrica* 48, 1281–1299.
https://doi.org/10.2307/1912184

{% Could not find the paper, or the outlet, on internet in 2024. Michèle Cohen then told me on 17 Oct. 2024 that this paper was comprised by Cohen, Jaffray, & Said (21987), so that one better go to that paper.

Experiments use hypothetical choice. Use choice lists to measure certainty equivalents of gambles on events.

P. 277 bottom argues for considering ambiguity attitude (they use different terminology: Optimism/pessimism) with risk attitude filtered out, which they oppose with Hurwicz's α-pessimism index that also comprises risk attitude. They don't do this by measuring matching probabilities but instead indirectly by measuring certainty equivalents and then comparing those.

They allow subjects to express indifference, in which case the exerimenter (who does not know more about the uncertainties than the subjects) chooses on their behalf.

For risk, they find risk aversion for gains and strong risk seeking for losses. They cannot infer **reflection at individual level for risk** because almost all subjects are risk seeking for losses.

For ambiguity, which they call complete ignorance, they do not control for suspicion. Given that choices are hypothetical, this is not a big problem. (**suspicion under ambiguity**)

For gains, they find ambiguity aversion (they call it pessimism) and for losses ambiguity neutrality (so, not entirely **ambiguity seeking for losses**). %}

Cohen, Michèle & Jean-Yves Jaffray (1981) "Experimental Results on Decision Making under Uncertainty," *Methods of Operation Research Proceedings* 44, 275–289.

{% **principle of complete ignorance** %}

Cohen, Michèle & Jean-Yves Jaffray (1983) "Approximations of Rational Criteria under Complete Ignorance," *Theory and Decision* 15, 121–150.
https://doi.org/10.1007/BF00143068

{% %}

Cohen, Michèle & Jean-Yves Jaffray (1985) "Decision Making in a Case of Mixed Uncertainty: A Normative Model," *Journal of Mathematical Psychology* 29, 428–442.

{% Nice discussion, intuitive/formal. %}

Cohen, Michèle & Jean-Yves Jaffray (1988) "Is Savage's Independence Axiom a Universal Rationality Principle?," *Behavioral Science* 33, 38–47.

{% **inverse S** %}

Cohen, Michèle & Jean-Yves Jaffray (1988) "Preponderance of the Certainty Effect over Probability Distortion in Decision Making under Risk." *In* Bertrand R. Munier (ed.) *Risk, Decision and Rationality*, 173–187, Reidel, Dordrecht.

{% **inverse S** %}

Cohen, Michèle & Jean-Yves Jaffray (1988) "Certainty Effect versus Probability Distortion: An Experimental Analysis of Decision Making under Risk," *Journal of Experimental Psychology: Human Perception and Performance* 14, 554–560. https://doi.org/10.1037/0096-1523.14.4.554

{% %}

Cohen, Michèle & Jean-Yves Jaffray (1991) "Incorporating the Security Factor and the Potential Factor in Decision Making under Risk." *In* Attila Chikàn et al. (eds.) *Progress in Decision, Utility and Risk Theory*, 308–316, Kluwer Academic Publishers.

{% This paper concerns the same experiment and data as the authors' paper published in 1987 in *Organizational Behavior and Human Decision Processes* 39, but the latter does not give a cross-reference!?!? It may also be the same as a paper by these three authors published in French in 1983 in Bulletin de Mathématiues Economiques 18. The 1987 OBHDP paper is better than this one here and, hence, I recommend reading only the latter. %}

Cohen, Michèle, Jean-Yves Jaffray, & Tanios Said (1985) "Individual Behavior under Risk and under Uncertainty: An Experimental Study," *Theory and Decision* 18, 203–228.

{% This paper influenced me much. Several times, if I thought to have a recent new insight or opinion, I would discover that it was already in this paper. It comes from the times when Jaffray influenced me much and was in his hey days for decision theory.

They use the term uncertainty for what the literature today mostly calls ambiguity. Their term pessimism/moderate/optimism designates ambiguity aversion/neutrality/seeking.

- P. 1 ℓ. 5 ("Its two-step") nicely describes probabilistic sophistication (= the "first step "), called probability-oriented.

- P. 1 bottom, and the paper throughout, points out that unknown probability is the anchor and that people may treat known probabilities as if unknown, rather than the tendency throughout the ambiguity literature these days (2011) which does nothing but try to relate unknown probability to known probability where the latter is treated as heaven that we all long for. In partucular, it writes that unknown probability, and not known probability, is the common case.

- Insensitivity (towards known/unknown probability; underlies inverse S) is a central concept throughout, rather than focusing on the aversion/seeking dimension as most people do even today.

- The paper understands well that gain-loss reflection should not only be considered for group averages but, more or less independently, also at the individual level.

- The paper applies the random incentive system as it should.

- The paper pays one subject high instead of paying all subjects small (p. 3).

- The paper has nice measurements of indifferent and incomplete preferences (although subjects did not understand the incompleteness well).

- P. 13 middle defines the concept of ambiguity (though using different term: Uncertainty) as the difference between unknown and known probabilities, which I like, but then only when probabilities are completely unknown.

- Appendix nicely gives a formal account of isolation.

On all these points, often debated, I agree 100% with this paper.

N = 134 students. P. 3: Use **random incentive system between-subjects (paying only some subjects, only one in fact)**. Plead for this being better than paying all a small amount. P. 3: for losses: **losses from prior endowment mechanism**. Nicely explained using isolation effect.

This paper concerns the same experiment and data as the authors' paper published in Theory and Decision in 1985, but it does not give a cross-reference!?!? It may also be the same as a paper by these three authors published in French in 1983 in Bulletin de Mathématiues Economiques 18.

Introduction splits SEU up into two stages: (1) probabilistic sophistication; (2) Given probability soph., EU maximization à la vNM. It also points out that unknown probability is more familiar than known probability.

Subjects did questions repeatedly so that errors could be assessed. Unfortunately, errors for losses are not compared to those for gains.

P. 2 penultimate para: They use the choice list method, with a clarifying figure on p. 4. Thus, they belong to the numerous papers that preceded Holt & Laury (2002) in this.

They allow for "I do not know" and "equivalent," finding at each question about 10% of subjects using it (Cettolin & Riedl 2019 JET also found much use of it). Then they take the middle of the indecision interval as switching value.

P. 10 emphasizes that their definitions of risk aversion do not assume any model.

P. 10-11: they point out that risk aversion or seeking depends much on the probabilities considered (in perfect agreement with inverse S probability weighting both for gains and for losses, i.e., fourfold pattern!), and then write nicely (pp. 10-11):

"The reason why subjects' risk attitudes are not correctly conveyed by the conventional definitions may simply be that these definitions, despite their intrinsic character, take their origins in the EU [expected utility] model, and therefore share in its deficiencies."

P. 13 3rd para:

"The notion of attitude with respect to uncertainty, first introduced by Ellsberg (1961), does not claim to reflect subjects' absolute behavior under uncertainty but the differences between their behavior with respect to risk and with respect to uncertainty—more precisely, to the extreme situation of uncertainty known as complete ignorance."

One nice point here is that they do not take uncertainty [ambiguity] attitude in any absolute sense, but in a relative sense. Another remarkable point is that they do not take ambiguity attitude source dependent, as I would prefer, but as only the difference between complete ignorance and risk. Thus, ambiguity attitude becomes a property of the agent independent of the source considered. Then a very ambiguity averse person may exhibit moderate ambiguity aversion for some source because the person apparently considers the source not to be very ambiguous. This terminology is logically sound, but I think it will not work because ambiguity aversion will be too diverse. People can be ambiguity averse for one source and ambiguity seeking for another. So, I prefer to take ambiguity attitude as source dependent.

P. 13: they derive ambiguity attitude indirectly from elicited CEs (certainty equivalents).

P. 14, Table 5: for gains, 58% is ambiguity averse, and 5% is ambiguity seeking. For losses, 28.5% is ambiguity averse and 29.5% is ambiguity seeking (**ambiguity seeking for losses**: They find neutrality on average). Pity they do not separate likely and unlikely events.

Pp. 15-18 give an extensive and wonderful test of probabilistic sensitivity of subjects, showing they are less sensitive for losses.

Table 3 on p. 12: more risk seeking for losses than risk aversion for gains.

inverse S, stated on p. 10 ℓ. –10/–8 and visible in Table 2, p. 11. For probabilities 1/2, 1/3, 1/4, 1/6 at gaining FF1000, they find less risk aversion as the probability gets lower. They actually find quite a lot of risk seeking for gains and risk aversion for losses. For gains, risk aversion occurs only for probability 1/2 and strong risk seeking occurs for all other probabilities. For losses it is the opposite, for the same probabilities they find risk seeking for probabilities 1/2 and 1/3 and risk aversion for probabilities 1/4 and 1/6. This may be because they only consider probabilities ≤ 1/2.

Nicely, argue against regression to the mean because the variance in the CEs are not smaller for small probabilities.

CE bias towards EV: Appears from the large risk seeking for gains (see above). They determined CEs (certainty equivalents) through tables with sequential binary choices in such a way that the subjects could see that the CE was searched for so that, as Bostic, Herrnstein, & Luce (1990) suggested, subjects may have taken these as CE matchings.

reflection at individual level for risk & **reflection at individual level for ambiguity**: evidence against reflection: They find that both risk attitudes for gains and losses are unrelated; and ambiguity attitudes are unrelated too, at the individual level. Average weight of total ignorance (unknown 2-color urn) is .4; p. 2 ℓ. 1 interprets inverse S as insensitivity towards probability.

correlation risk & ambiguity attitude: They have the data at the individual level so could inspect, but they do not report it. Cohen (personal communication, 14Nov2011), let me know that the correlation between risk aversion and ambiguity aversion is 0.31 for gains and 0.30 for losses. %}

Cohen, Michèle, Jean-Yves Jaffray, & Tanios Said (1987) “Experimental Comparisons of Individual Behavior under Risk and under Uncertainty for Gains and for Losses,” *Organizational Behavior and Human Decision Processes* 39, 1–22.
https://doi.org/10.1016/0749-5978(87)90043-4

{% Investigate Yaari’s more-risk-averse concept in sense of stronger preference for certainty in RDU, give some results for binary prospects, and show that these results do not extend to multiple-outcome prospects, where RDU is different from EU. %}

Cohen, Michèle & Isaac Meilijson (2014) “Preference for Safety under the Choquet Model: In Search of a Characterization,” *Economic Theory* 55, 619–642.

{% **correlation risk & ambiguity attitude**: They find no significant correlation in a student population, despite a large sample. They do find a positive relation in the general population but, as they point out, this is entirely driven by subjects who simply at each question choose the riskless option. Similarly, time attitudes are unrelated to the other measures. Subjects may not have understood the questions well. For real payment, ambiguity was generated through second-order probability.

decreasing/increasing impatience: seem to find increasing. %}

Cohen, Michèle, Jean-Marc Tallon, & Jean-Christophe Vergnaud (2011) "An Experimental Investigation of Imprecision Attitude, and Its Relation with Risk Attitude and Impatience," *Theory and Decision* 71, 81–109.

{% %}

Cohen, Paul J. (2008) "*Set Theory and the Continuum Hypothesis*." Dover Publications, New York.

{% Did an experiment in 355 cities in 40 countries, with 17000 "lost" wallets. Each time, a research assistant entered an institution such as bank/hotel, said to have found a lost wallet, gave it to the person serving at the counter (that I will call server), said to be in a hurry, asked the server to handle the case, and then left without leaving name or address. Wallets contained a key, a grocery list, an address, and either some money (mostly $13.45), or not. Surprisingly, wallets with money were returned more often than those without. In some countries they put 7 times more money in some wallets, and this only further increased the rate of return. The paper suggests altruism and self-image explanations.

Psychologists often have to work with vague ill-defined concepts, where there are many confounds beyond control. They then do 20 DIFFERENT experiments, each time showing their claimed effect. Each single experiment can be questioned, but the 20 together still make the claimed effect credible. This paper also collects much data, but everything always the same way. Thus, any deviating detail of their setup can lead to strange things, and explain the findings. In this study, I can think of such details and alternative explanation: (1) Because wallets had been found by someone else than the server, for wallets without money the server could conjecture that the finder might have taken out any money, and that the server could then be accused of having taken that money; hence they preferred not to return such money-less wallets. (2) keeping a wallet with money may be risky here because the finder may know about it and return to enquire about it. (3) People working at counters of institutions are a nonrepresentative sample, and may be subject to all kinds of special rules.

Another explanation may be that wallets without money have no value (the owner got a copy-key by now and already did shopping), so no use for the effort of returning it. This is like altruism. Only, there have been other studies (e.g. by

Jan Stoop) finding that that is not the case.

I regret that such a big study, costing $170,000 in total, has been done for just one such thin finding. (Or, hopefully, the authors will write several papers on this beautiful data set?) More remarkable/interesting than the whole rest of the paper could have been Figure 1, showing percentages for different countries. China is the worst here. I would expect Japan to be 1st, but Japan was not included. My country, the Netherlands, is nicely ranked 3rd, after Switzerland and Norway. Big problem with this figure, under a loaded heading such as civic honesty (see title of paper), is that there are (too) many confounds to make comparisons between countries meaningful, which may be why the authors do not discuss it much. For example, several people have argued, about China, that the finding may be because the experimenters work with email, but email is rarely used in China. This table, unqualified in this prominent journal, will do more harm than good. %}

Cohn, Alain, Michel André Maréchal, David Tannenbaum, & Christian Lukas Zünd (2019) "Civic Honesty around the Globe," *Science* 365 (5 July 2019), 70–73.

{% **utility elicitation**?; **decreasing ARA/increasing RRA**: Find decreasing RRA, strangely enough. The authors properly and correctly point out many questionable aspects of their data. P. 606 gives some references to other studies finding decreasing RRA. %}

Cohn, Richard A., Wilbur G. Lewellen, Ronald C. Lease, & Gary G. Schlarbaum (1975) "Individual Investor Risk Aversion and Investment Portfolio Composition," *Journal of Finance* 30, 605–620.

{% %}

Coiculescu, Gabriela, Yehuda Izhakian, & S. Abraham Ravid (2019) "Innovation under Ambiguity and Risk," SSRN 3428896.

{% %}

Coignard, Yves & Jean-Yves Jaffray (1994) "Direct Decision Making." *In* Sixto Rios (ed.) *Decision Theory and Decision Analysis: Trends and Challenges*, 81–90, Kluwer Academic Publishers, Dordrecht.

{% **intertemporal choice** %}

Cojuharenco, Irina & Dmitry Ryvkin (2008) "Peak-End Rule versus Average Utility: How utility Aggregation Affects Evaluations of Experiences," *Journal of Mathematical Psychology* 52, 326–335.

{% **cognitive ability related to risk/ambiguity aversion** Correlated risky choices (always sure prospect versus 2-outcome prospect) with measures of numeracy and so on. Mostly compared expected value with the priority heuristic. Do not clearly discuss risk seeking, risk aversion, or inverse S. %}

Cokely, Edward T. & Colleen M. Kelley (2009) "Cognitive Abilities and Superior Decision Making under Risk: A Protocol Analysis and Process Model Evaluation," *Judgment and Decision Making* 4, 20–33.

{% **coherentism**: focuses on writings between 1890 and 1930 on the topic. %}

Colander, David (2007) "Edgeworth's Hedonimeter and the Quest to Measure Utility," *Journal of Economic Perspectives* 21, 215–225.

{% **information aversion**: Several reasons are given why patients may dislike receiving info, several emotional (that may be qualified as irrational), but also a substantive one: that it complicates their interaction with their health insurance company. %}

Colby, Helen, Deidre Popovich, & Tony Stovall (2024) "How Much Information Is too Much? An Experimental Examination of how Information Disclosures May Unintentionally Encourage the Withholding of Health Information," *Medical Decision Making* 44, 880–889. https://doi.org/10.1177/0272989X241275645

{% %}

Cole, Harold L., George J. Mailath, & Andrew Postlewaite (1992) "Social Norms, Saving Behavior, and Growth," *Journal of Political Economy* 100, 1092–1125.

{% **Dutch book**; **updating: discussing conditional probability and/or updating** %}

Coletti, Giulianella (1988) "Conditionally Coherent Qualitative Probabilities," *Statistica* 48, 235–242.

{% **ordering of subsets**; nice introduction about absence of completeness; coherent indeed induces sums of indicator-functions. %}
Coletti, Giulianella (1990) "Coherent Qualitative Probability," *Journal of Mathematical Psychology* 34, 297–310.

{% Use the smooth model to accommodate historical data on the equity premium. %}
Collard, Fabrice, Sujoy Mukerji, Kevin Sheppard, & Jean-Marc Tallon (2018) "Ambiguity and the Historical Equity Premium," *Quantitative Economics* 9, 945–993.

{% **DC = stationarity**; Use real incentives. Find that constant discounting is not rejected if there are no zero delays. Argue that the strong immediate discounting may be due to risk and transaction costs, and not to strong discounting. %}
Coller, Maribeth, Glenn W. Harrison, & E. Elisabet Rutström (2002) "Dynamic Consistency in the Laboratory,"

{% **real incentives/hypothetical choice, for time preferences**. Argue that when measuring discount rates much can be explained by transaction costs for future payments, by incorporating a constant transaction cost for every future payment.
decreasing/increasing impatience: they find constant discounting when no presence is involved. %}
Coller, Maribeth, Glenn W. Harrison, & E. Elisabet Rutström (2005) "Are Discount Rates Constant? Reconciling Theory and Observation."

{% **real incentives/hypothetical choice, for time preferences**; more discounting for hypothetical than for real. Test effect of adding front-end delay. %}
Coller, Maribeth & Melonie B. Williams (1999) "Eliciting Individual Discount Rates," *Experimental Economics* 2, 107–127.

{% %}

Cominetti, Roberto & Alfredo Torrico (2016) "Additive Consistency of Risk Measures and Its Application to Risk-Averse Routing in Networks," *Mathematics of Operations Research* 41, 1510–1521.
http://dx.doi.org/10.1287/moor.2016.0787

{% %}
Commonwealth of Australia (1990) "Guidelines for the Pharmaceutical Industry on Preparation of Submissions to the Pharmaceutical Benefits Advisory Committee," Woden (ACT) Dept. of Health, Housing and Community Services, Canberra, AGPS.

{% Application of ambiguity theory;
Combines survival literature with ambiguity literature. Compares ambiguity aversion (taken as maxmin) with rational expectations. Shows that in markets with aggregate risks in long run ambiguity averters will end up inferior to EU maximizers with probability 1. %}
Condie, Scott (2008) "Living with Ambiguity: Prices and Survival when Investors Have Heterogeneous Preferences for Ambiguity," *Economic Theory* 36, 81–108.

{% Application of ambiguity theory;
Assume ambiguity aversion in overlap of maxmin EU and CEU (Choquet expected utility), showing that analysis of REE (rational expectations equilibrium) then is tractable. Paper favors non-smooth ambiguity models. %}
Condie, Scott & Jayant V. Ganguli (2011) "Ambiguity and Rational Expectations Equilibria," *Review of Economic Studies* 78, 821–845.

{% "By three methods we may learn wisdom:
first, by reflection, which is noblest;
second, by imitation, which is easiest;
and third, by experience, which is the bitterest."

"Learning without thinking is useless,
And thinking without learning is dangerous." %}
Confucius (552 b. C. - 479 b. C.)

{% %}

Conitzer, Vincent (2015) "A Dutch Book against Sleeping Beauties Who Are Evidential Decision Theorists," *Synthese* 192, 2887–2899. https://doi.org/10.1007/s11229-015-0691-7

{% %}

Conley, John P. & Ali Sina Önder (2015) "The Research Productivity of New PhDs in Economics: The Surprisingly High Non-Success of the Successful," *Journal of Economic Perspectives* 28, 205–216.

{% **Nash bargaining solution** %}

Conley, John P. & Simon Wilkie (1996) "An Extension of the Nash Bargaining Solution to Nonconvex Problems," *Games and Economic Behavior* 13, 26–38.

{% %}

Conlisk, John (1987) "Verifying the Betweenness Axiom or Not: Take Your Pick," *Economics Letters* 25, 319–322.

{% Presents in three-step form, which explicitly relates to 1/11–10/11 probability distribution and then appeals to mixture-indep. Gives remarkable statistic that interests me but I did not (yet) take time to understand on Dec.31, 1992.

real incentives/hypothetical choice; in pilot study, Appendix IV, for 53 subjects variations of the Allais paradox were tested, both for real payments and for hypothetical choice. No differences were found between the two. Shows that **RCLA** is violated more than compound independence, which gives evidence in favor of backward induction (**backward induction/normal form, descriptive**). On the reason that this ended up in an appendix under the name "pilot study," an insider whose name I will not reveal wrote to me:

"As it happens, Conlisk did this under protest from the editor and a brilliant, then-young referee, so it is perhaps no surprise that it was written up in the manner it was.…"

Probability weighting linear in interior: seems that few violations of independence in interior of probability triangle, and mostly at extremes. %}

Conlisk, John (1989) “Three Variants on the Allais Example,” *American Economic Review* 79, 392–407.

{% **utility of gambling** %}

Conlisk, John (1993) “The Utility of Gambling,” *Journal of Risk and Uncertainty* 6, 255–275.

{% %}

Conlisk, John (1996) “Why Bounded Rationality,” *Journal of Economic Literature* 34, 669–700.

{% **utility families parametric**: seems to propose a generalization of the Saha family, with one extra parameter. Is discussed by Meyer (2010). %}

Conniffe, Denis, The Flexible Three Parameter Utility Function,” Dept. of Economics, National University of Ireland, Maynooth.

{% **insurance frame increases risk aversion**: seems to have that. %}

Connor, Robert A. (1996) “More than Risk Reduction: The investment Appeal of Insurance,” *Journal of Economic Psychology* 17, 39–54.

{% **preferring streams of increasing income**; **intertemporal separability criticized**: habit formation

Complementarity in time periods by incorporating habit formation in utility, à la model of Gilboa (1989, Econometrica; there is no reference to him). In this way, by giving up intertemporal separability, an explanation is obtained for the equity premium puzzle. %}

Constantinides, George M. (1990) “Habit Formation: A Resolution of the Equity Premium Puzzle,” *Journal of Political Economy* 98, 519–543.

{% The authors do an experiment on bargaining on pie-sharing with alternating roles while reckoning extensively with strategic ambiguity attitudes, and advanced modeling of multi-stage behavior. For subjects, sophistication (rather than naïve) with backwards reasoning fits the data best. %}

Conte, Anne, Werner Güth, & Paul Pezanis-Christou (2023) "Strategic Ambiguity and Risk in Alternating Pie-Sharing Experiments," *Journal of Risk and Uncertainty* 66, 233–260.
https://doi.org/10.1007/s11166-022-09401-z

{% Subjects choose between two-stage lotteries, with only two prizes involved: €0 and €40. The second-stage probabilities are always 1/n for some n. The choices are done in an unusual manner: one two-stage lottery is called changing, and one unchanging (p. 115 top; p. 119 top). When the subjects made a choice, the changing lottery was modified by randomly removing one of its 1st stage lotteries, so that the remaining ones have probability 1/(n−1), until one 1-stage lottery was left. It seems that subjects did not know that this was the procedure. I do not understand this procedure, because it will give subjects all kinds of strange ideas that they are influencing next choices (even if in reality they aren't).

The authors do individual fit-predict, and a mixture model with fit-predict, for the following deterministic models: EU (which has no free parameters here and just maximizes the probability of getting the prize), the smooth model (SUM $\varphi(p_j)/n$ with p_j the 1st stage probability of winning and n 1st stage lotteries, each with 2nd stage probability 1/n), RDU (done with backward induction = CE substitution), and α maxmin. For the latter, 2nd stage probabilities are ignored. Results: for 53% of subjects the smooth model works best, for 22% EU works best, for 22% RDU works best, for 3% α maxmin works best. The poor performance of α maxmin is no surprise because, as implemented by the authors, it ignores the 2nd stage probabilities. The weak performance of RDU may be due to it being combined with backward induction (Eq. 5 p. 117), which is controversial under nonEU. The weak performance of EU may be due to it having no free parameters here. The good performance of smooth may be that the stimuli were designed for it, and not for RDU/α-maxmin.

DETAILS:

In the past the term multiple prior models referred only to theories where the set of priors is treated as a set. That is, a prior is in or out, and that's it. All in are in a way treated alike, and so are all out. Some in are not weighted more than others in. Models with different weighting of priors are for instance two-stage models. They were considered to be very different. Unfortunately, this terminology is being lost more and more. More and more, authors, when having a theory in which they think to discern a set of priors, already use the term multiple priors, to pay lip service to this model. Among the first to take this bad habit were Klibanoff, Marinacci, & Mukerji (2005) in their smooth model. They just have a two-stage model. However, the support of the second-stage distribution was designated by the authors as a set of priors and, hence, they used the term multiple priors for their model. The present paper by Conte & Hey follows the bad habit. Things get even worse on p. 131 beginning of 2nd para, where they suggest that the α maxmin model is not a genuine multiple prior model because it does not consider second-stage probabilities! The only thing non-genuine is the way C&H apply the α maxmin model to a situation where it is not meant to be applied.

P. 116 footnote 3 properly points out that the C&H assume the second-stage probabilities in the smooth model exogenously given, which is against the spirit of the smooth model where they are assumed to be endogenous. C&H rightfully point out that endogenous 2nd stage probabilities are hard to observe.

Pp. 116-117: C&H write the exponential utility function but do not know that with parameter $\alpha = 0$ this becomes linear utility and thus, erroneously, claim that EU is not part of it.

P. 117 beginning of §1.4: C&H claim that Ghirardato et al. (2004) “proposed”α maxmin and, thus, do not know that the model is over half a century old, being discussed in Luce & Raiffa (1957 Ch. 13).

P. 121 ℓ. –3 miscites Abdellaoui et al. (2011) on suspicion. In Abdellaoui et al., subjects were betting on all colors. Exhangeability was tested and found verified, meaning subjects did not find some colors more likely than others. This is one of the ways to control for suspicion.

§6.1: I do not understand why for nested theories they do not use BIC, but instead a likelihood-ratio test (which ignores number of parameters). %}

Conte, Anna & John D. Hey (2013) “Assessing Multiple Prior Models of Behaviour under Ambiguity,” *Journal of Risk and Uncertainty* 46, 113–132.

{% The authors invest the role of decision time for decision under ambiguity. They distinguish different types of subjects according to which ambiguity model best fits them. A straightforward analysis suggests no relation but more sophisticated analyses do suggest relations. The conclusion of the paper does not specify very clearly what those relations are. %}

Conte, Anna, Gianmarco De Santis, John D. Hey, & Ivan Soraperra (2023) "The Determinants of Decision Time in an Ambiguous Context," *Journal of Risk and Uncertainty* 67, 271–297.
https://doi.org/10.1007/s11166-023-09417-z

{% %}

Conte, Anna, John D. Hey, & Peter G. Moffatt (2011) "Mixture Models of Choice under Risk," *Journal of Econometrics* 162, 79–88.

{% Time pressure enhances irrationality. %}

Conte, Anna, Marco Scarsini, & Oktay Sürücü (2016) "The Impact of Time Limitation: Insights from a Queueing Experiment," *Journal of Behavioral Decision Making* 11, 260–274.

{% **dynamic consistency**: people rather have a strong electric shock immediately than weaker shock with eight seconds delay, in order to avoid anxiety. %}

Cook, John O. & Lehman W. Barnes, Jr. (1964) "Choice of Delay of Inevitable Shock," *Journal of Abnormal and Social Psychology* 68, 669–672.

{% %}

Cook, Philip J. & Daniel A. Graham (1977) "The Demand for Insurance and Protection: The Case of Irreplaceable Commodities," *Quarterly Journal of Economics* 91, 143–156.

{% **methoden & technieken**; have nice figs of QED; discusses various forms of validity. %}

Cook, Thomas & Donald E. Campbell (1979) "*Quasi-experimentation, Design and Analysis Issues for Field Settings*." Rand McNally, Chicago.

{% Arne, Thom %}
Cook, Wade D. & Moshe Kress (1987) "Tournament Ranking and Score Difference," *Cahiers du C.E.R.O.* 29, 215–222.

{% %}
Cooke, Nancy J., Robert S. Atlas, David M. Lane, & Robert C. Berger (1993) "Role of High-Level Knowledge in Memory for Chess Positions," *American Journal of Psychology* 106, 321–351.

{% %}
Cooke, Roger M. (1987) "A Theory of Weights for Combining Expert Opinion," Report 87-25, Department of Mathematics, Delft University of Technology.

{% **probability elicitation** %}
Cooke, Roger M. (1988) "Uncertainty in Risk Assessment: A Probabilist's Manifesto," *Reliability Engineering and System Safety* 23, 277–283.

{% **proper scoring rules**; cited by Winkler as standard work on the valuation of experts. %}
Cooke, Roger M. (1991) "*Experts in Uncertainty; Opinion and Subjective Probability in Science*." Oxford University Press, New York.

{% They take finite models, such as Savage's model of decision under uncertainty with, say, 4 states and 4 consequences (and 4^4 acts = maps from states to consequences). Then they consider ALL binary relations on the acts. They count how many of those satisfy preference conditions, such as how many satisfy transitivity + sure-thing principle. The total number satisfying a group of conditions is taken as an index of the restrictiveness of this group of conditions. %}
Cooke, Roger M. & Henk Draaisma (1984) "A Method of Weighing Qualitative Preference Axioms," *Journal of Mathematical Psychology* 28, 436–447.

{% **probability elicitation** %}

Cooke, Roger M., Max Mendel, & Wim Thijs (1988) "Calibration and Information in Expert Resolution; a Classical Approach," *Automatica* 24(1), 87–94.

{% %}
Coombs, Clyde H. (1964) "*A Theory of Data.*" Wiley, New York.

{% %}
Coombs, Clyde H. (1987) "The Structure of Conflict," *American Psychologist* 42, 355–363.

{% %}
Coombs, Clyde H., Thom G.G. Bezembinder, & Frank M. Goode (1967) "Testing Expectation Theories without Measuring Utility or Subjective Probability," *Journal of Mathematical Psychology* 4, 72–103.

{% They consider triples of lotteries with the same expected value and the same variance, being variations of $-10_{0.5}10$, $-5_{0.8}20$, and $-20_{0.2}5$. %}
Coombs, Clyde H. & James N. Bowen (1971) "A Test of VE-Theories of Risk and the Effect of the Central Limit Theorem," *Acta Psychologica*, (1):15–28.

{% **maths for econ students.**

Say somewhere (I got this from George Wu), that the main contribution of the EU axioms is a theoretical justification that is independent of "long-run considerations .. (and) hence ... applicable to unique choice settings."

Teaching book for math. Psych.; math. app. on sets, product sets, eq.rel., ordering, fie, distance fie, matrix-multiplication, permutations, probability discr., total of 39 pp. %}
Coombs, Clyde H., Robyn M. Dawes, & Amos Tversky (1970) "*Mathematical Psychology, An Elementary Introduction*." Prentice-Hall, Englewood Cliffs, NJ.

{% Separate treatment of gaines and losses; %}
Coombs, Clyde H. & Lehner, Paul E. (1984) "Conjoint Design and Analysis of the Bilinear Model: An Application to Judgments of Risk," *Journal of Mathematical Psychology* 28, 1–42.

{% **risk seeking for symmetric fifty-fifty gambles**: seem to find it. P. 273 seems to suggest that these gambles are liked for being "fair" and easier to understand. %}

Coombs, Clyde H. & Dean G. Pruitt (1960) "Components of Risk in Decision Making: Probability and Variance Preferences," *Journal of Experimental Psychology* 60, 265–277.

{% %}

Cooper, William S. (1987) "Decision Theory as a Branch of Evolutionary Theory: A Biological Derivation of the Savage Axioms," *Psychological Review* 94, 395–411.

{% On ordinal revolution, concentrating on interpersonal comparability of utility. Many nice citations and references. The authors use Pareto's distinction between utility bringing usefulness and fulfilling needs (in principle objective and observable), and utility fulfilling desires (ophelimity, subjective). They argue that the ordinalists did not bring unambiguous progress in economics but instead changed the meaning of utility from usefulness (ordinal) to desires-fulfilment and changed the domain from welfare evaluation to consumer/price theory.

Pre-ordinalists (called "material welfare school" by Cooter & Rappoport) took utility not as revealed through choices, but still observable, by seeing how well a person is doing, usually taken at group level of number of sick people etc. This was taken as in principle objective and observable. Utility means usefulness, probably same as fulfilling needs ("wants"), and is normative/rational. Bad-tasting medicine for child gives usefulness but no ophelimity. (I don't see the difference, child misjudges desires by overlooking long-term desires. P. 516 footnote 23: Pareto (1896) seems to say that the two concepts should coincide for a rational person. So, then ophelimity is descriptive and usefulness is normative?)

P. 510: paradox of value (water is more useful than diamonds but we pay less for it) prevented utility to be useful in economics up to around 1870. Jevons (1871) resolved it by considering marginal utility.

Describes also the marginalist revolution of utility around 1870, initiated by Jevons.

marginal utility is diminishing: many refs and historical citations in diminishing marginal utility.

P. 516: "the power of commodities to satisfy material needs was called utility."

P. 520 etc.: big role for Robbins (1932/7) in ordinal revolution.

P. 527: "The belief that a utility structure was common to people made introspection an appropriate empirical tool."

I like the many details, but not the main message, of this paper. The ordinalists' idea to firmly base utility on observed choice was definitely a step forward. Only if ordinalists go too extreme by saying that all other things are useless ("meaningless," as ordinalists often argue, unfortunately) then they go too far I think. The authors make many distinctions on subtleties in utility, e.g. is it descriptive/normative, is it pleasure- or goal- fulfilling, is it on basic needs (food) or also on more abstract things (theatre, social life), etc. These aspects of interpretation of utility shift between different authors and in general over time, and some aspects are more prominent for ordinalist- than for other utility. I disagree that making distinctions on these details justifies the claim that ordinalists were dealing with completely different questions and concepts.

Lyons (1986) may be another reference for history of ordinal revolution. %}

Cooter, Robert D. & Peter Rappoport (1984) "Were the Ordinalists Wrong about Welfare Economics?," *Journal of Economic Literature* 22, 507–530.

{% %}

Cooter, Robert D. & Peter Rappoport (1985) "Reply to I.M.D. Little's Comment," *Journal of Economic Literature* 23, 1189–1191.

{% %}

Copas, John & Dan Jackson (2004) "A Bound for Publication Bias Based on the Fraction of Unpublished Studies," *Biometrics* 60, 146–153.

{% Beautiful title. %}

Copertari, Luis (2007) "Are Praying Useless, Free Will an Illusion and Some Evil Unavoidable?," *Revista de Investigación Científica* 3, Número 3, 2007ISSN 0188-53.

{% %}

Corbett, Charles J. & Luk N. van Wassenhove (1993) "The Natural Drift: What Happened to Operations Research?," *Operations Research* 41, 625–640.

{% %}

Corcos, Anne, François Pannequin, & Sacha Bourgeois-Gironde (2012) "Is Trust an Ambiguous rather than a Risky Decision," *Economics Bulletin* 32, 2255–2266.

{% Use the Epstein-Zin model to analyze it, with aversion to information, preference for timing of resolution of uncertainty, and so on.

information aversion: discuss it extensively. %}

Córdoba, Juan Carlos & Marla Ripoll (2017) "Risk Aversion and the Value of Life," *Review of Economic Studies* 84, 1472–1509. https://doi.org/10.1093/restud/rdw053

{% **(very) small probabilities**: study how the happening of small-probability-big-loss events impact people's risk attitudes, and how emotions do. %}

Corgnet, Brice, Camille Cornand, & Nobuyuki Hanaki (2024) "Negative Tail Events, Emotions and Risk Taking," *Economic Journal* 134, 538–578. https://doi.org/10.1093/ej/uead080

{% **ambiguity seeking**: They ask subjects in an experiment to price investments with uncertain returns. They induce ambiguity by giving interval info on returns. They do not find any ambiguity aversion. So, they do not find ambiguity seeking, but neutrality. %}

Corgnet, Brice, Praveen Kujal, & David Porter (2012) "Reaction to Public Information in Markets: How Much Does Ambiguity Matter?," *Economic Journal* 123, 699–737.

{% %}

Corner, James L. & Craig W. Kirkwood (1991) "Decision Analysis Applications in the Operations Research Literature, 1970–1989," *Operations Research* 39, 206–219.

{% %}

Cornilly, Dries, Ludger Rüschendorf, Steven Vanduffel (2018) "Upper Bounds for Strictly Concave Distortion Risk Measures on Moment Spaces," *Insurance: Mathematics and Economics* 82, 141–151.

{% **measure of similarity** %}

Corter, James E. (1982) "ADDTREE/P: A PASCAL Program for Fitting Additive Trees Based on Sattath & Tversky's ADDTREE Algorithm," *Behavior Research Methods and Instrumentation* 14, 353–354.

{% **foundations of quantum mechanics** %}

Corti, Alberto (2021) "Yet again, Quantum Indeterminacy Is not Worldly Indecision," *Synthese* 199, 5623–5643.
https://doi.org/10.1007/s11229-021-03039-1

{% **revealed preference**: The paper suggests that revealed preference theory has been developed for linear budget sets and not for the case where choice sets are finite, but this more important case has often been considered. Only the end of §1.1 very briefly mentions the existence of such literature, and then writes that this paper is intermediate in considering finite choice sets of commodity bundles. %}

Cosaert, Sam & Thomas Demuynck (2015) "Revealed Preference Theory for Finite Choice Sets," *Economic Theory* 59, 169–200.

{% For frequencies, people don't do so bad; evolutionary reasons also. %}

Cosmides, Leda & John Tooby (1996) "Are Humans Good Intuitive Statisticians after All? Rethinking Some Conclusions from the Literature on Judgment under Uncertainty," *Cognition* 58, 1–73.

{% %}

Costa-Gomes, Miguel, Steffen Huck, & Georg Weizsäcker (2014) "Beliefs and Actions in the Trust Game: Creating Instrumental Variables to Estimate the Causal Effect," *Games and Economic Behavior* 88, 298–309.

{% **probability elicitation**: applied to experimental economics.

P. 731: "We merely view our results as suggesting that economists should start to ask whether it

is reasonable to assume that decision makers act on their beliefs without much difficulty in all decision problems." This can be taken as a plea to use ambiguity models.

The paper uses the quadratic scoring rule to elicit subjective probabilities in repeated games. The beliefs do not perform well. Calibration and discrimination are not good relative to real play (p. 742, top), and they are inconsistent with players' own choices. The source method provides an explanation through a-insensitivity, i.e., inverse S weighting of subjective beliefs, enhanced by the involved ambiguity. Then it seems as if the players take their opponents strategy choices as random. The authors describe the latter finding on p. 731: "The subjects' play of the games appears to be naïve, as if they expected their opponents to choose actions randomly. But in the belief statement task they calibrate better, predicting roughly that their opponents respond to uniform beliefs." (p. 731) %}

Costa-Gomes, Miguel & Georg Weizsäcker (2008) "Stated Beliefs and Play in Normal-Form Games," *Review of Economic Studies* 75, 729–762.

{% **conservation of influence**: opening sentence: "A fundamental goal of science is to find invariants: constant mathematical relationships that hold between different variables (Simon, 1990)."

The paper considers psychological noise & process models of probability judgment. Despite allowing for biases, these models maintain particular normative rules, such as additivity, or Bayes rule, or some quantum rule. %}

Costello, Fintan & Paul Watts (2018) "Invariants in Probabilistic Reasoning," *Cognitive Psychology* 100, 1–16.

{% This paper mentions the well-known point that decision under uncertainty can be considered to be a special case of multiattribute utility. Then it examines and generalizes the Sugeno integral for the case of different component sets connected through utilituy functions, leading to state-dependent utility for decision under uncertainty. %}

Couceiro, Miguel, Didier Dubois, Henri Prade, & Tamas Waldhauser (2016) "Decision-Making with Sugeno Integrals: Bridging the Gap between Multicriteria Evaluation and Decision under Uncertainty," *Order* 33, 517–535. https://doi.org/10.1007/s11083-015-9382-8

{% %}
Cottrell, Allin (1993) "Keynes's Theory of Probability and its Relevance to His Economics," *Economics and Philosophy* 9, 25–51.

{% %}
Coulhon, Thierry & Philippe Mongin (1989) "Social Choice Theory in the Case of von Neumann-Morgenstern Utilities," *Social Choice and Welfare* 6, 175–187.

{% **ranking economists;** tijdschrift onder eigen naam (alfabetisch: J) in boekenkast. %}
Coupé, Tom (2003) "Revealed Performances: Worldwide Rankings of Economists and Economics Departments, 1990–2000," *Journal of the European Economic Association* 1, 1309–1345.

{% Introduced his equilibrium. %}
Cournot, Antoine Augustin (1838) "*Researches on the Mathematical Principles of the Theory of Wealth*." Chez L. Hachette, Paris.

{% %}
Cournot, Antoine Augustin (1843) "*Exposition de la Théorie des Chances et des Probabilités*." Ed.: Bernard Bru, Librairie J. Vin, Paris, 1984.

{% Argue that biases and WTP-WTA discrepancy can be solved by practicing, feedback and incentives. %}
Coursey, Don L., John L. Hovis, & William D. Schulze (1987) "The Disparity between Willingness to Accept and Willingness to Pay Measures of Value," *Quarterly Journal of Economics* 102, 679–690.

{% Measure β-δ model. Find that obesity is partly attributable to both discounting (δ) and time inconsistency (β). %}
Courtemanche, Charles, Garth Heutel, & Patrick McAlvanah (2015) "Impatience, Incentives and Obesity," *Economic Journal* 125, 1–31.

{% As criterion for rounding numbers I learned in primary school: Give only the number of digits that provide useful info. More than that only hurts the eye. Usually, that is two digits, and this is what APA recommends. I always believed it, and thought it would be generally understood. Big was my surprise that some do not agree. A respected colleague I could never convince, and he/she continues to always give six or so digits. Thus, also big is my surprise that this whole paper on the topic never seems to even mention my criterion. The author apparently considers only the degree of precision of measurement to be relevant. In other words, he seems to think: give the maximum number of digits that you reliably can. Pffff! %}

Cousineau, Denis (2020) "How Many Decimals? Rounding Descriptive and Inferential Statistics Based on Measurement Precision," *Journal of Mathematical Psychology* 97, 102362.

{% %}

Coutts, Alexander, Leonie Gerhards, & Zahra Murad (2024) "What to Blame? Self-Serving Attribution Bias with Multi-Dimensional Uncertainty," *Economic Journal* 134, 1835–1874.
https://doi.org/10.1093/ej/ueae005

{% **value of information**: value of free info under ambiguity. Use α maxmin, both theoretically and empirically. On farmers using pesticides.

correlation risk & ambiguity attitude: seem to find no relation. %}

Couture, Stéphane, Stéphane Lemarié, Sabrina Teyssier, & Pascal Toquebeuf (2024) "The Value of Information under Ambiguity: A Theoretical and Experimental Study on Pest Management in Agriculture," *Theory and Decision* 96, 19–47.
https://doi.org/10.1007/s11238-023-09942-y

{% **homebias**: seems to show that within same country there is a kind of homebias for own region. %}

Coval, Joshua D. & Tobias J. Moskowitz (1999) "Home Bias at Home: Local Equity Preference in Domestic Portfolios," *Journal of Finance* 54, 2045–2073.

{% Show that loss aversion affects prices. Prices in afternoon are often reaction to prices in the morning. %}
Coval, Joshua D. & Tyler Shumway (2005) “Do Behavioral Biases Affect Prices?,” *Journal of Finance* 60, 1–34.

{% %}
Cowell, Frank A. & Erik Schokkaert (2001) “Risk Perceptions and Distributional Judgments,” *European Economic Review* 45, 941–952.

{% %}
Cowen, Tyler & Jack High (1988) “Time, Bounded Utility, and the St. Petersburg Paradox,” *Theory and Decision* 25, 219–223.

{% **foundations of statistics**; try to argue that Ronald A. Fisher was not the first to propose the .05 level of significance by describing bits and pieces that existed before. After reading it seemed to me that still Fisher is the first who really proposed it. %}
Cowles, Michael & Caroline Davis (1982) “On the Origins of the .05 Level of Statistical Significance,” *American Psychologist* 37, 553–558.

{% **foundations of statistics**. The paradox that he discussed is maybe called John Pratt’s censoring paradox nowadays (1985-2020).

P. 358: “… the general point is that prior information that is not statistical cannot be included without abandoning the frequency theory of probability.”

P. 367 explains that level of significance etc. should depend on decisions, losses, etc.

P. 368 (where (2) is significance): “The advantage of (2) is that it has a clear-cut physical interpretation …” This page also has a good example suggesting that the likelihood ratio is a better measure than significance.

“We are faced with a conflict between the mathematical and logical advantages of the likelihood ratio, and the desire to calculate quantities with a clear practical meaning in terms of what happens when they are calculated.” %}
Cox, David R. (1958) “Some Problems Connected with Statistical Inference,” *Annals of Mathematical Statistics* 29, 357–372.

{% **foundations of statistics** %}

Cox, David R. (1977) “The Role of Significance Tests.” *In* Omar F. Hamouda & J.C. Robin Rowley (1997, eds.) “*Statistical Foundations for Econometrics.*” Edward Elgar, Cheltenham.

{% Emphasis on Fisher’s views %}

Cox, David R. (1990) “Role of Models in Statistical Analysis,” *Statistical Science* 5, 169–174.

{% **foundations of statistics**; …. “acceptance and rejection of hypotheses … give certain quantities hypothetical physical interpretations and are not instructive on how to apply the method …”

“we may wish to assess procedures that are not in a technical sense optimal either because none such exist or because of considerations such as transparency or robustness. Neyman-Pearson arguments are clearly very fruitful for this.” %}

Cox, David R. (1999) “Discussion of Michael D. Perlman & Lang Wu, “The Emperor’s New Tests “,” *Statistical Science* 14, 373–374.

{% **foundations of statistics**

Personal account of nine important statisticicans. Pp. 747-748 expresses Fisher’s view on mathematical rigor: “Mechanical drill in the technique of rigorouis statement was abhorrent to him, partly for its pedantry, and partly as an inhibition to the active use of the mind.”

P. 749 bottom on Harold Jeffrey using probability for objective degree of belief, and chance for physical frequencies. Tversky used “chance” the same way in conversations with me.

P. 754 on Savage. Was mathematician influenced much by Wald’s decision-approach. How Anscombe, Lindley, Cox read an early version of foundations of statistics. Cox writes: “I recall finding the book fascinating but ultimately unconvincing, at least as basis of applied statistical work in which I had been involved” P. 755: “Despite the undoubted interest of this [internal consistency] approach, it seems relatively remote from the objectives of much statistical work because it is not sufficiently firmly anchored in the real world.”

P. 755: [Wald] sought to cast the whole of statistical theory in decision-

theoretic terms. Despite the importance of specific decision-making problems, such as health screening and sampling inspection, most statistical problems, even if they have some decision-making element, do not fit easily into that formulation."

P. 755: "Rather, by probability Fisher meant a proportion in a hypothetical infinite population". %}

Cox, David R. (2016) "Some Pioneers of Modern Statistical Theory: A Personal Reflection," *Biometrika* 103, 747–759.

{% §2.3 ? (or pp. 33ff) on likelihood principle seems to point out a problem of conditioning on ancillary statistics; p. 38 seems to define the conditionality condition which says that one should condition on an ancillary statistic. %}

Cox, David R. & David V. Hinkley (1974) "*Theoretical Statistics.*" Chapman and Hall, London.

{% %}

Cox, David R., Ray Fitzpatrick, Astrid E. Fletcher, Sheila M. Gore, David J. Spiegelhalter, & David R. Jones (1992) "Quality-of-Life Assessment: Can we Keep it Simple?," *Journal of the Royal Statistical Society* A 155, 353–393.

{% %}

Cox, James C. & Seth Epstein (1989) "Preference Reversals without the Independence Axiom," *American Economic Review* 79, 408–426.

{% %}

Cox, James C., Daniel Friedman, & Steven Gjerstad (2007) "A Tractable Model of Reciprocity and Fairness," *Games and Economic Behavior* 59, 17–45.

{% Consider choices from convex compact subsets of Re^2, as for instance in bargaining game theory. Interpret it as welfare allocations over two players where one is one-self. They introduce axioms of "more altruistic than," "more generous than," and others, and indicate how empirical evidence of known games can test these, relating these to popular current developments in experimental game theory. %}

Cox, James C., Daniel Friedman, & Vjollca Sadiraj (2006) "Revealed Altruism," *Econometrica* 76, 31–69.

{% **real incentives/hypothetical choice**: seems to be on it .Second-price auction was run several times. Preference reversals were originally as usually found, but later decreased. %}

Cox, James C. & David M. Grether (1996) "The Preference Reversal Phenomenon: Response Mode, Markets and Incentives," *Economic Theory* 7, 381–405.

{% Discuss Rabin (2000, Econometrica). Point out the relevance of the assumption whether or not people think in terms of final wealth or changes w.r.t. the status quo. They point out that EUI (Expected utility of income, where income is taken as change w.r.t. status quo) is not rejected by Rabin's points. This is, as far as I can see, in perfect !agreement! with Rabin's viewpoint because Rabin, and most of the literature, calls EUI "prospect theory" (without probability transformation), in which loss aversion can come into play. %}

Cox, James C. & Vjollca Sadiraj (2006) "Small- and Large-Stakes Risk Aversion: Implications of Concavity Calibration for Decision Theory," *Games and Economic Behavior* 56, 45–60.

{% Criticize Weber's coefficient of variation (CV) for having unsound properties, such as violations of stochastic dominance, and falsify it in an experiment with real incentives. %}

Cox, James C. & Vjollca Sadiraj (2010) "On the Coefficient of Variation as a Criterion for Decision under Risk," *Journal of Mathematical Psychology* 54, 387–394.

{% **random incentive system**: Imagine a risky choice between S and R. But it is preceded by a risky choice between S´ and R´ where R´ is superior to R and S´ is inferior to S (the preceding choice is called risky-dominating). The preceding choice will move choices between R and S in the direction of S, violating the isolation condition of RIS. %}

Cox, James C., Vjollca Sadiraj, & Ulrich Schmidt (2014) "Asymmetrically Dominated Choice Problems, the Isolation Hypothesis and Random Incentive Mechanisms," *PLoS ONE* 9, e90742.
http://dx.doi.org/10.1371/journal.pone.0090742

{% **random incentive system**: Test this as well as several other payment schemes, such as PAS (pay all sequentially, immediately after each choice, without knowing which choice comes next), and in an experiment with N choices pay all choices, at the end, but multiplied by 1/N to get average, and not very large total payment (PAC/N). The C here refers to correlated: The lotteries were not independent, but maximally correlated (with events specified), so that Yaari's (1987) dual independence holds. Take as gold standard OT (one task), something that for instance Birnbaum (1992) took issue with. Find that repeated payments (which suffer from income effects) do best in the sense of staying closest to OT. Although they do not explicitly choose a winner, I gather from the results that PAC/N did best overall, with PAS second-best, from choice percentages in Table 4 being closest to OT.

Sections 3.2 & 9.1 & 10.1 suggest that the RIS (they write POR) is not incentive compatible if expected utility is violated, such as under RDU and PT. But the counterexamples make particular assumptions about dynamic decisions and RCLA. It is possible to have incentive compatibility for RIS and nonEU under particular other dynamic decision principles, e.g. backward induction. Cohen, Jaffray, & Said (1987), and many others, use the term isolation for such cases. Bardsley et al. (2010 p. 269) points this out too. Section 11 cites the working paper Harrison & Swarthout (2013), later appeared in 2014, affirmatively on this point, but the Harrison & Swarthout paper is a weak one to side with.

§6 1st sentence strangely writes: "It has been argued in the literature (e.g., Kahneman and Tversky 1979) that subjects evaluate each choice independently of the other choice opportunities in an experiment." I cannot imagine that Kahneman and Tversky would ever write such a weird universal claim, with violations shown for instance in Redelmeier, Donald A. & Amos Tversky (1992) "On the Framing of Multiple Prospects," *Psychological Science* 3, 191–193.

Section 9.1 incorrectly claims that using the RIS (they write POR) is

incompatible with nonEU theories such as PT (they write CPT). I discussed this point above. It also incorrectly writes that PT would assume independence of wealth level.

§11 writes: "there is no known "ideal mechanism" that will solve all the problems we describe."

The authors claim that the PAS treatment (pay all sequentially immediately) is incentive compatible under Yaari's (1987) dual independence, but I do not see this. I assume that the repeated payments are done probabilistically independently, and then a complex joint distribution results. %}

Cox, James C., Vjollca Sadiraj, & Ulrich Schmidt (2015) "Paradoxes and Mechanisms for Choice under Risk," *Experimental Economics* 18, 215–250.

{% Test the St. Petersburg paradox. %}

Cox, James C., Eike B. Kroll, Marcel Lichters, Vjollca Sadiraj, & Bodo Vogt (2019) "The St. Petersburg Paradox despite Risk-Seeking Preferences: An Experimental Study," *Business Research* 12, 27–44. https://doi.org/10.1007/s40685-018-0078-y

{% %}

Cox, James C., Vjollca Sadiraj, Bodo Vogt, & Utteeyo Dasgupta (2013) "Is there a Plausible Theory for Risky Decisions? A Dual Calibration Critique," *Economic Theory* 54, 305–333.

{% %}

Cox, James C., Vernon L. Smith, & James M. Walker (1985) "Experimental Development of Sealed-Bid Auction Theory; Calibrating Controls for Risk Aversion," *American Economic Review* 75, 160–165.

{% **anonymity protection** %}

Cox, Lawrence H., Sarah-Kathryn McDonald, & Dawn Nelson (1986) "Confidentiality Issues at the United States Bureau of the Census," *Journal of Official Statistics* 2, 135–160.

{% A very didactical explanation that mean-variance can violate stochastic dominance. %}

Cox, Jr, Louis Anthony (2008) “Why Risk Is not Variance: An Expository Note,” *Risk Analysis* 28, 925–928.

{% %}

Cox, Richard T. (1946) “Probability, Frequency, and Reasonable Expectation,” *American Journal of Physics* 14, 1–13.

{% This paper discusses the role of preference foundations, i.e., preference axiomatizations, i.e., representation theorems. In particular, it considers the role of theoretical terms there. And then, the semantic role of giving meaning to those terms. P. 293: “Finally, the few explanations that have been offered as to why these results are so important sometimes reflect doctrines that have been largely abandoned in philosophy of science and in philosophy of language (notably operationalism and behaviorism).”

My opinion is a what the paper calls “anti-holist attitude towards meaning.” Preference foundations only show what the assumed existence (specifying also the decision theory, e.g., EU) means, not entirely the terms themselves. It is only part of the meaning. Showing how to measure them, which is something that particular proofs do (I always try to write my proofs this way), operationalizes them, which adds to their meaning.

P. 297 nicely relates to theoretical terms in natural sciences, such as electrons or genes. For this typical *existence* of subjective parameters in preference foundations I cannot think of an analog in natural sciences.

P. 297 3rd para: “The problem of the meaning of theoretical concepts is usually presented as follows: one assumes that theory T is formulated in a certain language, as a set of propositions, and that one can distinguish, in one’s conceptual repertoire, between two categories of terms. In the neo-positivist tradition, theoretical terms are contrasted with observational terms, where a term is considered observational when you can determine through observation whether or not it applies to an entity in its domain of application. Lewis (1970, 1972) liberalizes the distinction: the ‘theoretical’ terms are terms that are *introduced* by a theory T, and they are contrasted with terms whose meaning was determined *prior* to the theory T. For the discussion here, there is no need to decide between these distinctions. As standard, we will use the word *t*-terms to designate theoretical terms, and o-terms to designate observational terms *or* those introduced prior to the theory T.”

P. 297 last para: "Theoretical terms can be explicitly defined through observables, although usually this is complex, but mostly this is not done and the meaning is left implicit." The authors cite Ramsey (1929) and Carnap (1959), taking the RCL (Ramsey-Carnap-Lewis) approach. It takes theoretical terms as implicitly simultaneously defined in a theory.

Lewis defines every single theoretical term through the *existence* of all the other theoretical terms such that the theory considered holds. This is close to the existence sentences in behavioral foundations. P. 300 bottom seems to suggest that Lewis' definition may solve some philosophical problems but is trivial as regards its clarification of representation theorems. The main alternative is the causal-historical theory (p. 298 middle). It is something like through causal relations, but I did not understand. CRL fits best with decision theory.

P. 299 middle: "given the affinities between decision-theoretic and folk-psychological concepts (for example, between subjective probability and belief or between utility and desire), it may be asked to what extent the concepts used by decision theorists are truly theoretical terms, rather than (pre-existing) ordinary language terms. However, there are reasons to suspect that an objection along these lines is flawed. As Enç (1976) has pointed out in his discussion of similar examples from the natural sciences, there is a difference between terms such as 'heat' and 'magnet' on the one hand and 'caloric' or 'magnetic field' on the other."

P. 299-300 (**conservation of influence**): "First, this way of defining subjective utility and probability is very similar to the way in which, in the philosophy of mind, functionalists (such as Lewis himself) characterize ordinary beliefs and desires. More exactly the definitions are similar to forward-looking features in the characterization of mental states, i.e., features that refer to their effects, in contrast with backward-looking features, which refer to their causes." Unfortunately, the paper does not elaborate on this point.

§7 propagates constructive proofs of preference foundations, which show how the subjective concepts can be measured. If self-references can be allowed, I always week for such constructive proofs, as explained for instance in Step 4 of the five steps in Wakker (2010 p. 8), in Abdellaoui & Wakker (2018) "Savage for Dummies," and so on.

p. 304: "If one assumes that the axioms are satisfied, then the definitions in terms of preferences (Def-pref) seem to satisfy the strictest empiricist and operationalist criteria. Indeed, they correspond to what Carnap (1936/1937) refers to as 'explicit definitions. These theorems, and more specifically the [constructive] proofs discussed above, contain explicit definitions of decision-theoretic concepts that, in the eyes of an anti-holist … , are preferable to the Lewis definitions."

The authors suggest repeatedly, e.g. p. 306 ℓ. 15, that behavioral economics attaches less importance to behavioral foundations than was done before. I don't see this. Of course, behavioral models can be explicitly nonnormative, and then there is of course less interest in normative preference foundations. But there then is more interest in descriptive preference foundations. %}

Cozic, Mikael & Brian Hill (2015) "Representation Theorems and the Semantics of Decision-Theoretic Concepts," *Journal of Economic Methodology* 22, 292–311.

{% Maxmin EU, with definition of independence, Kyburg's argument against convexity of that set, and several mathematical tools developed. This paper is a nice reference to the large literature on sets of priors outside of decision theory. %}

Cozman, Fabio G. (2012) "Sets of Probability Distributions, Independence, and Convexity," *Synthese* 186, 577–600.

{% %}

Crainich, David, Louis Eeckhoudt, & Mario Menegatti (2019) "Some Implications of Common Consequences in Lotteries," *Journal of Risk and Uncertainty* 59, 185–202.

{% Extend results on prudence and so on to risk seekers. %}

Crainich, David, Louis Eeckhoudt, & Alain Trannoy (2013) "Even (Mixed) Risk Lovers are Prudent," *American Economic Review* 103, 1529–1535.

{% **utility families parametric**: First proposes bounded utility in order to resolve St. Petersburg paradox, described by Nicolas Bernoulli in 1713; then proposes, alternatively, square-root utility for money. Nicolas is a cousin of Daniel, the one who wrote the famous EU paper in 1738. So, Cramer's letter proposed EU 10 years before Daniel! Daniel correctly cites and credits Cramer.

His text can be interpreted as saying that in a truncated version of the St. Petersburg paradox risk neutrality is not unreasonable. 24 tosses have expected value of 13 ducates which Cramer judges as reasonable. %}

Cramer, Gabriel (1728) Letter from Cramer to Nicholas Bernoulli. Translated into English by Louise Sommer in Bernoulli, Daniel (1954) "Exposition of a New Theory on the Measurement of Risk," *Econometrica* 22, 23–36.

{% **foundations of statistics** %}

Cramer, Harald (1981) "Mathematical Probability and Statistical Inference." *In* Omar F. Hamouda & J.C. Robin Rowley (1997, eds.) "*Statistical Foundations for Econometrics.*" Edward Elgar, Cheltenham.

{% %}

Crawford, Ian (2010) "Habits Revealed," *Review of Economic Studies* 77, 1382–1402.

{% %}

Crawford, Vincent P. (1990) "Equilibrium without Independence," *Journal of Economic Theory* 50, 127–154.

{% %}

Crawford, Vincent P., Miguel Costa-Gomes, & Nagore Iriberri (2013) "Structural Models of Nonequilibrium Strategic Thinking: Theory, Evidence, and Applications," *Journal of Economic Literature* 51, 5–62.

{% Restores the reference-dependent explanation of the Cab drivers finding of Camerer et al. (1997) by using the Köszegi & Rabin (2006) reference dependence. %}

Crawford, Vincent P. & Juanjuan Meng (2011) "New York City Cab Drivers' Labor Supply Revisited: Reference-Dependent Preferences with Rational-Expectations Targets for Hours and Income," *American Economic Review* 101, 1912–1932.

{% Two experts and an agent all maximize maxmin expected utility. A Pareto condition is equivalent to the priors of the decision making being a convex combination of the priors of the experts. %}

Crès, Hervé, Itzhak Gilboa, & Nicolas Vieille (2011) "Aggregation of Multiple Prior Opinions," *Journal of Economic Theory* 146, 2563–2582.

{% Propose monotonicity/continuity criteria that cannot be reconciled with symmetry. They have a Pareto principle that $x \succ y$ whenever $x_j \geq y_j$ $\forall j$ and $x_j > y_j$ for infinitely many j. %}

Crespo, Juan Alfons, Carmelo Nuñez, & Juan Pablo Rincón-Zapatero (2009) "On the Impossibility of Representing Infinite Utility Streams," *Economic Theory* 40, 47–56.

{% About the British NICE H/E evaluations. %}

Cressey, Daniel (2009) "life in the Balance," *Nature* 461/17 September 2009, 336–339.

{% **common knowledge**: Agents receive private signals that are independent over time, but not over agents. If signal space is finite, approximate common knowledge will develop, if infinite then need not. %}

Cripps, Martin W., Jeffrey C. Ely, George J. Mailath, & Larry Samuelson (2008) "Common Learning," *Econometrica* 76, 909–933.

{% Ellsberg's three-color paradox has an ambiguous ("unknown") urn with one-third of balls red, and 2/3 black and yellow in unknown proportion. This paper considers a variation with only two colors: Between 0/3 and 2/3 are blue, and the rest is orange. It is as if joining the colors red and black in Ellsberg's urn. They also have a known urn, and they also have the regular three-color Ellsberg urns. They consider gambles on Yellow in the regular Ellsberg urn, and on blue in the variation. In the former they find ambiguity neutrality, so, not the regular ambiguity aversion, in agreement with many current (2019) findings. In the variation, remarkably, they find pronounced ambiguity seeking (73% of subjects!; **ambiguity seeking**). One explanation can be a general drift towards uniform distributions. In the variation there are two colors, which in the case of ambiguity moves subjects in the direction of 50-50, and it does so more than with risk. Such a drift is analyzed by Fox & Clemen (2005) for ambiguity. A similar (but I expect weaker) drift for risk is in Viscusi's (1989) prospective reference theory. It may also play a role that, whereas in the Ellsberg urn, the winning color yellow plays a role symmetric to its counterpart black, in the variation the winning color blue is a sort of a focal event, which may bring overweighting. In the treatment where some voluntary subjects, otherwise uninvolved and not knowing even that there would be bets with winning colors, could determine the composition of the ambiguous urn, on average they indeed put more than 1/3 of blue balls. That is, an ambiguity-neutral Bayesian who can predict this would prefer the ambiguous urn!

The above case always had an a(mbiguity)-neutral probability 1/3 of winning. They do similar things with an a-neutral probability of 2/3 of winning. So, in the variation there are between 1/3 and 3/3 blue balls as winning color. Here they find ambiguity aversion for Ellsberg (66%), but even stronger for the variation (73%)! Here the voluntary subjects who could determine the composition of the ambiguous urn, on average put less than 1/3 of blue balls. That is, an ambiguity-neutral Bayesian who can predict this would disprefer the ambiguous urn.

Putting together, there is more insensitivity for the variation. %}

Crockett, Sean, Yehuda Izhakian, & Julian Jamison (2019) “Ellsberg’s Second Paradox,”

{% %}

Cronbach, Lee J. & Paul E. Meehl (1955) “Construct Validity in Psychological Tests,” *Psychological Bulletin* 52, 281–302.

{% %}

Crone, Eveline A. & Maurits W. van der Molen (2004) “Developmental Changes in Real Life Decision Making: Performance on a Gambling Task Previously Shown to Depend on the Ventromedial Prefrontal Cortex,” *Developmental Neuropsychology* 25, 251–279.

{% %}

Cropper, Maureen L., Sema K. Aydede, & Paul R. Portney (1994) “Preferences for Live Saving Programs: How the Public Discounts Time and Age, *Journal of Risk and Uncertainty* 8, 243–265.

{% %}

Crosby, Fave (1976) “A Model of Egoistical Relative Deprivation,” *Psychological Review* 83, 85–113.

{% **questionnaire for measuring risk aversion**: the authors introduce the BRET (bomb risk elicitation task) method: Subjects can choose a number of boxes from 100 boxes. One of those contains a bomb. Payment is linear in number of boxes if no bomb (10 €-cents times), and 0 if bomb. Risk neutrality implies choosing 50 boxes. The authors consider both a dynamic version, choosing boxes one by one until stop-decision, and all-in-once version. They analyze the data assuming EU with power (CRRA) utility.

A good move: Whether or not the boxes selected contain the bomb is determined only at the end of the experiment, thus avoiding truncation. Hence, the bomb is called time bomb.

The authors favor the dynamic version, but my hunch is to prefer the all-in-once version because the dynamic version does not inform subjects that their choices will influence future options offered.

Nice, and similar to balloon task of Lejuez et al. (2002) which the authors cite. These are all variations of the Binswanger (1981) method. Even closer, and maybe nicer (for not referring to the emotional bomb) is the Columbia card task by Figner et al. (2009, *Journal of Experimental Psychology* 35, 709–730), which the authors are unaware of, maybe because it is in a psychological journal.

decreasing ARA/increasing RRA: In one task, they double the stakes. It leads to higher relative risk aversion, confirming the common increasing RRA. In another treatment, they let subjects first make some money from another task, and then carry out the bomb task. Then they find no clear result, with risk aversion increasing for prior gains between 0 and €2.7, but decreasing after, so, no clear results on increasing/decreasing ARA. I think that whatever effects the prior gains have, these are psychological effects other than wealth effects, because the prior gains are too small to generate real wealth effects.

gender differences in risk attitudes: analyzed in §3.2, where a reference point of €2.5 is framed in. Here, and in several places, the authors claim to find that women are more loss averse then men, but their results in fact are not significant. Women are not more risk averse otherwise. This agrees with Booij &

van de Kuilen (2009).

The authors’ BRET method has some less risk aversion than other methods, which surprises me because I would expect the term bomb to generate risk aversion. %}

Crosetto, Paolo & Antonio Filippin (2013) “The “Bomb” Risk Elicitation Task,” *Journal of Risk and Uncertainty* 47, 31–65. https://doi.org/10.1007/s11166-013-9170-z

{% P. 615 Footnote 2: BDM (Becker-DeGroot-Marschak) is difficult. Analyze four ways to elicit risk attitudes: Multiple price lists (I prefer the efficient term price list; bw., to me this is not a specific risk elicitation, but in general a way to obtain indifferences), ordered lottery selection à la Binswanger (1981), investment game, and bomb elicitation. They also do general introspection. They first analyze the different methods using simulations, to see what differences are due to the methods. Then they investigate in an experiment. There they find differences more than what the methods themselves induce, showing that the underlying risk theory is violated. Unfortunately, the authors implicitly assume EU throughout (stated only on p. 631), with constant relative risk aversion (CRRA), so, logpower utility. Much is known about violations of EU which gives insights into what happens here, but, as often in experimental economics (Holt & Laury 2002), the authors ignore this literature. (**Prospect theory not cited**) They find that the presence or not of a riskless, sure, option matters a lot. This is no surprise given that the certainty effect is about the main cause of EU violations. The authors do mention this point on p. 637 2nd para in the discussion. They don’t find clear superiority of any method. %}

Crosetto, Paolo & Antonio Filippin (2016) “A Theoretical and Experimental Appraisal of Four Risk Elicitation Methods,” *Experimental Economics* 19, 613–641.

{% A safe option being available impacts gender differences in two of three traditional risk-aversion measurement tasks. Characteristic for the citations in this paper is, for instance, that the authors only cite Andreoni & Sprenger (2012) for the certainty effect. %}

Crosetto, Paolo & Antonio Filippin (2023) "Safe Options and Gender Differences in Risk Attitudes," *Journal of Risk and Uncertainty*, 66, 19–46. https://doi.org/10.1007/s11166-022-09400-0

{% **probability elicitation**: seems that they consider continous distributions %}
Crosetto, Paolo, Antonio Filippin, Peter Katuščák., & John Smith (2020) "Central Tendency Bias in Belief Elicitation," *Journal of Economic Psychology* 78, 102273.

{% Subjects much choose between two-dimensional objects, specifying price and volume, but of each they can buy any quantity they want, so that there is an objective criterion for goodness: volume per price. The attraction effect is studied. The authors find a rise-fall effect: at first it gets stronger, but then it gets weaker. I think the first rise effect is just due to reduction of noise, when subjects are learning the stimuli. %}
Crosetto, Paolo & A. Gaudeul (2023), "Fast then Slow: Choice Revisions Drive a Decline in the Attraction Effect," *Management Science* 70, 3711–3733. https://doi.org/10.1287/mnsc.2023.4874

{% **probability elicitation**: applied to experimental economics %}
Croson, Rachel (2000) "Thinking like a Game Theorist: Factors Affecting the Frequency of Equilibrium Play," *Journal of Economic Behavior and Organization* 41, 299–314.

{% **gender differences in risk attitudes &? gender differences in ambiguity attitudes (?)**:Review, a.o., gender differences in risk attitudes. Women more risk averse than men. %}
Croson, Rachel & Uri Gneezy (2009) "Gender Differences in Preferences," *Journal of Economic Literature* 47, 448–474.

{% %}
Crouzeix, Jean-Pierre & Per Olov Lindberg (1986) "Additively Decomposed Quasiconvex Functions," *Mathematical Programming* 35, 42–57.

{% Do what title says, following up on %}

Crupi, Vincenzo, Nick Chater, & Katya Tentori (2013) "New Axioms for Probability and Likelihood Ratio Measures," *British Journal for the Philosophy of Science* 64, 189–194.

{% **Compare different measurement methods**

Compare risk attitude measurements that use choice lists. In standard gamble questions (finding indifference between a sure outcome and a two-outcome prospect) matching, through choice list, on the highest outcome works best. The distinction between matching on various of the entries was also discussed by Farquhar (1984). %}

Csermely, Tamás & Alexander Rabas (2016) How to "Reveal People's Preferences: Comparing Time Consistency and Predictive Power of Multiple Price List Risk Elicitation Methods," *Journal of Risk and Uncertainty* 53, 107–136.

{% Coherent measures of risk are used to distribute diversification benefits over portfolios. %}

Csóka, Péter, P., Jean-Jacques Herings, & László Á. Kóczy (2009) "Stable Allocations of Risk," *Games and Economic Behavior* 67, 266–276.

{% **dynamic consistency**;

Alias: Wakker (1999) http://personal.eur.nl/Wakker//pdf/alias.pdf

This paper is very very similar to my Alias paper and my Alias lecture (Madrid 92 and many times after), bringing out clearly the way independence follows from dynamic principles. It was called to my attention by David Kelsey when I did my Alias presentation in Birmingham (26 April 1996). The paper was thus important to me that I spent about 5 days full time studying it.

The paper is not always accurate in its graph-definitions, although it greatly improves on Hammond (1988) in this respect. Thus, on page 3, lotteries are not defined. They apparently can be compound. The formal def. does not say that n0 is the only node without predecessor. There might be other such nodes and then trees would consist of separate components that have nothing in common (they can then never meet, as can be proved). Only p. 3 l. -2 excludes this case; it should have been in the definition. It would save some symbolism (e.g., the capital O) if end nodes were identified with the prizes/gambles there. I would prefer it if only prizes, not compound gambles, could be end nodes; in this paper, the identity of T1 and T2 on p. 4 has to be imposed as another formal condition. Also, definitions are not highlighted by italicizing or so.

A major omission is that the analysis assumes that all “isomorphic” trees are treated the same way, but does not make that explicit. In other words, the name of a node does not matter. Many papers have that assumption only implicit. This paper does so for instance when defining “the” simple choice tree, and runs into trouble in Footnote 9 because of it.

Identifying a plan with the terminal node(s) that it is heading for is nice, avoiding some discussions about what to do in counterfactual decision nodes. The definition with connectedness to specify when nodes are not separated by decision nodes but only by chance nodes serves to make that possible. The nonemptiness requirement may be too weak. It only requires nonempty choice at !some! decision node, whereas one would expect that at all noncounterfactual decision nodes.

Footnote 7 says that DC is automatically built in in the approach of Hammond (1988). That of course (?) refers to DC as defined in this paper which is in the very weak sense, see hereafter.

The paper uses the term consequentialism in an overall sense to comprise all conditions, so different than I will do hereafter (I use the term for Cubit’s axiom A2).

Plan: shouldn’t there be some completeness in the sense that for every noncounterfactual decision node there is at least one possible terminal node? For the purposes of this paper, only deriving implications for static preferences, it need not be. It is supposed to choose everything that is best, not just be a partial restriction.

A major complication for my understanding of the paper was the concept of “plan.” Many papers use that concept in an informal sense, which I do not like. This paper formalizes it in a mathematical sense, indeed, as a subset of available strategies (through end-nodes). Its decision-status is, however, not very clear. I can think of two different interpretations that considerably affect the meaning of the axioms, mainly A1 and A3. Only the discussion Section 5 and the conclusion section 7 make clear that what I hereafter call the deviation-interpretation is what is meant to be.

Committed plan: Plan means what you would do if at a given node you could lay down all your decisions in following nodes with commitment, so without being able to deviate later; that is, if you can choose between strategies from there on.

Deviation-plan: Plan means what you do if at each subsequent node you can deviate if you like.

Deviation-plan can still be in backward sense as in sophisticated choice or in forward sense as in resolute choice à la Machina (1989), who favors resolute choice but does not need a commitment device for it. Later on in the paper it becomes clear that the deviation-interpretation is meant to be. I will discuss also what the conditions would be under the commitment interpretation.

Plan can be given more decision-theory meaning by letting a tree be a choice option in another decision node (say one where a sure amount is an alternative, to do evaluation in terms of certainty equivalents). That then, however, would require a consideration of more complex decision trees and more assumptions about sequential decisions versus one-shot decisions which, for the mere derivation of independence, would be just too much.

Note that the ambiguity in the meaning of plans does not play a role when the only decision node is the initial node, so there the decision-theoretic meaning of decision is clear.

A1, DC: This is a quite weak condition and only excludes myopia, something that plays no role in Alias because I work with committed plans there.

For committed plans, the condition would be strong, being (b) => (c) in Alias.

A2 is forgone-event independence (Cubit's term separability is unfortunate because this only compares pref. over alternative with pref. over "subalternative" = conditional act). It is (a) => (b) in Alias. The difference between committed and deviation plans is not important here.

Later A2 will be split up into A2a, independence from past chance nodes, and A2b, independence from past decision nodes.

A3 is irrelevance of the timing of the resolution of uncertainty. It speaks to the interchange of a chance and decision node when that is strategically equivalent. In the case when the decision node comes last, it does not involve a "nondecision tree" as in my Alias Figure (c), but puts a decision node (which might be trivial) before it all and considers “plans” at that decision node.

For deviation plans as is Cubit’s interpretation, A3 is, as usually, hard to interpret in a decision theory sense, but it looks really strong because under deviation plans there is really little reason to take the prior perspective. It then captures about all of Machina’s dynamic consistency where one considers risks borne in the past to be relevant (not really all because it also needs A1 but A1 is really weak, only excluding myopia).

For committed plans, A3 is step (c) => (d) in Alias which is not very strong. (Cubit’s terminology that a plan “offers a lottery” on p. 9 suggests a bit the latter interpretation.)

A4 is reduction of compound lotteries, not in full force, but all that is needed to derive independence.

A5 is reduction of consecutive choice nodes, i.e., Plott’s path independence. It says that prior plan in sequential tree is prior plan (= choice) in reduced tree. It then needs A1 to relate the prior plan in the sequential tree to what is really done in the final decision node and A2 to relate that to what is done in the “sniped-off tree.” A5 is not very strong.

Under committed plans, it is very weak and is similar in spirit to A3.

Section 5 contains the discussion. The forward/backward discussion on top of p. 13 shows that the author has the deviation-plan interpretation in mind. Principles relating normal representations to extensive representations, such as A3-A5, are in general forward because they entail that all ways to write a backward representation for the same forward representation should give the same. For A3 and A5 the point is clear, for A4 less so because A4 is not very easily reformulated as a decision principle.

Under committed planning, A1 would be forward and A3/A5 would be weak.

In Table 1, I don’t find it very convincing that A1 and A3 are in the column of chance. Well, if that means that it does not only refer to chance-less trees then OK, but then it’s not very interesting.

The text following Proposition 3, on A1, once more suggests that this paper uses the deviation-interpretation for plan.

On the discussion of splitting Hammond’s consequentialism up or not, I think there is interest in both views, but I like Hammond’s much. I like seeing this all as one idea.

P. 15 has a useful discussion of McClennen. %}

Cubitt, Robin P. (1996) "Rational Dynamic Choice and Expected Utility Theory," *Oxford Economic Papers* 48, 1–19.

{% "We cannot observe plans, only actions." %}

Cubitt, Robin P. (1997) discussion at FUR conference in Mons 1997.

{% The authors investigate the DE (decision from description versus experience) gap. (**DFE-DFD gap but no reversal**?) I think that the early literature on decision from experience (DFE) oversold their case for marketing purposes. One can expect a gap with less overweighting of extreme events in decision from experience, which is unsurprising. But not a reversal leading to underweighting of extreme events, as the early literature claimed. Many recent studies have confirmed this (no reversal), and the present study also does so. This paper is close to Aydogan (2021, Management Science), which also corrects for many things and also finds no reversal.

This paper considers the role of sampling bias (rare events are mostly undersampled), ambiguity attitude, likelihood representation, and memory. Only for the sampling bias they find an effect.

In the unambiguous treatment, subjects sample without replacement a whole urn with 40 balls and are told so. In the ambiguous treatment the same info is given except that subjects are not told that they have sampled the whole urn, and they may think that there were more balls. Although this in principle, in theory, is correct as implementation, I think subjects are so overwhelmed with info at that stage, and inability to handle it all, that this difference (complete sampling or ot) will not matter much. The study indeed finds that ambiguity plays no role. So, I still think that ambiguity attitude plays a role here, also in the unambiguous treatment. %}

Cubitt, Robin, Orestis Kopsacheilis, & Chris Starmer (2022) "An Inquiry into the Nature and Causes of the Description - Experience Gap," *Journal of Risk and Uncertainty* 65, 105–137.
https://doi.org/10.1007/s11166-022-09393-w

{% Discuss the BDM (Becker-DeGroot-Marschak) mechanism and random incentive mechanism, referring to the independence-violation criticism of this mechanism leveled at the end of the 1980s. They do not refer to the counterarguments based on isolation published in later papers such as Cubitt, Starmer, & Sugden (1998), which are referred to only for other reasons. Instead, they use an alternative design, claimed not to be subject to the same criticism. At first it was not clear to me why the alternative design would not be subject to the same independence-violation criticism. The logic seems to be as follows: Even if there is no isolation, no systematic differences of directions of preference reversals can be expected. So, although they have a random lottery, they have a stronger test for preference reversals because they need not rely on the isolation demonstrated in Cubitt, Starmer, & Sugden (1998). %}

Cubitt, Robin P., Alistair Munro, & Chris Starmer (2004) "Testing Explanations of Preference Reversals," *Economic Journal* 114, 709–726.

{% Preference elicitation where subjects indicate CEs and are rewarded by some BDM (Becker-DeGroot-Marschak) procedure. In addition, subjects are asked to indicate an interval for the CE value, where they doubt. This is not incentivized (would be hard to find incentivization). The authors investigate factors influencing the intervals. %}

Cubitt, Robin P., Daniel Navarro-Martinez, & Chris Starmer (2015) "On Preference Imprecision," *Journal of Risk and Uncertainty* 50, 1–34. https://doi.org/10.1111/j.1468-0297.2004.00238.x

{% **time preference, fungibility problem**; The paper analyzes experimental intertemporal choice from a purely theoretical perspective, assuming that there are market opportunities outside the laboratory of borrowing or lending at the market interest rate, and assuming a perfectly rational optimizing agent. It argues that there then is no easy way to experimentally elicit the subjective interest rate, for instance. The paper in particular discusses Coller & Williams (1999), which also addressed this question. This C&R paper is the best to cite on this problem.

I think that an argument against perfect-market driven is the individual variation in measured discount rates. %}

Cubitt, Robin P. & Daniel Read (2007) "Can Intertemporal Choice Experiments Elicit Time Preferences for Consumption?," *Experimental Economics* 10, 369–389.

{% **dynamic consistency**: Use the term separability for what is often called consequentialism in dynamic decision making under risk, and which here entails both indendence of forgone acts and of forgone events. Test the condition and do not find it violated, even though the subjects do violate independence/EU. %}

Cubitt, Robin, Maria Ruiz-Martos, & Chris Starmer (2012) "Are Bygones Bygones?," *Theory and Decision* 73, 185–202.

{% Compare, for choices between simple lotteries, **the random incentive system** to single-choices (with real payment), and find they are not different, confirming their 91- American Economic Review finding. This paper adds to it a check of cross-task contamination, which is something between complete isolation and complete no-isolation I understand. Seems that they also test (paying only some subjects) (**random incentive system between-subjects**).

P. 116 takes single choices as gold standard: "We define true preferences with respect to a given task as those that would be elicited by *single choice* experimental design in which each subject faces onlym that task, and knows it to be for real." [italics from original] Birnbaum (1992 *Contemporary Psychology*) gives counterarguments.

They conclude that isolation may hold for simple stimuli as studied in their paper, but can still be violated for complex stimuli, citing Beattie & Loomes (1997) for it. %}

Cubitt, Robin P., Chris Starmer, & Robert Sugden (1998) "On the Validity of the Random Lottery Incentive System," *Experimental Economics* 1, 115–131.

{% **dynamic consistency**. Nicely split the static vNM independence condition for risk (that axiomatizes EU) into four dynamic decision principles: Separability (I'd prefer the term forgone-event independence), timing independence (I'd prefer the term time consistency), frame independence (I'd prefer the term decision-tree independence), and RCLA. I disagree with them suggesting that frame independence would be the one that Kahneman & Tversky in their prospect theory would want to give up so as to explain violations of independence. K&T consider its violations of frame independence, but never commit to other conditions not being violated.

They find that timing independence is mostly violated (e.g. p. 1378). %}

Cubitt, Robin P., Chris Starmer, & Robert Sugden (1998) "Dynamic Choice and the Common Ratio Effect: An Experimental Investigation," *Economic Journal* 108, 1362–1380.
https://doi.org/10.1111/1468-0297.00346

{% Discuss Plott's discovered preference hypothesis versus the constructive view of preference. Then discuss their experimental methods where each subject will only make one choice in one situation, which should not mean that the subject is not well-instructed or -trained.

Para on pp. 401/ 402 says that people commonly find power utility with power 0.3 (so, RRA = 1 – 0.3 = 0.7). Says that utility in terms of final wealth can, in fact, not explain this, and outcomes must be reference dependent.

P. 401 second half suggests that if subjects by learning and repetition get closer to EU, it may be not because their true preferences are EU and are better revealed, but because subjects better learn to use heuristics independently of true preference and these heuristics, rather than true preference, may get closer to EU.

P. 402 writes:

"…are entirely explained by the relative sizes and relative probabilities of the payoffs in each task. This striking regularity …. we cannot eliminate the possibility that the regularity is induced by context-dependent heuristics which are learned in the course of these experiments."

This is very reminiscent of Stalmeier's proportional heuristic for time-tradeoff questions in the health domain.

It is like their shaping hypothesis as they call it in later papers (e.g. Loomes, Starmer, & Sugden 2003 EJ), but the term is not yet used here. %}

Cubitt, Robin P., Chris Starmer, & Robert Sugden (2001) "Discovered Preferences and the Experimental Evidence of Violations of Expected Utility Theory," *Journal of Economic Methodology* 8, 385–414.

{% **Nash bargaining solution**: P. 761 extensively discusses the (weakness of) assuming vNM utility in game theory. P. 762 links vNM utility with evolutionary replicator dynamics.

P. 770 4th para explains that transitivity is a kind of separability requiring separate preferability of each individual prospect. So, that it is kind of unitary evaluation, in Burks' (1977) terminology. %}

Cubitt, Robin P. & Robert Sugden (1998) "The Selection of Preferences through Imitation," *Review of Economic Studies* 65, 761–771.

{% **dynamic consistency**; **Dutch book**, etc.; gives formal definition of money pump, relating it to the sure-thing principle; argues, citing Fishburn (1988 pp. 43-44), that an agent would not take all trades knowing several trades are to come. They formalize "surprise choices," being choices not announced beforehand. %}

Cubitt, Robin P. & Robert Sugden (2001) "On Money Pumps," *Games and Economic Behavior* 37, 121–160.

{% **dynamic consistency**; Assume some independent boxes, each with probability p a win box and with probability 1−p a loss box (p may depend on box). A subject is endowed with an initial endowment b > 0, and m > 0 is a constant. At each round, if the subject draws a win box, then his endowment of that moment is multiplied by m, if a loss box then by 0 (so, the game is over with no gain). Subjects can choose to take 0, 1, or 2 (extra) rounds. Some do only this (de novo). Others, prior to this choice, had to take 4 compulsory rounds, and only if they win all these they get the choice. Of these others, some do prior commitment, others do posterior choice. This framework is the usual test of consequentialism and dynamic consistency. Given the dynamic framing, no common ratio effect is to be predicted a priori, as shown by Kahneman & Tversky (1979). What emotions the prior-commitment rounds arouse, I could not predict. It turned out that they make the subjects less risk seeking, so, lead to a reversed common ratio.

In the beginning of the paper, the authors present a formal model way more complex than used in the experiment, and they discuss several general issues of decision theory before turning to their particular experiment. %}

Cubitt, Robin P. & Robert Sugden (2001) "Dynamic Decision-Making under Uncertainty: An Experimental Investigation of Choices between Accumulator Gambles," *Journal of Risk and Uncertainty* 22, 103–128.

{% N = 88 subjects, with RIS.

The authors organize two-stage uncertainty as follows: A black bag contains 12 balls each with no. 1 or no. 2 on them, in unknown proportion. There is another bag, a white bag (called ambiguous urn in the paper but not to the subjects), containing 10 balls, either (composition 1) 7 colored orange and 3 colored blue, or (composition 2) 3 colored orange and 7 colored blue. First a ball is drawn from the black bag. If its number is 1, then the white bag gets composition 1, and if its number is 2, then the white bag gets composition 2. Then a ball is drawn from the white ball, its color inspected, determining a payoff. Here the Savage state space S can be taken to have two elements, being the color of the ball drawn from the white bag, which is orange or blue. Subjects get partial info, subject-dependent, about result of number of draws and they can little bit peek into a bag.

In this very simple case the set of possible 1st order probaility distributions over S contains only two elements. The space of second-order probability distributions over the 1st order distributions can be equated with [0,1], specifying the subjective degree of belief that the white urn has composition 1. **Important to note** is that the novelty of the smooth model, of assuming no exogenous two-stage setup with a conditioning event determining an objective probability over S, is NOT the case here. Instead, the two-stage composition is exogenously determined by the experimenters, with the conditioning event the composition of the white ("ambiguous") urn, just as in the Ellsberg urn and in numerous experiments on recursive utility. And, in all experiments of the smooth model that I am aware of … That the absence of this exogenous two-stage setup in the smooth model is "too" general has often been discussed, and the authors address it when writing:

"However, the fact that a second-order belief is involved is widely regarded as making the estimation of the parameters of the smooth ambiguity model a particular challenge (see, e.g., Wakker 2010, p. 337; Carbone et al. 2017, p. 89). We are motivated, in part, by the goal of showing that a subject's second-order belief can be estimated solely through revealed preference, that is by observing his choices over first-order acts." (p. 278)

As will be clear from my preceding comments, I think that the authors did not succeed in achieving their goal. I find it telling that in an apparent attempt to demonstrate the observability of the smooth model, the authors still did not succeed in avoiding an exogenous two-stage decomposition.

The authors assume log-power (CRRA) utility for the EU in the first stage with the vNM utility function, and linear-exponential (CARA) transformation φ capturing ambiguity in the second stage, giving three parameters in total (μ the third). They measure CEs and then fit data. After fitting they can calculate monetary risk- and ambiguity premia, which they find about equally big. %}

Cubitt, Robin, Gijs van de Kuilen, & Sujoy Mukerji (2018) "The Strength of Sensitivity towards Ambiguity: A Qualitative Test and a Measurement," *Theory and Decision* 85, 275–302.

{% P. 709: "The pioneering models in the decision theory literature on ambiguity, and arguably still the most popular, are the Choquet expected utility model of uncertainty aversion introduced in Schmeidler (1989) and the maxmin expected utility (MEU) model of Gilboa and Schmeidler (1989). These models have preference representations that show the DM behaving as if she has a set of probability distributions that she considers possible or relevant." The authors may be right on CEU, but I am more interested in this model with likelihood insensitivity instead of uncertainty aversion. Then it is not a subset of multiple priors.

P. 710: "The literature is therefore at a point where clearer guidance on the relative empirical performance of these models in particular—and the broader classes that they exemplify—is needed." This is, indeed, the case. There are many models now and it must be found out which work best.

This paper provides an experiment distinguishing between the smooth model and the α maxmin model. However, it tests hedging-against-ambiguity predictions in multistage settings that depend much on the dynamic assumptions that for instance α maxmin is coupled with. α maxmin is coupled with the usual backward induction that precludes the hedging found. Then the smooth model does better. I take it more as a test of dynamic principles than of ambiguity models. %}

Cubitt, Robin, Gijs van de Kuilen, & Sujoy Mukerji (2020) "Discriminating between Models of Ambiguity Attitude: A Qualitative Test," *Journal of the European Economic Association* 18, 708–749.
https://doi.org/10.1093/jeea/jvz005

{% **one-dimensional utility** %}

Cui, Zhenyu (2014) "Comment on "Modeling Non-Monotone Risk Aversion Using SAHARA Utility Functions" [J.Econ.Theory 146 (2011) 2075–2092]," *Journal of Economic Theory* 153, 703–705.

{% **utility elicitation** %}

Culyer, Anthony J. & Adam Wagstaff (1993) "QALYs versus HYEs," *Journal of Health Economics* 11, 311–323.

{% **real incentives/hypothetical choice**; hypothetical WTP is higher than real WTP; subjects could borrow cash if not with them, would then have to sign loan agreement; such practical complications may have deterred them in the real WTP! %}

Cummins, Robert G., Glenn W. Harrison, & E. Elisabet Rutström (1995) "Homegrown Values and Hypothetical Surveys: Is the Dichotomous Choice Approach Incentive-Compatible?," *American Economic Review* 85, 260–266.

{% %}

Curley, Shawn P., Stephen A.Eraker, J. Frank Yates (1984) "An Investigation of Patient's Reactions to Therapeutic Uncertainty," *Medical Decision Making* 4, 501–511.
https://doi.org/10.1177/0272989X8400400412

{% **ambiguity seeking for unlikely**: Well, only null hypothesis there. Curley & Yates (1989, JMP) do find it and suggest that this paper lacks power.

They assume that p is unknown in an interval [R2, R1] with midpoint C. Thus, boundary effect precludes high ambiguity for extreme values C. P. 282: For C ≥ .45, they find ambiguity aversion, for C ≤ .40 they find null hypothesis. Fig. 6 might suggest an ambiguity-seeking trend below C = .2, with weird counterevidence when both choices have ambiguity but one has larger ambiguity-interval than the other (the most ambiguous of the two has probability zero as option, the other hasn't, which might enhance ambiguity aversion).

Ambiguity aversion increases with probability of winning whenever second-

order probabilities assign positive probability to 0 probability (**second-order probabilities to model ambiguity**) %}

Curley, Shawn P. & J. Frank Yates (1985) "The Center and Range of the Probability Interval as Factors Affecting Ambiguity Preferences," *Organizational Behavior and Human Decision Processes* 36, 273–287.

{% **ambiguity seeking for unlikely**: finds clear ambiguity seeking for "central unknown probability" p = 0.25, and ambiguity aversion for p = .50 and p = .75. %}

Curley, Shawn P. & J. Frank Yates (1989) "An Empirical Evaluation of Descriptive Models of Ambiguity Reactions in Choice Situations," *Journal of Mathematical Psychology* 33, 397–427.

{% Always real incentives with RIS.

Find that "other-evaluation" hypothesis, (choice should be justifiable to others) explains ambiguity aversion.

Do usual two-color Ellsberg in five ways.

1 (hostile nature). Ask subjects if they think that the unknown urn will be biased to their disfavor.

2 (other-evaluation). Subjects must stand in front of the whole group when their choice is revealed and the content of the unknown urn is also revealed.

3 (self-evaluation). Content of unknown urn is revealed to subject but in private, others don't know.

4 (forced choice). People are actually indifferent and ambiguity avoidance is second-order lexicographic.

5 (general uncertainty avoidance). Ambiguity avoidance is related to risk aversion, general aversion to lacking info. (If true, would imply **correlation risk & ambiguity attitude.**)

Only 3 (self-evaluation) is found to have an effect.

P. 235 2/3: subjects could choose winning color (**suspicion under ambiguity**)

P. 253 contains a strange argument suggesting that accepting the null hypothesis does give strong evidence.

They gave subjects normative arguments for and against ambiguity aversion, as did Slovic & Tversky (1974). 80% preferred to be ambiguity averse.

correlation risk & ambiguity attitude: find none. P. 239: Experiment 1 finds no correlation between risk- and ambiguity aversion, but N = 26 is small. Experiment 2 (N = 39) confirms this (p. 241), also if the data of the two experiments are pooled. P. 252 suggests that, according to the hypothesis of general uncertainty aversion, risk aversion should be positively related to ambiguity aversion. (**correlation risk & ambiguity attitude**). The text doesn't show awareness that risk and ambiguity aversion are in a way complementary.

I think that the explanation on p. 255 about contradiction about composition resulting from ambiguity aversion is incorrect. %}

Curley, Shawn P., J. Frank Yates, & Richard A. Abrams (1986) "Psychological Sources of Ambiguity Avoidance," *Organizational Behavior and Human Decision Processes* 38, 230–256.

{% Multiattribute preferences can be approximated well by additive representations. %}

Currim, Imran S. & Rakesh K. Sarin (1984) "A Comparative Evaluation of Multiattribute Consumer Preference Models," *Management Science* 30, 543–561.

{% The analysis of for example value function etc. essentially uses OPT which I consider to be less interesting. Unlike the authors, I here use the OPT abbreviation of the 1979 version of prospect theory

End of abstract: - for the paradoxical choices, OPT outperforms EU - on other choices it does not do better

utility elicitation;

§2: nice simple summary of original prospect theory of 1979;

P. 24 point (ii) points out that shifting reference point (à la Shalev) has problems with PT's assumption that U is concave above the reference point and convex below: "Note that the utility function for gains and losses cannot be s-shaped with respect to a moving reference point. To see this consider an interval $[x_1, x_2]$, $x_2 > x_1$. Now if w is the initial wealth and $w + x_2$ is the reference point then $u(w + x)$, $x_1 \le x \le x_2$ is convex; whereas within the same range it is concave if $w + x_1$ is the reference point. The inconsistency between the utility function for final wealth and the induced utility function for gains and losses does not occur if a person's utility function is exponential or linear."

P. 28 contains a nice method of eliciting utility for OPT nonparametrically

Parametric utility elicitation is by taking exponential utility (p. 26: “as is traditionally done”)

P. 26: “By choosing simple scenarios, we have conveniently avoided the complications of the editing phase”

risky utility u = strength of preference v (or other riskless cardinal utility, often called value): On p. 28 they suggest that the value function of prospect theory is a riskless utility function (where “certainty method” is a kind of direct rating): “The value function in the prospect model can either be assessed by a *certainty method* or by a *gamble method*. We employed both methods even though we believe the certainty method is more desirable for capturing the psychological effects assumed by the prospect model, and is easier to implement.” They suggest this point also in their conclusion on p. 39.

Data analysis is hard to interpret because of the many assumptions made. Conclusions on p. 39 are nice

- properties of value function and probability transf. in OPT hold

- Parametric fitting of utility (“that smooth out errors”) provide predictions superior to those of directly assessed values.

- **PE doesn’t do well**: certainty method (direct assessment of values without risk present) is easier to implement, and more accurate, than gamble method (where risky choices are used). (This suggests strongly that they are willing to interpret the value function in prospect theory as riskless.)

- probability transf. seems to be different for gains than for losses

- **concave utility for gains, convex utility for losses**: P. 30, where two-piece u is concave for gains, convex for losses (They use term value function here. The term utility function refers to what utility would be if expected utility were to hold, so, is less interesting I think.)

P. 39: “It is not uncommon in consumer research that tradeoffs are made between generality of a model estimated and burden on respondents.”

real incentives: use hypothetical choices.

P. 39: Argue for parametric fitting as opposed to parameter-free methods: “analytical forms for the utility and value functions that smooth out errors provide superior predictions than directly assessed values.” %}

Currim, Imran S. & Rakesh K. Sarin (1989) “Prospect versus Utility,” *Management Science* 35, 22–41.

{% **free will/determinism**

Timelessness has been used to defend free will. This paper argues that then the essence is dependence. %}

Cyrl, Taylor (2020) "Timelessness and Freedom," *Synthese* 197, 4439–4453. https://doi.org/10.1007/s11229-018-01930-y

{% %}

D'Acunto, Francesco, Daniel Hoang, Maritta Paloviita, & Michael Weber (2023) "IQ, Expectations, and Choice," *Review of Economic Studies* 90, 2092–2325. https://doi.org/10.1093/restud/rdac075

{% Seems to write the following, which means that he suggested transforming probabilities (!), on p. 284/285 (citation from Keynes 1921, p. 314, translation into English given after):

"Il me sembloit [in reading Bernoulli's Ars Conjectandi] que cette matière avoit besoin d'être traitée d'une manière plus claire; je voyois bien que l'espérance étoit plus grande, 1^0 que la somme espérée étoit plus grande, 2^0 que la probabilité de gagner l'étoit aussi. Mais je ne voyois pas avec la même évidence, et je ne le vois pas encore, 1^0 que la probabilité soit estimée exactement par les méthodes utisées; 2^0 que quand elle le seroit, l'espérance doive être proportionnelle à cette probabilité simple, plutôt qu'à une puissance ou même à une fonction de cette probabilité; 3^0 que quand il y a plusieurs combinaisons qui donnent différens avantages ou différens risques (qu'on regarde comme des avantages négatifs) il faille se contenter d'*ajouter* simplement ensemble toutes les espérances pour avoir l'espérance totale." [italics from the original]

My translation into English is:

"It seemed to me [in reading Bernoulli's Ars Conjectandi] that this material needs to be treated more clearly; I saw well that the expectation is larger, 1^0 that the expected sum is larger, 2^0 that the probability of winning is so too. But I did not see the same evidence, and I still do not see, 1^0 that the probability were estimated exactly by the methods used; 2^0 that if it were, the expectation should be proportional to that simple probability, rather than to a power or even to a function of that probability; 3^0 that if there are several combinations that give different averages or different risks (which one considers as negative averages) one had to be satisfied to simply *add* together all these expectations for having the total expectation." [italics from the original] %}

D'Alembert (1768) "*Opuscules Mathématiques*, vol. iv., (extraits de lettres)."

{% **principle of complete ignorance**;

Argued that probability theory is of no use in medicine because in medicine one treats individual patients and, so the argument goes, probabilities don't apply to single cases.

P. 33: "Votre principe vous interdit cette recherche des applications individuelles: car le problème de numéristes n'est pas de guérir tel ou tel malade, mais d'en guérir le plus possible sur un totale déterminé. Or ce problème est essentiellement anti-médicale."

My translation: "Your problem prohibits you that investigation of individual applications: because the problem of the numerists is not to cure this or that ill person, but to cure the largest possible on a determined total. Hence, this problem essentially is anti-medical." %}

d'Amador, Risueňo (1837) "Le Calcul des Probabilités Appliqué à la Médicine," *Bulletin de l'Académie Royale de Medicine* 1, 622–679.

Also:

d'Amador, Risueňo (1837) "*Mémoire sur Le Calcul des Probabilités Appliqué à la Médicine, Lu à l'Académie Royale de Médicine dans Sa Scéance du 25 Avril 1837*." Baillière-J.B., Librairie de l'Académie Royale de Médicine, Paris.

{% %}

D'Ambrosio, Bruce (1987) "Truth Maintenance with Numeric Certainty Estimates," *Proceedings of the 3rd IEEE Conference on AI Applications*, Orlando, Fla., 244–249.

{% %}

d'Aspremont, Claude & Louis-André Gérard-Varet (1979) "Incentives and Incomplete Information," *Journal of Public Economics* 11, 25–45.

{% Characterize Savage's (1954) SEU but for a finite state space and continuous utility, using different axioms than did Wakker (1984) or Gul (1992) who also used continuum of outcomes and finite state space to axiomatize SEU.

d'Aspremont & Gevers assume two equally likely states of nature, so that they can compare utility differences. I write $\alpha\beta \sim^* \gamma\delta$ if the pairs have the same utility difference, measured this way (Wakker 1984 used a tradeoff tool to get the same). Their main axiom is Difference-Scale Neutrality (p. 72), which requires that $f \succcurlyeq g$ iff $h \succcurlyeq k$ if there is a state of nature t such that, for all states s, $f(t)f(s) \sim^*$

h(t)h(s) and (f(t)g(s) ~* h(t)k(s). That is, all utilities of h and k are like those of f,g, only moved up by U(h(t)) – U(f(t)). Then utility differences are the same for each state in both decisions, so that the condition is necessary for SEU. They assume this axiom and separability (sure-thing principle). %}

d'Aspremont, Claude & Louis Gevers (1990) "Invariance, Neutrality and Weakly Continuous Expected Utility." *In* Jean-Jaskold Gabszewicz, Jean-François Richard, & Laurence A. Wolsey (eds.) *Economic Decision-Making: Games, Econometrics and Optimisation: Contributions in honour of Jacques H. Drèze,* 87–100, North-Holland, Amsterdam.

{% d**iscounting normative**: Rothbard (1990) writes that he "inaugurated the tradition of moralistically deploring **time preference** as an over-estimation of a present that can be grasped immediately by the senses," referring to Kauder (1965) for it. %}

da Volterra, Gian Francesco Lottini (1574) "*Avvedimenti Civili*."

{% **error theory for risky choice**; gives axiomatization of probabilistic version of EU. Can account for Allais paradoxes. %}

Dagsvik, John K. (2008) "Axiomatization of Stochastic Models for Choice under Uncertainty," *Mathematical Social Sciences* 55, 341–370.

{% **Z&Z** %}

Dahlby, Bey G. (1981) "Adverse Selection and Pareto Improvements through Compulsory Insurance," *Public Choice* 37, 548–558.

{% %}

Dahlby, Bey G. (1987) "Inequality Measures in a Harsanyi Framework," *Theory and Decision* 22, 187–202.

{% %}

Dai, Zhixin, Robin M. Hogarth, & Marie Claire Villeval (2015) "Ambiguity on Audits and Cooperation in a Public Goods Game," *European Economic Review* 74, 146–162.

{% Finds, according to Karmarkar, overestimation of lower probabilities and underestimation of higher. %}
Dale, H.C.A. (1959) "A Priori Probabilities in Gambling," *Nature* 183, 842–843.

{% %}
Dalkey, Norman C. (1949) "A Numerical Scale for Partially Ordered Utilities," Rand memo 296, Dec. 5.

{% %}
Dalkey, Norman C. (1953) "Equivalence of Information Patterns and Essentially Determinate Games." *In* Harold W. Kuhn & Albert W. Tucker (eds.) *Contributions to the Theory of Games* II, 217–243, Princeton University Press, Princeton NJ.

{% Seems that he already studied anticomontonicity, also called counter-monotonicity. %}
Dall'Aglio, Giorgio (1972), "Fréchet Classes and Compatibility of Distribution Functions," *Symposia Mathematica* 9, 131–150.

{% %}
Dalton, Patricio S. & Sayantan Ghosal (2012) "Decisions with Endogenous Frames," *Social Choice and Welfare* 38, 585–600.

{% **updating under ambiguity with sampling**: Assumes that an agent is given the info that the true probability belongs to some set of probability measures, and no other info. So, much like multiple priors, although the author does not refer to that. Assumes that the agent does EU, and formulates and discusses some axioms for updating. There are not many literature references. %}
Damiano, Ettore (2006) "Choice under Limited Uncertainty," *Advances in Theoretical Economics* 6, issue 1, article 5.

{% Tried to study emotions at a low, material, level of aggregation, opening his lecture with: "Emotions are chemical and neural responses, forming a pattern" (**ubiquity fallacy**) %}

Damasio, Antonio (2001) June 15, lecture at Amsterdam.

{% **probability communication**: Not only numerical but also graphical. For the latter they use pie charts and icon arrays. The pie charts don't perform well, agreeing with previous findings in the literature, and even enhance risk aversion. Other than that, graphs reduce (but do not eliminate) risk aversion, which can be taken as a move in a rational direction. %}

Dambacher, Michael, Peter Haffke, Daniel Groß, & Ronald Hübner (2016) "Graphs versus Numbers: How Information Format Affects Risk Aversion in Gambling," *Judgment and Decision Making* 11, 223–242.

{% This paper lets subjects make hypothetical binary choices between a sure and a risky or uncertain option. It does it both for money (quantitative) and qualitative health outcomes. It, correctly, writes that most studies studied quantative outcomes. It is, apparently, the first to consider qualitative outcomes (medical in this paper). Li, Müller, Wakker, & Wang (2018 Management Science) also considered medical outcomes, but they were life durations, so, quantitative. I propagated using matching probabilities and pmatchers, for them the nature of outcomes is not important and they work with qualitative outcomes the same way as quantitative.

The authors take the number of safe choices of subjects as index in their analyses. They find moderate correlations across domains and time. %}

Dan, Ohad, Chelsea Y. Xu, Ruonan Jia, Emily K. Wertheimer, Megha Chawla, Galit Fuhrmann Alpert, Terri Fried, & Ifat Levy (2025) "Moderate Stability of Risk and Ambiguity Attitudes across Quantitative and Qualitative Decisions," *Scientific Reports* 15, 3119. https://doi.org/10.1038/s41598-025-87644-x

{% %}

Dana, Rose-Anna (2005) "A Representation Result for Concave Schur Concave Functions," *Mathematical Finance* 15, 615–634.

{% **preference for flexibility** %}

Danan, Eric (2003) "A Behavioral Model of Individual Welfare," EUREQua, Université de Paris I.

{% **preference for flexibility** %}
Danan, Eric (2003) "Revealed Cognitive Preference Theory," EUREQua, Université de Paris I.

{% **preference for flexibility** %}
Danan, Eric (2005) "Money Pumps for Incomplete and Discontinuous Preferences," Dept. d'Economia i Empresa, Universitat Pompeu Fabra, Barcelona, Spain.

{% **preference for flexibility** %}
Danan, Eric (2008) "Revealed Preference and Indifferent Selection," *Mathematical Social Sciences* 55, 24–37.

{% This paper considers situations of incomplete preference, some consistency principles, and possibly random selection in case of no preference. It shows that random selection under absence of preference can nevertheless lead to inconsistencies (that under some assumptions can be led into money pumps). In a way, there is no space for incompleteness, and one still better satisfy the consistency conditions throughout also if perceived nonpreference, and one should not just do random choice. %}
Danan, Eric (2008) "Randomization vs. Selection: How to Choose in the Absence of Preference?," *Management Science* 56, 503–518.

{% Preference aggregation for multiple prior references. Unambiguous Pareto says that the social preference should respect unanimously agreed individual preferences if those all are unambiguous (hold for every prior). If there is enough overlap between the individuals (something like the intersections of their prior sets being nonempty) then a social preference relation, multiple prior type, exists. Social utility then is an affine aggregate of the individual utilities. %}
Danan, Eric, Thibault Gajdos, Brian Hill, & Jean-Marc Tallon (2016) "Robust Social Decisions," *American Economic Review* 106, 2407–2425.

{% Harsanyi's aggregation, but with incomplete preferences through multi-utility functions and unanimity criterion. %}

Danan, Eric, Thibault Gajdos, & Jean-Marc Tallon (2013) "Aggregating Sets of von Neumann-Morgenstern Utilities," *Journal of Economic Theory* 19, 663–668.

{% Extend Harsanyi's beautiful aggregation theorem to incomplete preferences, with sets of utility functions and unanimous agreement. I did not study enough to see the relation with their 2013 JME paper. %}

Danan, Eric, Thibault Gajdos, & Jean-Marc Tallon (2015) "Harsanyi's Aggregation Theorem with Incomplete Preferences," *American Economic Journal: Microeconomics* 7, 61–69.
http://dx.doi.org/10.1257/mic.20130117

{% Theoretical study on preferences over menus. %}

Danan, Eric, Ani Guerdjikova, & Alexander Zimper (2012) "Indecisiveness Aversion and Preference for Commitment," *Theory and Decision* 72, 1–13.

{% **foundations of quantum mechanics**, some nice references to people (a.o., Piron) who say that probability distribution over place/momentum does not exclude that these things be called properties. Paper itself does not seem to contribute to that question other than linguistically. %}

Daniel, Wojciech (1989) "Bohr, Einstein and Realism," *Dialectica* 43, 249–261.

{% **revealed preference** %}

Danilov, Vladimir I. & Gleb A. Koshevoy (2006) "A New Characterization of the Path Independent Choice Functions," *Mathematical Social Sciences* 51, 238–245.

{% **probability elicitation**: seems that they consider continous distributions %}

Danz, David, Lise Vesterlund, & Alistair J. Wilson (2020) "Belief Elicitation: Limiting Truth-Telling with Information on Incentives (No. w27327) ." National Bureau of Economic Research.

{% **proper scoring rules**

Proper scoring rules, quadratic being most popular, are incentive compatible under subjective expected value maximization. This requires linear utility of money. —As an aside, I think that linearity of utility is reasonable for small stakes, and empirical violations of expected value are more driven by other "nonEU" factors such as nonlinear probability weighting.— An old idea to get linear utility, at least under expected utility (EU), is to take as unit of payment probability of winning a prize (Roth & Malouf 1979). This can be done for proper scoring rules as well. One then has incentive compatibility under EU, more general than expected value. Selten, Sadrieh, & Abbink (1999) observed that one does not need all of EU for this. Reduction of compound lotteries (RCL) is enough. Then maximizing EU amounts to maximizing the probability of winning the prize. It leads to what is called the binarized scoring rule (BSR), for which Hossain & Okui (2013) are usually cited, although they did some more complex things.

Whereas a generation ago, 1990-2010, researchers were well aware that RCLA, and some other principles for dynamic decision making, are less innocuous than first meets the eye (e.g., see Machina 1989, JEL), this is less well-known at this moment of writing, in 2022. There are already many violations if all the probabilities are known, objective, and available to decision makers so that they can readily do multiplication (e.g., Bernasconi 1994; see keyword RCLA). The violations will be way and way more serious if some of the probabilities involved are subjective, making RCLA way more problematic even in an as-if sense. I think that it is way more likely that subjects in the BSR do backward-induction with violation of RCLA and nonlinear probability weighting hitting in in full force. (And also ambiguity attitudes ...) That these deviations from linearity are bigger than with monetary payment. Comes to it that the two-stage payment in BSR is more complex. The authors seem to overlook the critical role of RCLA when they write that BSR is incentive compatible for "any decision-maker who maximizes the overall chance of winning a prize." (p. 2852 middle) However, their paper goes in the right direction by showing empirically that the BSR works poorly.

The aforementioned incentive compatibility works theoretically if one assumes RCLA, but not empirically because of the violations. The authors go in this direction when writing "We argue that to secure truthful revelation, elicitation mechanisms need to not only be incentive compatible in a purely theoretical sense, but also in a behavioral one." This is the main motivation of the paper. Note that many people are aware of this, as in criticisms of the BDM mechanism and Bardsley et al. (2010 §6.5, p. 265 & p. 285), which also distinguishes between theoretical incentive compatibility and behavioral incentive compatibility. But yet more people are not aware of this and typically only discuss theoretical incentive compatibility.

In one treatment, subjects receive a calculator that does the RCLA calculations and gives the overall probability of winning the prize. I did not read the paper enough to know what first-order subjective probabilities were used for these calculations, and how they were related to scores that subjects provide.

To test the method, they use it for risky events for which objective probabilities are given and then the subjective probabilities should agree with those ("truthfulness"). They show that this is *worse* with BSR than with no incentives at all, both in the sense that fewer subjects do it (their first weak incentive compatibility criterion), and in the sense that fewer subjects choose the proper optimal r with BSR then without (their second weak criterion). I must admit that I see no difference between these two criteria, but never mind.

I think that future work should focus on best clarifying instructions to give to subjects. %}

Danz, David, Lise Vesterlund, & Alistair J. Wilson (2022) "Belief Elicitation and Behavioral Incentive Compatibility," *American Economic Review* 112, 2851–2883.
https://doi.org/10.1257/aer.20201248

{% An accessible, but not specialized, discussion, of behavioral versus theoretical incentive compatibility. These nice terms I first saw in Bardsley et al. (2010).

The paper focuses on belief measurements. More narrowly, iIt focuses on belief measurements in situations where true objective probabilities are clearly existing (e.g. relative frequencies) and even known to the experimenter and, sometimes, also to the subjects. Belief measurements are more interesting in cases of probabilities unknown to everyone or even objective probabilities not conceivable, as with unique events.

A very negative conclusion, based mostly on another paper by this team:

explaining incentive compatibility seems to worsen the case, with more/bigger errors. The authors are negative on the binarized scoring rule.

It will not surprise the readers that I think that the Prince method of Johnson, Baillon, Bleichrodt, Li, van Dolder, & Wakker (2021) will fare better. I regret that the authors never mention the important role of ambiguity nonneutrality. %}

Danz, David, Lise Vesterlund, & Alistair J. Wilson (2024) "Evaluating Behavioral Incentive Compatibility: Insights from Experiments," *Journal of Economic Perspectives* 38, 131–154. https://doi.org/10.1257/jep.38.4.131

{% In a particular jurisdiction in Israel, judges judged positive 65% of the cases just after lunch, and close to 0 just before. The authors corrected for many things such as seriousness of case, and order of cases before/after was completely random as far as the authors could detect. Here positive judgments were hard to make and negative ones easy. The effect is incredibly strong. %}

Danziger, Shai, Jonathan Levav, & Liora Avnaim-Pesso (2011) "Extraneous Factors in Judicial Decisions," *Proceedings of the National Academy of Sciences* 108, 6889–6892.

{% **Z&Z** %}

Danzon, Patricia (2002) "Welfare Effects of Supplementary Insurance: A Comment," *Journal of Health Economics* 21, 923–926.

{% %}

Darjinoff, Karine (1998) "An Experimental Study of Insurance Behavior," LAMIA, Paris.

{% %}

Darjinoff, Karine (1999) "Experimental Tests of Private Valuations and Binary Choices in Insurance Decisions," LAMIA, Paris.

{% **ratio-difference principle** %}

Darke, Peter R. & Jonathan L. Freedman (1993) "Deciding whether to Seek a Bargain: Effects of Both Amount and Percentage off," *Journal of Applied Psychology* 78, 960–965.

{% **gender differences in risk attitudes**: With simple certainty equivalents (BDM: Becker-DeGroot-Marschak), women were not more risk averse than men. In 2nd part of experiment, subjects had to make risky decisions for others than themselves. The predicted risk attitudes of others was mix of own risk attitude and risk neutrality, and subjects believed (incorrectly in this group) that women would be more risk averse. %}

Daruvala, Dinky (2007) "Gender, Risk and Stereotypes," *Journal of Risk and Uncertainty* 35, 265–283.

{% Predecessors:

- Lamarck (1809) also put forward that species develop through evolution. He believed that things learned during lifetime could be inherited by offspring, an idea that later was generally abandoned, but, then, evidence supporting it has been put forward. And, it is plausible …

- After publishing the first edition, Darwin received a letter from Patrick Matthew pointing out that Matthew had already described the idea of natural selection in his 1831 book, and Darwin credited him in following editions.

- Wallace (1958) sent his unpublished essay "On the Tendency of Species to form Varieties," also containing the ideas of selection and evolution, to Darwin, who then hurried up to publish his book. Seems that they coordinated, well respecting and crediting each other. %}

Darwin, Charles (1859) "*On the Origin of Species.*" John Murray, London.

{% A fancy statistical technique is developed and applied to returns to stock markets in five countries, to find that the index of relative risk aversion is not constant over time. %}

Das, Samarjit & Nityananda Sarkar (2010) "Is the Relative Risk Aversion Parameter Constant over Time? A Multi-Country Study," *Empirical Economics* 38, 605–617.

{% **decreasing/increasing impatience**: provides theoretical arguments for the possibility of increasing impatience.

Consider intertemporal choice when there is probability of earlier or later payment than thought. Show that all kinds of plausible probability distributions of the latter can imply decreasing (as in hyperbolic) discounting at $t = 0$. There are also plausible probability distributions that imply increasing discounting at $t = 0$, such as the example of Sozou on p. 1292, and the example at the beginning of §III, pp. 1294-1295. In these examples of nonconstant discounting, a reversal of preference at a different timepoint is not dynamic inconsistency, but can simply follow from Bayesian updating: arriving at the later timepoint without consumption received yet gives the extra information that the "risk" of receiving the consumption before that later timepoint did not happen.

P. 1290, footnote 2, nicely explains how the term hyperbolic discounting originally meant something specific (discount rate depending inversely on time) but nowadays (2005) is used for anything with decreasing discounting.

P. 1291, first para of §I, mentions that discounting can be due to uncertainty about the future, referring to Yaari (1965) for it.

DC = stationarity: **dynamic consistency**; End of §I carefully distinguishes between variation in the time of consumption ("comparisons across decision problems") versus variation in the time of decision making ("comparison within the same decision problem") and properly says that the former is not a violation of **dynamic consistency**. §IV gives example of preference change when decision timepoint changes, so, dynamic inconsistency, which however rationally follows because the model is more complex than just single intertemporal choice and more is going on. The more going on is that it is in fact a repeated decision with learning, where learning is taken in an evolutionary sense. Refer for it to experimental evidence with pigeons. %}

Dasgupta, Partha & Eric Maskin (2005) "Uncertainty and Hyperbolic Discounting," *American Economic Review* 95, 1290–1299.

{% Seems to describe the early Buffon who argued that all probabilities < .0001 be treated as "morally" equal to zero. %}

Daston, Lorraine J. (1980) "Probabilistic Expectation and Rationality in Classical Probability Theory," *Historia Mathematica* 7, 234–260.

{% **foundations of probability**

1837-1842 six authors discussed objective-subjective probabilities. Originally, probabilities were primarily taken as subjective/epistemic, although (observed) relative frequencies were also considered from the beginning. Around 1840 the objective concept became more established. Cournot, well known for his equilibrium, was important here. The first part of the paper, pp. 332 ff., discussed the terms objective versus subjective, which also developed and changed over time. Quite some authors argued that only certainty can be objective (p. 332 middle). It surely can achieve a high degree of objectivity, not available to uncertainty.

P. 336 middle discusses separation of inside and outside of human mind (Descartes)

P. 335 ℓ. –5/–4 cites Poisson on arguing that the law of large numbers is the "base of all applications of the calculus of probabilities," which is close to the frequentist interpretation. The next text cites Poisson on using the term probability for subjective probabilities (which he, thus, still did consider) and the term chance for objective probabilities. The chance of heads-tails is not precisely 0.5, but the probability is. During my collaborations with Amos Tversky, early 1990s, I noticed that Amos liked to use the term chance for objective probabilities.

P. 336 middle cites Cournot (1843):

> The "subjective probabilities" based on equal ignorance of outcomes were fit only for the "*frivolous use of regulating the conditions of a bet*" [9, 111, 288], and were moreover the "*cause of a crowd of equivocations [which] have falsified the idea one ought to have of the theory of chances and of mathematical probabilities*" [9, 59]. [italics added here]

Then it cites Cournot on calling upon statisticians to avoid subjective inputs.

P. 337 cites later editions of Mill (1843) on admitting the (subjective) more probable than concept and relating it to betting on!:

> Mill grudgingly conceded that "as a question of prudence" we might rationally assume that "one supposition is more probable to us than another supposition," and even bet on that assumption "if we have any interest at stake" and if we were in the desperate (and rare)

situation of having no relevant experience whatsoever
[31, 7:535-536].

P. 337 middle:

Mill curiously remained the most traditional of the revisionists in his interpretation of all probabilities as epistemic.

My opinion may fit with Mill: basically, all probabilities are subjective, but in communications and virtually all applications except the final decision almost exclusively the objective probabilities are relevant.

P. 339 starts with an interesting topic: "The objectivity of chance in a deterministic world." It discusses stable vs. variable causes, but most I could not understand. %}

Daston, Lorraine J. (1994) "How Probabilities Came to Be Objective and Subjective," *Historia Mathematica* 21, 330–344.

{% **value of information**: Signal dependence designates situations in which new info affects not only beliefs but also the utility of outcomes. Shows that value of experimentation will always be positive if cross-derivative of the value function with respect to beliefs and the signal is positive. Otherwise, value of info may be negative.

information aversion: P. 579 nicely describes my 1988 information-aversion paper: "First, if an agent violates the independence axiom of expected utility, then the agent may be dynamically inconsistent and accordingly may prefer less information to more." %}

Datta, Manjira, Leonard J. Mirman, & Edward E. Schlee (2002) "Optimal Experimentation in Signal-Dependent Problems," *International Economic Review* 43, 577–607.

{% Seem to find that percentage of lawyers negatively affects the GNP growth rate. Seem to write: "since lawyers are by and large among the most intelligent members of society, their diversion from normal and especially from growth-enhancing economic activities, has the effect of reducing both the level of aggregate output and its rate of growth." %}

Datta, Samar K. & Jeffrey B. Nugent (1986) "Adversary Activities and Per Capita Income Growth, *World Development* 14, 1457–1461.

{% **questionnaire for measuring risk aversion** %}

Datta Gupta, Nabanita, Anders Poulsen, & Marie-Claire Villeval (2013) "Gender Matching and Competitiveness. Experimental Evidence," *Economic Inquiry* 51, 816–835.

{% **violation of risk/objective probability = one source**
CRRA risk aversion measures were elicited from 900 subjects in two ways: First, using choice lists, second, choosing one from 6 prospects (considered simpler). The simpler task works better for non-sophisticated subjects, and the more complex task works better for sophisticated subjects. Consider gender differences. %}
Dave, Chetan, Catherine C. Eckel, Cathleen A. Johnson, & Christian Roja (2010) "Eliciting Risk Preferences: When Is Simple Better?," *Journal of Risk and Uncertainty* 41, 219–243.

{% %}
David, Herbert A. (1988) "*The Method of Paired Comparisons;*" 2nd edn. *G*riffin, London.

{% **ambiguity seeking for losses** %}
Davidovich, Liema & Yossi Yassour (2009) "Ambiguity Preference," School of Social Sciences and Management, Ruppin Academic Center, Emek Hefer 40250, Israel.

{% %}
Davidson, Donald (1974) "The Philosophy of Mind." *In* Jonathan Glover (ed.) *The Philosophy of Mind*, 101–110, Oxford University Press, New York.

{% Presented at FUR 84 in Venice. Pp. 89-91 have a nice discussion that normative and descriptive decision theory are not very different. Even our common descriptive decision theories are about highly idealized intentional actions with many rational operations built in (such as weak ordering). And normative theories must of course use many descriptive inputs. Relatedly, in my descriptive work I am more interested in prospect theory than in models of Erev and Birnbaum and others that may be descriptively and predictively better but, unlike prospect theory, have no components such as utility that are close to normative theories. With my normative interests I am primarily interested in descriptive theories that give better insights into what the normative components are, and see prospect theory primarily as an improved method of measuring utility. %}

Davidson, Donald (1985) "A New Basis for Decision Theory," *Theory and Decision* 18, 87–398.

{% **free will/determinism**: seems to find free will/behavior and determinism irreconcilable. %}

Davidson, Donald (1990) "The Structure and Content of Truth," *Journal of Philosophy* 87, 279–328.

{% First ? with money pump argument; ascribe idea to Norman Dalkey; vNM-utility=strength.pr.??; Probabilities nonadditive!!! %}

Davidson, Donald, John C.C. McKinsey, & Patrick Suppes (1955) "Outlines of a Formal Theory of Value, I," *Philosophy of Science* 22, 140–160.

{% **strength-of-preference representation**; seem to have introduced the crossover property;

just noticeable difference: Seem to suggest that those can be useful for risky decision theory. Nicely puts forward that probabilistic decision theory can serve as a basis for strength of preference and cardinal utility. %}

Davidson, Donald & Jacob Marschak (1956) "Experimental Tests of Stochastic Decision Theory." *In* C. West Churchman & Philburn Ratoosh (eds.) *Measurement: Definitions and Theories,* Wiley, New York.

{% This paper can be taken as a full formalization of Ramsey (1931).

Opening page nicely argues for using only finitely many observations, nicely comparing with physics where there are more reliable measurements coming closer to continuity.

The paper assumes an event with probability 0.5 as did Ramsey, and a finite set of outcomes equally spaced in utility units. This latter is a big restriction. It also makes the theory close to trivial.

risky utility u = strength of preference v (or other riskless cardinal utility,

often called value); footnote 5 gives nice discussion that vNM bring in independence by taking indifference as congruence.

utility of gambling: p. 266

P. 266 discusses that indifference cannot easily be observed from **revealed preference**. %}

Davidson, Donald & Patrick Suppes (1956) "A Finitistic Axiomatization of Utility and Subjective Probability," *Econometrica* 24, 264–275.
https://doi.org/10.2307/1911631

{% Try to improve Mosteller & Nogee (1951), for one thing by avoiding the certainty effect by not using certain outcomes. So, **utility elicitation**; **risky utility u = strength of preference v (or other riskless cardinal utility, often called value)**; vNM utility is as well curved for small amounts, as for large (got this from Lopes, 1984)

They seem to investigate the "probabilistic reduction" principle by which I mean the basic assumption of decision under risk, meaning that for an act only the probability distribution generated over the outcomes matters. Don't know now if this is RCLA.

Real incentives: did it with repeated payments (so, income effect). Implementing losses: **losses from prior endowment mechanism**: That, however, might not suffice to always keep the balance positive. If their balance became negative, they stopped the experiment and for the rest of the time had to work in the laboratory. Income effect, and attempt to moderate it, are described on p. 183-184.

P. 198: "Perhaps not very surprisingly, most subjects were somewhat sanguine about small wins and conservative with respect to small losses." That is, they find risk aversion and concave utility for losses and risk seeking/convexity for gains. %}

Davidson, Donald, Patrick Suppes, & Sidney Siegel (1957) "*Decision Making: An Experimental Approach.*" Stanford University Press, Stanford, CA;
Ch. 2 has been Reprinted in Ward Edwards & Amos Tversky (1967, eds.) *Decision Making*, 170–207, Penguin, Harmondsworth.

{% **foundations of probability**, Knight risk-uncertainty %}

Davidson, Paul (1991) “Is Probability Theory Relevant for Uncertainty? A Post Keynesian Perspective,” *Journal of Economic Perspectives* 5 no. 1, 129–143.

{% **foundations of quantum mechanics** %}

Davies, E. Brian (2005) “Some Remarks on the Foundations of Quantum Mechanics,” *British Journal for the Philosophy of Science* 56, 521–539.

{% %}

Davies, Greg B. (2006) “Rethinking Risk Attitude: Aspiration as Pure Risk,” *Theory and Decision* 61, 159–190.

{% PT is fit to equity returns data from the US and the UK. They confirm the findings of Tversky & Kahneman (1992):

concave utility for gains, convex utility for losses: find concave utility for gains, convex utility for losses, closer to linear for losses than for gains, **inverse S** probability weighting, and a loss aversion between 2 and 3. Remark 5 of version of September 24, 2003: the optimal equity allocation is highly sensitive to loss aversion. %}

Davies, Greg B. & Stephen E. Satchell (2003) “Continuous Cumulative Prospect Theory and Individual Asset Allocation,” University of Cambridge, UK.

{% %}

Davies, Greg B. & Stephen E. Satchell (2006) “The Behavioural Components of Risk Aversion,” *Journal of Mathematical Psychology* 51, 1–13.

{% Seem to have something similar to the smooth model. %}

Davis, Donald B. & M.-Elisabeth Paté-Cornell (1994) “A Challenge to the Compound Lottery Axiom: A Two-stage Normative Structure and Comparison to Other Theories,” *Theory and Decision* 37, 267–309.

{% Ch. 8 seems to discuss paying in probabilities of a prize rather than in $, so as to get linearity of utility, and to find that empirical evidence on it is mixed at best.

random incentive system: P. 455: The authors criticize the random incentive system as justified by Starmer & Sugden (1991) by arguing that with only a 0.5

probability of a choice played for real, the expectations are 0.5 smaller and that it would accordingly be better to multiply all outcomes by 2. I think that this criticism is irrelevant because it crucially assumes expected value. Their suggestion is even harmful under the plausible assumption of isolation. The point is tested by Laury (2005, working paper) who finds that it does not arise. %}

Davis, Douglas D. & Charles A. Holt (1993) "*Experimental Economics*." Princeton University Press, Princeton NJ.

{% Developed MYCIN, using certainty factors with ad hoc rules to combine them. Mention need for a normative theory. %}

Davis, Randall, Bruce G. Buchanan, & Edward H. Shortliffe (1977) "Production Rules as a Representation for a Knowledge-Based Consultation System," *Artificial Intelligence* 8, 15–45.

{% **measure of similarity** %}

Davison, Mark L. (1992) "*Multidimensional Scaling*." Krieger Publishing, Malabar, Fl.

{% In the early days of multiattribute utility theory, there was a sort of paradoxical finding that if you just added all attibutes and did nbot care about attribute weights, then it gave remarkably good results. It seems that this paper initiated it. %}

Dawes, Robyn M. (1979) "The Robust Beauty of Improper Linear Models in Decision Making," *American Psychologist*, 34, 571–582.

{% verbal textbook %}

Dawes, Robyn M. (1988) "*Rational Choice in an Uncertain World*." Harcourt Brace Jovanovich, San Diego.

{% %}

Dawes, Robyn M. (1990) "False Consensus Effect." *In* Robin M. Hogarth (ed.) *A Tribute to Hillel J. Einhorn*, University of Chicago Press, Illinois, 179–199.

{% **intuitive versus analytical decisions**; Argue that statistical reasoning is superior to intuitive reasoning. All examples and references exclusively concern clinical prediction. Kleinmuntz et al. (1990, Science) will criticize the paper for being too narrow. %}

Dawes, Robyn M., David Faust, & Paul E. Meehl (1989) "Clinical versus Actuarial Judgment," *Science* 243, 1668–1673.

{% **suspicion under ambiguity**: incomplete preliminary research ideas, but interesting. Unfortunately, a paper was never completed. %}

Dawes, Robyn M., Gunne Grankvist, & Jonathan W. Leland (1999) "Avoiding the "Ellsberg Bag" as Avoiding a "Stacked Deck" Possibility, rather than Avoiding Ambiguity," Carnegie Mellon University.

{% Introduced calibration. %}

Dawid, A. Philip (1982) "The Well Calibrated Bayesian," *Journal of the American Statistical Association* 77, 605–613.

{% **foundations of statistics**, Fisher versus others %}

Dawid, A. Philip (1991) "Fisherian Inference in Likelihood and Frequential Frames of Reference" and discussion, *Journal of the Royal Statistical Society, Ser. B*, 53, 79–109.

{% **proper scoring rules;** A duality between decisions and outcomes is exploited. %}

Dawid, A. Philip (2007) "The Geometry of Proper Scoring Rules," *Annals of the Institute of Statistical Mathematics* 59, 77–93.

{% foundations of probability; briefly lists many interpretations. Focuses on whether probability refers to individuals or to grous. %}

Dawid, A. Philip (2007) "On Individual Risk," *Synthese* 194, 3445–3474.

{% **proper scoring rules**: Extend locality to also allow dependence on the scores in a neighborhood of the observed event. Then more than just the logarithmic function can do it. %}

Dawid, A. Philip, Steffen Lauritzen, & Matthew Parry (2012) "Proper Local Scoring Rules on Discrete Sample Spaces," *Annals of Statistics* 40, 593–608. https://doi.org/10.1214/12-aos972

{% verbal textbook %}
Dawid, A. Philip & Mervyn Stone (1982) "The Functional-Model Basis of Fiducial Inference" (plus discussion), *Annals of Statistics* 10, 1054–1074.

{% Discusses levels of selection including that of the group, the individual, and the gene itself. Seems that he introduced the concept of a meme. %}
Dawkins, Richard (1976) "*The Selfish Gene*." Oxford University Press, Oxford.

{% Explains Gould's theory. Gould invented theory of stepwise evolution. %}
Dawkins, Richard (1985) "*The Blind Watchmaker*." Oxford University Press, Oxford.

{% **conservation of influence**.
Discusses Tinbergen's (1963) four questions, and adds four questions: Who benefits from action such as singing of bird. Are they genes, individual of bird, bird-species, gene pool?; Here Tinbergen is Niko Tinbergen, biologist and brother of the economist Jan Tinbergen. Both got Nobel prizes. %}
Dawkins, Richard (2004) "Lecture of May 19'04 in St. Pieterskerk in Leiden, the Netherlands."

{% %}
Day, Brett & Graham Loomes (2010) "Conflicting Violations of Transitivity and where They May Lead Us," *Theory and Decision* 68, 233–242.

{% What the title says, with many statistics on numbers of publications. %}
de Almeida, Adiel Teixeira, Marcelo Hazin Alencar, Thalles Vitelli Garcez, & Rodrigo José Pires Ferreira (2017) "A Systematic Literature Review of Multicriteria and Multi-Objective Models Applied in Risk Management," *IMA Journal of Management Mathematics* 28, 153–184.

{% Use prospect theory to analyze the risk perception of traffic participants. Use **tradeoff method** to measure utility for losses. Find that it is predominantly convex (**concave utility for gains, convex utility for losses**). %}
de Blaeij, Arianne T. & Daniel J. van Vuuren (2003) "Risk Perception of Traffic Participants," *Accident Analysis and Prevention* 35, 167–175.

{% %}
De Bock, G.H., S.A. Reijneveld, Jan C. van Houwelingen, André Knottnerus, & Job Kievit (1999) "Multi-Attribute Utility Scores: Can They Be Used to Predict Family Physicians' Decisions Regarding Patients Suspected from Sinusitis," *Medical Decision Making* 19, 58–65.

{% Does waht title says. %}
de Bruin, Boudewijn (2023) "Ranking Philosophy Journals: A Meta-Ranking and a New Survey Ranking," *Synthese* 202, 188. https://doi.org/10.1007/s11229-023-04342-9

{% If endowments are unambiguous, then ambiguity aversion reduces trade for a very general class of preference models. %}
de Castro, Luciano I. & Alain Chateauneuf (2011) "Ambiguity Aversion and Trade," *Economic Theory* 48, 243–273.

{% Under expected utility, efficiency often cannot be combined with incentive compatibility. This paper shows, under some assumptions, that incentive compatibility can be if and only if maxmin maximization by all agents. (Complete maxmin, not maxmin EU.) The model has a full-blown economy with many agents, all with signals. %}
De Castro, Luciano & Nicholas C. Yannelis (2018) "Uncertainty, Efficiency and Incentive Compatibility: Ambiguity Solves the Conflict between Efficiency and Incentive Compatibility," *Journal of Economic Theory* 177, 678–707.

{% Introduces behavioral agents into implementation problems. %}
de Clippel, Geoffroy (2014) "Behavioral Implementation," *American Economic Review* 104, 2975–3002.

{% %}

de Clippel, Geoffroy, Hans J.M. Peters, & Horst Zank (2004) “Axiomatizing the Harsanyi Solution, the Symmetric Egalitarian Solution and the Consistent Solution for NTU-Games,” *International Journal of Game Theory* 33, 145–158.

{% Despite the broad title of the paper, it focuses on what I might call one-dimensional utility, and, basically, violations of transitivity or, roughly equivalently, of revealed-preference axioms such as IIA or SARP. This paper considers deviations from transitivity/IIA due to attraction effects, overlooking choice options, threshold preferences, probabilistic choice, and many other reasons. Rationality requirements beyond transitivity, that concern tradeoffs, such as the sure-thing principle, are not considered. The authors here side with a tradition in revealed preference theory, e.g. the textbook Mas-Colell, Whinston, & Green (1995) that I often criticized: to use the term rational for weak ordering (≈ transitivity). First, the natural-language term rational is so important for our field, that we should not lose it to some mathematical concept. Second, weak ordering is way to permissive to capture all of rationality.

Reference dependence and loss aversion are discussed to the extent that they violate transitivity. But the authors cite much literature on the focus of the paper, including much psychological literature from long ago. The discussion of the use of axiomatizations in §4 does not enter the issues of operationalization and making observable, or of the unobservability of technical axioms. §4.3, with title limited data, points out that many axiomatizations need full rich domain. They give a central place to Bernheim & Rangel (2009) and Salant & Rubinstein (2008), but I have found those papers straightforward. %}

de Clippel, Geoffroy & Kareen Rozen (2024) “Bounded Rationality in Choice Theory: A Survey,” *Journal of Economic Literature* 62, 995–1039. https://doi.org/10.1257/jel.20231592

{% The following poem, translated from Dutch, nicely illustrates loss aversion. By reframing the status quo, a loss is turned into a gain in the last four lines. The fool in the beginning of the poem is also trying to get mileage from playing with the reference point.

Translation (joint with Thom Bezembinder; the Dutch word “geluk” means both happiness and lucky thing. This identity is lost in the translation.)

“Lucky thing, it could have been worse

As for the fool from the joke,/
who, continuously hammering on his head,/
when asked for the reason, said/
“Because of the joy when stopping it/
so things are for me. I have stopped/
losing you. I have lost you./

Maybe this is happiness: lucky thing, it could have been worse/
maybe happiness is: lucky thing/
That I can remember you, for instance,/
instead of someone else./”

Original text:

“Nog een geluk dat”

Zoals met de gek uit het grapje/
die zich voortdurend met een hamer/
op het hoofd sloeg, en naar de reden gevraagd, zei/
“Omdat het zo prettig is als ik ermee ophou” -/
zo is het een beetje met mij. Ik ben ermee opgehouden/
je te verliezen. Ik ben je kwijt./

Misschien is dat geluk: een geluk bij een ongeluk./
Misschien is geluk: nog een geluk dat./
Dat ik aan jou kan terugdenken, bv.,/
in plaats van aan een ander./ %}

de Coninck, Herman (2002) “Nog een Geluk Dat.” *In* the book *De Gedichten*, Arbeiderspers, Amsterdam, 10th edn., p. 136.

{% Abstract, where fuzzy measure is what is also called Sugeno integral: "…in a numerical context, the Choquet integral is better suited than the fuzzy integral for producing coherent upper previsions starting from possibility measures." %}

De Cooman, Gert (2000) "Integration in Possibility Theory." *In* Michel Grabisch, Toshiaki Murofushi & Michio Sugeno (eds.) *Fuzzy Measures and Integrals: Theory and Applications*, 124–160, Physica-Verlag, Berlin.

{% **Dutch book** %}

de Finetti, Bruno (1930) "Problemi Determini e Indetermini nel Calcolo delle Probabilità," *Rendiconti della Academia Nazionale dei Lincei* XII, 367–373.

{% §13, Postulate 4 introduces additivity axiom for qualitative probability. **Dutch book**.

§3 (p. 296 in English translation) refers to Bertrand (1889) for idea that equally probable judgment can be inferred from equal willingness to bet either way. %}

de Finetti, Bruno (1931) "Sul Significato Soggettivo della Probabilità," *Fundamenta Mathematicae* 17, 298–329. Translated into English by Mara Khale as "On the Subjective Meaning of Probability." *In* Paola Monari & Daniela Cocchi (1993, eds.) "*Probabilità e Induzione*," 291–321, Clueb, Bologna.

{% The necessary and sufficient conditions for EU with a continuous strictly increasing utility U are:

[1] CE(x) = x;

[2] Strict stochastic dominance;

[3] CE(F) = CE(F*) $\Rightarrow$ CE(tF+(1-t)G) = CE(tF*+(1-t)G) for all 0 < t < 1. (pp. 379-380).

P. 380 explains that this condition is close to associativity as in Nagumo (1930) and Kolmogorov (1930).

Condition [3] above is nothing other than the celebrated independence condition. Should we then credit de Finetti as the first to have had the vNM EU characterization? I asked my Italian colleague Enrico Diecidue to read the whole paper to check if anywhere de Finetti points out that the weights are probabilities and that this can concern decision under risk. But he nowhere does. Maybe deliberately because he wanted to push subjective probabilities with his famous statement "Probability does not exist." Anyway, for this reason I do not credit de Finetti for preceding vNM. Muliere & Parmigiani (1993, p. 423) cite de Finetti (1952, 1964) for discussing the decision interpretation.

Nagumo (1930) and Kolmogorov (1930), cited by de Finetti, had such results before, but only for equally likely prospects, which comprises all prospects with rational probabilities, and where their independence condition was the associativity condition for taking means.

P. 386 bottom shows the Pratt-Arrow result that CEs (certainty equivalents) are smaller the more concave utility is. %}

de Finetti, Bruno (1931) "Sul Concetto di Media," *Giornale dell'Istituto Italiano degli Atturia* 2, 369–396.

{% **coherentism**: this paper expresses, unfortunately, the viewpoint that the only criterion for rationality is preference coherence.

P. 174 of English translation (1989): "… however an individual evaluates the probability of a particular event, no experience can prove him right, or wrong; nor in general, could any conceivable criterion give any objective sense to the distinction one would like to draw, here, between right and wrong." de Finetti has many such narrow views, showing that he is not of the same intellectual league as the kindred spirits Savage or Ramsey. Dennis Lindley, at age 90, in an interview by Tony O'Hagan in 2013, cited de Finetti on this narrow view and sided with de Finetti, stating "coherence is all." He also, rightfully, pointed out that de Finetti's writings are obscure. %}

de Finetti, Bruno (1931) "Probabilism," *Logos* 14, 163–219. Translated into English by Maria Concetta Di Maio, Maria Carla Galavotti, & Richard C. Jeffrey as: de Finetti, Bruno (1989) "Probabilism," *Erkenntnis* 31, 169–223.

{% Introduced multivariate risk aversion preceding Richard (1975). %}

de Finetti, Bruno (1932) "Sulla Preferibilità," *Giornale degli Economisti e Annali di Economia* 11, 685–709.

{% Explains that probabilities cannot be modeled as multi-valued logic (degree of truth). The reason is that the degree of belief of a composition of propositions is

not determined only by the degree of belief of the separate propositions. See also Dubois & Prade (2001). %}

de Finetti, Bruno (1936) “La Logique de la Probabilité.” *In Actes du Congres International de Philosophie Scientifique a Paris 1935. Tome IV,* 1–9, Hermann et Cie, Paris.

{% **Dutch book**; Footnote (a) in a 1964 translation says that he viewed the reliance of his book argument on money and its game-theory complications as potential short-comings. The original 1937 version apparently did not have these things stated.

linear utility for small stakes %}

de Finetti, Bruno (1937) “La Prévision: Ses Lois Logiques, ses Sources Subjectives,” *Annales de l’Institut Henri Poincaré* 7, 1–68. Translated into English by Henry E. Kyburg Jr. “Foresight: Its Logical Laws, its Subjective Sources,” *in* Henry E. Kyburg Jr. & Howard E. Smokler (1964, eds.) *Studies in Subjective Probability,* 93–158, Wiley, New York; 2nd edn. 1980, 53–118, Krieger, New York.

{% Conjectured that qual. probability axioms suffice to give representing probabilities. For infinite models this obviously cannot be true because the cardinality of the indifference classes can be larger than $\mathbb{R}$. For finite models it is harder to see. Kraft, Pratt, & Seidenberg (1959) provided a counterexample and necessary and sufficient conditions using the theory of linear inequalies. %}

de Finetti, Bruno (1949) “La “Logica del Plausible” Secondo la Concezione di Pòlya,” *Atti della XLII Riunione della Società Italiana per il Progresso delle Scienze,* 227–236.

{% **foundations of probability** %}

de Finetti, Bruno (1951) “Recent Suggestions for the Reconciliation of Theories of Probability.” *In* Jerzy Neyman (ed.) *Second Berkeley Symposium on Mathematical Statistics and Probability,* University of California Press, Berkeley.

{% P. 77 following Theorem 3.4.1 on the Pratt-Arrow measure:

On p. 700/701, this following paper introduced, before Pratt/Arrow, the

Pratt/Arrow measure –u´´/u´ and its elementary properties such as:

- it being a measure of concavity;

- the 50/50 gamble for gaining or losing h being equivalent to losing h^2 divided by the measure (P.s.: that's the special case of risk premium when expected value is zero);

- the measure also being related to an excess probability for gaining;

- it entirely comprising all of u that's relevant.

P. 700 points out that expected utility in a mathematical sense is the associative mean and refers back to his and Kolmogorov's work on associative means of 1931. Had de Finetti written that one interpretation taking only one sentence also in 1931, he would also have been the predecessor of von Neumann & Morgenstern. %}

de Finetti, Bruno (1952) "Sulla Preferibilitá," *Giornale degli Economistii e Annali di Economia* 11, 685–709.
Link to paper

{% I read it diagonally on 18Oct2020, but did not recognize issues that interest me. de Finetti seems to emphasize that probabilities used in game theory can be taken subjective, and that one should look at coalitions. %}

de Finetti, Bruno (1953) "Role de la Théorie des Jeux dans l'Économie et Role des Probabilités Personnelles dans la Théorie des Jeux" (including discussion). C*olloques Internationaux du Centre National de la Recherche Scientifique* (Econométrie) 40, 49–63.

{% De Finetti independently discovered the idea of **proper scoring rules** in this paper, not knowing Brier (1950), Good (1952), or McCarthy (1956), for one reason because he did not speak English. This point was confirmed by Savage (1971, 2nd para of 2nd column of p. 783). %}

de Finetti, Bruno (1962) "Does It Make Sense to Speak of "Good Probability Appraisers "? ". *In* Isidore J. Good (ed.) *The Scientist Speculates: An Anthology of Partly-Baked Ideas,* William Heinemann Ltd., London.
Repeprintedrinted as Ch. 3 in Bruno de Finetti (1972) "*Probability, Induction and Statistics*." Wiley, New York.

{% **proper scoring rules**: Seems to propose using proper scoring rules for grading exams. This does not work because for proper scoring rules it is important that there is no other consequence than the payment received from the proper scoring rule. Grades of exams have many more consequences. All the rest of the student's life society will reward/punish him in unpredictable manners for the grades obtained for the exam. %}

de Finetti, Bruno (1965) "Methods for Discriminating Levels of Partial Knowledge Concerning a Test Item," *British Journal of Mathematical and Statistical Psychology* 18, 87–123.

{% **Dutch book**;

This is a collection of texts, often informal but nice brief expressions, published by de Finetti. Its Ch. 1 is what brought me in the field of decision theory! When I, as a mathematics student in 1978, was amazed about my statistics teacher's claim, frequentist as I know now, that the probability of life on Mars could not be defined, and was at all treated very differently than the probability of a coin toss, he told me that an, in his words, crazy, Italian had argued for the same, and wrote the name de Finetti on a piece of paper. With this piece of paper I went to the library, found this book, and read its first chapter. It opened to me the technique of preference foundations, and the possibility to tangibly define something as seemingly intangible as one's subjective degree of belief. I felt electrified by the idea, and decided that I wanted to work on these ideas. Thanks to the freedom provided by the Dutch academic system and the generous Dutch unemployment benefits of those days, I could work on these ideas even though for some years I could not find other researchers with similar interests, many related references or even journals, and for a while could not find a paid job to do this work. I hope that these ideas can be as magic to the readers as they have always been to me.

Preface, pp. xviii – xxiv explain why it is useful notation to equate events with their indicator functions, and probabilities of events with expectations of their indicator functions. %}

de Finetti, Bruno (1972) "*Probability, Induction and Statistics.*" Wiley, New York.

{% Book, preface p. x, opens with the famous: "Probability does not exist."
coherentism: P. 8 seems to write: "From the theoretical, mathematical point of view, even the fact that the evaluation of probability expresses somebody's opinion is then irrelevant. It is purely a question of studying it and saying whether it is coherent or not; i.e., whether it is free of, or affected by, intrinsic contradictions. In the same way, in the logic of certainty one ascertains the correctness of the deductions but not the accuracy of the factual data assumed as premisses."

Pp. 22-23 explain that this is meant to be a text book and that, therefore, references are minimized.

Dutch book; Ch. 3 is, probably, the best account available in the literature about the book argument. §3.4 ff. discuss the domain on which preference is defined because of book argument, and that it can be a subset of the set of all acts. §5.4 discusses **proper scoring rules**. §5.5 gives many applications of proper scoring rules, to expert-opinion elicitation such as geologists for oil drilling, forecasting sports events, replies to multiple choice,

P. 196, §5.5.7, footnote there, recognizes game-theoretic complications of book argument when opponent is better informed.

§4.17: seems to discuss inner products so as to deal with covariance etc. %}

de Finetti, Bruno (1974) "*Theory of Probability.*" Vol. I. Wiley, New York.

{% Seems to say that **risky utility u = transform of strength of preference v. %**}

de Finetti, Bruno (1979) "A Short Confirmation of My Standpoint." *In* Maurice Allais & Ole Hagen (1979, eds.) *Expected Utility Hypotheses and the Allais Paradox*, 161, Reidel, Dordrecht.

{% Seems to argue, from a narrow static Bayesian viewpoint, that higher-order probabilities is just a misunderstanding. %}

de Finetti, Bruno (1977) "Probabilities of Probabilities: A Real Problem or a Misunderstanding?." *In* Ahmed Aykac & Carlo Brumat (eds.) *New Directions in the Application of Bayesian Methods*, 1–10, North-Holland, Amsterdam.

{% **Dutch book; proper scoring rules** %}

de Finetti, Bruno (1981) "Discussion. The Role of 'Dutch Books' and of 'Proper Scoring Rules'," *British Journal for the Philosophy of Science* 32, 55–56.

{% **proper scoring rules**: Gives a table of some data of his probability scoring experiment. However, it concerns a measurement of 1971 and not of 1961/1962. It also suggests that not much data were collected, and that things were left unfinished. %}

de Finetti, Bruno (1982) "Exchangeability in Probability and Statistics." *In* George S. Koch & Fabio Spizzichino (eds.) *Exchangeability in Probability and Statistics* (Proceedings of the International Conference on Exchangeability in Probability and Statistics, Rome, 6th -9th April, 1981, in honour of professor Bruno de Finetti, 1–6, North-Holland, Amsterdam.

{% %}

de Finetti, Bruno & Leonard J. Savage (1962) "Sul Modo di Scegliere le Probabilità Iniziali," *Sui Fondamenti della Statistica Biblioteca del Metron Series C* 1, 81–47 (English summary, pp. 148-151).

{% Seem to find that people have an aversion to AI tools. (**intuitive versus analytical decisions**) %}

De Freitas, Julian, Stuti Agarwal, Bern Schmitt, & Nick Haslam (2023) "Psychological Factors Underlying Attitudes toward AI Tools," *Nature Human Behaviour* 7, 1845–1854.

{% Mooie 60er jaren visies van een socioloog op de welvaartsstaat en tegen de vereconomisering tegenwoordig. %}

De Gier, Erik (2001) "De Sociologische Interventie."

{% %}

de Giorgi, Enrico & Thorsten Hens (2006) "Making Prospect Theory Fit for Finance," *Financial Markets and Portfolio Management* 20, 339–360.

{% Footnote 2: **SPT instead of OPT** %}

De Giorgi, Enrico, Thorsten Hens, & Janos Mayer (2007) "Computational Aspects of Prospect Theory with Asset Pricing Applications," *Computational Economics* 29, 267–281.
https://doi.org/10.1007/s10614-006-9062-2

{% Because of nonconvexity of PT, no equillibria need to exist. Assume finite state space. %}

De Giorgi, Enrico, Thorsten Hens, & Marc Oliver Rieger (2010) "Financial Market Equilibria with Cumulative Prospect Theory," *Journal of Mathematical Economics* 46, 633–651.

{% Seems to show that individual stocks and underdiversified portfolios have positive skewness. %}

De Giorgi, Enrico G. & Shane Legg (2012) "Dynamic Portfolio Choice and Asset Pricing with Narrow Framing and Probability Weighting," *Journal of Economic Dynamics and Controls* 36, 951–972.

{% Surveys the many conditions of strong and weak risk aversion, preference for diversification, 2nd order risk aversion, and the like, giving logical relations both for risk and uncertainty, assuming, EU, or RDU, or no model at all. P. 147 middle: the paper assumes continuity throughout. %}

De Giorgi, Enrico G. & Ola Mahmoud (2016) "Diversification Preferences in the Theory of Choice," *Decisions in Economics and Finance* 39, 143–174.

{% Model with stochastic reference point. If chosen to optimize, endogenously, then coincides with optimal consumption without loss aversion. Hence, there will be an exogenous component to loss aversion and reference dependence. The authors develop a model with a sticky reference point, which fits historical IS investment benchmark data well. %}

De Giorgi, Enrico G. & Thierry Post (2011) "Loss Aversion with a State-Dependent Reference Point," *Management Science* 57, 1094–1110.

{% Subject has to specify subjective probability distribution over the entire state space. Next a two-level partition is randomly chosen. It means that a first-level partition is chosen and, for each element of this partition, a ("2nd level") partition. Then the subject is offered a gamble on the element of a randomly chosen 2nd-level partition that she deemed most likely there. This procedure amounts to eliciting the more-likely-than relation over events. Results are given on when this

procedure is weakly proper or proper, and how strong the incentives are relative to other methods. %}
de Haan, Thomas (2019) "Eliciting Entire Belief Distributions Using a Random Two-Level Partitioning of the State Space," working paper.

{% Gives no clear-cut advices but discusses many complications. Argues for instance that it should not matter whether you invest for the short or the long term; etc. %}
De Jong, Frank (2003) "Is Mijn Pensioen nog wel Veilig? Over Sparen en Beleggen voor Later." (Inaugurale rede.) Department of Economics, University of Amsterdam, Amsterdam, the Netherlands.

{% Opening page gives many references that people distort probabilities, utilities, and other things in the direction of justifying their preference. Experiment does the usual psychological thing of finding that things depend on other things. %}
DeKay, Michael L., Dalia Patiño-Echeverri, & Paul S. Fischbeck (2009) "Distortion of Probability and Outcome Information in Risky Decisions," *Organizational Behavior and Human Decision Processes* 109, 79–92.

{% Confirm that deviations from EU (certainty and possibility effects) are reduced under repeated decisions and learning. The authors focus on psychological studies and do not cite economic studies on learning. %}
DeKay, Michael L., Dan R. Schley, Seth A. Miller, Breann M. Erford, Jonghun Sun, Michael N. Karim, & Mandy B. Lanyon (2016) "The Persistence of Common-Ratio Effects in Multiple-Play Decisions," *Judgment and Decision Making* 11, 361–379.

{% %}
de Koster, Rene, Hans J.M. Peters, Stef H. Tijs, & Peter P. Wakker (1983) "Risk Sensitivity, Independence of Irrelevant Alternatives and Continuity of Bargaining Solutions," *Mathematical Social Sciences* 4, 295–300.
https://doi.org/10.1016/0165-4896(83)90031-8
Direct link to paper

{% Lamarck (1809) put forward that species develop through evolution. He believed that things learned during lifetime could be inherited by offspring, an idea that later was generally abandoned, but, then, evidence supporting it has been put forward. And, it is plausible … %}

de Lamarck, Jean-Baptiste (1809) "*Philosophie Zoologique*." Muséum national d'histoire naturelle (Jardin des Plantes), Paris.

{% Seem to measure prospect theory parameters from revealed preferences regarding risky transportation decisions. %}

De Lapparent, Matthieu (2010) "Attitude toward Risk of Time Loss in Travel Activity and Air Route Choices," *Journal of Intelligent Transportation Systems* 14, 166–178.

{% N = 107; **losses from prior endowment mechanism**: Was not done, but hypothetical choice was used, because for losses real incentives are hard to implement. The authors argue against **losses from prior endowment mechanism** because of house money effects (p. 119 last para), and I agree with this viewpoint (would add the more general term income effect as objection against losses from **prior endowment mechanism**). I also think that for losses hypothetical is better.

natural sources of ambiguity;

ambiguity seeking for losses: They investigate the competence effects not only for gains, but also for losses (the latter is the novelty.) Use temperatures on more and less known places. They control for the belief component in several ways: (1) They take pairs of places that actually have very similar climates, and the same temperature event for both places.

(2) **source preference directly tested**: They test EXACTLY the source preference condition with source preference if a bet on an event and its complement is preferred.

(3) They also asked for direct subjective probability judgments.

Find the usual competence effect confirmed for gains, but mostly H_0 for losses, with a reflection (source preference AGAINST source with most competence) significantly for one of six cases considered. One explanation that they put forward is that loss choices are noisier (p. 129; confirmed by logit parameter λ).

Each subject made only one choice for each case (and not many as in choice lists when going for indifferences for instance) and then a representative agent was assumed.

reflection at individual level for ambiguity: they have the data for it, but do not report.

They also test the two-stage model, assuming representative agent, and taking direct judgments of probability as inputs. So, much of the deviation from additivity and EU can then be comprised in the probability judgment. P. 113 1/3 writes that the two-stage model cannot capture source preference, which is true by the basic spirit of that model, although one (not me) could argue that source preference can be captured in the belief component.

There is much collinearity between the elevation and curvature parameter (p. 127). The authors take the curvature parameter at its best level, keep it there, and then let only the elevation parameter vary to test source preference (p. 127). It confirms the other claims, being more elevation for known sources under gains (with parameter values similar to Kilka & Weber (2001), and significantly so for all six cases considered, and no significant effects for losses.

P. 126 2nd para: assume that weighting function, and not utility, depends on the source.

losses give more/less noise: p. 129: choices for losses are noisier, and take more response time, than for gains. %}

de Lara Resende, José G., & George Wu (2010) "Competence Effects for Choices Involving Gains and Losses," *Journal of Risk and Uncertainty* 40, 109–132. https://doi.org/10.1007/s11166-010-9089-6

{% **foundations of statistics**; discussion done in Amsterdam with Molenaar and Linssen. %}

de Leeuw, Jan (1984) "Models of Data," *Kwantitatieve Methoden* 13, 17–30.

{% **game theory for nonexpected utility %}**

De Marcoa, Giuseppe & Maria Romaniello (2015) "Variational Preferences and Equilibria in Games under Ambiguous Belief Correspondences," *International Journal of Approximate Reasoning* 60, 8–22.

{% Do fMRI for simple choice between sure outcome and gamble, where a simple and neat rephrasing makes people risk averse for gains and risk seeking for losses where only the framing and not the terminal wealth is different, and then measure related brain activities. %}

de Martino, Benedetto, Dharshan Kumaran, Ben Seymour, & Raymond J. Dolan (2006) "Frames, Biases, and Rational Decision-Making in the Human Brain," *Science* 313, August 4, 684–687.

{% Nice clear proof of the claim that I formulated as: A linear function is a function of linear functions if and only if it is a linear function of linear functions. In particular, this paper shows how Anscombe & Aumann (1963) is a corollary of Harsanyi (1955). %}

De Meyer, Bernard & Philippe Mongin (1995) "A Note on Affine Aggregation," *Economics Letters* 47, 177–183.
https://doi.org/10.1016/0165-1765(94)00531-6

{% Citation taken from goodby speach by Thom Bezembinder.
P. 719 of de Graaff's translation: "de Stoïcijnen [gaven] op de vraag hoe in onze geest de keuze tussen twee willekeurige dingen tot stand komt en wat er de oorzaak van is dat wij uit een groot aantal daalders liever de ene dan de andere nemen, hoewel ze allemaal gelijk zijn als antwoord dat dit geestelijke proces buitengewoon is en niet aan regels gebonden, omdat het door een toevallige, bijkomende impuls of buitenaf in ons komt" %}

de Montaigne, Michel (1580) "*Essays.*" Translation into Dutch by Frank de Graaff (1993); Boom, Amsterdam.

{% May argue that discrepancies within risky utility measurements is as big as between risky and riskless utility??? %}

de Neufville, Richard de & Philippe Delquié (1988) "A Model of the Influence of Certainty and Probability Effects on the Measurement of Utility." *In* Bertrand R. Munier (ed.) *Risk, Decision and Rationality*, 189–205, Reidel, Dordrecht.

{% %}

de Palma, André, Mohammed Abdellaoui, Giuseppe Attanasi, Moshe Ben-Akiva, Ido Erev, Helga Fehr-Duda, Dennis Fok, Craig R. Fox, Ralph Hertwig, Nathalie

Picard, Peter P. Wakker, Joan L. Walker, & Martin Weber (2014) "Beware of Black Swans," *Marketing Letters* 25, 269–280.
https://doi.org/10.1007/s11002-014-9316-z
Direct link to paper

{% %}

de Palma, André, Moshe Ben-Akiva, David Brownstone, Charles Holt, Thierry Magnac, Daniel McFadden, Peter Moffatt, Nathalie Picard, Kenneth Train, Peter P. Wakker, & Joan Walker (2007) "Risk, Uncertainty and Discrete Choice Models," *Marketing Letters* 19, 269–285.
https://doi.org/10.1007/s11002-008-9047-0
Direct link to paper

{% %}

de Palma, André, Nathalie Picard, & Jean-Luc Prigent (2008) "Eliciting Utility for (Non)Expected Utility Preferences Using Invariance Transformations,"

{% %}

De Paola, Maria & Francesca Gioia (2015) "Who Performs Better under Time Pressure? Results from a Field Experiment," *Journal of Experimental Psychology* 53, 37–53.

{% This paper investigates experimenter demand effects in some standard experiments (dictator game, risky investment, time budget, trust game as first or second mover, ultimatum game as first or second mover, lying game, real effort with/without payment, and some of these both hypothetical and with real incentives. To do so, or at least provide bounds for the effect, the authors do the following, for, say, the dictator game. In one "positive weak demand" treatment, they tell subjects: "we expect that subjects who are shown these instructions will give more that they would normally do." In a "negative weak demand" treatment, they tell the same but with "more" replaced by "less." They also have strong treatments, where they write "You will do us a favor if you give more/less than you normally would." They expect, and find, that most subjects will be compliant, and offer more in the positive treatment, and less in the negative.

(They call this monotonicity.) Some subjects will defy and act the opposite way. At any rate, they expect experimenter demand effects to be stronger under these explicit treatments than in regular treatments. They call this bounding. It seems that they add monotonicity to what they call bounding, and that they need it for their tests of group averages, and that too many defiers would invalidate their tests (p. 3276 last para). Probably tests at the individual level could have avoided this (seems to be possible in their seventh experiment). They find little difference between positive and negative effects, like 0.13 standard deviation, usually not significant, and take this as evidence that there is not much experimenter demand effect. They can also see which factors impact the effects. There is more for the trust game than for effort tasks, for instance.

The basic idea is nice and useful.

It may seem that the paper uses deception. If for half the subjects they say they expect a positive result, and for the other half they say they expect a negative result, it may seem that at least one is untrue and must be a lie. But this is, fortunately, not so because the instructions are self-fulfilling profecies.

A bit of a difficulty, especially for the strong treatment, where experimentes' hope is expressed, is that it would be lousy research because researchers are not supposed to try to influence data that way. This may give a general bad impression of research, which is especially damaging if done in an often-used lab. Also, this can arouse emotions in subjects that can distort the experiment.

This paper is only of interest to specialists doing experiments and has no other implication of interest to general economists. It think it would have been better in a specialized journal, not in this broadly read journal.

The authors develop a theoretical model for experimenter demand effect but I must say that it did not seem to be helpful to me.

P. 3276 footnote 11 is incomprehensible to me. The authors "thank" an anonymous referee for it. Often, when authors have to add something weird because of a silly referee (and possibly weak editor) and are annoyed by it, they add a thanks to the referee so that the readers know so.

P. 3292: as the authors explain, it is very natural to find more experimenter demand in hypothetical choice than with real incentives, but they do not find this at all.

P. 3294: women are more prone to experimenter demand than men. %}

de Quidt, Jonathan, Johannes Haushofer, & Christopher Roth (2018) "Measuring and Bounding Experimenter Demand," *American Economic Review* 108, 3266–3302. https://doi.org/10.1257/aer.20171330

{% NRC Handelsblad is a daily newspaper, with 200,000 copies per day, and is the 4th most sold newspaper in the Netherlands. %}
de Raat, Friederike, Erik Hordijk, & Peter P. Wakker (2014) "Laat het Los, Al Die Verzekeringen," *NRC Handelsblads* 8 February 2014, E18–E19. Direct link to paper

{% **foundations of quantum mechanics**: discusses subjective versus physical interpretations, and determinism, in quantum mechanics. %}
de Ronde, Christian, Hector Freytes, & Giuseppe Sergioli (2021) "Quantum Probability: A Reliable Tool for an Agent or a Reliable Source of Reality?," *Synthese* 198 (Suppl 23), S5679–S5699. https://doi.org/10.1007/s11229-019-02177-x

{% Forestry is a beautiful example of investing in the future. After replanting forests it may take 100 or 200 years before they become productive. de Vauban, hence, argued that the government or the church should handle this. %}
de Vauban, Sèbastien Le Prestre (1910) "Traité de la Culture des Forêts." *In* Albert de Rochas d'Aiglun (ed.) *Vauban, Sa Famille et Ses Écrits, Ses Oisivetés et Sa Correspondance: Analyse et Extraits, vol.2*. Berger-Lévrault, Paris.

{% Forestry is a beautiful example of investing in the future. After replanting forests it may take 100 or 200 years before they become productive. de Vauban, hence, argued that the government or the church should handle this. %}
de Vauban, Sèbastien Le Prestre (2007) "Traité de la Culture des Forêts." *In* Hélène Vérin (ed.) *Édition Intégrale. Les Oisivetés de Monsieur de Vauban*, CDHTE-Cnam, SeaCDHTE, Seyssel, Champ Vallon.

{% Rol van risico in Nederlandse maatschappij en beleid. Dec. '99 gekregen van Hans Peters. %}

de Vroon, Bert (1998, ed.) "*Betwijfelde Zekerheden.*" Universiteitsdrukkerij, Enschede.

{% %}

De Waegenaere, Anja, Robert Kast, & André Lapied (2003) "Choquet pricing and Equilibrium," *Insurance: Mathematics and Economics* 32, 359–370.

{% **time preference** %}

De Waegenaere, Anja & Peter P. Wakker (2001) "Nonmonotonic Choquet Integrals," *Journal of Mathematical Economics* 36, 45–60.
https://doi.org/10.1016/S0304-4068(01)00064-7
Direct link to paper
Link to comments
(Link does not work for some computers. Then can:
go to Papers and comments; go to paper 01.4 there; see comments there.)

{% Calculated expected present value of annuity. May have been the first to use expected value for risk, and, also, present value for intertemporal. de Wit made this contribution, and some other scientific innovations, while being statesman, leading the Netherlands. %}

de Wit, Johan (1671) "*Waardije van Lyf-Renten naer Proportie van Los-Renten.*" ("The Worth of Life Annuities Compared to Redemption Bonds").

{% Find that status quo effect becomes stronger for larger choice sets. This means that also for a fixed status quo, WARP is violated. %}

Dean, Mark, Özgür Kıbrıs, & Yusufcan Masatlioglu (2017) "Limited Attention and Status Quo Bias," *Journal of Economic Theory* 169, 93–127.

{% **biseparable utility**: satisfied.

event/outcome driven ambiguity model: event driven

Assume Anscombe-Aumann framework with the restrictive backward induction assumption of CE substitution, but do not assume EU for the second-stage lotteries, but Quiggin's RDU. This is desirable for empirical purposes but loses the main pro of two-stage models: tractability. P. 380 footnote 7 follows up

on this and mentions that omitting the two-stage could be desirable. More precisely, they consider a set of probability measures and a SET OF probability weighting functions (and only one utility function), over which they do maxmin RDU. Wang (2022, Management Science) will do maxmin RDU with a set of probability measures but only one weighting function.

The authors use an endogenous utility midpoint operation (p. 381), the one used by Ghirardato, Maccheroni, Marinacci, & Siniscalchi (ECMA 2003), which involves several certainty equivalents (so, many measurements!), and use it to mix acts statewise. On p. 383 they adapt it to decision under risk and mix lotteries by taking as joint distribution of two lotteries the comonotonic distribution (maximizing correlation). Then under RDU and also under biseparable utility the utility midpoints come as under EU. As a memory from youth, Wakker (1990 JET) showed that such comonotonic mixtures are preferred less than noncomonotonic ones if and only if pessimism holds under RDU. Fortunately, the authors use only this midpoint operation and not the extended subjective mixture operation as Ghirardato et al. (2003) did. The latter has the problem that it is too far from direct observability, requiring infinitely many observations for its very definition, e.g. for 1/3-2/3 mixtures. An alternative concept of endogenous utility midpoints was used by Baillon, Driesen, & Wakker (2012): if $x_p\alpha \sim y_p\beta$ and $x_p\beta \sim y_p\gamma$, comonotonic, then β is the endogenous utility midpoint between α and γ. This requires fewer indifferences by not using certainty equivalents, and no multistage. Baillon et. al. in their footnote 2 cite several preceding alternative definitions of endogenous utility midpoints.

Using the endogenous midpoint operation, the authors define quasi-convexity of preference (Axiom 5 p. 384) and the analog of certainty independence (Axiom 6 p. 386). They thus get a multiple prior representation for uncertainty. It is reminiscent of Alon & Schmeidler (2014) (improved by Alon 2022). Importantly, they do not need the EU assumption of the Anscombe-Aumann framework in this, using the endogenous operation instead. It gives them the freedom to use alternative models for risk, where they characterize a risky analog of Maxmin EU taking a minimum over RDU functionals. Their characterizing Axiom 4 is bisymmetry-type to get biseparable. They can thus define ambiguity attitudes in more realistic manners, using conditions that, in my terminology, are of the source-preference type. A restriction is in Definition 7 that they only do it for agents with the same risk attitudes, as common with the Yaari CE type conditions as used here.

P. 386: "The RDU model is arguably the most well known non-expected utility model for objective lotteries. The cumulative prospect theory model of Tversky and Kahneman (1992), for example, is based on this framework." (**Prospect theory/Rank-Dependent Utility most popular for risk**)

P. 393: The authors very properly point out that ambiguity neutrality means probabilistic sophistication but with added that this involves (agreement with) objective probabilities. They state this more or less implicitly in Definition 6, and make it more or less explicit in Footnote 31. Probabilistic sophistication in itself does not mean much if we do not specify the domain on which it is valid. The footnote is about comparing with general probabilistic sophistication à la Machina & Schmeidler (1992). The latter was, erroneously, taken as ambiguity neutrality by Epstein (1999). His confusion came from his desire to avoid using objective probabilities, something impossible when defining ambiguity neutrality, as every experimenter will know. The last sentence of footnote 31 is:

"At the same time, both notions differ from probabilistic sophistication as defined by Machina and Schmeidler (1992) in a Savage setup, as here we require that not only the agent reduces subjective uncertainty to objective risk using a prior π, but also that the non-expected utility functional used to evaluate such reduction is the same one used to evaluate objective lotteries."

P. 396 points out that they have nontrivial overlap with the cautious model.

Their whole analysis is focused on pessimism and aversion, and does not consider insensitivity for instance, which is another direction of generalization that I hope for.

Their model is called multiple priors-multiple weighting. %}

Dean, Mark & Pietro Ortoleva (2017) "Allais, Ellsberg, and Preferences for Hedging," *Theoretical Economics* 12, 377–424.
https://doi.org/10.3982/te1960

{% With N=190 subjects in a lab they do standard measurements of many decision attitudes: Present discounting, risk aversion, common consequence, common ratio, ambiguity aversion, aversion to compound risk, altruism. They consider relations. Ambiguity aversion is strongly related to compound-risk aversion (80 percentage points) supporting Halevy (2007), mixed (gains and losses) risk aversion, common ratio (40 pp.), common consequence (20 pp.). Ambiguity aversion is also strongly positively related to risk aversion. (**correlation risk & ambiguity attitude**)

The presence effect is strongly positively related to risk aversion, and discounting in general is weakly positively related to risk aversion. Strangely, presence effect it not related to common ratio or common consequence. Loss aversion is positively related to the endowment effect, also after correction for risk aversion. These results survive correction for all kinds of demographic variables.

Cognitive ability is measured using Raven's matrices. It is not related to the other variables. (**cognitive ability related to discounting**; **cognitive ability related to risk/ambiguity aversion**; **cognitive ability related to likelihood insensitivity (= inverse S)**). %}

Dean, Mark & Pietro Ortoleva (2019) "The Empirical Relationship between Nonstandard Economic Behaviors," *Proceedings of the National Academy of Sciences* 116, 16262–16267. https://doi.org/10.1073/pnas.1821353116

{% %}

Dean, Moira, & Richard Shepherd (2007) "Effects of Information from Sources in Conflict and in Consensus on Perceptions of Genetically Modified Food," *Food Quality and Preference* 18, 460–469.

{% P. 190 argues that there is more to risk attitude than can be captured in marginal utility; i.e., the point that Schoemaker (1982) is well known for. %}

Deber, Raisa B. & Vivek Goel (1990) "Using Explicit Decision Rules to Manage Issues of Justice, Risk, and Ethics in Decision Analysis: When It It not Rational to Maximize Expected Utility?," *Medical Decision Making* 10, 181–194.

{% **conservation of influence**

Patients want physicians to structure the problem and provide probabilities (those two steps are described as "problem solving (PS)" in the paper), but want to

influence utilities and decisions; argue that previous studies did not sufficiently distinguish PS from rest. %}

Deber, Raisa B., Nancy Kraetschmer, & Jane Irvine (1996) “What Role Do Patients Wish to Play in Treatment Decision Making?,” *Arch. Intern. Med.* 156, 1414–1420.

{% §4 cites von Neumann (1928) for the existence of mixed Nash-equilibrium in noncooperative game theory if preferences are quasi-concave w.r.t. probabilistic mixing. %}

Debreu, Gérard (1952) “A Social Equilibrium Existence Theorem,” *Proceedings of the National Academy of Sciences* 38, 886–893.

Reprinted *in* Gérard Debreu (1983) “*Mathematical Economics: Twenty Papers of Gérard Debreu,*” Ch. 2, Cambridge University Press, Cambridge.

{% Introduced modeling of uncertainty as multiattribute utility. %}

Debreu, Gérard (1953) “Une Economie de l’Incertain,” Electricité de France.

Translated into English as “Economics of Uncertainty” in Gérard Debreu (1983) *Mathematical Economics: Twenty Papers of Gérard Debreu*, 115–119, Cambridge University Press, Cambridge.

{% **one-dimensional utility** %}

Debreu, Gérard (1954) “Representation of a Preference Ordering by a Numerical Function.” *In* Robert M. Thrall, Clyde H. Coombs, & Robert L. Davis (eds.) *Decision Processes*, 159–165, Wiley, New York.

{% **strength-of-preference representation**: Theorem on p. 441;

Introduced a solvability-like condition: if P(A,B) > z > P(A,D) then there exists C such that P(A,C) = z. %}

Debreu, Gérard (1958) “Stochastic Choice and Cardinal Utility,” *Econometrica* 26, 440–444.

{% %}

Debreu, Gérard (1959) “Cardinal Utility for Even-Chance Mixtures of Pairs of Sure-Prospects,” *Review of Economic Studies* 26, 174–177.

{% Preface, p. viii: "Outstanding among these influences has been the work ... which freed mathematical economics from its traditions of differential calculus and compromises with logic."

Seems to be among the first to use the state-preference approach where states of nature are like dimensions of commodity bundles, like Arrow (1953). %}

Debreu, Gérard (1959) "*Theory of Value. An Axiomatic Analysis of Economic Equilibrium*." Wiley, New York.

{% On the year of publication (1959 or 1960): The conference was 1959 but the book 1960. Hence, 1960 is the right year. But many people see the year of the conference upfront and then go by 1959.

Since the 1970s, this paper is given all the credit for deriving additively decomposable representations from separability preference conditions, and I agree with this for simplicity reasons. But it is good to know that these results had essentially been known before, by Leontief (1947), Nataf (1948), and Fleming (1952) for instance, who in fact used weaker separability assumptions. However, those papers used differentiability assumptions, which are especially problematic for preference foundations. Debreu's contribution is to do with only continuity and not use any differentiability assumption.

Theorem 2 gives utility-difference representation, using Shapley's (1975, 1982) crossover property, assuming existence of quantitative ordinal representation already, and using solvability; formulates it for choice probabilities.

I never understood the last lines of Debreu's proof regarding the function g, and conjecture that he assumes that local additivity implies global additivity on subsets of Cartesian products, which need not be true in general. I visited Debreu end 1990s and asked him but he did not remember. I also corresponded with Fishburn who in his 1970 book has similar problems. (See my annotations to his book.) He did not remember either. These things made me work on Chateauneuf & Wakker (1993 JME), where the missing steps are provided. %}

Debreu, Gérard (1960) "Topological Methods in Cardinal Utility Theory." *In* Kenneth J. Arrow, Samuel Karlin, & Patrick Suppes (1960, eds.) *Mathematical Methods in the Social Sciences*, 16–26, Stanford University Press, Stanford, CA.

{% A famous review. He brings the counterexample best known as later rephrased by McFadden (1974):the red bus/blue bus example. %}

Debreu, Gérard (1960), Review of Luce, R. Duncan (1959) “Individual Choice Behavior: A Theoretical Analysis,” *American Economic Review* 50, 186–188.

{% **one-dimensional utility**; Good reference for existence of continuous representation of preference. %}

Debreu, Gérard (1964) “Continuity Properties of Paretian Utility,” *International Economic Review* 5, 285–293.
https://doi.org/10.2307/2525513

{% Seems to do the following (I did not read myself): **risky utility u = transform of strength of preference v**: Considers vNM utility u on commodity bundles. Writes u = f∘v with v least concave utility function, proposes v as riskless utility function and f as reflecting risk attitude. %}

Debreu, Gérard (1976) “Least Concave Utility Functions,” *Journal of Mathematical Economics* 3, 121–129.

{% %}

Debreu, Gérard & Tjalling C. Koopmans (1982) “Additively Decomposed Quasiconvex Functions,” *Mathematical Programming* 24, 1–38.

{% %}

Debreu, Gérard (1983) “*Mathematical Economics: Twenty Papers of Gérard Debreu.*” Cambridge University Press, Cambridge.

{% P. 4, last paragraph: about integrability problem, that it can be bypassed altogether by moving from commodity space to pairs of points. %}

Debreu, Gérard (1991) “The Mathematization of Economic Theory,” *American Economic Review* 81, 1–7.

{% Want to refer to my Fuzzy Sets and Systems paper but instead refer to my book. %}

Decampos, Luis M. & Manuel J. BolaÑos (1992) “Characterization and Comparison of Sugeno and Choquet Integrals,” *Fuzzy Sets and Systems* 52, 61–67.

{% **crowding-out**: meta-analysis of 128 experiments on crowding-out %}
Deci, Edward L., Richard Koestner, & Richard M. Ryan (1999) “A Meta-Analytic Review of Experiments Examining the Effects of Extrinsic Rewards on Intrinsic Motivation,” *Psychological Bulletin* 125, 627–668.

{% Test prudence and temperance. Find some support for prudence, but none for temperance. Results rule out CARA (constant absolute risk aversion) and CRRA utility (under EU). Results agree well with prospect theory (pp. 1414-1415). %}
Deck, Cary & Harris Schlesinger (2010) “Exploring Higher Order Risk Effects,” *Review of Economic Studies* 77, 1403–1420.

{% They experimentally extend previous work to risk seeking and risk aversion orders exceeding order 4, and find two prevailing patterns: risk averters are “mixed risk averse “:they dislike an increase in risk for every degree n. Risk lovers are “mixed risk loving “:they like risk increases of even degrees, but dislike increases of odd degrees. %}
Deck, Cary & Harris Schlesinger (2014) “Consistency of Higher Order Risk Preferences,” *Econometrica* 82, 1913–1943).

{% %}
Deelstra, Griselda, Jan Dhaene, & Michèle Vanmaele (2011) “An Overview of Comonotonicity and Its Applications in Finance and Insurance.” *In* Giulia Di Nunno & Bernt Øksendal (eds.) *Advanced Mathematical Methods for Finance,* 155–180, Ch. 6, Springer, Berlin.

{% %}
DeGroot, Morris H. (1970) “*Optimal Statistical Decisions.*” McGraw-Hill, New York.

{% %}
DeGroot, Morris H. (1986) “*Probability and Statistics*”; 2nd edn. Addison-Wesley, Reading MA.

{% Discussion of artificial intelligence %}

DeGroot, Morris H. (1987) *Statistical Science* 2, no. 1.

{% About brain activities regarding numerical perception. Funny that the first author in this multi-author paper writes "I proposed … " %}

Dehaene, Stanislas, Nicolas Molko, Laurent Cohen, & Anna J. Wilson (2004) "Arithmetic and the Brain," *Current Opinion in Neurobiology* 14, 218–224.

{% Study risky choices where the outcome received is certain but the time of receipt is risky, citing Chesson & Viscusi (2003) and Onay & Öncüler (2007) as predecessors. Unlike their predecessors, they use real incentives.

The main new condition is called stochastic impatience. Assume that you own (0.5: (t=0, x); 0.5: (t=01, x)): With probability 0.5 you receive $x today (t=0), and with probability 0.5 you receive $x tomorrow (t=1). You can choose which of the two small amounts $x > 0$ is improved into $X > x$. So, you can choose between

(0.5: (t=0, X); 0.5: (t=01, x))

and

(0.5: (t=0, x); 0.5: (t=01, X))

Stochastic impatience says that you should prefer the former. In general, the sooner you can get an improvement, the more you should like it, given that it occurs with the same probability. The condition is a special case of multivariate risk seeking. It is a convincing special case and can be given a normative status. (Another normatively convincing case is for chronic health states, where an improvement of health quality should be preferred more as it is associate with a longer time duration.)

The authors show that, within a large class of models, stochastic impatience implies risk seeking over time lotteries. This is not so if one relaxes independence between different periods.

§4 discusses several generalizations of discounted expected utility, and whether to first integrate over time or over risk.

The experiments consider 50-50 lotteries over various timepoints. Thus, there

is a richer domain of timepoints than of risk levels, and more to do for time attitude than for risk attitude. %}

DeJarnette, Patrick, David Dillenberger, Daniel Gottlieb, & Pietro Ortoleva (2020) "Time Lotteries and Stochastic Impatience," *Econometrica* 88, 619–656.

{% %}

Dekel, Eddie (1986) "An Axiomatic Characterization of Preferences under Uncertainty: Weakening the Independence Axiom," *Journal of Economic Theory* 40, 304–318.

{% For general nonEU, preference for diversification (~ convexity w.r.t. outcome mixing) implies strong risk aversion (called risk aversion in this paper) under continuity, but not the other way around. In the presence of the not-necessary quasi-concavity w.r.t. probabilistic mixing, the two are equivalent. %}

Dekel, Eddie (1989) "Asset Demands without the Independence Axiom," *Econometrica* 57, 163–169.

{% %}

Dekel, Eddie (1992) "Discussion of "Foundations of Game Theory" and "Refinements of Nash Equilibrium"." *In* Jean-Jacques Laffont (ed.) *Advances in Economic Theory* I, 76–88, Cambridge University Press, Cambridge.

{% %}

Dekel, Eddie & Faruk Gul (1997) "Rationality and Knowledge in Game Theory." *In* David M. Kreps & Kenneth F. Wallis (1997, eds.), *Advances in Economics and Econometrics: Theory and Applications,* Vol. 1, Ch. 5, 87–172, Cambridge University Press, Cambridge.

{% Abstract: "We also argue … that nonchoice data, interpreted properly, can be valuable in predicting choice and therefore should not be ignored."

P. 258 argues for what I would call the desirability of homeomorphism:

"Confidence in the story of the model may lead us to trust the model's predictions more. Perhaps more importantly, the story affects our intuitions about the model and hence whether and how we use and extend it."

Friedman argued against the desirability of homeomorphic modeling, arging that all that matters is good predictions, but his argument weak because we usually cannot know what exactly will be predictions needed in the future. I argued this way in Wakker (2010 p. 3). I take it that these authors have the same opinion because they write on pp. 260-261: "Finally, even if a model does not immediately change or enlarge our set of predictions, it may yield a clearer understanding of why A might cause X. Why would such an understanding be useful? The primary value of such understanding is that it may lead in the long run to more or better predictions. Lest this comment be misinterpreted, we emphasize that understanding may involve concepts for which the translation into observables is not direct."

Several authors have argued that direct introspective questions on risk attitude are more useful than decision-under-risk experimental measurements because they better predict real-life decisions. I disagree. First, introspective questions often amount to just asking the same as the real-life decisions. But, second, risk attitudes are connected to rich theories with, for instance, meaning in normative models. I take it that these authors have the same opinion because they write on pp. 261: "For example, if A is the description of an agent's choice problem and X is his purchase of insurance, we could trivially explain the choice by saying that he just likes to buy insurance policies. However, a fuller and therefore more appealing explanation is that insurance reduces risk and the agent values it for this reason. One reason this explanation would be more appealing is that it would lead us to make other predictions about his behavior—e.g., investment decisions. Hence a decision-theoretic model that provides a formal notion of risk and risk aversion provides a broader range of other predictions."

P. 261: Besides fit, also intuitive interpretation of a model is important. I take it that these authors have the same opinion because they write on pp. 261: "As Kreps (1990) argues, this consistency with intuition is just another kind of consistency with data. Thus, in making out-of-sample predictions, we may be more inclined to trust an intuitive model with slightly worse predictions in sample than a less intuitive model that is more consistent with sample data. Conversely, if we find the story implausible, this may make us less willing to accept the predictions." Then follows a footnote diplomatically criticizing Gul & Pesendorfer (2008): "Gul & Pesendorfer (2008) argue forcefully that the implausibility of the story of a model cannot refute the model. We entirely agree. However, the implausibility may make us less confident in the predictions of the model."

P. 262 has the nice metaphor that a model can never be perfect similarly as a map cannot have scale 1 inch = 1 inch. The rest of §2, up to p. 264, gives many illustrations of this point, and that a falsification need not imply that we abandon the model.

P. 266 points out that axioms can be used to criticize and falsify a model.

§3.1, pp. 265-269, discusses preference foundations, with axioms necessary and/or sufficient. It does not discuss the problematic nature of completeness and (not-purely-technical) axioms such as continuity. It takes behavioral economics as different than decision theory and then discusses differences.

§4.2, pp. 274-275: unlike Gul & Pesendorfer (2008), they are not entirely against using nonchoice data in economics.

§4.3 discusses good and bad axiomatizations. P. 276 claims that Kreps & Porteus (1978) and Segal (1990) were first to abandon RCLA, but the keyword

second-order probabilities to model ambiguity

in this bibliography gives earlier references, including Kahneman & Tversky (1975) and Yates & Zukowski (1976).

P. 276: "Identifying the key behavior and the domain is the most essential step, but also the step that is closest to an art. Thus we find it difficult to tell the reader how to do it or how to distinguish good and bad modeling choices."

P. 276: "Axioms should be about variables of interest that are at least potentially observable." I would state it more strongly: DIRECTLY observable.

P. 276 last para argues that axioms should not be too close to the representing functional. Here I disagree somewhat. In general, and maths., it is true that one wants axioms to keep a gentlemanlike distance from what they axiomatize, because otherwise the result is trivial. But decision theory is a different ballgame. Here the name of the game is to get behavioral axioms, not to do deep logic. I often prefer that the axioms are close to the functional axiomatized, because they then clarify the empirical meaning of that functional.

P. 277: "First, it is generally better to state axioms in terms of the preferences, not a series of relations derived from the preference. For example, a key in Savage's representation theorem is the more-likely-than relation, which is constructed from the preference relation. Yet Savage states his axioms in terms of the preference, not in terms of the derived relation, as the preference is what we are making predictions about." (**derived concepts in pref. axioms**) I think that derived concepts can be used if they greatly simplify things. I disagree much with the claim on Savage. As my annotations of Savage (1954) explain, most of his axioms use derived concepts.

P. 277 2nd para argues against "there exist" quantifiers, but "for all"

quantifiers are just as problematic. One can more readily be verified, and the other falsified.

P. 277, 4th para points out that often there is a great deal of interaction between axioms, so that each in isolation does not give much. %}

Dekel, Eddie & Barton L. Lipman 2010) "How (Not) to Do Decision Theory," *Annual Review of Economics* 2, 257–282.

{% Epistemic: uses knowledge operator. %}

Dekel, Eddie, Barton L. Lipman, & Aldo Rustichini (1998) "Standard State-Space Models Preclude Unawareness," *Econometrica* 66, 159–173.

{% **small worlds**; A useful survey on unforeseen contingencies. §1 is on epistemic. §§2-3 can be read independently and give nice summary of decision models on the topic.

P. 528 makes a distinction between the state space of the agent and the, more refined, state space of the analyst. This would be a nice basis for Tversky's support theory.

SEU = risk: P. 539 writes that Savage (1954) called the conceptual difference between known and unknown probabilities into question, in the sense that his axioms imply the existence of subjective probabilities and that the agent treats these in the same way as objective probabilities. %}

Dekel, Eddie, Barton L. Lipman, & Aldo Rustichini (1998) "Recent Developments in Modeling Unforeseen Contingencies," *European Economic Review* 42, 523–542.

{% Correction in their 2007 paper. Text up to p. 901 (§2) gives nice general introduction on Kreps' (1979) **preference for flexibility** but interpreted as Kreps' (1992) unforeseen contingencies. %}

Dekel, Eddie, Barton L. Lipman, & Aldo Rustichini (2001) "Representing Preferences with a Unique Subjective State Space," *Econometrica* 69, 891–934.

{% In their 2001 paper, independence is too strong and continuity too weak. %}

Dekel, Eddie, Barton L. Lipman, & Aldo Rustichini (2007) "Representing Preferences with a Unique Subjective State Space: A Corrigendum," *Econometrica* 75, 591–600.

{% A generalization of Gul & Pesendorf temptation. %}

Dekel, Eddie, Barton L. Lipman, & Aldo Rustichini (2009) "Temptation-Driven Preferences," *Review of Economic Studies* 76, 937–971.

{% **game theory for nonexpected utility** & **dynamic consistency**: use recursive utility, giving up **RCLA. %**}

Dekel, Eddie, Zvi Safra, & Uzi Segal (1991) "Existence and Dynamic Consistency of Nash Equilibrium with Non-expected Utility Preferences," *Journal of Economic Theory* 55, 229–246.

{% %}

Dekel, Eddie & Suzanne Scotchmer (1990) "Collusion through Insurance: Sharing the Cost of Oil Spill Cleanups," *American Economic Review* 80, 249–252.

{% How two recent mass shootings affected people's risk preferences regarding mass shootings. %}

Dalafave, Rachel E. & W. Kip Viscusi (2023) "The Locus of Dread for Mass Shooting Risks: Distinguishing alarmist Risk Beliefs from Risk Preferences," *Journal of Risk and Uncertainty* 66, 109–139. https://doi.org/10.1007/s11166-023-09403-5

{% **survey on belief measurement**: in developing countries. %}

Delavande, Adeline, Xavier Giné, & David McKenzie (2011) "Measuring Subjective Expectations in Developing Countries: A Critical Review and New Evidence," *Journal of Development Economics* 94, 151–163. https://doi.org/10.1016/j.jdeveco.2010.01.008

{% Seems that he considered capacities that are convex transformations of additive measures (law-invariant). %}

Delbaen, Freddy (1974) "Convex Games and Extreme Points," *Journal of Mathematical Analysis and Applications* 45, 210–233.

{% This paper provides an expected utility axiomatization for decision under risk, extending the von Neumann-Morgenstern axiomatization to nonsimple prospects. Several preceding axiomatizations used conditions implying continuity of utility. This paper provides results that do not require continuity of utility. As pointed out by Spinu & Wakker (2012), more general results, neither using continuity of utility, had been obtained before by Fishburn (1975, Annals of Statistics, Theorem 3 = Fishburn's 1982 monograph, Theorem 3.4), Kopylov (2010 JME), and Wakker (1993, MOR, Theorem 3.6).

An appealing feature ofTheorem 1 in this paper, obtaining expected utility on the set of all probability distributions by no more than the usual weak ordering, independence, and Archimedeanity, and then stochastic dominance, is that it can be stated entirely in elementary terms, unlike the preceding references. It does imply boundedness of utility. %}

Delbaen, Freddy, Samuel Drapeau, & Michael Kupper (2011) "A von Neumann-Morgenstern Representation Result without Weak Continuity Assumption," *Journal of Mathematical Economics* 47, 401–408.

{% A very general version of the fundamental theorem of asset pricing (on no-arbitrage iff as-if risk neutral). %}

Delbaen, Freddy & Walter Schachermayer (1998) "The Fundamental Theorem of Asset Pricing for Unbounded Stochastic Processes," *Mathematische Annalen* 312, 215–250.

{% %}

Dellacherie, Claude (1970) "Quelques Commentaires sur les Prolongements de Capacités," *Seminaire de Probabilités V Strasbourg*, (Lecture Notes in Mathematics 191), Springer Verlag, Berlin.

{% **time preference**. Uses **total utility theory** of Kahneman et al. %}

Dellaert, Benedict G.C. & Barbara E. Kahn (1999) "How Tolerable is Delay? Consumers' Evaluations of Internet Web Sites after Waiting," *Journal of Interactive Marketing* 13, 41–54.

{% Paper surveys behavioral-economics models in risky choice, intertemporal choice, social preferences, overconfidence, choice from menus, with some more framing effects. It focuses on a detailed discussion of a limited number of empirical studies, being field studies.

P. 318: in beta-delta model, beta captures self-control problems. %}

DellaVigna, Stefano (2009) "Psychology and Economics: Evidence from the Field," *Journal of Economic Literature* 47, 315–372.

{% Reading the first two pages immediately reveals the kind of enthusiasm that the author has. Two characteristic sentences:

"In this chapter I ask: Is there an important role for structural estimation in behavioral economics, or for short Structural Behavioral Economics? For our purposes, I define structural as the "estimation of a model on data that recovers estimates (and confidence intervals) for some key behavioral parameters" ."

Reassuring to read that it is done for key variables.

And

"Having said this, should all of behavioral economics be structural? Absolutely not."

I am glad that the author leaves space for other things! %}

DellaVigna, Stefano (2018) "Structural Behavioral Economics." *In* B. Douglas Bernheim, Stefano DellaVigna, & David Laibson (eds.) *Handbook of Behavioral Economics; Volume 2*, 613–723, Elsevier, Amsterdam.

{% %}

DellaVigna, Stefano & Marco LiCalzi (2000) "Learning to Make Risk Neutral Choices in a Symmetric World," *Mathematical Social Sciences* 41, 19–37.

{% The abstract writes an average impact of a nudge in academic papers of 8.7 percentage take-up effect in academic papers, but I don't know what this means. %}

Dellavigna, Stefano & Elizabeth Linos (2022) "Rcts to Scale: Comprehensive Evidence from Two Nudge Units," *Econometrica* 90, 81–116.

{% %}

DellaVigna, Stefano & Ulrike Malmendier (2004) "Contract Design and Self-Control: Theory and Evidence," *Quarterly Journal of Economics* 119, 353–402.

{% N = 9861 subjects from M-Turk. They investigate effects of (1) monetary incentives; (2) behavioral factors such as present bias, social preferences, reference dependence; (3) nonmonetary inducements from psychology. An example of the latter is: "Your score will not affect your payment in any way. After you play, we will show you how well you did relative to other subjects." Monetary incentives are more effective than nonmonetary inducements. A problem with the latter as implemented here is that they are put in a stark contrast effect, which will reduce their impact. They also have a treatment where they pay with small probability, but it seems not to work well (**random incentive system**). %}

DellaVigna, Stefano & Devin Pope (2018) "What Motivates Effort? Evidence and Expert Forecasts," *Review of Economic Studies* 85, 1029–1069.

{% The paper discusses what its title says. %}

DellaVigna, Stefano, Devin Pope, & Eva Vivalt (2019) "Predict Science to Improve Science," *Science* 336 (6464), 428–429. https://doi.org/10.1126/science.aaz1704

{% %}

Delnoij, Diana M.J., Jack B.F. Hutten, Corina C. Ros, Peter P. Groenewegen, Roland D. Friele, Eloy van de Lisdonk, & Dinny H. de Bakker (1999) "Effecten van Eigen Bijdragen in het Ziekenfonds in Nederland," *Tijdschrift voor Gezondheidswetenschappen* 77, 406–412.

{% **PE higher than CE**; a nice paper. For two-dimensional options, say (X1,X2) versus (Y1,Y2), one of the four values is left out, say X1´, and the value of X1 is found to give indifference. But then (X1´,X2), (Y1,Y2) is presented, one of the other three value is left out, say Z, and then the value of Z is found, say Z´, to give indifference. Under rationality, Z=Z´ should be. But there are many biases, such as scale compatibility, going on, and we find Z´≠ Z. Very nice, irrespective of which of the other values are chosen, irrespective of which values are higher of

lower, and other things, always Z´ ends up too close to its opposing value. For instance, if Z was Y2, Z´ will end up too close to X2, so, between Y2 and X2.

The author takes the term framing narrow, it refers to only one thing: if one chooses between a riskless and risky option, the riskless option is taken as reference point. He avoids this.

P. 1385: "the tendency for preferences to appear more compensatory in quantitative than in qualitative evaluations"

P. 1385 describes the, advanced, method to measure indifferences, combining bisection and direct matching, although the choices were hypothetical: "All matching responses were obtained through a converging sequence of choices to help subjects determine their indifference values. This standard psychometric procedure was managed by a computer program which iteratively generates new choices based on subjects' own choices, so as to progressively narrow the range of possible matching values. To avoid directional biases, bounds are tightened on both sides. Once the algorithm has converged to a sufficiently narrow range, subjects are finally invited to enter their *numerical* matching responses. This whole process was presented to subjects as an aid to accurately determine their matching responses and they were encouraged to fully rely on it." [italics from original]

P.. 1395: "simple trade-off of two quantities, which is the central, irreducible and delicate part of subjective evaluation."

P. 1395, final sentence: "The premise of any prescriptive analysis of a decision problem is that there exist correct, unbiased answers to the problem. This very premise may be in jeopardy if we prove unable to elicit coherent, unbiased opinions from individual decision makers." %}

Delquié, Philippe (1993) "Inconsistent Trade-Offs between Attributes: New Evidence in Preference Assessment Biases," *Management Science* 39, 1382–1395.
https://doi.org/10.1287/mnsc.39.11.1382

{% %}

Delquié, Philippe (1997) " "Bi-Matching ": A New Preference Assessment Method to Reduce Compatibility Effects," *Management Science* 43, 640–658.

{% **error theory for risky choice**: In devising tradeoff-stimuli in multiattribute settings, it is useful to consider which sizes of tradeoffs will lead to minimal errors in the parameters of interest. Should think about the response errors, but also in the "leverage," which means how much the parameter of interest is sensitive to a response error.

P. 108 (**tradeoff method's error propagation**): Often the response error (in an absolute sense?) will increase with tradeoff size, but the leverage will decrease. This is a useful observation for the error-propagation problem in the TO-method. %}

Delquié, Philippe (2003) "Optimal Conflict in Preference Assessment," *Management Science* 49, 102–115.

{% **value of information**

Takes it in the EU-LaValle sense, of EU increase generated. There are not many clear relations with risk aversion and so on. This paper does find some regularities. Usually the value of info decreasing in preference intensity. %}

Delquié, Philippe (2008) "The Value of Infrmation and Intensity of Preference," *Decision Analysis* 49, 129–139.

{% %}

Delquié, Philippe (2008) "Valuing Information and Options: An Experimental Study," *Journal of Behavioral Decision Making* 21, 91–109.

{% Under linear-exponential (CARA) utility, utility is bounded above. Hence there is, for every probability, a loss threshold that cannot be made up by an infinite utility even. This provides an interpretation of risk tolerance. Table 1 gives results. %}

Delquié, Philippe (2008) "Interpretation of the Risk Tolerance Coefficient in Terms of Maximum Acceptable Loss," *Decision Analysis* 5, 5–9.

{% Assume a prospect $x = (p_1{:}x_1,\ldots,p_n{:}x_n)$. The authors assume that x is kind of compared to an independent replica. If the subject evaluates x_i, he thinks that it could have been x_j with probability p_j. Thus, he evaluates the prospect by (using my notation)

$$\sum_{i=1}^{n} p_i U(x_i) + \sum_{i=1}^{n} p_i\Big(\sum_{j=1}^{n} p_j D(U(x_j) - U(x_i))\Big)$$

where in the second summation $D(U(x_j) - U(x_i))$ is the disappointment of having gotten just x_i and not x_j. If x_i is better than x_j then it is negative disappointment, so, it is elation. The authors use a different symbol E for the disappointment function defined on its negative domain.

It is natural that in disappointment emotions all other possible outcomes float around in the mind of the agent.

biseparable utility: for the most common D, which is piecewise linear with a kink at 0. %}

Delquié, Philippe & Alessandra Cillo (2006) "Disappointment without Prior Expectation: A Unifying Perspective on Decision under Risk," *Journal of Risk and Uncertainty* 33, 197–215.

{% %}

Delver, Robert, Herman Monsuur, & Ton J.A. Storcken (1991) "Ordering Pairwise Comparison Structures," *Theory and Decision* 31, 75–94.

{% **gender differences in risk attitudes**: no difference %}

Demaree, Heath A., Michael A. DeDonno, Kevin J. Burns, Pavel Feldman, & D. Erik Everhart (2009) "Trait Dominance Predicts Risk-Taking," *Personality and Individual Differences* 47, 419–422.
http://dx.doi.org/10.1016/j.paid.2009.04.013

{% One explanation of the home bias is that one wants hedges against domestic shocks. As an aside, this paper puts up other explanations. %}

Demarzo, Peter M., Ron Kaniel, & Ilan Kremer (2004) "Diversification as a Public Good: Community Effects in Portfolio Choice," *Journal of Finance* 59, 1677–1715.

{% Discuss questionaires to measure optimism/pessimism;

Find that optimism is not inverse of pessimism; they are more or less independent entities. %}

Dember, William N., Stephanie H. Martin, Mary K. Hummer, Steven R. Howe, & Richard S. Melton (1989) "The Measurement of Optimism and Pessimism," *Current Psychology: Research & Reviews* 8, 102–119.

{% The consider risky choices from linear budget sets where the commodities are event-contingenty payoffs. They assume given probabilities. Whereas Choi et al. (2007, 2014) considered 2-outcome lotteries, this paper considers 3-outcome

lotteries. 3-outcome lotteries have been considered for ambiguity before but, apparenlty, not for risk. They quantify violations of theories by the wel-known index of the minimal number of preferences that have to be changed to be able to fit the theory. This way, the number of violations of EU with stoch. dom. is hardly more than the number of violations of transitivity with stochastic dominance, suggesting that most problems come from violations of basic conditions. %}

Dembo, Aluma, Shachar Kariv, Matthew Polisson, & John K.-H. Quah (2021) "Ever Since Allais," working paper.

{% %}

Dempster, Arthur P. (1967) "Upper and Lower Probabilities Induced by a Multivalued Mapping," *Annals of Mathematical Statistics* 38, 325–339.

{% **foundations of statistics** %}

Dempster, Arthur P. (1997) "The Direct Use of Likelihood for Significance Testing," *Statistics and Computing* 7, 247–252. (Originally published in 1973).

{% %}

Demuynck, Thomas (2009) "Absolute and Relative Time-Consistent Revealed Preferences," *Theory and Decision* 66, 283–299.

{% Apply revealed-preference techniques to Nash Bargaining and so on. %}

Demuynck, Thomas & Luc Lauwers (2009) "Nash Rationalization of Collective Choice over Lotteries," *Mathematical Social Sciences* 57, 1–15.

{% **DC = stationarity**: Distinguish the conditions well, and have longitudinal data to properly test for DC (dynamic consistency) also. This paper is in this regard a particularly clean version of what was also done by Halevy (2015). The authors use the term dynamic consistency for what Halevy calles time consistency, the term age independence (which would in fact be my preference also, were it not that the conventions in the field have gone differently and are beyond return) for Halevy's vague term time invariance, and the term stationarity is the same way as Halevy's. The field has by now (2017) converged on Halevy's terminology.

This paper does more, by comparing individual decisions with group decisions, where it again does a clean job showing that group communication (and not repeated choice or other-regarding preferences) decreases impatience and inconsistencies. %}

Denant-Boemont, Laurent, Enrico Diecidue, Olivier l'Haridon (2017) "Patience and Time Consistency in Collective Decisions," *Experimental Economics* 20, 181–208.

{% %}

Denayer, Lieve, Myriam Welkenhuysen, Gerry Evers-Kiebooms, Jean-Jacques Cassiman, & Herman Van den Berhe (1997) "Risk Perception after CF Carrier Testing and Impact of the Test Result on Reproductive Decision Making," *American Journal of Medical Genetics* 69, 422–428.

{% In Dutch. Propagates the **tradeoff method**, in general multiattribute setting, for consultancy purposes.

real incentives/hypothetical choice: propagates the use of hypothetical choice to reveal client's preferences, because these can give precisely the data needed. %}

Deneffe, Daniel (2003) "Waarvoor Wil de Klant Betalen," *Industrie Magazine* (September), 20.

Link to paper

{% %}

Deneffe, Daniel & Peter P. Wakker (1996) "Mergers, Strategic Investments and Antitrust Policy," *Managerial and Decision Economics* 17, 231–240.

https://doi.org/10.1002/(SICI)1099-1468(199605)17:3<231::AID-MDE748>3.0.CO;2-M

Direct link to paper

{% **ratio bias**: seem to find it. %}

Denes-Raj, Veronika & Seymour Epstein (1994) "Conflict between Intuitive and Rational Processes: When People Behave against Their Better Judgment," *Journal of Personality and Social Psychology* 66, 819–829.

{% %}

Deng, Liurui & Traian A. Pirvu (2019) "Multi-Period Investment Strategies under Cumulative Prospect Theory," *Journal of Risk and Financial Management* 12(2), 83.

{% **SIIA/IIIA** %}

Denicolò, Vincenzo (2000) "Independence of Irrelevant Alternatives and Consistency of Choice," *Economic Theory* 15, 221–226.

{% %}

Denicolò, Vincenzo & Marco Mariotti (2000) "Nash Bargaining Theory, Nonconvex Problems and Social Welfare Orderings," *Theory and Decision* 48, 351–358.

{% %}

Denneberg, Dieter (1990) "Premium Calculation: Why Standard Deviation Should Be Replaced by Absolute Deviation," *ASTIN Bulletin* 20, 181–190.

{% Proposition 3.1: nice equivalent formulations of comonotonicity;

P. 19: gives nice reference to Hardy, Littlewood & Pòlya (1934) with term "similarly ordered" for comonotonicity. %}

Denneberg, Dieter (1990) "Subadditive Measure and Integral," Preprint 39, Universität Bremen, Dept. Mathematik/Informatik. Presented at 5th FUR conference, Duke University, Durham, NC USA.

{% Grabisch (2016) is a follow-up in a similar spirit. %}

Denneberg, Dieter (1994) "*Non-Additive Measure and Integral.*" Kluwer Academic Publishers, Dordrecht.

{% **updating: nonadditive measures** %}

Denneberg, Dieter (1994) "Conditioning (Updating) Non-Additive Measures," *Annals of Operations Research* 52, 21–42.

{% %}

Denneberg, Dieter (1997) “Representation of the Choquet Integral with the σ-Additive Möbius Transform,” *Fuzzy Sets and Systems* 92, 139–156.

{% conditioning and product measures for capacities %}
Denneberg, Dieter (2002) “Conditional Expectation for Monotone Measures, the Discrete Case,” *Journal of Mathematical Economics* 37, 105–121.

{% %}
Denneberg, Dieter & Michel Grabisch (1999) “Interaction Transform of Set Functions over a Finite Set,” *Information Sciences* 121, 149–170.

{% %}
Denneberg, Dieter & Michel Grabisch (2004) “Measure and Integral with Purely Ordinal Scales,” *Journal of Mathematical Psychology* 48, 15–27.

{% Analyzes optimal design of lotteries for RDU subjects. Finite prizes can only be under implausible utility and probability weighting. Continuum of prizes can well be, under inverse S probability weighting. %}
Dennery, Charles & Alexis Direr (2014) “Optimal Lottery,” *Mathematical Social Sciences* 55, 15–23.

{% **conservation of influence**: social sciences takes intentional rather than physical stance. %}
Dennett, Daniël C. (1987) “*The Intentional Stance.*” MIT Press, Cambridge MA.

{% %}
Dennett, Daniel C. (1995) “*Darwin’s Dangerous Idea. Evolution and the Meanings of Life*.” Simon and Schuster.

{% **free will/determinism**. Seems to argue that there is no real difference between “real randomness” and quasi-randomness, in the same way as there is no real difference between “real free will” and quasi-free will. Wrote on it since 1980s. %}

Dennett, Daniël C. (2003) "*Freedom Evolves.*" Viking Penguin, London.

{% Combining several non-independent belief functions. %}
Denoeux, Thierry (2008) "Conjunctive and Disjunctive Combination of Belief Functions Induced by Non Distinct Bodies of Evidence," *Artificial Intelligence* 172, 234–264.

{% A good and well-organized review. Section 2.2 is on complete ignorance. Section 2.2.1 presents some common decision models for total absence of info, being maximax, maximin, Hurwicz, Laplace, minimax regret. Section 2.2.2 presents ordered weighted average (OWA), which is in fact RDU taking uniform probabilities, nicely citing Yager (1988), for it, and with a pessimism index (Eq. 7) equivalent to the pessimism index of Abdellaoui et al. (2011 AER). Section 2.2.3 goes into axiomatizations. Section 2.3 gives vNM EU, briefly mentioning Savage. (A small detail: P. 93 erroneously writes that Ellsberg 1961 would have done experiments. This is not so.) Section 3 considers belief functions, with p. 94 mentioning imprecise probabilities, i.e., using sets of priors. Section 4 nicely presents decision models for belief functions as extensions of the models of §2. Belief functions can be taken as probability distributions over states of complete ignorance, providing the basic link. Section 4.2 gives the generalized Hurwicz criterion, §4.3 Smets' pignistic model (like Jaffray's but in its strictest version taking Laplace-type average utilities under complete ignorance; this was the first time I understood Smets' model, having known its existence since youth). §4.4 has the generalized OWA criterion, §4.5 generalized maxmin regret, §4.6 Jaffray's model exactly as I came to understand it. §4.7 considers dropping completeness. §5 considers imprecise probabilities, i.e., sets of priors. §6 presents Shafer's (2016) decision theory, and §7 concludes. %}
Denoeux, Thierry (2019) "Decision-Making with Belief Functions: A Review," *International Journal of Approximate Reasoning* 109, 87–110.

{% **substitution-derivation of EU**: in their §2.
A generalization of Jaffray's (1989) linear Utility Theory for Belief Functions (*Operations Research Letters*). Let us assume a best outcome M and a worst outcome m. If I understand right, they do not require that for every belief function

over outcomes an equivalent objective lottery over {m,M} exists, but only some sort of belief u in M and belief v in m (so, 1−v is plausibility of M). For focal sets, preference only if both u and v dominate. Is extended to general belief functions by taking probability-weighted averages over u and v. Gives incomplete preferences. Jaffray' theory is the special case where u=1−v always. Then we get completeness. Their Assumption 4.6, called monotonicity, is restrictive by more or less just assuming the representation in terms of u and v.

Assumption 4.7, called dominance, requires that preferences between focal sets are determined only by their best and worst outcomes, with an obvious dominance added. The authors rightfully point out that this is restrictive, implying the PCI (**principle of complete ignorance**), and violations of some sorts of monotonicity axioms, illustrated in their Example 8. With this assumption added, Theorem 4.3 results: a sort of two-tire representation, specifying two Jaffray-type functionals with local pessimism indexes $\alpha_{m,M}$ and $\beta_{m,M}$, respectively, and preference only if both functionals are higher.

Section 5 conveniently compares with other decision theories, such as Smet's. Jaffray used sets of priors (called credal sets in belief-function-theory) to justify his axioms, but this interpretation does not seem to sit well with Dempster-Shafer combination of belief functions. He uses regular probabilistic mixing whereas this paper uses the Dempster-shafer combination rule for multistage mixing.

The authors take the belief functions over outcomes as observable (p. 200 ℓ. -4), which fits with Dempster (1967) who took them as objective but I think not with Shafer (1976) who took them as subjective.

P. 213 writes about Shafer's (2016) new decision theory: "Shafer's constructive decision theory needs to be fleshed out before it can be applied to practical decision-making situations." %}

Denoeux, Thierry & Prakash P. Shenoy (2020) "An Interval-Valued Utility Theory for Decision Making with Dempster-Shafer Belief Functions," *International Journal of Approximate Reasoning* 124, 194–216.

{% Show that Yaari's 1987 representation is dual to vNM EU. %}

Dentcheva, Darinka & Andrzej Ruszczynski (2013) "Common Mathematical Foundations of Expected Utility and Dual Utility Theories," *SIAM Journal on Optimization* 23, 2381–405.

{% **value of information**: on theory of rational inattention, when acquiring information is costly. Characterizes posterior searability. %}

Denti, Tommaso (2022) "Posterior Separable Cost of Information," *American Economic Review* 112, 3215–3259.
https://doi.org/10.1257/aer.20211252

{% This paper axiomatizes a subcase of the smooth ambiguity model. However, I think that this subcase is, essentially, recursive expected utility (REU). More precisely, it is isomorphic to REU. Explanation follows. For simplicity, I assume the state space finite and monetary outcomes with continuous utility.

REU (Kahneman & Tversky 1975 pp. 30-33; Kreps & Porteus 1978; Neilson 2010) assumes a two-stage event space with expected utility maximization at each stage (objective or subjective) and backward induction, but it deviates from EU by allowing for different utility functions in the two stages.

Notation is as follows. Events C_1, …, C_n partition the universal event. Each C_j is partitioned into $E_{j_1,\ldots,j_{m_j}}$, where it is conceptually useful (see later) to note that m_j can depend on j. Exactly one of the C_j is true and conditional on C_j, exactly one of $E_{j_1,\ldots,j_{m_j}}$ is true. Outcomes are real-valued (money), and acts map events E_{j_i} to outcomes. In principle, every assignment of outcomes to events is conceivable, and the act space, the domain of preference, is $\mathbb{R}^{m_1+\cdots+m_n}$. In the smooth model, analogs of the C_j are called *second-order*, and analogs of the $E_{j_1,\ldots,j_{m_j}}$ are called *first-order*, and I will follow this terminology here for REU. (In some other fields these terms are reversed, unfortunately.) Acts depending only on the C_j are called *second-order*. The C_j are also called *conditioning events*.

For a utility function U, conditional on each E_j, EU is maximized using U. (U could also depend on j but we assume not here. He, 2021, has a model with such dependence.) We do certainty equivalent (CE) substitution at each C_j through such an EU model. After this done, we aggregate over the C_js using EU with another utility function $V = \varphi \circ U$. The probability distributions conditional on C_j, so over the $E_{j_1,\ldots,j_{m_j}}$, are called *conditional* or *first-order distributions*. The probability distribution over the C_js is the *second-order distribution*.

Apart from $V \neq U$, REU may be just any Bayesian model with multistage resolution of uncertainty as occurring in every application, and having nothing to do with ambiguity. But REU can be interpreted to capture ambiguity. We then take the probabilities conditional on the true C_j as true/correct, but unknown in the sense that we do not know which C_j is true. Some observations: The C_j are exogenously determined. One can conceive/implement gambles on them, i.e., they can be outcome-relevant. For this reason, they have been called physical/identifiable. Further, the events $E_{j_1},\ldots, E_{j_{m_j}}$, for different j, may just be different events, just disjoint, with nothing in common otherwise. In particular, the m_js can be different. We don't say $E_{i_1}=E_{j_1}$ in any sense. We call each set $\{E_{j_1},\ldots, E_{j_{m_j}}\}$ a *conditional state space*.

REU is a particular ambiguity model that is not widely applicable. Its two-stage setup is rarely available. Usually, uncertainty about true probabilities cannot be specified in terms of physical/identifiable events. A gamble like "if the true probability of E exceeds 0.65 then you receive €40" is usually inconceivable because we cannot identify the winning event. Ellsberg urns do allow for such gambles if the content of the urns can be inspected, but this is not representative of natural ambiguity.

The smooth ambiguity model (SAM) seeks general applicability. It uses a functional form like REU, but with two differences. First, the events C_j to specify the true probabilities are not required to be identifiable. They are allowed to concern nothing other than specification of the true probabilities, and can be equated with them. The probability distribution over the C_js then is simply a "second-order" distribution over the first-order distributions. (That there are infinitely many such events does not affect any claim in this analysis.) Thus, the smooth model becomes applicable whenever one is willing to accept a concept of true probability, where that probability is allowed to be subjective. (Although most ambiguity theories popular today (2022), including multiple prior theories, use a concept of true but unknown probability, I think that it is not meaningful in many applications.) Second, $m_j = m$ is independent of j and for each i we identify all $E_{i_k}=E_{j_k}$ for all i≠j and k, writing $E_{i_k}=E_{j_k}=E_k$. Thus, the first-stage probability distributions all concern the same events. I call $\{E_1,\ldots,E_m\}$ the *unconditional space*. The crucial restriction for unconditional state space that we impose is that any act should assign the same outcomes to all $E_{i_k}=E_k$ for all i and k. Thus, the act space, the domain of preferfence, is not $\mathbb{R}^{m_1+\cdots+m_n}$ or $\mathbb{R}^{mn}$ but $\mathbb{R}^m$ (to be expanded later). Because there is no exogenous specification of second-order events it is sometimes said that it is endogenous. Strictly speaking, the set of all first-order distributions is given beforehand though and can be called exogenous. The second-order distribution is subjective and endogenous—as it can also be in REU. Because all second-order distributions are now considered, and not just those over the C_js, this free parameter of SAM is of very high cardinality with little parsimony.

That the second-order events are no more identifiable, brings serious observability problems for experimental and theoretical analyses of SAM. The analyses provided in the literature as yet invariably assumed identifiable second-order events. They concerned REU rather than SAM.

Klibanoff, Marinacci, & Mukerji (2005), KMM provided a preference foundation. However, in this they assumed second-order acts, maps from the set of all first-order probability distributions to outcomes, available. For those, the second-order events should be identifiable after all. The authors acknowledged and discussed this problem on p. 1856.

Denti & Pomatto (2022) provided a preference foundation for a subclass of SAM, but it is in fact REU, or isomorphic to REU. They do not explicitly assume a two-stage model, but require separability (the sure-thing principle) of the second-stage events C_j. It is well-known, though, that two-stage backward induction is equivalent to separability of the conditioning events. As for an unconditional state space, a conditional state space can always be formally turned into an unconditional state space as follows. The unconditional state space S is defined as the union $\{E_{j_1},\ldots, E_{1_{m_1}}\} \cup \cdots \cup \{E_{n_1},\ldots, E_{n_{m_n}}\}$, containing $m_1 + \cdots + m_n$ states. Let P_j denote the REU conditional probability measure on $\{E_{j_1},\ldots, E_{j_{m_j}}\}$. Then Q_j is the unconditional probability measure on S that agrees with P_j on $\{E_{j_1},\ldots, E_{j_{m_j}}\} \subset S$ and assigns probability 0 to the rest of S. This way REU with a conditional state space can formally be turned into SAM with an unconditional state space. However, it is a very special case, where the conditional probability distributions have empty support. I call this case a *quasi-unconditional state space*. It is isomorphic to REU. It is similar to Cerreia-Vioglio, Maccheroni, Marinacci, & Montrucchio's (2013 PNAS) orthogonality which also imposes disjoint supports and then shows that a second-order distribution then is identifiable.

Exogenous concepts can be turned endogenous using the "there exists" quantifier. Thus, in REU, instead of assuming the two-stage decomposition with separable events E_j given beforehand, one can start from a general state space and then assume that *there exists* a two-stage decomposition with separable E_j, and then impose all restrictions. A nice thing with separable events, noted by Gul & Pesendorfer (2014), is that usually there is a maximal partition/sigma-algebra of those events, a common refinement of all. It obviously is unique. The point is that if two events are separable then by Gorman's theorem usually so is the algebra generated by them.

I think that this paper axiomatized REU. It used separability as equivalent to two-stage folding back, a quasi-unconditional state space, and a "there exists" endogenization of something exogenous, but the result is isomorphic to REU. In particular, the main novelty of SAM over REU, nonidentifiability of the conditioning events, is not there. It is needed to move from REU to general ambiguity.

I next discuss terminologies and notation used by the authors. The abstract suggests a preference foundation for the general smooth model. But it is only if there are identifying conditioning events. The authors use the Anscombe-Aumann framework. The authors interpret the identifiable conditioning events to be statistical models. But they can be any kinds of events satisfying separability. Equating separability with being a statistical model is an interpretation. P. 552 middle writes: "Under this view, ambiguity is generated by uncertainty about the correct law of nature p, rather than by inability to express decisive first-order beliefs." Thus, they assign some objective physical meaning although it will be purely subjective and endogenous in this paper. The sentence "We ask P to satisfy what is perhaps the single most fundamental assumption in statistical modeling, that of being identifiable." (p. 552) shows how important the identifiability assumption of the authors is to themselves. Identifiability in the first displayed eq. on p. 552 means disjoint supports of the correct laws of nature, i.e., they are 100% incompatible, which of course is a very restrictive assumption. The later sentence "identifiable smooth preferences formalize the common view that ambiguity is due to lack of information" puts identifiability in a broad perspective.

The predictive assessment π is the overall probability measure over the state space that gives the probabilities of the conditioning events E_j and, conditioned on E_j, the candidates for being called correct law of nature. The sigma-algebra T is the one generated by the conditioning events. The last sentence on p. 552 was incomprehensible to me: "Both T and π are purely subjective and make no reference to any agreed-upon statistical notion of "true" law of nature." Because just before the authors endorsed the interpretation of true law of nature.

The main axiom in the axiomatization is Axiom 4 (p. 560). It combines the sure-thing principle for the conditioning events with the vNM independence condition (using the mixture in their Anscombe-Aumann framework) conditional on the conditioning events, the latter formulated indirectly via a $\succcurlyeq^*$ relation.

Proposition 4 has a condition of more perceived ambiguity which is roughly equivalent to having the same 1st order utility and a less refined set of separable (conditioning) events. Proposition 5 has the usual more-ambiguity-averse relation through Yaari-type certainty-equivalent comparisons, which capture the desired attitudinal component, ambiguity aversion in this case, by assuming all other components (the vNM utilities in the 1st order events) fixed. Then it corresponds with φ being more concave and same πs.

P. 566 2nd para nicely points out that identifiable events may not be available. %}

Denti, Tommaso & Luciano Pomatto (2022) "Model and Predictive Uncertainty: A Foundation for Smooth Ambiguity Preference," *Econometrica* 90, 551–584.

{% Gives general definitions of higher-order absolute risk aversion, extending previous work by Chiu. %}

Denuit, Michel M. & Louis Eeckhoudt (2010) "A General Index of Absolute Risk Attitude," *Management Science* 56, 712–715.

{% **one-dimensional utility**: linex family (part of Bell's one-switch family) is only one that satisfies particular Ross-type strong risk aversion conditions everywhere. %}

Denuit, Michel M., Louis Eeckhoudt, & Harris Schlesinger (2013) "When Ross Meets Bell: The Linex utility Function," *Journal of Mathematical Economics* 49, 177–182.

{% Optimal risk sharing. %}

Denuit, Michel & Jan Dhaene (2012) "Convex Order and Comonotonic Conditional Mean Risk Sharing," *Insurance: Mathematics and Economics* 51, 265–270.

{% %}

Denuit, Michel, Jan Dhaene, Marc Goovaerts, Rob Kaas, & Roger Laeven (2006) "Risk Measurement with Equivalent Utility Principles," *Statistics and Decisions* 24, 1–26.

{% Two standard theorems in risk sharing:

(i) any feasible allocation is convex-orderdominated by a comonotonic allocation;

(ii) an allocation is Pareto optimal for the convex order if and only if it is comonotonic.

This paper gives new proof:

(i) explicit enough (in terms of α-quantiles (mixed quantiles) for algorithmic implementation

(ii) closed-form characterization of Pareto optima. %}

Denuit, Michel, Jan Dhaene, Mario Ghossoub, Christian Y. Robert (2025) "Comonotonicity and Pareto Optimality, with Application to Collaborative Insurance," *Insurance Mathematics and Economics* 120, 1–16. https://doi.org/10.1016/j.insmatheco.2024.11.001

{% %}

Denuit, Michel, Dominik Sznajder, & Julien Trufin (2019) "Model Selection Based on Lorenz and Concentration Curves, Gini Indices and Convex Order," *Insurance: Mathematics and Economics* 89, 128–139.

{% They show that salience theory can accommodate skewness preference. However, they do not take salience theory in its original form, but a continuous version that in fact is a special case of (generalized) regret theory. Fortunately, they state this explicitly, in §2 (I would have preferred in the intro though).

P. 2063 para below Def. 3 discusses a normalization. But it should be understood that the preference functional is invariant up to multiplication by any positive function g(C) where g can entirely depend on the choice situation C, so that this normalization has no empirical meaning.

In itself it is not surprising that salience theory can accommodate much because of its big generality, also its continuous version. In an experiment they find violations of transitivity. This is a violation of every transitive theory including prospect theory (**PT falsified**). It can be taken as support for salience theory

§2.2 defines certainty equivalents. In the absence of transitivity, these do not mean much.

§7.3 critically discusses regret theory. For one, the authors argue that regret must be anticipated, requiring info about the forgone outome. This info need not ocur in their experiment, for instance if subjects reeive a sure outcome. I see this differently. First, regret theory is only more convincing if info about foregone outcomes, and will still be working, but weaker, if not. But, seond, this holds the same for salience theory. Salience will be weaker if no info about foregone outcome. Further, this is only a difference of interpretation, not of preference functional. %}

Dertwinkel-Kalt, Markus & Mats Köster (2020) “Salience and Skewness Preferences,” *Journal of the European Economic Association* 18, 2057–2107.

{% %}

Deschamps, Robert & Louis Gevers (1978) “Leximin and Utilitarian Rules: A Joint Characterization,” *Journal of Economic Theory* 17, 143–163.

{% %}

Deschamps, Robert & Louis Gevers (1979) “Separability, Risk-Bearing and Social Welfare Judgements.” *In* Jean-Jacques Laffont (ed.) *Aggregation and Revelation of Preferences*, Ch. 8, 145–160, North-Holland, Amsterdam.

{% Should rare diseases get priority in C/E (cost-effectiveness) analyses? This was asked to Norwegian doctors, and to the general public. Doctors, rationally I think, did not want prioritizing the rare diseases, but the general pubic did. Doctors did want to leave a little budget for the rare diseases, and did not want the budget to go entirely to the more frequent disease with more cost-effective treatment. %}

Desser, Arna S. (2013) "Prioritizing Treatment of Rare Diseases: A Survey of Preferences of Norwegian Doctors," *Social Science and Medicine* 94, 56–62.

{% Seem to find that people are not willing to spend more money on rare diseases if the opportunity costs (non-rare-disease treatments lost) are specified. %}

Desser Arna S., Dorte Gyrd-Hansen, Jan A. Olsen, Sverre Grepperud, & Ivar S. Kristiansen (2010) "Societal Views on Orphan Drugs: Cross Sectional Survey of Norwegians Aged 40 to 67," *British Medical Journal* 341, c4715.

{% About 3,000 subjects answered questions between two hypothetical choice questions. Half of them got either an opt-out choice option added or a "neither" option. Between-subjects, more subjects chose neither than opt-out. In debriefings, subjects turned out to give many different interpretations to these options, such as that they wanted improvements of the options offered. In particular, the "neither" option got any interpretations, because of which the authors in their conclusion advise against it. It also gave a worse model-fit, adding to the authors warning against it.

For the other half of subjects it was as above, but also a status quo option was added. 55.7% chose the status quo. I am not able to interpret this because I don't know how good the status quo was relative to the other options. In general, the added options did affect choices, but no clear conclusions can be drawn from this. %}

Determann, Domino, Dorte Gyrd-Hansen, G. Ardine de Wit, Esther W. de Bekker-Grob, Ewout W. Steyerberg, Mattijs S. Lambooij, & Line Bjørnskov Pedersen (2019) "Designing Unforced Choice Experiments to Inform Health Care Decision Making: Implications of Using Opt-Out, Neither, or Status Quo Alternatives in Discrete Choice Experiments," *Medical Decision Making* 39, 681–692.

{% %}

Detsky, Allan S. (1993) "Guidelines for Economic Analysis of Pharmaceutical Products: A Draft Document for Ontario and Canada," *PharmacoEconomics* 3, 354–361.

{% **foundations of probability**: Popular book on invention of probability, from correspondence of Pascal and Fermat (1654), Christiaan Huygens, Johan de Witt, up to Black & Scholes. %}

Devlin, Keith (2008) "*The Unfinished Game*." Basic Books, New York.

{% Propose to handle states worse than death in TTO by interspersing some duration with positive health state at the beginning, so that the overall utilities are always positive, and test it. %}

Devlin, Nancy J., Aki Tsuchiya, Ken Buckingham, & Carl Tilling (2011) "A Uniform Time Trade Off Method for States Better and Worse than Dead: Feasibility Study of the 'Lead Time' Approach," *Health Economics* 20, 348–361.

{% %}

Dewdney, Alexander K. (1993) "*200% of Nothing. An Eye-Operning Tour through the Twists and Turns of Math Abuse and Innumeracy*." Wiley, New York.

{% %}

Dhaene, Jan, Michel Denuit, Marc J. Goovaerts, Rob Kaas, & David Vyncke (2002) "The Concept of Comonotonicity in Actuarial Science and Finance: Theory," *Insurance: Mathematics and Economics* 31, 3–33.

{% %}

Dhaene, Jan, Roger J.A. Laeven, Steven Vanduffel, Grzegorz Darkiewicz, & Marc J. Goovaerts (2008) "Can a Coherent Risk Measure Be too Subadditive?," *Journal of Risk and Insurance* 75, 365–396.

{% Assume random variables $X_1,\ldots,X_n$ with some joint distribution that is assumed hard to analyze, and consider their sum. They are maximally correlated, and their sum is most risky, if they are taken to be comonotonic (Theorem 1, p. 258).

Hence, under risk aversion, a comonotonic combination of the marginals gives a worst-case approximation. The authors demonstrate analytical advantages, taking the X_j as incomes over several years, and considering criteria as maximization of probability of reaching some target (the “termunal wealth problem,” p. 254) or maximizing the 1−p quantile (the “p-target capital,” p. 277), or maximization of integral over the lowest p-part of the distribution etc. for investment problems (conditional left-tail expectation). %}

Dhaene, Jan, Steven Vanduffel, Marc J. Goovaerts, Rob Kaas, & David Vyncke (2005) “Comonotonic Approximations for Optimal Portfolio Selection Problems,” *Journal of Risk and Insurance* 72, 253–300.

{% Give survey of risk measures, and how those can be modeled through RDU. %}

Dhaene, Jan, Steven Vanduffel, Marc J. Goovaerts, Rob Kaas, & David Vyncke (2004) “Solvency Capital, Risk Measures and Comonotonicity: A Review,” Research Report OR 0416, Dept. of Applied Economics, K.U. Leuven.

{% %}

Dhami, Sanjit (2016) “*Foundations of Behavioral Economic Analysis*.” Oxford University Press, Oxford.

{% Given small fees, under EU it is optimal to evade tax. Prospect theory can explain that people still pay tax. %}

Dhami, Sanjit & Ali al-Nowaihi (2007) “Why Do People Pay Taxes,” *Journal of Economic Behavior and Organization* 64, 171–192.

{% Find that a model with prospect theory for taxpayers and EU for government best explains phenomena related to tax. Nice for the view that PT is descriptive and EU is normative. %}

Dhami, Sanjit & Ali al-Nowaihi (2010) “Optimal Taxation in the Presence of Tax Evasion: Expected Utility versus Prospect Theory,” *Journal of Economic Behavior and Organization* 75, 313–337.

{% Becker argued, based on EU, that punishment of crimes works best if the the punishment is maximized while probability of punishment may get very small. The authors show similar things under RDU and PT, where the overestimation of small probabilities will add. %}

Dhami, Sanjit & Ali al-Nowaihi (2012) "An Extension of the Becker Proposition to Non-Expected Utility Theory," *Mathematical Social Sciences* 65, 10–20.

{% A cardinal version of Arrow giving utilitarianism. %}

Dhillon, Amrita & Jean-François Mertens (1999) "Relative Utilitarianism," *Econometrica* 67, 471–498.

{% Find that risk attitudes of Ethiopia farmers are strongly impacted by rainfall. %}

Di Falco, Salvatore & Ferdinand M. Vieider (2022) "Environmental Adaptation of Risk Preferences," *Economic Journal* 132, 2737–2766. https://doi.org/10.1093/ej/ueac030

{% Subjects trade state-contingent payments in an experimental market. They get a prize conditional on an event, either a chance event with known probability 0.5, or an event about temperature exceeding some value in some city. The temperature was always the median, although subjects did not know this. In one treatment, subjects indicated about which cities they were knowledgeable, in the other not. If subjects understood arbitrage, all market probabilities would satisfy the laws of probability.

Subjects may pay more for gambling on an ambiguous event than on a chance event, not because they are ambiguity seeking, but because they consider the ambiguous event more likely, especially if they are knowledgeable. Hence, just testing that is not good. The author, properly, always takes the price for a gamble on an event PLUS the price on its complement, thus avoiding likelihood effects as mentioned and truly testing ambiguity attitudes.

Subjects paid most for ambiguous events they were knowledgeable about (**ambiguity seeking**), more than for random events, and paid more for the latter than for ambiguous events they were not knowledgeable about. This confirms the competence effect of Heath & Tversky (1991). As explained by the author, it also implies arbitrage opportunities. %}

Di Mauro, Carmela (2008) "Uncertainty Aversion vs. Competence: An Experimental Market Study," *Theory and Decision* 64, 301–331.

{% In Voluntary Contribution Mechanism games, ambiguity aversion may be an explanation for deviations from classical models rather than other-regarding preferences. %}

Di Mauro, Carmela & Massimo Finocchiaro Castro (2011) "Kindness, Confusion, or … Ambiguity?," *Experimental Economics* 14, 611–633.

{% all hypothetical. N = 84.

second-order probabilities to model ambiguity

Table 6: to some extent **ambiguity seeking for losses** (because anchoring and adjustment model, which is **inverse S**, does by far the best)

reflection at individual level for ambiguity: only losses so does not consider it. %}

Di Mauro, Camela & Anna Maffioletti (1996) "An Experimental Investigation of the Impact of Ambiguity on the Valuation of Self-Insurance and Self-Protection," *Journal of Risk and Uncertainty* 13, 53–71.

{% **losses from prior endowment mechanism**: Subjects receive £10 as prior endowment, and then are faced with a risk of losing these £10 again, and can "insure" against it. This term insure is NOT used in the instructions for the subjects. It is described to them as "reduce this potential loss to zero." In one treatment they receive probabilities of loss, in second it is said that an expert has guessed a probability, in a third an expert has expressed an interval of probabilities, and in a fourth ("SOP") the probability is mean of second-order probability distribution. Difficulty with second treatment may be that there is no full control of belief, and a regression to the mean (0.5) can be expected because of absence of control for beliefs, and not because of ambiguity attitude, in the same way as this occurs in studies by Einhorn & Hogarth.

They interpret the second-order probabilities treatment as more probabilistic information and less ambiguity than the expert-judgment treatment, but find no significant differences in the data (though they discuss nonsignificant trends).

ambiguity seeking for losses: find this for high probabilities

ambiguity seeking for unlikely: they find the reflected effect; i.e., ambiguity aversion for unlikely losses.

Find ambiguity neutrality for intermediate probabilities (0.20 to 0.50).

reflection at individual level for ambiguity: only losses so does not consider it. %}

Di Mauro, Camela & Anna Maffioletti (2001) "The Valuation of Insurance under Uncertainty: Does Information about Probability Matter?," *Geneva Papers on Risk and Insurance Theory* 26, 195–224.

{% **ambiguity seeking for losses**:

Study ambiguity attitudes for gains and losses (comparing gambles with known probabilities to those with unknown). Ambiguity means second-order distributions. Use WTP questions. For losses they have, in fact, regular CE (certainty equivalent) questions and there their findings agree with those in the literature; i.e., with ambiguity seeking for events of moderate and high likelihood.

For gains, the WTP questions mean that, after aggregation of the gamble obtained and the price paid, it is a gamble with a gain and loss, so, loss aversion comes in.

Real incentives: by means of auctions among 8 subjects each time.

reflection at individual level for ambiguity: only losses or mixed (that is what WTP for gains is) so does not consider it.

correlation risk & ambiguity attitude: Table 6: no relation. %}

Di Mauro, Camela & Anna Maffioletti (2004) "Attitudes to risk and Attitudes to Uncertainty: Experimental Evidence," *Applied Economics* 36, 357–372.

{% Compare bidding behavior and prices in market-like settings to valuations obtained from individual pricing tasks. Repetitions of the market experience tends to improve SEU. (**real incentives/hypothetical choice**) Presence or absence of financial incentives does not matter.

second-order probabilities to model ambiguity: ambiguity is generated through second-order probabilities.

It is not easy to derive aspects of individual risk and uncertainty attitudes from the findings of this paper. First, subjects get 8 (or 8 times 4?) repetitions of gambles and are paid the sum of the separate gambles, so, it is not single choice

but repeated and integrated choice. Second, the bidding and market environment can distort. Third, for the real incentives experiments, subjects receive a prior payment so that in total they never really lose and, therefore, the part of the subjects who integrate the payments and don't do isolation do not really perceive losses. (The third argument does not hold for the hypothetical payment subjects.)
The real incentives were 1% of the nominal amounts. %}
Di Mauro, Camela & Anna Maffioletti (2000) "Reaction to Uncertainty and Market Mechanisms: Experimental Evidence," Dept. of Economics, University of Torino.

{% Show how direct introspective measurements of happiness are affected by macro-economic phenomena. %}
Di Tella, Rafael, Robert J. MacCulloch, & Andrew J. Oswald (2004) "The Macroeconomics of Happiness," *Review of Economics and Statistics* 85, 809–827.

{% Develops a decision model for the Harsanyi/Mertens-Zamir hierarchies of beliefs over types. %}
di Tillio, Alfredo (2008) "Subjective Expected Utility in Games," *Theoretical Economics* 3, 287–323.

{% How counterfactuals are construed and justified. Omniscientist does not benefit from considering counterfactuals. %}
Di Tillio, Alfredo, Itzhak Gilboa, & Larry Samuelson (2013) "The Predictive Role of Counterfactuals," *Theory and Decision* 74, 167–182.

{% Seller can benefit from ambiguous mechanism if buyer is ambiguity averse. %}
Di Tillio, Alfredo, Nenad Kos, & Matthias Messner (2017) "The Design of Ambiguous Mechanisms," *Review of Economic Studies* 14, 237–276.

{% Show that people who are more subject to decision biases more often refuse flu vaccin. To the extent that the latter is irrational [sic] biases then correspond with bigger irrationality in real-life decisions. %}

DiBonaventura, Marco daCosta & Gretchen B. Chapman (2008) "Do Decision Biases Predict Bad Decisions? Omission Bias, Naturalness Bias, and Influenza Vaccination," *Medical Decision Making* 28, 532–539.

{% **three-doors problem** %}
Diaconis, Persi (1978) Review of Shafer (1976) *Journal of the American Statistical Association* 73, 677–678.

{% Discuss de Finetti's exchangeability theorem and give recent references on it. %}
Diaconis, Persi & David A. Freedman (1990) "Cauchy's Equation and de Finetti's Theorem," *Scandinavian Journal of Statistics* 17, 235–250.

{% Explain bootstrep. %}
Diaconis, Persi & Bradley Efron (1982) "Computer-Intensive Methods in Statistics," *Scientific American* 248, May, 96–108.

{% **updating: discussing conditional probability and/or updating** %}
Diaconis, Persi & Sandy L. (1982) "Updating Subjective Probability," *Journal of the American Statistical Association* 77, 822–830.

{% **Kirsten&I**: assumes bounded utility, infinitely many timepoints as in Koopmans (1960), and shows that continuities imply ultimate impatience. And that his versions of continuity preclude symmetry (such as under zero discounting) of the preference relation. %}
Diamond, Peter A. (1965) "The Evaluation of Infinite Utility Streams," *Econometrica* 33, 170–177.

{%

	H	T			H	T
A1	1	0		A1	1	1
			>			
A2	0	1		A2	0	0

Assume a fair coin toss, giving heads (H) or tails (T). There are two agents, A1 and A2, in the society. The two matrices give two risky welfare allocations. Diamond argues for the preference indicated based on fairness. That this means that society should violate the sure-thing principle because the process matters. He uses this to criticize Harsanyi (1955). %}

Diamond, Peter A. (1967) "Cardinal Welfare, Individual Ethics, and Interpersonal Comparison of Utility: Comment," *Journal of Political Economy* 75, 765–766. https://doi.org/10.1086/259353

{% Seems to claim that a major contribution of "behavioral economics is the identification of circumstances where people make mistakes." %}

Diamond, Peter A. (2008) "Behavioral Economics," *Journal of Public Economics* 92, 1858–1862.

{% %}

Diamond, Peter A. & Joseph E. Stiglitz (1974) "Increases in Risk and in Risk Aversion," *Journal of Economic Theory* 8, 337–360.

{% Analyze Hume's views on utility, which are Benthamite, and on "beliefs" that, as the authors argue, captures some sort of psychological distance (reminding me of Baucells & Heukamp, 2012) that can as much concern time as probability.

just noticeable difference: Hume wrote quite some on this. %}

Diaye, Marc-Arthur & André Lapidus (2012) "Pleasure and Belief in Hume's Decision Process," *European Journal of the History of Economic Thought* 19, 355–384.

{% **tradeoff method**: is used in axiomatizations;

nonconstant discount = nonlinear time perception: central theme in the paper.

The paper describes ways to transform discounting into probability weighting, which the authors call probability discounting. It is used in rank-dependent utility. It chooses a family of discounting functions, derives the corresponding probability weighting functions, and links there respective properties. %}

Diaye, Marc-Arthur, André Lapidus, & Christian Schmidt (2024 "From Decision in Risk to Decision in Time (and Return)," *Theoretical Economics Letters*14, 2036–2065.

https://doi.org/10.4236/tel.2024.145101

{% Seems to write: “Reality is that which, when you stop believing in it, doesn’t go away.” %}
Dick, Philip K. (1981) “*VALIS*.” Bantam Books, New York.

{% N = 9 subjects. Real incentives: Random prize mechanism, but with two choices paid out which may have generated some income effect. Data are from the same experiment as their Management Science 2003 paper.

risk averse for gains, risk seeking for losses: They find that, with much risk aversion for gains and close to risk neutral for losses. In choice situations where one of the two options is riskless, brain activities and response times are different than if both options are risky. The latter finding is repeatedly interpreted by the authors as showing that “choice behavior alone [they mean whether it is going for lowest variance (called risk averse) to highest variance (called risk seeking)] does not reveal completely how choices are made” (p. 3536), and as possibly informative on policy decisions and on how social institutional forms (regarding risky situations) have evolved (p. 3541). They interpret context-dependence not as it is commonly done in the literature, where preferences and utilities over IDENTICAL choice options are different because of different contexts (= available choice options), but they interpret it as changes from biggest-variance to smallest-variance choices when the choice options are different. %}
Dickhaut, John W., Kevin McCabe, Jennifer C. Nagode, Aldo Rustichini, Kip Smith, & José V. Pardo (2003) “The Impact of the Certainty Context on the Process of Choice,” *Proceedings of the National Academy of Sciences* 100, 3536–3541.

{% From the abstract: “The model predicts that the further two stimuli are from each other in utility space, the shorter the reaction time will be, fewer errors in choice will be made, and less neural activation will be required to make the choice.” %}
Dickhaut, John, Vernon Smith, Baohua Xin, & Aldo Rustichini (2013) “Human Economic Choice as Costly Information Processing,” *Journal of Economic Behavior and Organization* 94, 206–221.

{% Seems to be experimental counterpart to Köbberling & Peters (2003). %}

Dickinson, David L. (2009) “The Effects of Beliefs versus Risk Attitude on Batrgaining Outcomes,” *Theory and Decision* 66, 69–101.

{% %}
Diecidue, Enrico (2001) “Nonexpected Utility and Coherence,” Ph.D. dissertation, CentER, Tilburg University, the Netherlands.

{% %}
Diecidue, Enrico (2006) “Deriving Harsanyi’s Utilitarianism from De Finetti’ Book-Making Argument,” *Theory and Decision* 61, 363–371.

{% Formalize support theory with axioms. Probably first to give preference axioms for support theory.

There is formally a set of states of nature, and a set of hypotheses, where each hypothesis corresponds with an event but different hypotheses may correspond with the same event. They consider extended gambles, being gambles with outcomes depending on hypotheses. They use an affine bookmaking argument corresponding with multiple priors, where the different priors relate to the nonextensionality. %}
Diecidue, Enrico & Dolchai La-Ornual (2009) “Reconciling Support Theory and the Book-Making Principle,” *Journal of Risk and Uncertainty* 38, 173–190.

{% The authors carefully test the aspiration level theory introduced by two of them in the well-known Diecidue & van de Ven (2008). They do not find any support at all. I admire their decision to just publish this negative finding. Prospect theory can explain their findings. %}
Diecidue, Enrico, Moshe Levy, & Jeroen van de Ven (2015) “No Aspiration to Win? An Experimental Test of the Aspiration Level Model,” *Journal of Risk and Uncertainty* 51, 245–266.

{% **Dutch book**. %}
Diecidue, Enrico & Fabio Maccheroni (2003) “Coherence without Additivity,” *Journal of Mathematical Psychology* 47, 166–170.

{% **utility of gambling**

Pp. 248 discusses **restrictiveness of monotonicity/weak separability %}**

Diecidue, Enrico, Ulrich Schmidt, & Peter P. Wakker (2004) “The Utility of Gambling Reconsidered,” *Journal of Risk and Uncertainty* 29, 241–259.

https://doi.org/10.1023/B:RISK.0000046145.25793.37

Direct link to paper

Link to comments

Link does not work for some computers. Then can:

go to Papers and comments; go to paper 04.1 there; see comments there.)

{% The authors give an appealing and very efficient preference foundation of RDU with: (a) Power weighting; (b) exponential weighting; (c) **inverse S** weighting with a power function cp^a up to some reflection-point probability t, and a different dual power function $(1 - dw(1-p)^b)$ thereafter.

The result is efficient because, first, it only uses the richness present in the probability scale anyhow, and no richness of outcomes. Second, besides the axiom to characterize the particular shape of w (such as $P \geq Q \Rightarrow \alpha P + (1-\alpha)0 \geq \alpha Q + (1-\alpha)0$ to have power-w) the authors only use a general rank-dependent additive separability condition, and nothing extra to separate probability weighting from utility. The latter comes free of charge, so, to say.

The result is appealing because all preference conditions used are direct weakenings of vNM independence, with the power weighting axiom directly related to the common ratio effect and the exponential weighting axiom directly related to the common consequence effect.

So, this paper is exemplary both regarding the technical richness conditions and regarding the intuitive conditions! %}

Diecidue, Enrico, Ulrich Schmidt, & Horst Zank (2009) “Parametric Weighting Functions,” *Journal of Economic Theory* 144, 1102–1118.

{% **tradeoff method**: Regret theory gives up transitivity. It is hard to imagine what optimization then means, and what a utility function could mean. This may explain why measuring or axiomatizing it is hard. Mainly Fishburn worked on axiomatizations with his skew-symmetric models. Bleichrodt, Cillo, & Diecidue (2010) showed that the tradeoff method can be used to still measure the theory.

This paper shows that it can give an axiomatization of the most popular special case with nonlinearly transformed utility differences. D-transitivity generalizes transitivity by imposing it only whenever one of the antecedent preferences is by dominance. The proof heavily uses a nontransitive state-dependent utility axiomatization by Fishburn (1990). The acknowledgement makes clear that Horst Zank contributed much. %}

Diecidue, Enrico & Jeeva Somasundaram (2017) "Regret Theory: A New Foundation," *Journal of Economic Theory* 172, 88–119.

{% Payne (2005) and others have shown that people are especially sensitive to the probability of a lottery giving strictly positive outcomes, and giving strictly negative outcomes. This paper formalizes the idea, adding only that deviation to EU. Mathematically, though not psychologically, this amounts to the same as utility being discontinuous at 0. %}

Diecidue, Enrico, & Jeroen van de Ven (2008) "Aspiration level, Probability of Success and Failure, and Expected Utility," *International Economic Review* 49, 683–700.

{% **inverse S** %}

Diecidue, Enrico & Peter P. Wakker (2001) "On the Intuition of Rank-Dependent Utility," *Journal of Risk and Uncertainty* 23, 281–298.
https://doi.org/10.1023/A:1011877808366
Direct link to paper

{% **Dutch book** %}

Diecidue, Enrico & Peter P. Wakker (2002) "Dutch Books: Avoiding Strategic and Dynamic Complications, and a Comonotonic Extension," *Mathematical Social Sciences* 43, 135–149.
https://doi.org/10.1016/S0165-4896(01)00084-1
Direct link to paper

{% **violation of certainty effect**: p. 195 penultimate para %}

Diecidue, Enrico, Peter P. Wakker, & Marcel Zeelenberg (2007) "Eliciting Decision Weights by Adapting de Finetti's Betting-Odds Method to Prospect Theory," *Journal of Risk and Uncertainty* 34, 179–199.
https://doi.org/10.1007/s11166-007-9011-z
Direct link to paper

{% Proposes and axiomatizes an original ambiguity model. Consider act $(E_1:x_1,\ldots,E_n:x_n)$,with $(E_1,\ldots,E_n)$ a partition of the universal event and the x_js outcomes. The act is evaluated by SL expected utility (the abbreviation SL I did not see explained)

$$\sum_{i=1}^{n}\sum_{j=1}^{n}u(x_i,x_j)P(E_i,E_j)$$

where $P(E_i,E_j)$ is something like: the subjective probability of what is probably event E_i but might also be event E_j, and $u(x_i,x_j)$ is something like: the subjective utility of what is probably outcome x_i but might also be outcome x_j.

There is a sigma-algebra of unambiguous events E, which I guess have $P(E,F) = 0$ for all $F \subset E^c$ and $P(E,E) = P(E)$ is a regular probability measure, with $u(x,x) = u(x)$ regular utility. These events are, I guess, characterized by satisfying the sure-thing principle, i.e., being separeable, and are, I guess, called S events. There is also a sigma-algebra of completely ambiguous events, sort of complete ignorance, probably similar to Gul & Pesendorfer's diffuse events E, for which $P(E_i,E_j) = P(E_i) \times P(E_j)$. They are defined as L events through Definition 2, entailing in a way that they are orthogonal to the ambiguous events, so that acts measurable with respect to one can serve as outcomes for the other, in quasi two-stage. The author interprets interactions $P(E_i,E_j)$ as ambiguity (perception), and $u(x_i,x_j)$ as ambiguity perception. The total sigma-algebra is the one generated by the other two.

I have the impression that the disappointment model by Delquié & Cillo (2006) is a special case of the model of this paper. %}

Diedrich, Ralf (2024) "Combining Savage and Laplace: A New Approach to Ambiguity," *Theory and Decision* 97, 423–453.
https://doi.org/10.1007/s11238-024-09980-0

{% %}

Diener, Ed, & Robert Biswas-Diener (2008) "*Rethinking Happiness: The Science of Psychological Wealth*." Blackwell Publishing, Malden, MA.

{% %}
Diener, Ed, Eunkook M. Suh, Richard E. Lucas, & Heidi L. Smith (1999) "Subjective Well-Being: Three Decades of Progress," *Psychological Bulletin* 125, 276–303.

{% **foundations of statistics** %}
Dienes, Zoltan (2011) "Bayesian versus Orthodox Statistics: Which Side Are You on?," *Perspectives on Psychological Science* 6, 274–290.
https://doi.org/10.1177/1745691611406920

{% **foundations of statistics**; seems to argue in favor of using Bayesian factors %}
Dienes, Zoltan (2014) "Using Bayes to Get the Most out of Nonsignificant Results," *Frontiers in Psychology* 5, Article ID 781.

{% The paper analyzes the common ratio effect. Unfortunately, what the authors call common ration is not so, but the authors add uncommon things. It is in Definition 2, p. 4. The new condition of his paper, called indistinguishability of small probabilities ($\lim_{p \to 0} w(\Delta p)/w(p) = 1$ for all $0 < \Delta < 1$), only comes about because of the authors' uncommon things. Next follow details.

First, the authors' definition restricts attention to two lotteries of the same expected value (Δp: z) (receive outcome z with probability Δp, and outcome 0 otherwise) versus (p: Δz) (where $0 < p < 1$, $0 < \Delta < 1$), where p varies. Hence, a preference reversal must always combine risk aversion with risk seeking. Second, they require that there is only one preference reversal. A difficulty is that the definition is not clear on its quantifiers. Is it for every such pair of lotteries? Is it supposed to happen for EVERY possible utility function? Proposition 1 gives a formal result. As it turns out there, for each fixed lottery pair they want the preference reversal FOR EVERY UTILITY FUNCTION. It is only this restrictive and unusual assumption that implies the new condition of his paper, indistinguishability of small probabilities.

P. 1 2nd column: The preference condition of Prelec & Loewenstein (1991) is

equivalent to the other definitions as soon as utility is regular (strictly increasing and continuous). Contrary to what the authors claim here and repeat later, it does NOT depend on utility beyond it being regular.

The discussion on p.2 2nd column last paras, and several other places, not only has the problem that the authors are restricting attention to lotteries of the same expected value, but also that on the domain considered (one nonzero outcome), a joint power of probability weighting and utility is in general unidentifiable. It becomes identifiable only if one adds further assumptions such as specifying utility. In this paper a restriction on the transformations that can be considered comes from the assumption that utility is concave (for gains). Yet this leaves too much flexibility to speculate meaningfully on convexity/concavity or overweighting/underweighting of the probability weighting function. %}

Dierkes, Maik & Vulnet Sejdiu (2019) "Indistinguishability of Small Probabilities, Subproportionality, and the Common Ratio Effect," *Journal of Mathematical Psychology* 93, Article Number 102283.

{% Unfortunately, what the authors call Allais paradox is not so, but is the common ratio effect. The Allais paradox concerns only the case where one probability is 1, so that the certainty effect is involved. The common ratio paradox can also apply to small probabilities near 0, making them be overweighted much, which increases rather than decreases the value of the St. Petersburg paradox. The authors here use a part of the common ratio effect that is NOT the Allais paradox.

Btw, whether empirically there is risk seeking or risk aversion for truncated versions of the St. Petersburg paradox is not so clear. Tversky & Bar-Hillel (1983) predicted risk seeking. %}

Dierkes, Maik & Vulnet Sejdiu (2019) "St. Petersburg Paradox vs. Allais Paradox: How CPT is torn between the two most prominent Paradoxes in Decision Theory," working paper.

{% If all experts have subjective probability 0.70, should aggregation also be 0.70? Probably yes if something like fair group decision, but less so if purpose is information aggregation. %}

Dietrich, Franz (2010) "Bayesian Group Belief," *Social Choice and Welfare* 35, 595–626.

{% A scoring rule for judgment aggregation. %}

Dietrich, Franz (2014) "Scoring Rules for Judgment Aggregation," *Social Choice and Welfare* 42, 873–911.

{% %}

Dietrich, Franz (2015) "Aggregation Theory and the Relevance of Some Issues to Others," *Journal of Economic Theory 160*, 463–493.
http://dx.doi.org/10.1016/j.jet.2015.03.0120022-0531

{% By, unlike this paper, using mother sets (basic starting sets from which everything comes), I present a simplified version of this paper's model: Assume a Savagean "mother structure" of a mother state space S and mother outcome set X. T is a set of contexts. For every context t, a structure called a Savage Structure S_t, X_t is given where S_t, X_t partition $\mathbb{S}_t \subset S$ and $\mathbb{X}_t \subset X$, respectively. An act maps S_t to X_t. An element $x \in X_t$, so $x \subset X$, is a set of outcomes that the subject cannot distinguish, so, blurs, and $s \in S_t$ is similar. It reflects limited awareness. For each Savage structure an SEU model is given.

Consistency conditions between Savage structures are imposed. If U denotes a "mother utility" on X, then $x \subset X$ may have as utility the minimum of U, or maximum, or something else, but if different contexts have overlaps of outcomes then there their utility functions are affinely related. Probabilities over different contexts are assumed to be consistent in having the same event-probability-ratios where-ever there is overlap, as resulting from Bayesian conditioning and so on. St and $\mathbb{X}_t$ are called objective states and outcomes encompassed in context t, respectively, and S_t and X_t are subjective.

The paper does not start from an underlying mother structure, but starts from the various Savage structures. Then ensuring consistencies such as handling states of nature appearing in different contexts, (partially) overlapping, and giving no violations of set-monotonicity of probability for instance, is more complex to handle.

Although the paper assumes that every S_t and X_t are finite, it also assumes that each such structure can be extended to an infinite structure that maintains all axioms and satisfies Savage's P6 to the required degree, and in this sense still assumes infinitely many Savage structures, in Axiom 6** on p. 19. Axiom 6 on p. 20 is similar. The paper descibes this on pp. 18-19:

"Just as Savage's 6th postulate, Axiom 6* is very demanding. It forces the agent to conceive plenty of small events, ultimately forcing all state spaces St to be infinite (assuming Axiom5 for non-triviality). I shall thus use a cognitively less demanding Archimedean axiom, which permits all state spaces S_t to be finite. To avoid 'state-space explosion', it allows the events A_1, ..., A_n to be *not yet* conceived in context t: they are conceived in *some* possibly different context t´. So the agent can presently have limited state awareness, as long as states are refinable by moving to a new context/awareness. The slogan is: '*refinable* rather than (already) *refined* states'. To refine states, it suffices to incorporate new contingencies into states until a sufficiently fine partition exists;"

The paper also considers structures with partially objective states, and then assumes those infinitely many. See Remark 20, p. 26. The agent is stable in preferences and beliefs for objective levels of description, but instable for subjective levels.

The paper cites Ahn & Ergin (2010) for a related partition-dependent model. Such models were also used by Luce, unknown to Ahn & Ergin and this author; see my comments to the Ahn & Argin paper. %}

Dietrich, Franz (2018) "Savage's Theorem under Changing Awareness," *Journal of Economic Theory* 176, 1–54.

{% Combines values linearly and beliefs geometrically to get an aggregation that is both statically and dynamically desirable. %}

Dietrich, Franz (2021) "Fully Bayesian Aggregation," *Journal of Economic Theory* 194, 105255.
https://doi.org/10.1016/j.jet.2021.105255

{% **risky utility u = transform of strength of preference v**: this paper revisits the old idea of decision analysis of the 1980s and 1990s, giving a new turn to it. The old idea was that risk attitude should be more than intrinsic ("riskless") utility, and therefore the risky vNM utility function should transform the nonrisky one, often called value function, nonlinearly. In my paper Wakker (1994), I argued that probability weighting of prospect theory (and also loss aversion) can be used to let risk attitudes have properties beyond riskless marginal utility, so that it was

no more needed to transform riskless utility. This paper argues, and I agree, that Wakker's proposal means deviating from expected utility which means (I agree) that it cannot be done normatively. My position has always been to let cardinal riskless utility be equal to cardinal risky utility, as a normative position. But one can see that differently of course, and this paper does so. It then develops theory for it. Truly reviving the old idea in the bold keyword above. %}

Dietrich, Franz (2025) "Welfare vs. Utility," working paper.

{% If judgment aggregation is relaxed by allowing for incomplete judgments (so as to escape from the dictator result), only an oligarchy result follows. %}

Dietrich, Franz & Christian List (2008) "Judgment Aggregation without Full Rationality," *Social Choice and Welfare* 31, 15–39.

{% **paternalism/Humean-view-of-preference**:
Propose a theory with weighting arguments to underly choice making, giving reasons why subjective parameters such as utility are as they are. The primary purpose is positive, although there are also implications for normative choice. The opening para equates rational-choice-in-general (which can include intertemporal choice) with expected utility maximization. %}

Dietrich, Franz & Christian List (2013) "A Reason-Based Theory of Rational Choice," *Nous* 47, 104–134.

{% %}

Dietrich, Franz & Christian List (2013) "Reasons for (Prior) Belief in Bayesian Epistemology," *Synthese* 190, 787–808.

{% %}

Dietrich, Franz & Christian List (2013) "Propositionwise Judgment Aggregation: The General Case," *Social Choice and Welfare* 40, 1067–1095.

{% How preferences come into existence and can develop depending on properties of the alternatives, with a role for perception and formal versus substantive concepts of rationality. (**coherentism**) %}

Dietrich, Franz & Christian List (2013) "Where Do Preferences Come from," *International Journal of Game Theory* 42, 613–637.

{% Argue against Gul & Pesendorfer's mindless economy. The authors favor, as I do, the mentalist view, where concepts as utility are treated as really existing, such as electrons. I like more the comparison with energy. (**coherentism**)

Section 3.1, nicely, puts forward the *misconception of a fixed evidence base*: The strict revealed-preference view does not realize that we cannot predict what phenomena and data we may get in the future, and that we cannot exclude the future decision-relevance of what now only is introspective data. I argue the same in my 2010 book p. 3 3rd para. This is why I disagree with Friedman (1953).

Section 8, p. 274, nicely, formulates the *supervenience thesis*: people who think that micro-levels such as molecules completely determine macro-levels. %}

Dietrich, Franz & Christian List (2016) "Mentalism versus Behaviourism in Economics: A Philosophy-of-Science Perspective," *Economics and Philosophy* 32, 249–281.

{% **R.C. Jeffrey model; updating: discussing conditional probability and/or updating**: Present a general model of belief updating that contains Bayesian updating but many generalizations most notably for Jeffrey's model. %}

Dietrich, Franz, Christian List, & Richard Bradley (2015) "Belief Revision Generalized: A Joint Characterization of Bayes's and Jeffrey's Rules," *Journal of Economic Theory* 162, 352–371.

{% P. 144: "Given that Savage is one of the all-time greats of decision theory". I think that the first half of Savage (1954) is the greatest contribution in all of decision theory.

The authors revisit Savage's violation of the sure-thing principle when first confronted with the Allais paradox, and how Savage then corrected his error, as he put it.

The authors seem to want to criticize what they call behavioral economics. P. 145: "Savage's concept of error correction is coherent, but it is not the concept that behavioural welfare economics invokes." They seem to think that behavioral economics should make people better off *in their own perception*, with which I disagree. They cite Gilboa (2010) on it, on p. 145: "a mode of behaviour is rational for a given decision maker if, when confronted with the analysis of her behaviour, the decision maker does not wish to change it", and Thaler & Sunstein (2008): "make choosers better off, as judged by themselves". I did not check T&S08 on this, but speculate that they take this as a definition of nudge or libertarian paternalis but not of behavioral economics. One can argue that Dietrich et al. take this as definition of behavioral economics. Then Savage's resolution of his sure-thing principle violation may not always work because there exist decision makers silly enough not to understand the relevant reasonings. But, again, these definitions deviate from mine.

The authors discuss the case also from the perspective of a theory by Broome with a variation by Dietrich. An individual has a set of mental states, being pairs (p,a) where p is content and a an attitude type. P. 148: Broome defines rationality as requirement that the set of mental states satisfies some conditions (which is dangerously close to the, I think silly, coherence view of rationality) and seems to think that it has nothing to say about how the mental states change. Such theories are, of course, too simplistic to capture reasoning, but the authors only use them to shed new light on rationality and behavioral economics.

P. 160: "We conclude that Savage's concepts of error and correction are very different from those that behavioural welfare economists use to identify individuals' latent preferences." This holds for the authors' definition of behavioral economics, but not for my definition.

P. 161 points out that Slovic & Tversky (1974) had too few subjects to reach significance. Humphrey & Kruse (2024) redo Slovic & Tversky (1974) and reach significance, confirming the findings. %}

Dietrich, Franz, Antonios Staras, & Robert Sugden- (2021) "Savage's Response to Allais as Broomean Reasoning," *Journal of Economic Methodology* 28, 143–164. https://doi.org/10.1080/1350178X.2020.1857424

{% I discovered this in Sep. 2011 because Nicolas Gravel sent it to me. Many theorems on EU with finitely many equally likely states. P. 358 explains how the theory of general means is related to decision making. It discusses consistency in aggregation, as used by Nagumo and the like, and as generalized associativity or substitution independence from DUR. Section 3 shows that you essentially only need it for binary decompositions of the attributes and for the overall attributes, and not for all decompositions of the attributes. This is similar to Köbberling &

Wakker (2003, p. 407 bottom), who wrote, on multisymmetry: "The preference conditions need to be imposed only on one mixing event. With the exception of Quiggin (1982), all the works mentioned imposed the preference conditions on all mixing events." K&W are somewhat more general because they have no symmetry. They did not know about Diewert's chapter.

Diewert also discusses constant absolute and relative risk aversion for these functionals, and aversion to mean-preserving spread type conditions.

End of §4 mentions that log-power and linear-exponential is "all of the nontrigonometric elementary functions of one variable."

§7 considers variable dimension, with all finite-dimensional subspaces. It points out the omission in Blackorby, Primont, & Russel (1977) of not imposing consistency across different dimensions so as to ensure the same utility function there (following Proposition 20). It points out that one gets all rational-probability prospects this way. It also tries to extend to nonrational-probability prospects by taking limits, but then from Eqs. 150-152 implicitly uses that the functional is continuous in probability (the continuity it refers to is of the EU functional, and not of the functional considered and yet to be proved to be EU).

The paper throughout gives generalizations to implicit (betweenness) functionals as studied primarily by Chew. It heavily leans on Chew & Epstein (1989), a paper that unfortunately has several mathematical problems. %}

Diewert, Walter E. (1993) "Symmetric Means and Choice under Uncertainty." *In* Walter E. Diewert & Alice O. Nakamura, Elsevier, (eds.) *Essays in Index Number Theory*, 355–441, Elsevier, Amsterdam.

{% Discovering new particle in physics requires p-value of $1/(3.5 \times 10^6)$. Reason is that apparently H_0 and H_1 were not specified well a priori. This is called the problem of multiple comparisons, or, in popular press, the look-elsewhere effect. %}

Dijkgraaf, Robert (2015) Column in NRC, December 19, 2015.

{% **intuitive versus analytical decisions**; In simple situations, conscious deliberation gives best decisions. In complex situations, unconscious thought does better.

Abstract ℓ. 2 writes that the authors use recent insights into …, so as to suggest novelty. The novelty viz-a-viz many preceding studies into analytic versus intuitive decision making seems to be that these authors put forward some explanation about unconscious, but this is speculation and other explanations as in Wilson & Schooler (1991) work as well.

P. 1005 middle column writes: "the idea that conscious deliberation is the ideal (if not always attainable) way to approach a decision forms the backbone of classic (4, 5) as well as contemporary perspectives on decision making (6,7) …" I disagree. Also decision theorists including me and many others know that in most decision situations decision theory has absolutely no help to offer. Only if very particular conditions are met (such as completeness of preferences over a rather rich set of prospects), it can be of some use. During my work in health this happened for 1 out of 1000 diseases. (Many decision theorists, unfortunately, oversell their theories by making the mistake, common in any science, to pretend that they cover everything in life.)

One of the many problems for the studies is that the evaluation of what is the best option is weak in each study. In the car studies (studies 1 and 2) the criterion taken is that the car is to be best that is best on MOST attributes (described as "normative" on p. 1006 middle column). But very obviously, different individuals weigh the attributes differently. (P. 1006 2nd column end of 1st para qualifies this as normative.) Maybe the subjects subconsciously just went by majority-attribute rule as a heuristic. In study 2 they may just have reported bigger evaluation differences because of lack of nuance. In studies 3 and 4, the outcomes of deliberate choice need not be worse, but instead there may be an error in the evaluation of the outcomes of nondeliberate choice being that people here haven't thought enough about the drawbacks of their choice so that their evaluation as given is too optimistic, and there then is more space for instance for cognitive dissonance. Also, people may think more, or less (which may depend on complexity) BECAUSE they like it less. There are too many interactions between selection criterion and dependent variable of how much they like it. Wilson & Schooler (1991) in a thorough study on the same topic, write (p. 182 2nd column penultimate para): "evaluating a stimulus on several different dimensions causes people to moderate their evaluations."

They claim, p. 1005 top of 3rd column, that scientists have investigated the pros of unconscious decisions "infrequently" and that they are going to show the opposite, suggesting novelty on this point. But there have been dozens of solid studies doing and showing it before, as the keyword **intuitive versus analytical**

decisions in this bibliography shows. To not only claim this novelty for the superficial readers, but also defend against closer readers that they do not claim this novelty and that they do credit predecessors, the next para lists a number of predecessors.

P. 1005 3rd column middle writes "Two reasons why conscious deliberation sometimes leads to poor decisions have been identified" but there are many similar biases.

P. 1006 claims: "Unconscious thought does not suffer from low capacity," citing a paper by one of the authors for this unqualified claim.

P. 1007 2nd column 3rd para is typical of psychology: for each study alone one can raise doubts, but the studies together are so many that they support the general hypothesis.

The last para suggests, optimistically and based on a "there is no reason that not" argument, that the findings of this study, studied only for consumers, will not hold for politicians, managers, and, may I add, why not for all of mankind?

Nieuwenstein et al. (2015) does a meta-analysis on the Deliberation-without-Attention Effect with a negative conclusion.

The sample sizes are small, as indicated in the corresponding figures: 18 to 22 for each of the four conditions in Study, same in Study 2, 49 for Study 3, and 27 for both conditions in Study 4. %}

Dijksterhuis, Ap, Maarten W. Bos, Loran F. Nordgren, & Rick B. van Baaren (2006) "On Making the Right Choice: The Deliberation-without-Attention Effect," *Science* 311, February 17 2006, 1005–1007.

{% Provide statistical techniques for analyzing censored risk aversion measurements. %}

Dijkstra, Nienke F.S., Henning Tiemeier, B Bernd Figner, & Patrick J.F. Groenen (2022) "A Censored Mixture Model for Modeling Risk Taking," *Psychometrika* 87, 1103–1129.

{% **proper scoring rules**; Paper discusses scoring rules that have the special purpose of best fitting only in a particular region, relating it to conditioning and censoring, and deriving properness results.

P. 217 1st column: under proper scoring rules, it may be better to deliberately not take the best statistical model if it incorporates as yet unknown parameters

and those are easier to guess approximately from a wrong model.

P. 218: the authors like logarithmic scoring rules because those have nice properties, close to likelihood ratios. %}

Diks, Cees, Valentyn Panchenko, & Dick van Dijk (2011) "Likelihood-Based Scoring Rules for Comparing Density Forecasts in Tails," *Journal of Econometrics* 163, 215–230.

{% Considers recursive expected utility. Considers preference for one-shot resolution of uncertainty (PORU) versus gradual, and other things. So, not preference for early or late, but, as written. All kinds of conditions are then equivalent to all kinds of static preference conditions. Proposition 1 shows that a kind of certainty effect, NCI, negative certainty independence; p. 1980,

$$x \sim \alpha \;\Rightarrow\; \lambda x + (1-\lambda)c \succcurlyeq \lambda\alpha + (1-\lambda)c$$

(substituting CE for sublottery is always bad) is equivalent to PORU. PORU is also equivalent to preference for perfect info (Proposition 2, p. 1984). NCI and rank dependence imply EU (Proposition 3, p. 1986). Smoothness can also imply EU (Proposition 5, p. 1989). I write more on NCI in the annotations to the paper Cerreia-Vioglio, Dillenberger, & Ortoleva (2015). %}

Dillenberger, David (2010) "Preferences for One-Shot Resolution of Uncertainty and Allais-Type Behavior," *Econometrica* 78, 1973–2004.

{% %}

Dillenberger, David, Daniel Gottlieb, & Pietro Ortoleva (2019) "Stochastic Impatience and the Separation of Time and Risk Preferences," Report, Princeton University.

{% A well-known characterization of EU for risk with continuous utility function, which has to be bounded, can through isomorfisms be used in other structures. Pity for me that this paper does not cite Spinu & Wakker (2013, JME) in the same journal.

The literature discussion in §5 is misleading. The penultimate para on p. 146 says that Fishburn (1975) "must necessarily be silent about the continuity of the vN-M utility u." However, approaches of Fishburn (1975) and Wakker (1993) need not commit to continuity and have it optional. They can very easily get it by adding a continuity axiom. The last para writes that "the above works [including Fishburn 1975] implicitly recover a growth condition on the utility function" but I do not understand this. They suggest it is growth function as in their approach but then write "growth condition" and keep it vague. %}

Dillenberger, David & R. Vijay Krishna (2014) "Expected Utility without Bounds—A Simple Proof," *Journal of Mathematical Economics* 52, 143–147.

{% Preferences over menus of acts. Arrival of info, but unobservable to researcher. Different preferences for flexibility signal different anticipations of learning. %}

Dillenberger, David, Juan Sebastián Lleras, Philipp Sadowski, & Norio Takeoka (2014) "A Theory of Subjective Learning," *Journal of Economic Theory* 153, 287–312.

{% Imagine that an agent maximizes SEU. As pointed out primarily by Karni, may be the subjective probabilities are not the tue beliefs, and U is not the true utility. There may be state-dependent utility with all utilities for states in event E multiplied by 2, and all probabilities within E divided by 2 (followed by renormalization). Default is that we choose the simplest model, being state-independent. But there can be alternative info, such as introspective, pointing at another model.

This paper does something related, but of course different. (It discusses Karni and other similar approaches in §4.3.) Assume risk aversion with concave utility U. Utility may in reality be linear. But the decision-maker has act-dependent pessimistic transformations of probability that always "happen" to give the same certainty equivalent as would result with the concave utility function. Again, introspective info could make one go for such a model.

P. 1165 considers a perfectly fitting SEU model with supposed utility U, but real utility V ≠ U. Then there can be many SEU models with V and act-dependent probabilities (optimistic or pessimistic or otherwise) that assign the same certainty equivalent to the act, and the act-dependent probability model is too general in this sense. The authors suggest on p. 1165 that one then takes the model whose probabilities minimize the Euclidean distance to the SEU probabilities.

P. 1165-1166: If one can additionally observe choices with objective probabilities and it is plausible that those give the real utility function, then one can observe that the Savage SEU utility is not the real one and that something like the model of this paper must be going on. Note here that this analysis assumes that the objective-probability events are not part of the Savage state space, and for instance are not like the ones in Machina (2004 ET).

P. 1166 footnote 9 very properly points out that source-dependent SEU can do things like Anscombe-Aumann, but totally avoid the complications of multi-stage.

Pp. 1166-1167 consider a known and unknown Ellsberg urn. For both urns SEU may hold, with ambiguity aversion captured by a more concave U for the unknown urn, as happening for Chew et al. (2008)'s source-dependent SEU, with similar things in the smooth model. As p. 1167 argues and I fully agree, the utility explanation is not plausible. The outcomes are the same in both cases, so why would utility be different? They write: "After all, the prizes are the same across both domains; it is only the probabilities that differ." (**event/outcome driven ambiguity model: event driven)** Researchers who want representations to not just represent choices, but also be psychologically plausible (homeomorph), will be open to such arguments. This paper argues that pessimistic probability weighting may be more plausible. I fully agree, and this is the basis of the source method of ambiguity that I work on. The source method leads to preferences deviating from SEU or source-dependent SEU, whereas this paper focuses on preferences that stay within SEU, or source-dependent SEU.

In my words, this paper says: "Even if a utility-driven model perfectly fits the data, then still we don't believe it." It makes this paper one of the strongest going against **coherentism**. %}

Dillenberger, David, Andrew Postlewaite, & Kareen Rozen (2017) "Optimism and Pessimism with Expected Utility," *Journal of the European Economic Association* 15, 1158–1175.

{% %}

Dillenbergery, David & Collin Raymond (2018) "Additive-Belief-Based Preferences," working paper.

{% Individuals tend to conform to choices of group members, called the consensus effect, is equivalent to strict quasi-convexity (w.r.t. probabilistic mixing) of risk preferences. Anomalies are implied. %}

Dillenberger, David & Collin Raymond (2019) "On the Consensus Effect," *Journal of Economic Theory* 183, 384–416.

{% Risk aversion depends on whether preceding resolutions of risk were favorable or unfavorable, where unfavorable outcomes enhance risk aversion. This is different than Köszegi & Rabin (2006), where only future expectations matter. It entails a violation of consequentialism (forgone-event independence) because counterfactual events (what could have happened but did not happen) matter. %}

Dillenberger, David & Kareen Rozen (2015) "History-Dependent Risk Attitude," *Journal of Economic Theory* 157, 445–477.

{% %}

Dillenberger, David & Philipp Sadowski (2012) "Ashamed to be Selfish," *Theoretical Economics* 7, 99–124.

{% Behavior is stable if a preference between two acts is not changed if we are informed of the event that they differ. It is a sort of s.th.pr. For a Bayesian expected utility maximizer, stable behavior—formulated in terms of indirectly observed contingent ranking—is a tight characterization of subjective learning via a generalized partition. %}

Dillenberger, David & Philipp Sadowski (2019) "Stable Behavior and Generalized Partition," *Economic Theory* 68, 285–302.

{% They use Segal's (1987) two-stage model of ambiguity, showing that it can accommodate Machina's (2009) examples. %}

Dillenberger, David & Uzi Segal (2015) "Recursive Ambiguity and Machina's Examples," *International Economic Review* 56, 55–61.

{% Consider two-outcome prospects, where there is a 2^{nd} order distribution over the probability of getting the best outcome. A noise decision model is proposed. The

last section of the paper points out that the model can accommodate ambiguity seeking for small likelihood gains. (**ambiguity seeking for unlikely**) %}

Dillenberger, David & Uzi Segal (2017) "Skewed Noise," *Journal of Economic Theory* 169, 344–364.

{% %}

Dimitri, Nicola (1995) "On the Notion of Independence between Events with Non-Additive Probabilities."

{% **dynamic consistency** %}

Dimitri, Nicola (2009) "Dynamic Consistency in Extensive Form Decision Problems," *Theory and Decision* 66, 345–354.

{% %}

Dimmock, Stephen G. & Roy Kouwenberg (2010) "Loss-Aversion and Household Portfolio Choice," *Journal of Empirical Finance* 17, 441–459.

{% After their paper in the Journal of Financial Economics, this is the second paper following up on Dimmock, Kouwenberg, & Wakker (2016 MS; DKW). This paper has considerably more content than the JFE paper. It uses the same data set as the JFE paper, with same arguments of why not controlled for suspicion and so on. But now it also uses the likely (p = 0.9) and unlikely (p = 0.1) urns. Further, for the fifty-fifty urns it also does hypothetical loss. The ambiguity aversion in these four questions will all be positively correlated. The authors explain (p. 222 footnote 3), and I agree, that hypothetical is better than paying from prior endowment. (**losses from prior endowment mechanism**)

ambiguity seeking for losses: they find it (p. 228 last sentence).

ambiguity seeking for unlikely: they find it.

reflection at individual level for ambiguity: ambiguity aversion for gains and losses is positively related (p. 229 penultimate sentence of first para)

The authors use the α-maxmin model to analyze things. They take an ε-contaminated set of priors. For the stimuli considered, with only two-outcome prospects, and with EU for risk, it is equivalent to the source method of

Dimmock, Kouwenberg, & Wakker (2016 MS; DKW) with a neo-additive source function, as shown by Chateauneuf, Eichberger, & Grant (2007), and as pointed out by the authors. But a restriction is that their model assumes EU for risk whereas DKW do not need that restriction. The authors propose an index δ that they interpret as perceived ambiguity, and then the α index of ambiguity aversion. As they point out in their footnote 20 (p. 231), their indexes δ, α are transformations of the a-insensitivity index a and the ambiguity aversion index b of DKW. More precisely, their perception index δ is identical to the insensitivity index a and for their aversion index α we have $\alpha = (b/\delta + 1)/2$. The linear rescaling $b/\delta \rightarrow (b/\delta + 1)/2$ is immaterial. But the division of b by δ means that their index gives ambiguity aversion per unit of perceived ambiguity δ, whereas b of DKW is an index of absolute ambiguity aversion. Which is more convenient depends on context. The important thing is that the two pairs of indexes are equivalent. This relation between the two index pairs was first pointed out at the end of §2 of the 2013 working paper version of

Baillon, Aurélien, Han Bleichrodt, Umut Keskin, Olivier L'Haridon, & Chen Li (2018) "The Effect of Learning on Ambiguity Attitudes," *Management Science* 64, 2181–2198.

As regards their findings, in the neo-additive terminology of Chateauneuf et al., their α (ambiguity aversion) is 0.56 and their δ (confidence in probability, = 1–a-insensitivity) = 0.60 (p. 221 ℓ. –5). They test a number of less interesting sets of priors but those all perform poorly.

P. 241 2nd para: ambiguity aversion is positively related to being male, old, and, strangely enough, college-educated.

P. 241 3rd para: confirms the Fox-Tversky finding that ambiguity aversion is higher if the ambiguous option is presented after the risky one, than when before.

Ambiguity aversion is positively related to being male, old, and, p. 241 4th para: a-insensitivity (or level of perceived ambiguity) is positively related to being male, white, and, again strangely enough, college-educated (vs. high school), going against some cognitive hypotheses. (**cognitive ability related to risk/ambiguity aversion**)

correlation risk & ambiguity attitude: positive but weak (p. 222 2nd para), both for gains and losses. Correlation risk aversion and a-insensitivity: not significant (p. 222 2nd para). P. 241 last para of §4 repeats it, saying that it is plausible if perceived ambiguity is formed independently from risk preferences.

Pp. 239-240: the authors make the assumption that perceived ambiguity is the same for gains and losses, which is plausible if this is cognitive.

They assume that a-insensitivity is the same for gains and losses, citing Baillon & Bleichrodt (2015) for it. It is plausible because a-insensitivity is cognitive.

Ambiguity aversion is stronger for subjects who first get the risk aversion question, confirming the contrast effect of Fox & Tversky (1995).

P. 242 argues against universal ambiguity aversion.

reflection at individual level for ambiguity: seems that $AA_{0.5}$ and $AA_{-0.5}$ are positively correlated (0.25), going against reflection at the individual level. %}

Dimmock, Stephen G., Roy Kouwenberg, Olivia S. Mitchell, & Kim Peijnenburg (2015) "Estimating Ambiguity Preferences and Perceptions in Multiple Prior Models: Evidence from the Field," *Journal of Risk and Uncertainty* 51, 219–244. https://doi.org/10.1007/s11166-015-9227-2

{% Data set: publicly available from the RAND American Life Panel (ALP) website, as survey number 243:

https://alpdata.rand.org/

The authors were so kind to provide me with their questionnaire.

Abstract: "In this paper we test the relation between ambiguity aversion and five household portfolio choice puzzles: nonparticipation in equities, low allocations to equity, home-bias, own-company stock ownership, and portfolio under-diversification. In a representative US household survey, we measure ambiguity preferences using custom-designed questions based on Ellsberg urns. As theory predicts, ambiguity aversion is negatively associated with stock market participation, the fraction of financial assets in stocks, and foreign stock ownership, but it is positively related to own-company stock ownership. Conditional on stock ownership, ambiguity aversion is related to portfolio under-diversification, and during the financial crisis, ambiguity-averse respondents were more likely to sell stocks."

correlation risk & ambiguity attitude: find positive relation.

suspicion under ambiguity: in the end of §2, p. 563, the authors carefully explain, with good arguments, that they deliberately do not control for suspicion.

This paper is a follow-up on Dimmock, Kouwenberg, & Wakker (2016 MS; DKW hereafter). DKW used some 1935 subjects from the Dutch population of which only half were incentivized (paying €7650 in total). This study has 3258 subjects from the US that are all incentivized, paying $23,850 real incentives (!; p. 560 3rd para), and measuring way more of their financial decisions. DWK measured both ambiguity aversion and insensitivity, but this paper considers only aversion. It, thus uses only the fifty-fifty likelihoods, with the standard known and unknown Ellsberg urns. DKW used richer stimuli, also including 0.05 and 0.95 a-neutral probabilities. DKW found: Relation financial decisions with insensitivity is significant but with aversion it is not. (As possible explanation of the latter DKW suggest that their standard measurement had only considered gains, whereas for financial decisions also (ambiguity attitude for) losses is relevant.) This paper finds the opposite: Relation financial decisions with aversion is significant but with insensitivity it is not. These findings are not inconsistent! Erroneously claiming inconsistency is qualified as misinterpretation 16 in Greenland et al. (2016). The significance of aversion may be because of more subjects. Because it has rich financial data, it finds many relations, a.o. with home bias, showing that ambiguity aversion is important for finance. Ambiguity aversion is negatively related with stock market participation, fraction of financial assets in stocks, foreign stock ownership. It is positively related with homebias, own-company stock ownership, portfolio-underdiversification, and selling stocks during financial crisis. Also with being male (**gender differences in ambiguiuty attitude**), college educated (vs. high school), and young (**relation age-ambiguity attitude**).

They confirm many common things, with 52% ambiguity averse, 10% neutral, and 38% seeking.

The intro, p. 561 2nd column 3rd para, misleadingly writes that DKW would use a theory, the source method, which would differ from models used in the finance literature. However, the theory used in the present paper is identical to that in DKW, and is just an equivalent rewriting (details below). The authors further write that, hence, DKW’s predictions do not align with the theoretical predictions in the literature. This is again misleaeding as explained above, e.g. through misinterpretation 16 in Greenland et al. (2016).

Details on identity of models used: The model used by DKW (biseparable utility) is, for the stimuli considered (gambles with no more than two outcomes), equivalent to the α maxmin model that this paper uses. Because this paper satisfies the axioms of Chew & Sagi (2006, 2008) as can be seen, it is in fact a special case of the source method used by DKW (having within-source probabilistic sophistication), and therefore is not different after all. The ambiguity aversion index used in this paper is equivalent to the one used by DKW. Further, the ambiguity perception index used in the JRU follow-up paper by these authors is equivalent to the a-insensitivity index used by DKW, as the authors point out there in their footnote 20 there. This relation between the two index pairs was first pointed out at the end of §2 of the 2013 working paper version of

Baillon, Aurélien, Han Bleichrodt, Umut Keskin, Olivier L'Haridon, & Chen Li (2018) "The Effect of Learning on Ambiguity Attitudes," *Management Science* 64, 2181–2198,

not cited by the authors although they had been informed about it way beforehand. Anyway, hence the decision theory and index in this paper are not different than DKW, but are identical.

cognitive ability related to risk/ambiguity aversion: This paper relates cognitive ability with ambiguity aversion but finds no relation. It does, surprisingly, find higher ambiguity aversion among higher educated than lower educated. §2 nicely explains in words that matching probabilities are so nice to measure ambiguity attitudes because everything of risk attitude drops. %}

Dimmock, Stephen G., Roy Kouwenberg, Olivia S. Mitchell, & Kim Peijnenburg (2016) "Ambiguity Aversion and Household Portfolio Choice Puzzles: Empirical Evidence," *Journal of Financial Economics* 119, 559–577. https://doi.org/10.1016/j.jfineco.2016.01.003

{% **tradeoff method;** Comments on version of August 2018, NBES Working paper 24928, http://www.nber.org/papers/w24928.

Use representative sample from US of N = 2,072 subjects, paying them $16,020. Use tradeoff-method based choice questions to assess utility, but do not do chaining and derive theory-free risk premium index to capture concavity. Their main focus is on certainty equivalents for risky choices that are used to derive an index of inverse S, taking, in their Eq. 4,

PW88% + PW75% + PW50% − PW25% − PW12% − PW5%

as index of inverse S, where PWp% is a proportional risk premium for the certainty equivalent of a lottery giving a prize with probability p. I would have liked it if they had in some way added PW95%, possibly dropping PW50%, and I would also have liked it if they had taken the some of the six to capture optimism/pessimism.

Find extensive Inverse S (**inverse S**). It is positively related with nonparticipation, underdiversification, preference for positively-skewed equity portfolios and, strangely enough, weakly but significantly with education numerical reasoning and financial literacy (**cognitive ability related to likelihood insensitivity (= inverse S)**). They interpret the positive relation with cognitive ability and so on as evidence that it is not probability misperception but deliberate preference.

P. 3: "We find that high Inverse S is associated with large Sharpe ratio losses due to idiosyncratic risk. In particular, our results imply that a one-standard deviation higher Inverse S implies a cost to the average (median) stockholder of $2,504 ($351) per year, as for the same amount of risk the person could have had a higher expected return." This nicely makes the irrationality of inverse S very tangible!

P. 10: they properly do NOT equate risk aversion with utility curvature.

They find that utility curvature and inverse S are empirically unrelated.

The authors are enthusiastic and claim, last sentence in abstract: "We are the first to empirically link individuals' elicited probability weighting and real-world decisions under risk." %}

Dimmock, Stephen G., Roy Kouwenberg, Olivia S. Mitchell, & Kim Peijnenburg (2021) "Household Portfolio Underdiversification and Probability Weighting: Evidence from the Field," *Review of Financial Studies* 34, 4524–4563. https://doi.org/10.1093/rfs/hhaa131

{% **correlation risk & ambiguity attitude**: risk aversion is negatively related to ambiguity aversion and a-insensitivity.

Theorem 3.1 shows that matching probabilities capture ambiguity attitude while correcting for risk attitude.

testing color symmetry in Ellsberg urn: beginning of §5.1 confirms it. %}

Dimmock, Stephen G., Roy Kouwenberg, & Peter P. Wakker (2016) "Ambiguity Attitudes in a Large Representative Sample," *Management Science* 62, 1363–1380.
http://dx.doi.org/10.1287/mnsc.2015.2198
Direct link to paper

{% To resolve the Harrison (1986) problem of strategic answering for adaptive questions: Tells subjects that a preference functional will be derived from their anwers that will subsequently be used to general real choices. So, subjects have to trust the functional. Gives a theoretical derivation of incentive compatibility, and implements it in an experiment. %}
Ding, Min (2007) "An Incentive-Aligned Mechanism for Conjoint Analysis," *Journal of Marketing Research* 44, 214–223.

{% **Z&Z** %}
Dionne, Georges & Scott E. Harrington (1992, eds.) "*Foundations of Insurance Economics: Readings in Economics and Finance.*" Kluwer, Dordrecht.

{% **Z&Z**; two-period insurance where there can be renegotiation or precommitment; the efficiencies and inefficiencies of that. %}
Dionne, Georges & Neil A. Doherty (1994) "Adverse Selection, Commitment, and Renegotiation: Extension to and Evidence from Insurance Markets," *Journal of Political Economy* 102, 209–235.

{% **Z&Z** %}
Dionne, Georges & Christian Gouriéroux, & Charles Vanasse (2001) "Testing for Evidence of Adverse Selection in the Automobile Insurance Market: A Comment," *Journal of Political Economy* 109, 444–453.

{% Assume EU with differentiable utility. Assume you face a small risk that, however, is correlated with a big background risk. Then the small risk itself can have big implications as a signal of what the background risk is. So, in this sense it can give first-order risk aversion. I guess that this underlies the result of this paper. Section 6 considers RDU but, unfortunately, does bottom-up integration

rather than top-down as is nowadays (1990-2023) common. P. 4517 1st para: They equate risk aversion with concave (so, convex if top-down integration) probability weighting, which deviates from usual definitions of preference for EV over prospect although, if I could change the world and history the way I wanted, the term risk aversion would not involve any utility and would be this. %}

Dionne, Georges & Jingyuan Li (2014) "When Can Expected Utility Handle First-Order Risk Aversion?," *Journal of Economic Theory* 154, 403–422.

{% "A physical law must possess mathematical beauty" Seems that he wrote this on a blackboard when he visited the University of Moscow in 1956 and was asked to write an inscription summarizing his basic view of physics. %}

Dirac, Paul A.M. (1956)

{% Seems to have written: "It is more important to have beauty in one's equations than to have them fit an experiment." %}

Dirac, Paul A.M. (1963)

{% "Pick a flower on Earth and you move the farthest star."
"People who equate all the different kinds of human activity to money are taking too primitive a view of things." %}

Dirac, Paul A.M.

{% **probability elicitation**; with feedback etc. children are taught to express probabilities through scoring rules. %}

Dirkzwager, Arie (1996) "Testing with Personal Probabilities: 11-Year-Olds Can Correctly Estimate Their Personal Probabilities," *Educational and Psychological Measurement* 56, 957–971.

{% **probability elicitation**: using de Finetti scoring rules etc. as alternative to multiple choice. %}

Dirkzwager, Arie (2000) "A Bayesian Testing Paradigm: Multiple Evaluation, a Feasible Alternative for Multiple Choice," University of Twente.

{% %}

Dirkzwager, Arie (2001) “Consensus Measurement in Multi-Participant Conversations,” *Kybernetes* 30, 573–588.

{% Shows that adding loss aversion can better explain observed contracts of 595 CEOs in a principal-agent model than if it is done using only utility curvature. It can also explain an observed convexity of the shape of optimal contracts. %}

Dittmann, Ingolf, Ernst Maug, & Oliver Spalt (2010) “Sticks or Carrots? Optimal CEO Compensation when Managers are Loss Averse,” *Journal of Finance* 65, 2015–2050.

{% Loss aversion explains bidding behavior, and is also relevant for non-rare events. %}

Dittrich, Dennis A. Werner Güth, Martin G. Kocher, & Paul Pezanis-Christou (2012) “Loss Aversion and Learning to Bid,” *Economica* 79, 226–257.

{% ISBN 0-393-31035-3 %}

Dixit, Avinash K. & Barry J. Nalebuff (1993) “*Thinking Strategically*.” Norton, New York.

{% %}

Dixit, Avinash K. & Jörgen W. Weibull (2007) “Political Polarization,” *Proceedings of the National Academy of Sciences* 104, 7351–7356.

{% r**eal incentives/hypothetical choice, for time preferences**: seems to be on it %}

Dixon, Mark R., Nicholas M.K. Lik, Leonard Green, & Joel Myerson (2013) “Delay Discounting of Hypothetical and Real Money: The Effect of Holding Reinforcement Rate Constant,” *Journal of Applied Behavior Analysis* 46, 512–517.
https://doi.org/10.1002/jaba.42

{% **bisection** > **matching**:
Seems that they introduced bisection, called the up and down method (also known as the staircase method), in psychophysics, shortly after von Békésy (1947) who in fact used it to measure hearing. They did it so as to need fewer

measurements than other methods, which have been called limiting methods, and were already used by Fechner (1860). %}

Dixon, Wilfrid J. & Alexander M. Mood (1948) "A Method for Obtaining and Analyzing Sensitivity Data," *Journal of the American Statistical Association* 43, 109–126.

{% They use the same analysis technique as do Barberis, Mukherjee, & Wang (2016) (assume historical probability distribution of stocks and use new 1992 prospect theory to evaluate them). Cite several other studies that also did so. BMW only analyzed overall stocks and this paper considers emerging markets, and does so per country, studying differences. They find that probability weighting explains most. %}

do Nascimento Junior, Arnaldo João, Marcelo Cabus Klotzle, Luiz Eduardo T., Brandão, & Antonio Carlos Figueiredo Pinto (2021) "Prospect Theory and Narrow Framing Bias: Evidence from Emerging Markets," *Quarterly Review of Economics and Finance* 80, 90–101.

{% **biseparable utility violated;**

event/outcome driven ambiguity model: outcome driven

§III describes an experiment for the three-color Ellsberg urn. For gains the great majority of subjects is ambiguity averse, for losses about as many are ambiguity seeking as averse. So, mixed evidence on **ambiguity seeking for losses**.

second-order probabilities to model ambiguity: Models ambiguity through subjective second-order probabilities with recursive expected utility. This is very similar to the recursive (smooth) ambiguity model of KMM. But it is different. It is as follows: Imagine an act a that can give n outcomes $x_1,\ldots,x_n$. There is a random variable $\theta = (\theta_1,\ldots,\theta_n)$ reflecting a subjective first-order probability distribution over the n outcomes generated by act a. θ itself is a random variable, reflecting subjective uncertainty about the first-order probabilities. $(p_1,\ldots,p_n)$ is the first-order distribution that results by averaging out the θs. The author denotes by ψ the expected utility of a w.r.t. $(p_1,\ldots,p_n)$ but I think that it plays no particular role here. Anyway, after an outcome x_j results, the agent can update the second-order distribution of the θs using Bayes formula. He can recalculate the updated $(p_1,\ldots,p_n)_j$ here. He can then calculate the updated EU of act a under the updated $(p_1,\ldots,p_n)_j$, which we write as $EU_j(a)$. Now he uses a utility-transformation α, much like φ of KMM, and evaluates a by

$\sum_{j=1}^{n} p_j \alpha(EU_j(a))$. If α is the identity then we just get ψ, α concave gives something smaller (ambiguity aversion), and α convex gives something bigger.

One may wonder why an agent, after receiving x_j, would bother to re-evaluate the whole act a. The author argues for an ex-ante regret-like psychology. He also argues that this is just a way to capture ambiguity using tools similar to usual EU studies of risk, and that it does not need to resort to nonadditive or transformed probabilities (p. 435 2nd para and before). This he also shares with the smooth model.

The author puts reflection central, with ambiguity seeking for losses, which he can model by α being convex for losses. This is indeed where he beats non-reference dependent nonadditive models. The smooth model can also handle sign-dependence this way.

P. 424 penultimate para: his functional generates overweighting of unlikely events/outcomes (for the RDU workers: unlikely is not the same as extreme).

P. 420 2nd para writes that getting 2nd-order probabilities will be harder than getting 1st order ones, an argument also advanced by Lindley (1996). Dobbs counters that much knowledge of the 2nd order distribution is not needed for his analysis, only some general characteristics. (p. 421 top: all we need are mean values and a covariance matrix of 2nd order probabilities).

Nicely, the model is tested with an experiment on Ellsberg 3-color, both with gains and losses within subjects. Subjects can choose neutral if they like. Hence, there are $3^4 = 81$ choice patterns. 5 of those fit with the author's theory (neutral, and the four combinations of amb. av. or seeking for gains and losses; the author only allows neutral for both gains and losses, apparently).

reflection at individual level for ambiguity: The data in Table 2, p. 428, give numbers of observations for the five most interesting choice patterns. Unfortunately, there is almost no ambiguity seeking for gains in these five patters and, hence, we cannot asses reflection at the individual level. Would have been possible if more data on deviating patterns had been provided, but it isn't.

Roughly, of the ambiguity averse people for gains as many are ambiguity averse for losses as ambiguity seeking.

P. 430 2nd para points out (admits I would say when it is beyond sign dependence) that in this model ambiguity attitudes depend not only on the probabilities but also on the outcomes. The author's writing here and in general is mature. %}

Dobbs, Ian M. (1991) "A Bayesian Approach to Decision-Making under Ambiguity," *Economica* 58, 417–440.

{% **conservation of influence**: Self-aware agents must possess self-directed goals. Can virtual animals be considered situated and embodied? %}

Dobbyn, Chris & Susan Stuart (2003) "The Self as an Embedded Agent," *Minds and Machines* 13, 187–201.

{% Two-dimensional tradeoffs where one dimension is waiting time for biosurveillance info and other is value of info. %}

Doctor, Jason N., Janet G. Baseman, William B. Lober, Jac Davies, John Kobayashi, Bryant T. Karras, & Sherrilynne Fuller (2008) "Time-Tradeoff Utilities for Identifying and Evaluating a Minimum Data Set for Time-Critical Biosurveillance," *Medical Decision Making* 28, 351–358.

{% **PE higher than others**: meta-analysis of rating scale (RS) versus TTO and PE (if I remember well, they call it SG). RS and TTO were not significantly different, but PE was significantly higher if analyzed the usual (EU) way. If analyzed using prospect theory, PE is no longer different than the others. %}

Doctor, Jason N., Han Bleichrodt, & Jill H. Lin (2010) "Health Utility Bias: A Meta-Analytic Evaluation," *Medical Decision Making* 30, 58–67.

{% Subjects are risk averse w.r.t. life duration in impaired health states, suggesting concave utility under nonexpected utility. However, the risk aversion can also be explained by probability transformation, after which the null hypothesis of linear utility for life duration is no longer rejected. This is confirmed in an experiment where invariance w.r.t. unit and level of outcomes (which characterizes linear utility) is tested. %}

Doctor, Jason N., Han Bleichrodt, John M. Miyamoto, Nancy R. Temkin, & Sureyya Dikmen (2004) “A New and More Robust Test of QALYs,” *Journal of Health Econonomics* 23, 353–367.

{% Shows that constant proportional tradeoffs can simplify other aspects of axiomatizations. %}

Doctor, Jason N. & John M. Miyamoto (2003) “Deriving Quality-Adjusted Life Years (QALYs) from Constant Proportional Time Tradeoff and Risk Posture Conditions,” *Journal of Mathematical Psychology* 47, 557–567.

{% Characterize person tradeoffs evaluations, using Fishburn’s (1966) marginal independence and an additivity condition about adding unaffected people. Give a rank-dependent extension. Test some conditions and they do not fare very well. Find that probability 0.5 is some underweighted. %}

Doctor, Jason N., John Miyamoto, & Han Bleichrodt (2009) “When Are Person Tradeoffs Valid?,” *Journal of Health Economics* 28, 1018–1027.

{% The reply Peters (2020) is weak; see my comments there.
Impact factor of journal in 2020: 19.25.
Accessible 12-minutes lecture on this paper:
https://www.youtube.com/watch?v=FDvBrcytU7Q&t=52s %}

Doctor, Jason N., Peter P. Wakker, & Tong V. Wang (2020) “Economists’ Views on the Ergodicity Problem,” *Nature Physics* 16, 1168 (2020).
https://doi.org/10.1038/s41567-020-01106-x
Direct link to paper
Supplementary info

{% **foundations of probability**: Joyce (2005) argued that our beliefs should be modeled by sets of probability measures (advocates of multiple prior models in decision theory will, contrary to me, like this), being all that are compatible with the info we have. Roger Wite provided a counterargument. This paper provides a counter-counter argument. %}

Dodd, Dylan (2013) “Roger White’s Argument against Imprecise Credences,” *British Journal for the Philosophy of Science* 64, 66–77.

{% They have data from a long continuous period from Germany and the Nehterlands, where risk aversion is measured each year, not from revealed preferences but from introspective questions. They study how risk aversion depends on age. (**relation age-risk attitude**) The big challenge is of course how to correct for other factors related to historical events. The main contribution of the paper is handling this. They find that people's risk aversion increases linearly with age until age 65, after which it becomes flatter. %}

Dohmen, Thomas, Armin Falk, Bart H.H. Golsteyn, David Huffman, & Uwe Sunde (2017) "Risk Attitudes across the Life Course," *Economic Journal* 127, F95–F116.
https://doi.org/10.1111/ecoj.12322

{% **cognitive ability related to risk/ambiguity aversion** %}

Dohmen, Thomas, Armin Falk, David Huffman, & Uwe Sunde (2010) "Are Risk Aversion and Impatience Related to Cognitive Ability?," *American Economic Review* 100, 1238–1260.

{% Use a 2004 representative sample in Germany. Risk and trust attitudes are measured using purely introspective questions of the type:

"How much do you like to take risks."

Find that risk attitudes of children are associated with those of their parents. %}

Dohmen, Thomas, Armin Falk, David Huffman, & Uwe Sunde (2012) "The Intergenerational Transmission of Risk and Trust Attitudes," *Review of Economic Studies* 79, 645–677.

{% Impressive sample of 22,019 (from 11,803 families) in the 2004 wave of the Socio-economic panel (SOEP), representative of the German population (later the paper restricts this to adult Germans). In addition, 450 people, representative for the 22,019, are visited at their home and interviewed. Asked to the 22,000 people and also the 450 people, on 11-point scale (0-10), to indicate how much they were willing to take risk, (0) in general (1); car driving; (2) financial matters; (3) sports and leisure; (4) career; (5) health. Then they ask other questions about risky behavior from such domains, such as about smoking etc.

From the 450 people they also revealed an indifference of the prospect $300_{0.5}0$ by measuring the switching value for increasing sequence of sure amounts, with random incentive system paying one of every seven subjects (p. 532: Doing a 1/7 chance for every subject, rather than select one from every seven; as often, subjects could not verify this randomization. This is why I prefer selecting in class rooms one of every 7 subjects, visible for all.) (**random incentive system between-subjects**). That's an average payment of about €25 per subject. Subjects were not paid cash on the spot, but by check sent by mail. Their CEs (certainty equivalents) ranged from 0 to 190, so, did not allow for much risk seeking as the authors explain on p. 532). 87% (= 78%+9%) was risk averse (pp. 533-534) and 13% (4% + 9%) was risk seeking. The correlation between introspective general risk attitude and CE of $300_{0.5}0$ is about 0.5 (Table 2), correcting for some variables, and is significant ($p \leq 0.01$).

Relate it to demographic variables, where risk aversion is enhanced by being female (**gender differences in risk attitudes**), being old (**relation age-risk attitude**), having low education and, remarkably, being small.

They obtain natural and intuitively plausible results: The willingness-to-take risk question are all positively related to the real-incentive choice (see above, regarding the 450 subjects). The general question best correlates with the whole of the others. Domain-specific question better correlate with questions specific to their domain, e.g. health-risk willingness better correlating with smoking.

As the authors point out, the general attitude questions, in contrast to the prospect-choice questions, comprise not only risk attitude, but also risk perception and risk exposure. A person with a good job does not take career risks, not because he is risk averse, but because he has little to gain and much to lose.

P. 538, end of 2nd para, when discussing a correlation, precedes it with:

"The answer to these questions is of obvious importance from both a methodological and a practical point of view."

Positive relations found are described as "economically significant."

real incentives/hypothetical choice: p. 543 is positive about asking hypothetical questions:

"In light of these findings, the usual practice of only eliciting risk attitudes in the context of hypothetical financial lotteries would be expected to have benefits for predicting financial decisions, but be a less effective approach for providing a summary statistic of risk attitudes across other nonfinancial contexts."

P. 523 advanced another argument against real incentives: They are very expensive, and also cumbersome, to implement in large samples such as 22,000 subjects. To those subjects a hypothetical risky choice was asked, not reported but briefly discussed on p. 543, which correlates well with things. %}

Dohmen, Thomas, Armin Falk, David Huffman, Uwe Sunde, Jürgen Schupp, & Gert G. Wagner (2011) "Individual Risk Attitudes: Measurement, Determinants, and Behavioral Consequences," *Journal of the European Economic Association* 9, 522–550.
https://doi.org/10.1111/j.1542-4774.2011.01015.x

{% **cognitive ability related to risk/ambiguity aversion**: They survey the literature on risk aversion. I regret that the authors only consider risk aversion and not insensitivity (inverse S shape), from which more action can be expected regarding relations with cognitive ability. %}

Dohmen, Thomas, Armin Falk, David Huffman, & Uwe Sunde (2018) "On the Relationship between Cognitive Ability and Risk Preference," *Journal of Economic Pespectives* 32, 115–134.

{% Version of October 2020: They measure introspective indexes of optimism, willingness to take risks in everyday life, attention for good or bad outcomes, focusing on large versus small gains, focusing on large versus small losses, and simple risk aversion through three certainty equivalents (for winning probabilities 0.25, 0.50, 0.75), and examine relations between them. In a second experiment, they repeated these measurements but added an elicitation of the RDU model as in Fehr-Duda, de Gennaro, & Schubert (2006), but they do not analyze the latter much. %}

Dohmen, Thomas, Simone Quercia, & Jana Willrodt (2020) "Willingness to Take Risk: The Role of Risk Conception and Optimism?," working paper.

{% N = 348 subjects, mostly students. This paper measures risk attitudes and also a psychological scale of optimism. They measure introspective indexes of optimism, willingness to take risks in everyday life, attention for good or bad outcomes, focusing on large versus small gains, focusing on large versus small

losses, and simple risk aversion through three certainty equivalents (for winning probabilities 0.25, 0.50, 0.75), and examine relations between them. In a second experiment, they repeated these measurements but added an elicitation of the RDU model as in Fehr-Duda, de Gennaro, & Schubert (2006), but they do not analyze the latter much. The psychological optimism nicely correlates with optimistic rank-dependence of decision weights in rank-dependent utility, i.e., focusing on good or bad outcomes. This is most clearly at the end of §5.1. %}

Dohmen, Thomas, Simone Quercia, & Jana Willrodt (2023) "On the Psychology of the Relation between Optimism and Risk Taking," *Journal of Risk and Uncertainty* 67, 193–214.
https://doi.org/10.1007/s11166-023-09409-z

{% Seems that they define a bi-order between sets and that that is very close to triple cancellation etc. %}

Doignon, Jean-Paul, André Ducamp & Jean-Claude Falmagne (1984) "On Realizable Biorders and the Biorder Dimension of a Relation," *Journal of Mathematical Psychology* 28, 73–109.

{% %}

Doignon, Jean-Paul & Jean-Claude Falmagne (1974) "Difference Measurement and Simple Scalability with Restricted Solvability," *Journal of Mathematical Psychology* 11, 473–499.

{% **AHP** %}

Dolan, James G. (1990) "Can Decision Analysis Adequately Represent Clinical Problems?," *Journal of Clinical Epidemiolog* 43, 277–284.

{% **AHP**; uses example of dogbite with risk of rabies to illustrate. %}

Dolan, James G., Bernard J. Isselhardt, Joseph D. Cappuccio (1989) "The Analytic Hierarchy Process in Medical Decision Making: A Tutorial," *Medical Decision Making* 9, 40–50.

{% **questionnaire versus choice utility**: Seems that, for each EQ-5D state, a general population "tarif" value is proposed. Is recommended by the UK's National Institute for Clinical Excellence for use in cost-utility studies. %}

Dolan, Paul (1997) "Modeling Valuations for EuroQol Health States," *Medical Care* 11, 1095–1108.

{% Indicates that **HYE** s have theoretical problems but still treat it throughout as if a serious idea.

Seems to argue that time separability is the most problematic assumption of the QALY model.

risky utility u = strength of preference v (or other riskless cardinal utility, often called value): p. 1735 says that "in general" utility is an index of strength of preference.

P. 1732 suggests that for policy decisions utilities should be elicited from the general public; i.e., the unfortunate viewpoint of Gold et al. (1996). P. 1739 says that for intervention for particular group better only that group is asked.

intertemporal separability criticized: p. 1743 (quality of life depends on past and future health)

PE doesn't do well: p. 1745; (if I remember well, he calls it SG)

PE higher than TTO: §3.2.3 gives refs.

P. 1746 and p. 1748: people who experience health state, value it higher.

P. 1747: converting VAS to PE/TTO does not work well.

P. 1753-1754 pleas for more intense interviews of fewer subjects. %}

Dolan, Paul (2000) "The Measurement of Health-Related Quality of Life for Use in Resource Allocation Decisions in Health Care." *In* Antony J. Culyer & Joseph P. Newhouse (eds.) *Handbook of Health Economics*, 1723–1760, Elsevier, Amsterdam.

{% N = 1173 internet and telephone survey

TTO questions capture relevant aspects of health evaluation not captured by other measurements. %}

Dolan, Paul (2011) "Thinking about It: Thoughts about Health and Valuing QALYs," *Health Economics* 20, 1407–1416.

{% Study spillover effects of policy recommendations. “No behavior sits in a vacuum” the authors write sometimes. %}

Dolan, Paul & Matteo M. Galizzi (2015) “Like Ripples on a Pond: Behavioral Spillovers and Their Implications for Research and Policy,” *Journal of Economic Psychology* 47, 1–16.

{% %}

Dolan, Paul & Claire Gudex (1995) “Time Preference, Duration and Health State Valuations,” *Health Economics* 4, 289–299.

{% %}

Dolan, Paul, Claire Gudex, Paul Kind, & Alan Williams (1996) “The Time Trade-Off Method: Results from a General Population Study,” *Health Economics* 5, 141–154.

{% P. 1735: PE **doesn’t do well** (if I remember well, they call it SG). Find, remarkably, that PE gives lower values than TTO.

Find that ping-pong and top-down give different results. %}

Dolan, Paul, Claire Gudex, Paul Kind, & Alan Williams (1996) “Valuing Health States: A Comparison of Methods,” *Journal of Health Economics* 15, 209–231.

{% An interesting study, nicely investigating central topics of prospect theory about source preference and source sensitivity.

Both the ambiguity that is objective in the terminology of this paper, and that is subjective, combines objective (lack of) info about choice stimuli with preference conditions. What they call objective is comparing probability intervals with their midpoints (the latter as known, objective), what they call subjective is a kind of source preference (each part of a partition dominates its counterpart).

Fig 1, p. 285, is w^{inv}(W), so, it is matching probability, i.e. the belief index of my ’04 Psych. Rev. paper. P. 286 mentions that the “subjective” approach of this paper cannot elicit source sensitivity (“venture-theory relationship” in the terminology of this paper). In my Psych. Rev. paper it is shown how it can be done.

P. 287: unfortunately, in the ambiguous choice subjects cannot choose the color for which they win, so that they have extra reason to be suspicious (**suspicion under ambiguity**) and the data will have extra ambiguity aversion. P. 288, subjects get vague info about experimenter choosing proportions "arbitrarily."

P. 290, adding complementary values (for 5% and 95%, etc.) leads to a test of source preference and not of source sensitivity.

ambiguity seeking for unlikely: p. 293: ambiguity aversion for moderate and high likelihood, ambiguity neutrality for low likelihood (5% and 10%).

For the comparative ignorance hypothesis, they do not find it, with not more prudence in comparative situation than in noncomparative.

All ambiguous high likelihoods had the explicit possibility that the unknown probability was 1, increasing attractiveness, and going against ambiguity aversion and subadditivity. All ambiguous low likelihoods had the explicit possibility that the unknown probability was zero, decreasing attractiveness, and reinforcing ambiguity aversion but going against subadditivity. %}

Dolan, Paul & Martin Jones (2004) "Explaining Attitudes towards Ambiguity: An Experimental Test of the Comparative Ignorance Hypothesis," *Scottish Journal of Political Economy* 51, 281–301.
https://doi.org/10.1111/j.0036-9292.2004.00307

{% %}

Dolan, Paul & Michael W. Jones-Lee (1997) "The Time Trade-off: A Note on the Effect of Lifetime Reallocation of Consumption and Discounting," *Journal of Health Economics* 16, 731–739.

{% Plead for experienced against decision utility for health measurements in an unqualified manner;

P. 215 ℓ. –1 writes that economists use *hypothetical* choice to elicit utility!

Gold et al. (1996) argued that QALYs should be measured from the general public and not from patients, and I disagree with their arguments. The approach of this paper goes in the opposite direction, as the authors point out (p. 230 3rd para).

Paper does not very consciously distinguish between intertemporal tradeoffs, risky tradeoffs, and so on. The hedonimeter of Edgworth (p. 215 1st para) and the adaptation (§1 opening para) concern merely intertemporal aggregation. When discussing rationality on p. 215 2nd para the authors suddenly switch to risky tradeoffs, consider the assumption of expected utility to be rational (without committing to it), which merely concerns risky tradeoffs. As an aside, Tversky considered expected utility to be rational and so did the early papers by Kahneman & Tversky, but in several later papers Kahneman argued that deviations are rational. P. 217 3rd para, in the context of general utility, suddenly turns to only intertemporal aggregation through the reference to streams in "the fundamental problem with such utilities, which is that they do not accurately represent the utility streams associated with different health states."

P. 227 last line again connects to EU and risky tradeoffs, probably because they connect to rationality.

QALY overestimated when ill: P. 218 cites studies for and against it through adaptation. P. 223 top gives further references, arguing that most find that ill overestimate.

intertemporal separability criticized: p. 228 ℓ. 2-3.

P. 230: "Although many economists, as well as a consensus panel convened by the US Public Health Service (Gold et al., 1996), recommended the use of utilities from the general public, eliciting decision utilities from those currently experiencing the health state in question will avoid some of the problems associated with eliciting decision utilities from the public." %}

Dolan, Paul & Daniel Kahneman (2008) "Interpretations of Utility and Their Implications for the Valuation of Health," *Economic Journal* 118, 215–234. https://doi.org/10.1111/j.1468-0297.2007.02110.x

{% %}

Dolan, Paul & Paul Kind (1996) "Inconsistency and Health State Valuations," *Social Science and Medicine* 42, 609–615.

{% **questionnaire versus choice utility**: relate the two empirically.

P. 578 writes, and references, for one thing that QALY measurements from the general public are preferred to those from people who are in the health state: "In the United Kingdom, the National Institute for Health and Clinical Excellence (NICE) recommends that

the value of changes in patients' health related quality of life should be based on public preferences using a choice-based method . . . [and] the EQ-5D is the preferred measure of HRQL in adults." %}

Dolan, Paul & Robert Metcalfe (2012) "Valuing Health: A Brief Report on Subjective Well-Being versus Preferences," *Medical Decision Making* 32, 578–582.

{% If an unequal division of health is taken as status quo, then loss aversion may work opposite to equity preference. They find this empirically. %}

Dolan, Paul & Angela Robinson (2001) "The Measurement of Preferences over the Distribution of Benefits: The Importance of the Reference Point," *European Economic Review* 45, 1697–1709.

{% %}

Dolan, Paul & Peep Stalmeier (2003) "The Validity of Time Trade-Off Values in Calculating QALYs: Constant Proportional Time Trade-Off versus the Proportional Heuristic," *Journal of Health Economics* 22, 445–458.

{% An extremely useful job that should have been done long before, so, good that these authors did it. As usual in meta-analyses, many "dirty" decisions have to be taken. For TTO they found that usually patient-preferences (preference is often used in the meaning of utility in this field, and I will do so too) are lower, not higher as commonly thought, than population (hypothetical) preferences. For VAS and EQ-5D is was the other way around. I did not read enough to know how they did a statistical analysis, and if they took every study as just one observation or did something different. %}

Dolders, Maria G.T., Maurice P.A. Zeegers, Wim Groot, & André Ament (2006) "A Meta-Analysis Demonstrates No Significant Differences between Patient and Population Preferences," *Journal of Clinical Epidemiology* 59, 653–664.

{% %}

Dolmas, Jim (1995) "Time-Additive Representations of Preferences when Consumption Grows without Bound," *Economics Letters* 47, 317–325.

{% %}

Domar, Evsey D. & Richard A. Musgrave (1944) "Proportional Income Taxation and Risk-Taking," *Quarterly Journal of Economics* 58, 388–422.

{% Let f : [0,1] → [0,∞] be a strictly increasing or strictly decreasing function, called the generator. The Dombi modifier changes it into:

$$f^{-1}\left(f(\nu_0)\left(\frac{f(x)}{f(\nu)}\right)^{\lambda}\right).$$

Here $\vee$ and $\vee_0$ are from (0,1) and $\lambda \in \mathbb{R}$. The smaller $\lambda > 0$, the more inverse S the function is, where $\lambda > 1$ makes it S-shaped rather than inverse S-shaped If $\vee = \vee_0$, then this is the point of intersection with the diagonal, which for inverse S means that it is an index of optimism The psper shows how the well-known two-parameter CI family of Prelec follows from f = –ln, and the Einhorn-Hogarth family (called after the later Lattimore in this paper) results from f = (1–p)/p. The functions are all continuous. %}

Dombi, József & Tamás Jónás (2020) "Towards a General Class of Parametric Probability Weighting Functions," *Soft Computing* 24, 15967–15977. https://doi.org/10.1007/s00500-020-05335-3

{% Show how many concepts used in prospect theory and proper scoring rules can be obtained as special cases of constructs from continuous-valued logic, witih useful roles for the kappa function and the Dombi operator. %}

Dombi, József & Tamás Jónás (2022) An Alternative Approach to Quadratic Scoring Rules Using Continuous-Valued Logic," *Soft Computing* 27, 25–46. https://doi.org/10.1007/s00500-022-07550-6

{% Coefficients of relative risk aversion well over 100, for instance, it is β_2 = 656 in Table 1.B and β_2 = 165 in Table 3.B. %}

Dominguez, Kathryn M. & Jeffrey A. Frankel (1993) "Does Foreign-Exchange Intervention Matter? The Portfolio Effect," *American Economic Review* 83, 1356–1369.

{% In reaction to Lo (1991), shows that iterated Choquet integrals (recursive CEU that should be CEU again) can exist if and only the partitions involved do not affect each others decision weights. That is, they are separable. %}

Dominiak, Adam (2013) "Iterated Choquet Expectations - A Possibility Result," *Economics Letters* 120, 155–159.

{% Implement traditional Ellsberg both as a game against an opponent, instead of nature, with common interests (coordination game) and with opposite (zero-sum game) interests. In the former case of common interests, people are less ambiguity averse, and traditional ambiguity aversion is like the opposite interest game. %}

Dominiak, Adam & Peter Duersch (2019) "Interactive Ellsberg Task: An Experiment," *Journal of Economic Behavior and Organization* 161, 145–157.

{% **updating under ambiguity**; **dynamic consistency**: This paper defines the subtle concepts of dynamic consistency and consequentialism for uncertainty correctly. It assumes collapse independence throughout; see p. 626 footnote 1. It studies various updatings in ambiguity, for Ellsberg 3-color. Unfortunately, they do not use Ellsberg's colors, but different ones. The subjects rather dropped dynamic consistency empirically than forgone event independence (Result 1, p. 630). They confirm and extend findings of Cohen et al. (2000). %}

Dominiak, Adam, Peter Duersch, & Jean-Philippe Lefort (2012) "A Dynamic Ellsberg Urn Experiment," *Games and Economic Behavior* 75, 625–638.

{% Use belief functions to model beliefs about strategy choices of opponents. They are a mix of endogenous belief and external info. Use Jaffray & Philippe (1997). Derive equilibria. %}

Dominiak, Adam & Jürgen Eichberger (2021) "Games in Context: Equilibrium under Ambiguity for Belief Functions," *Games and Economic Behavior* 128, 125–159. https://doi.org/10.1016/j.geb.2021.04.002

{% Study agreeable trade and bet for uncertainty and rank dependence, where they allow nonconvex weighting functions, including neo-additive. %}

Dominiak, Adam, Jürgen Eichberger, & Jean-Philippe Lefort (2012) "Agreeable Trade with Optimism and Pessimism," *Mathematical Social Sciences* 64, 119–126.

{% **dynamic consistency**; **updating: nonadditive measures**; defines consequentialism, DC (dynamic consistency), with conditioning on events, and derives that they imply the sure-thing principle, but has no explicit event-invariance (**RCLA**). It is not yet clear to me how these concepts are related to Machina (1989). It considers various updatings under RDU (CEU). It takes a fixed filtration (finer and finer partitions, more and more info) and shows that dynamic principles imply that last-stage events have EU maximization. Uses Nehring-definition of unambiguous meaning that decision weight is independent of rank. %}

Dominiak, Adam & Jean-Philippe Lefort (2011) "Unambiguous Events and Dynamic Choquet Preferences," *Economic Theory* 46, 401–425.

{% Extend Aumann's agreement theorem to neo-additive weighting functions. This involves using an updating rule. (**updating: nonadditive measures**) %}

Dominiak, Adam & Jean-Philippe Lefort (2013) "Agreement Theorem for Neo-Additive Beliefs," *Economic Theory* 52, 1–13.

{% Machina (2009) published a good thought experiment violating rank dependence. Baillon, l'Haridon, & Placido (2011) had a nice follow-up showing that Machina's example violates many other ambiguity models, most of the popular ones. However, that result essentially used the Anscombe-Aumann framework and says more about this framework than about the underlying ambiguity theories. This is what this paper shows. It shows that Machina's example is way more a violation of rank dependence than of other ambiguity theories. %}

Dominiak, Adam & Jean-Philippe Lefort (2021) "Ambiguity and Probabilistic Information," *Management Science* 67, 4310–4326.
https://doi.org/10.1287/mnsc.2020.3705

{% Uncertainty aversion in Anscombe-Aumann setting suggests preference for randomization. I called this equation a historical accident in Wakker (2010,

§11.6). The authors test both usual Ellsberg ambiguity aversion and preference for randomization (as per Schmeidler's uncertainty aversion) in an Anscombe-Aumann setting. Most subjects are neutral towards randomization, even slightly more are averse to it, and preference for randomization is unrelated to Ellsberg ambiguity aversion. So, this is bad news for the Anscombe-Aumann approach, supporting the claim in my book. (**criticism of monotonicity in Anscombe-Aumann (1963) for ambiguity**) %}

Dominiak, Adam & Wendelin Schnedler (2011) "Attitudes toward Uncertainty and Randomization: An Experimental Study," *Economic Theory* 48, 289–312. https://doi.org/10.1007/s00199-011-0649-z

{% Consider Savage's (1954) model but with states of nature mapping acts to consequences. %}

Dominiak, Adam & G. Tserenjigmid (2018) "Ambiguity under Growing Awareness," working paper.

{% %}

Domotor, Zoltan (1978) "Axiomatization of Jeffrey Utilities," *Synthese* 39, 165–210.

{% **Harsanyi's aggregation**: corrects an inaccuracy in Harsanyi's (1955) proof. %}

Domotor, Zoltan (1979) "Ordered Sum and Tensor Product of Linear Utility Structures," *Theory and Decision* 11, 375–399.

{% p. 71 Eq. 12 is Yaari's (1987) rank-dependent utility with linear utility for a comonotonic set of n-outcome equally-likely outcomes, for fixed n. Eq. 13 points out that weak Lorenz quasi ordering (aversion to elementary mean-preserving risks) is equivalent to pessimism (higher weight if ranked worse). Dependence on n is next discussed but in a way that deviates from rank-dependent utility. So, the overlap with RDU is too small to really credit it for it. %}

Donaldson, David & John A. Weymark (1980) "A Single-Parameter Generalization of the Gini Indices of Inequality," *Journal of Economic Theory* 22, 67–86.

{% Aggregation over two components: time and people ("experts"). But all experts face the same income stream, so it is not a case as in Rohde, Li, &

Wakker (2025). This paper assumes that each expert does quasi-hyperbolic discounting to get present values. Then they aggregate those present values using a prudent minimum. %}

Dong-Xuan, Bach, Philippe Bich, & Bertrand Wigniolle (2025) "Prudent Aggregation of Quasi-Hyperbolic Experts," *Economic Theory* 79, 417–444. https://doi.org/10.1007/s00199-024-01575-8

{% **PT: data on probability weighting**; panel-data, many subjects, 2593!; **inverse S:** find that 56% of their 2593 subjects prefer (.01, 6000) to (.02, 3000). No real incentives possible.

decreasing ARA/increasing RRA: Find decreasing absolute risk aversion, in other words richer people are less risk averse. In general, men (**gender differences in risk attitude**; **gender differences in ambiguity attitude**), young people (**relation age-risk attitude**), rich people, and people with high education are less risk averse. %}

Donkers, A.C.D., Bertrand Melenberg, & Arthur H.O. van Soest (2001) "Estimating Risk Attitudes Using Lotteries; A Large Sample Approach," *Journal of Risk and Uncertainty* 22, 165–195. https://doi.org/10.1023/A:1011109625844

{% **updating: nonadditive measures**:, deriving mathematical results. %}

Doria, Serena (2012) "Characterization of a Coherent Upper Conditional Prevision as the Choquet Integral with Respect to Its Associated Hausdorff Outer Measure," *Annals of Operations Research* 195, 33–48.

{% How a modified version of Hintzman's memory model can account for many biases (availability etc.). The model used thee parameters. %}

Dougherty, Michael R.P., Charles F. Getty, & Eve E. Ogden (1999) "MINERVA-DM: A Memory Processes Model for Judgments of Likelihood," *Psychological Review* 106, 180–209.

{% %}

Dougherty, Michael R.P. & Jennifer Hunter (2003) "Hypothesis Generation, Probability Judgment, and Individual Differences in Working Memory Capacity," *Acta Psychologica* 113, 263–282.

{% **inverse S:** seem to show that subadditivity in probability estimates can emerge from limited working memory capacity. %}

Dougherty, Michael R.P. & Jennifer Hunter (2003) "Probability Judgment and Subadditivity: The Role of Working Memory Capacity and Constraining Retrieval," *Memory & Cognition* 31, 962–982.

{% **updating: testing Bayes' formula**: Whereas most updating studies consider single events, this paper measures entire distributions. Something that confused me is that I think that base rate neglect (paying too little attention to the prior) and conservatism (paying too little attention to new observation) are complementary, and one is minus the other, this paper seems to treat them as different concepts that can both happen at the same time. Probably they have in mind a model with prior probabilities and some probabilities over signals, but the weight for the prior probabilities still indeterminate, i.e., the joint distribution still undetermined. This indeed turns out to be the case, in their Ellsberg urn stimuli; see below. They also seem to assume 2nd order distributions, on p. 965 suggesting this as universal. The experiment will consider an unknown Ellsberg two-color urn and have subjects specify their subjective probability distribution regarding the composition of the urn. Then one can indeed speak of a 2nd order distribution because the compositions of the urn are identifiable events, and letting prior refer to the composition and observations to drawings, the joint distribution of the composition and the observations is not yet determined but depends on the weight of the prior, as in Carnap's induction models. They use Goldstein & Rothschild's (2014) method. %}

Douglas, Piers, Lionel Howe, Andrew Perfors, Bradley Walker, Yoshihisa Kashima, & Nicolas Fay (2022) "Base Rate Neglect and Conservatism in Probabilistic Reasoning: Insights from Eliciting Full Distributions," *Judgment and Decision Making* 17, 962–987.
https://orcid.org/0000-0001-6171-1381

{% **foundations of statistics**: §2 has a discussion of the stopping rule debate between classical and Bayesian statistics. %}

Douven, Igor (2023) "Bayesian Stopping," *Journal of Mathematical Psychology* 116, 102794

{% They start from a proposition being acceptable as soon as its probability exceeds some threshold, discuss problems and paradoxes coming from it, with contributions by Kyburg. %}

Douven, Igor & Timothy Williamson (2006) "Generalizing the Lottery Paradox," *British Journal for the Philosophy of Science* 57, 755–779. https://doi.org/10.1016/j.jmp.2023.102794

{% %}

Dow, James, Vincente Madrigal, & Sérgio R.C. Werlang (1990) "Preferences, Common Knowledge, and Speculative Trade," London Business School.

{% **equilibrium under nonEU**?; presence of uncertainty and the agent's aversion to it. Def. 3.1: they define $1 - v(A) - v(A^c)$ as measure of uncertainty aversion. Don't seem to make intuitive mistakes. %}

Dow, James & Sérgio R.C. Werlang (1992) "Uncertainty Aversion, Risk Aversion and the Optimal Choice of Portfolio," *Econometrica* 60, 197–204.

{% **PT, applications**: nonadditive measures, excess volatility in security markets %}

Dow, James & Sérgio R.C. Werlang (1992) "Excess Volatility of Stock Prices and Knightian Uncertainty," *European Economic Review* 36, 631–638.

{% **equilibrium under nonEU** %}

Dow, James & Sérgio R.C. Werlang (1994) "Nash Equilibrium under Knightian Uncertainty: Breaking Down Backward Induction," *Journal of Economic Theory* 64, 304–324.

{% Shows that voting for sole the purpose of influencing the outcome is not rational given the very small probability that one vote will decide. %}

Downs, Anthony (1957) "*An Economic Theory of Democracy*." Harper and Row, New York.

{% Investigates relations of neurochemical systems to risk taking, discounting, and learning. %}
Doya, Kenji (2008) "Modulators of Decision Making," *Nature Neuroscience* 11, 410–416.

{% For ages, philosophers have discussed what should come first, observations or theory. It is a chicken-egg dilemma. Here is a citation pleaing for observations first. The story below lets the main character, Sherlock Holmes, say:"It is a capital mistake to theorize before one has data. Insensibly one begins to twist facts to suit theories, instead of theories to suit facts." I an more theoretically oriented and think sometimes it is better to adapt perception of facts to theory. %}
Doyle, Arthur Conan (1891) "A Scandal in Bohemia," *Strand Magazine* July 1891. Reprinted as first short story in Doyle, Arthur Conan (1892) "*The Adventures of Sherlock Holmes*." George Newnes, London.

{% Theoretical survey of different discount models.
P. 117 end of 2nd para points out that there have been no empirical comparisons of different discount models.
Pp. 120/122 is strange. The author favors working with a rate parameter rather than with NPV (net present value) and then starts arguing that NPV is a recent discovery and is non-obvious, citing Rubinstein (2003) who however shows that NPV was continuously used from the very beginning (de Wit 1671).
§ 3.6.2 and 3.6.3 on two families of Bleichrodt et al. are incorrect. They are criticized by Bleichrodt et al. (2013 *Judgment and Decision Making* 8): link to paper %}
Doyle, John R. (2013) "Survey of Time Preference, Delay Discounting Models," *Judgment and Decision Making* 8, 116–135.

{% Propose risk measures, characterized mostly by quasi-concavity, which can be applied both to probability-contingent and event-contingent prospects. %}

Drapeau, Samuel & Michael Kupper (2013) "Risk Preferences and Their Robust Representation," *Mathematics of Operations Research* 38, 28–62.

{% %}

Draper, Kaila (2021) "Direct Inference and the Sleeping Beauty Problem," *Synthese* 198, 2253–2271.
https://doi.org/10.1007/s11229-019-02203-y

{% **dynamic consistency**: surveys Kydland & Prescott like time inconsistency in macro-economics. %}

Drazen, Allen (2000) "*Political Economy in Macroeconomics*." Princeton University Press, Princeton NJ.

{% %}

Drechsler, Itamar (2013) "Uncertainty, Time-Varying Fear, and Asset Prices," *Journal of Finance* 68, 1843–1889.

{% %}

Drèze, Jacques H. (1958) "Individual Decision Making under Partially Controllable Uncertainty." Ph.D. dissertation, Columbia University.

{% This paper is remarkable, being from the author's Ph.D. thesis. It axiomatizes maxmax EU, which can easily be transferred to maxmin EU, famously axiomatized by Gilboa & Schmeidler (1989), using the same basic axioms. The author has a different interpretation. It is not about ambiguity. It is about moral hazard, with the agent having control over the priors. The agent can choose, after the act chosen, which prior will be the true one. He, of course, will take the best one, leading to maxmax. It makes the interpretation of quasiconcavity of preference very plausible. In a mixture of acts the agent must choose one and the same prior for the two acts, whereas for the nonmixed acts he can choose different priors for the different acts and can choose the best prior for each individual act.

I do not assign priority to this paper because it does not provide proofs of its theorems. I asked the author in personal communication if he had proofs available, and if only handwritten. But he could not provide such. Hence, not much credit to this paper. In general, no credit for theorems that are stated without proofs given. I add in 2024: proofs only provided in Online Appendixes are undesirable also. Good-quality proofs are essential for verifiability, essential for mathematics.

The author does provide an improved version in Ch. 2 of his 1987 book, with a proof, and that does deserve the priority. The postscript in Ch. 3 of his 1987 book, which is just the English translation of this 1961 paper, explains the case. %}

Drèze, Jacques H. (1961) "Les Fondements Logiques de l'Utilité Cardinale et de la Probabilité Subjective," *La Décision*, 73–83, Paris, CNRS.

link to the paper

Translation into Eglish by the author in his 1987 book

{% %}

Drèze, Jacques H. (1971) "Market Allocation under Uncertainty," *European Economic Review* 2, 133–165.

{% %}

Drèze, Jacques H. (1974, ed.) "*Allocation under Uncertainty: Equilibrium and Optimality*." MacMillan, London.

{% **risky utility u = transform of strength of preference v**, haven't checked if latter doesn't exist. %}

Drèze, Jacques H. (1982) "The Marginal Utility of Income Does Not Increase. Comment." Core Discussion paper 8231, Louvain-La-Neuve.

{% Ch. 2 is highly remarkable. It axiomatizes maxmax EU, which can easily be transferred to maxmin EU, famously axiomatized by Gilboa & Schmeidler (1989), using the same basic axioms. The author has a different interpretation. It is not about ambiguity. It is about moral hazard, with the agent having control over the priors. The agent can choose, after the act chosen, which prior will be the true one. He, of course, will take the best one, leading to maxmax. It makes the interpretation of quasiconcavity of preference very plausible. In a mixture of acts

the agent must choose one and the same prior for the two acts, whereas for the nonmixed acts he can choose different priors for the different acts and can choose the best prior for each individual act.

Pp. 11-12 strongly suggest that continuity is innocuous. P. 12 affirmatively cites Arrow's (1971) text: "The assumption of Monotone Continuity seems, I believe correctly, to be the harmless simplification almost inevitable in the formalization of any real-life problem." I, and many with me, disagree. See the keyword **criticizing the dangerous role of technical axioms such as continuity**.

state-dependent utility; P. 15 has example where consequences are act-dependent. The letters of Savage and Aumann on it are in Appendix 2.A.

Mononen (2023) showed that the claimed uniqueness in Theorem 8.2 can be violated in degenerate cases where the utility ranges over different states have no (nondegenerate) overlap. Then only the minimal set of priors is unique, but the set of priors can be a strict superset thereof. If the utility ranges for different states have sufficient nondegenerate overlap (sort of connecting all states) then the set of priors is unique and, hence, minimal and the uniquess holds. %}

Drèze, Jacques H. (1987) "*Essays on Economic Decision under Uncertainty.*" Cambridge University Press, Cambridge.

{% Reconsidering the beautiful work by Drèze on state dependence and moral hazard. %}

Drèze, Jacques H. & Aldo Rustichini (1998) "State Dependent Utility and Decision Theory." *In* Salvador Barberà, Peter J. Hammond, & Christian Seidl (eds.) *Handbook of Utility Theory, Vol. 1, Principles,* 839–895, Kluwer Academic Publishers, Dordrecht.

{% Put together models on preferences between conditioned acts such as Fishburn (1973), Luce & Krantz (1971) and, in particular, Drèze's moral hazard. %}

Drèze, Jacques H. & Aldo Rustichini (1999) "Moral Hazard and Conditional Preferences," *Journal of Mathematical Economics* 31, 159–181.

{% This paper studies risk sensitivity in bargaining. That is, how the solution is affected by changes in risk attitudes. More precisely, it assumes the Anscombe-Aumann framework and considers both risk attitudes, through the vNM utility function where, here, EU is assumed, and ambiguity attitudes, through a nonadditive weighting function. In this, it assumes exactly Schmeidler's (1989) RDU model. The Nash bargaining solution has no clear results and mostly things can go any way. This paper follows up on Köbberling & Peters (2003). For ambiguity, they use the Ghirardato & Marinacci (2002) comparative results giving pointwise dominance of capacities. %}

Driesen, Bram, Michele Lombardi, & Hans J.M. Peters (2016) "Feasible Sets, Comparative Risk Aversion, and Comparative Uncertainty Aversion in Bargaining," *Journal of Mathematical Economics* 67, 162–170.

{% This paper reconsiders the Holt & Laury (2002) measurement of risk attitudes. On **Prospect theory not cited**, the present paper puts everything right, with many nice sentences. The authors make clear that choice lists were used long before Holt & Laury, and cite the important Cohen, Jaffray, & Said (1987).

P. 89: "This observation about MPLs is well known to experts in the field of risk preference elicitation, and yet in our experience, it is not well known to newcomers or those outside the field."

P. 90 footnote 1: "The word "multiple" in multiple price list is redundant since the word "list" already implies repetitive choices. Nevertheless, we adopt the phrasing MPL in this paper as it is more commonly used in the literature than other variants such as "choice list." "

P. 91: "In what follows, we show that H&L's original MPL is, perhaps ironically, not particularly well suited to measuring the traditional notion of risk preferences — the curvature of the utility function. Rather, it is likely to provide a better approximation of the curvature of the probability weighting function. P. 93 2nd para gives a reason: the amount involved are too moderate to capture much utility curvature." %}

Drichoutis, Andreas C. & Jayson L. Lusk (2016) "What Can Multiple Price Lists Really Tell Us about Risk Preferences?," *Journal of Risk and Uncertainty* 53, 89–106.

{% The authors measure risk and time attitudes. For risk they use the Holt-Laury method and a certainty-equivalent measurement. Unfortunately, they only use expected utility to analyze their data. They do cite Drichoutis & Lusk (2016) on the claim that the Holt-Laury rather measures probability weighting, which I agree with, but also on the claim that the certainty equivalent, by varying

outcomes, would measure utility curvature, which I never understood. Whereas Drichoutis & Lusk (2016) put many things in good perspective, for instance in citing much literature that used choice lists prior to Holt & Laury, the present paper follows again the tradition of the field and journal Experimental Economics by ignoring all the literature from behavioral economics and psychology. (**Prospect theory not cited**) Characteristic is also that for every detail they cite papers by Glenn Harrison.

The authors test stability over time of risk and time preferences, and find that well satisfied. %}

Drichoutis, Andreas C. & Rodolfo M. Nayga (2022) "On the Stability of Risk and Time Preferences amid the COVID-19 Pandemic," *Experimental Economics* 25, 759–794.
https://doi.org/10.1007/s10683-021-09727-6

{% %}

Driesen, Bram, Andres Perea, & Hans J.M. Peters (2010) "On Loss Aversion in Bimatrix Games," *Theory and Decision* 68, 376–391.

{% %}

Driesen, Bram, Andres Perea, & Hans J.M. Peters (2011) "The Kalai-Smorodinsky Bargaining Solution with Loss Aversion," *Mathematical Social Sciences* 61, 58–64.

{% Use the elegant Shalev model of loss aversion to redo the Rubinstein bargaining solution, establishing the solution and providing results on it being (un)favorable to be loss averse. %}

Driesen, Bram, Andrés Perea, & Hans J.M. Peters (2012) "Alternating Offers Bargaining with Loss Aversion?," *Mathematical Social Sciences* 64, 103–118.

{% They transform the probability distribution using probability weighting. Then, however, they do not take expectation, which would lead to RDU and CPT, but they do mean-variance with that new distribution. That one can do other things with transformed cumulative probabilities than taking expectation was pointed out and axiomatized by Sarin & Wakker (1994, Econometrica). The authors

derive all kinds of implications for finance. They assume neo-additive probability weighting, meaning that only the two extreme outcomes are overweighted, and they only consider the symmetric case, giving insensitivity but no source preference. They assume that all traders can only take long positions, i.e., buy positive quantities, of assets. Traders cannot take short positions. They assume that there exists an event where all assets at the same time have their best outcome, and also one where they all at the same time have their worst outcome. In view of neo-additive weighting, this implies that all traders use the same weighting of events, irrespective of their financial position. %}

Driessen, Joost, Sebastian Ebert, & Joren Koëter (2022) "Π-CAPM: The Classical CAPM with Probability Weighting and Skewed Assets," working paper.

{% %}

Driessen, Theo S.H. (1988) "*Cooperative Games, Solutions and Applications.*" Kluwer Academic Publishers, Dordrecht.

{% Uses Choquet integral (RDU) for pricing European exchange options involving uncertain strikes under uncertainty. %}

Driouchi, Tarik, Lenos Trigeorgis, & Yongling Gao (2015) "Choquet-Based European Option Pricing with Stochastic (and Fixed) Strikes," *OR Spectrum* 37, 787–802.

{% %}

Dror, Itiel E., Beth Basola, & Jeromy R. Busemeyer (1999) "Decision Making under Time Pressure: An Independent Test of Sequential Sampling Models," *Memory & Cognition* 27, 713–725.

{% **utility families parametric** %}

Dror, Moshe & Bruce C. Hartman (1994) "Stopping Rules for St. Petersburg Gamble: Utility Functions and Stochastic Dynamic Programming Framework."

{% **DC = stationarity**: the author distinguishes between them. %}

Drouhin, Nicolas (2009) "Hyperbolic Discounting May be Time Consistent," *Economics Bulletin* 29, 2549–2555.

{% In the model considered, a time consistency can be satisfied iff the probability transformation is a power function, which is related to multiplicative (is Yaari 1965 additive) interaction with the hazard rate. %}

Drouhin, Nicolas (2015) "A Rank-Dependent Utility Model of Uncertain Life Time," *Journal of Economic Dynamics and Control* 53, 208225.

{% %}

Drouhin, Nicolas (2020) "Non-Stationary Additive Utility and Time Consistency," *Journal of Mathematical Economics* 86, 1–14. https://doi.org/10.1016/j.jmateco.2019.10.005

{% Seems to discuss the difference between pursuading people and framing. %}

Druckman, James N. (2001) "On the Limits of Framing Effects: Who Can Frame?," *Journal of Politics* 63, 1041–1066.

{% Consider discounting for infinite sequences with not only continuity conditions that assume that the far future becomes negligeable, but also with continuity axioms that the outcome "at infinity" (the limit) matters. %}

Drugeon, Jean-Pierre & Thai Ha Huy (2022) "A not so Myopic Axiomatization of Discounting," *Economic Theory* 73, 349–376. https://doi.org/10.1007/s00199-020-01336-3

{% P. 32:

"the literature suggests that all analysts would be willing to include estimates discounted at 5% per annum"

P. 33, near bottom: "economists are more frequently being asked to construct confidence intervals around their cost estimates, as is commonly done for the clinical outcome variables."

%}

Drummond, Michael F., Arno Brandt, Bryan R. Luce, & Joan Rovira (1993) "Standardizing Methodologies for Economic Evaluation in Health Care," *International Journal of Technology Assessment in Health Care* 9, 26–36.

{% **statistics for C/E**; use moment method to estimate variance of Cauchy distribution (which is infinite!?!?) %}

Drummond, Michael F. & Bernie J. O'Brien (1992) "Clinical Importance, Statistical Significance and the Assessment of Economic and Quality-of-Life Outcomes," *Health Economics* 2, 205–212.

{% Health related MAU scales; discount rate in cost-effectiveness and cost-benefit analysis for health should agree with "current practice" or be the government recommended rate. Note: this claim involves discounting of money!!!!

History of QALYs.

Seem to consider PE to be gold standard for utility measurement (**PE gold standard**). (if I remember well, they call it SG) %}

Drummond, Michael F., Gregg L. Stoddart, & George W. Torrance (1987) "*Methods for the Economic Evaluation of Health Care Programmes.*" Oxford University Press, Oxford; 2nd edn. 1997.

Drummond, Michael F., Bernie J. O'Brien, Gregg L. Stoddart, & George W. Torrance (1997) "*Methods for the Economic Evaluation of Health Care Programmes*; 2nd edn. Oxford University Press, Oxford.

Drummond, Michael F., Mark J. Sculpher, Karl Claxton, Gregg L. Stoddart, & George W. Torrance (2015). "*Methods for the Economic Evaluation of Health Care Programmes*; 4th edn." Oxford University Press, Oxford.

{% %}

Drynan, Ross G. (1981) "Risk Attitudes amongst Australian Farmers; Comment," *Australian Journal of Agricultural Economics* 25, 73–76.

{% Real incentives: use hypothetical choice;

Measure ambiguity attitudes for gains versus losses (manipulated by putting the benchmark for supposed managerial decision above or below all outcomes considered), when ambiguity is modeled the usual way through events and "vague probabilities" versus when ambiguity is modeled deviating from conventions through ambiguous outcomes (**ambiguous outcomes vs. ambiguous probabilities**), and when ambiguity is modeled through separate evaluation of

prospects through certainty equivalents (pseudo-pairwise choice, PPC, modeled as the choice for the option with the higher certainty equivalent) or when it is modeled through joint evaluation in direct pairwise choice (PC). Ambiguity is generated by giving probability intervals, and they also measure the effect of interval range.

P. 1797 1st para of 2nd column: strangely enough, subjects are risk seeking.

ambiguity seeking for losses: This they find. Subjects are ambiguity averse for gains but ambiguity seeking for losses (p. 1797 2nd column), although the latter is not significantly different from ambiguity neutrality (p. 1798 Table 3).

Pp. 1798-1799: People get more ambiguity averse for gains if ambiguity increases (so, larger probability intervals), and more ambiguity seeking for losses if ambiguity increases, although the effect for losses is smaller than the effect for gains.

Table 5 displays choices from straight choice. Interesting is the middle left matrix, which considers a classical preference reversal for ambiguity. Unfortunately, the data are not clear and may be mostly noise. In the upper row of people preferring ambiguity in pairwise choice (PC) exactly half prefers ambiguity in pseudo-pairwise choice. In the lower row of people preferring unambiguous in PC, some more, 60%, prefers unambiguous in PCC, but this difference apparently is not significant.

reflection at individual level for ambiguity: no data because gains-losses was between subjects.

loss aversion without mixed prospects and/or **loss aversion: erroneously thinking it is reflection**: P. 1800 2nd column 2nd para erroneously suggests that loss aversion can play a role in their data on losses. This paper has no mixed prospects and, hence, loss aversion can play no role at all. %}

Du, Ning & David V. Budescu (2005) "The Effects of Imprecise Probabilities and Outcomes in Evaluating Investment Options," *Management Science* 51, 1791–1803.

{% **anonymity protection** %}

du Feu, Chris (2006) "Biodiversity for Beginners," Teaching Statistics 28, 66–70.

{% Discuss ways to derive risk aversion indexes and risk premiums from finance data. %}

Duan, Jin-Chuan & Weiqi Zhang (2014) "Forward-Looking Market Risk Premium," *Management Science* 60, 521–538. http://dx.doi.org/10.1287/mnsc.2013.1758

{% Discuss in detail how important it is to separately identify utility and discount rates (and uncertainty) and how difficult that is. They use stated (hypothetical introspective, equated with the cardinal intertemporal utility function) questions to elicit utility. %}

Dubé, Jean-Pierre, Günter J. Hitsch & Pranav Jindal (2014) "The Joint Identification of Utility and Discount Functions from Stated Choice Data: An Application to Durable Goods Adoption," *Quantitative Marketing and Economics* 12, 331–377.

{% **finite additivity** %}

Dubins, Lester E. & Leonard J. Savage (1965) "*How to Gamble if You Must.*" Dover Publications, New York. Retitled 1976: "*Inequalities for Stochastic Processes.*"

{% %}

Dubois, Didier (1988) "Possibility Theory: Searching for Normative Foundations." *In* Bertrand R. Munier (ed.) *Risk, Decision and Rationality*, 601–614, Reidel, Dordrecht.

{% %}

Dubois, Didier, Lluís Godo, Henri Prade, & Adriana Zapico (1999) "On the Possibilistic Decision Model: From Decision under Uncertainty to Case-Based Decision," *International Journal of Uncertainty, Fuzziness and Knowledge-Based Systems* 7, 631–670.

{% About insurance in low development countries %}

Dubois, Pierre, Bruno Jullien, & Thierry Magnac (2008) "Formal and Informal Risk Sharing in LDCs: Theory and Empirical Evidence," *Econometrica* 76, 679–725.

{% %}

Dubois, Didier, Endre Pap, & Henri Prade (1999) “Hybrid Probabilistic-Possibilistic Mixtures and Utility Functions,” Université Paul Sabbatier.

{% %}

Dubois, Didier & Henri Prade (1988) “Default Reasoning and Possibility Theory,” *Artificial Intelligence* 35, 243–257.

{% **survey on nonEU**; **updating: nonadditive measures** %}

Dubois, Didier & Henri Prade (1988) “Modelling Uncertainty and Inductive Inference: A Survey of Recent Non-Additive Probability Systems,” *Acta Psychologica* 68, 53–78.

{% %}

Dubois, Didier & Henri Prade (1988) “Fuzzy Measures: Fuzzy Integral Approach.” *In* Madan G. Singh (ed.) *Systems* & *Control Encyclopedia; Theory, Technology, Applications*, 1821–1822, Pergamon, New York.

{% That fuzzy sets are still awaiting operationalization. %}

Dubois, Didier & Henri Prade (1989) “Fuzzy Sets, Probability, and Measurement,” *European Journal of Operational Research* 40, 135–154.

{% %}

Dubois, Didier & Henri Prade (1990) “Probability Theory in Artificial Intelligence. A Review of “Probabilistic Reasoning in Intelligent Systems: Networks of Plausible Inference,” by Judea Pearl,” *Journal of Mathematical Psychology* 34, 472–482.

{% Discusses Dempster’s rule for combining evidence, discusses **three-doors problem**, and distinguishes between information and evidence. %}

Dubois, Didier & Henri Prade (1992) “Evidence, Knowledge and Belief Functions,” *International Journal of Approximate Reasoning* 6, 295–319.

{% **updating: nonadditive measures**; Focusing: conditioning beforehand; learning: conditioning after. %}

Dubois, Didier & Henri Prade (1994) "Focusing versus Updating in Belief Function Theory." *In* Ronald R. Yager, Janusz Kacprzyk, & Mario Fedrizzi (eds.) *Advances in the Dempster-Shafer Theory of Evidence*, Wiley, New York.

{% Explain that probabilities, or other degrees of belief, cannot be modeled as multi-valued logic (degree of truth). The reason is that the degree of belief of a composition of propositions is not determined only by the degree of belief of the separate propositions. They refer to de Finetti (1936) who made the same point, and discuss many historical misunderstandings. %}

Dubois, Didier & Henri Prade (2001) "Possibility Theory, Probability Theory and Multiple-Valued Logics: A Clarification," *Annals of Mathematics for Artificial Intelligence* 32, 35–66.

{% %}

Dubois, Didier, Henri Prade, & Agnès Rico (2014) "On the Informational Comparison of Qualitative Fuzzy Measures." *In* Anne Laurent, Olivier Strauss, Bernadette Bouchon-Meunier, Ronald R. Yager (eds.): "*Information Processing and Management of Uncertainty in Knowledge-Based Systems*" - 15th International Conference, IPMU 2014, Montpellier, France, July 15-19, 2014, Proceedings, Part I. Communications in Computer and Information Science 442, 216–225, Springer, Berlin.

{% Does what title says. %}

Dubois, Didier, Henri Prade, & Regis Sabbadin (2000) "Qualitative Decision Theory with Sugeno Integrals." *In* Michel Grabisch, Toshiaki Murofushi & Michio Sugeno (eds.) *Fuzzy Measures and Integrals: Theory and Applications* 314–322, Physica-Verlag, Berlin.

{% %}

Dubois, Didier & Agnès Rico (2018) "New Axiomatisations of Discrete Quantitative and Qualitative Possibilistic Integrals," *Fuzzy Sets and Systems* 343, 3–19.

{% Presented at FUR in Oslo, with the strong evidence of anchoring biases and other things. %}

Dubourg, W. Richard, Michael W. Jones-Lee, & Graham Loomes (1997) "Imprecise Preferences and the WTP-WTA Disparity," *Journal of Risk and Uncertainty* 9, 115–133.

{% Presented at FUR in Oslo; contains the experiment with the different starting point of a wheel affecting WTP to an extreme extent. Starting the wheel at 25 pound gives a WTP of, if I remember right, about 100 pound, starting the wheel at 75 gives a WTP of about 180 pound. This is not just anchoring because the resulting answers differ greatly from the starting values. Maybe it is that the subjects want to ask five times for increases of the initial value but not more. %}

Dubourg, W. Richard, Michael W. Jones-Lee, & Graham Loomes (1997) "Imprecise Preferences and Survey Design in Contingent Valuation," *Economica* 64, 681–702.

{% Generalizes the bivariate additive representation without additivity of Ok & Masatlioglu (2007) "A Theory of (Relative) Discounting," by allowing the first component not to refer to real numbers but to a separable connected compact topological space. A natural conjecture is that both components need only be connected. Only considers positive first coordinates, so, monotonicity in time. %}

Dubra, Juan (2009) "A Theory of Time Preferences over Risky Outcomes," *Journal of Mathematical Economics* 45, 576–588.
https://doi.org/10.1016/j.jmateco.2007.12.002

{% Considers mixture set of probability distributions over a finite set. Shows that (usual, weak) forms of continuity hold if and only if completeness holds. Cites the related Schmeidler (1971, Econometrica). %}

Dubra, Juan (2011) "Continuity and Completeness under Risk," *Mathematical Social Sciences* 61, 80–81.

{% **completeness criticisms**;

Argue that it is natural to first determine preferences in simple situations ("core preferences”), then extend them to more complex through, for example, independence condition. (**extending preference relations using conditions**) %}

Dubra, Juan & Efe A. Ok (2002) “A Model of Procedural Decision Making in the Presence of Risk,” *International Economic Review* 43, 1053–1080. https://doi.org/10.1111/1468

{% **completeness criticisms**; Take vNM axioms with its least convincing one dropped. This least convincing one is completeness. Prove that then there is a set of utility functions such that one prospect is preferred to the other if and only if EU prescribes so for every utility function in the set. That is, there should be unanimous EU agreement. A pretty result, of which it is amazing that it had not been discovered before. The probable reason that it had not been discovered before is that Aumann (1962) raised confusions about it, because Aumann claimed the result in his text without really having it. %}

Dubra, Juan, Fabio Maccheroni, & Efe A. Ok (2004) “Expected Utility without the Completeness Axiom,” *Journal of Economic Theory* 115, 118–133.

{% Seems that they define a bi-order between sets and that that is very close to triple cancellation etc. %}

Ducamp, André & Jean-Claude Falmagne (1969) “Composite Measurement,” *Journal of Mathematical Psychology* 6, 359–390.

{% Treats the Ky Fan metric on L_0, which amounts to the Sugeno integral. Referred to by Denneberg (1994). %}

Dudley, Richard M. (1989) “*Real Analysis and Probability*.” Wadsworth and Brooks/Cole, Pacific Grove.

{% **information aversion**: For genetic diseases such as Huntington’s disease people can have themselves tested but there is no cure for the disease. For example, if your father has it you have .5 probability of also having it. Some want to have that test, others really do not want to know if they have the bad gene. %}

DudokdeWit, A. Christine (1997) “To Know or not to Know; The Psychological Implications of Presymptomatic DNA Testing for Autosomal Dominant

Inheritable Late Onset Disorders," Ph.D. dissertation, Erasmus University, Rotterdam, the Netherlands.

{% **information aversion**: For genetic diseases such as Huntington's disease people can have themselves tested but there is no cure for the disease. For example, if your father has it you have .5 probability of also having it. Some want to have that test, others really do not want to know if they have the bad gene. %}

DudokdeWit, A. Christine, E. Johanna Meijers-Heijboer, Aad Tibben, et al. (1994) "Effect on a Dutch Family of Predictive DNA-Testing for Hereditary Breast and Ovarian Cancer," *Lancet* 344, 197.

{% Test stability of ambiguity attitude over time using Ellsberg 3-color, doing it now and then in 2 months. There is more consistency (57%) than randomness (but less than if back-to-back (75%)), but it is much inconsistency yet. Interestingly, subjects who remember their past choices are not more consistent. (Compare Agranov & Ortoleva 2017.) For risk attitude, there is more consistency. For ambiguity, consistency decreases in time, but for risk it does not. %}

Duersch, Peter, Daniel Römer, & Benjamin Roth (2017) "Intertemporal Stability of Uncertainty Preferences," *Journal of Economic Psychology* 60, 7–20. https://doi.org/10.1016/j.joep.2017.01.008

{% Seems to have introduced habit formation. %}

Duesenberry, James (1952) "*Income, Saving, and the Theory of Consumer Behavior*." Harvard University Press, Cambridge, MA.

{% %}

Duffie, Darrell & Larry G. Epstein (1991) "Stochastic Differential Utility," *Econometrica* 60, 353–394.

{% **probability elicitation**: applied to experimental economics %}

Dufwenberg, Martin & Uri Gneezy (2000) "Measuring Beliefs in an Experimental Lost Wallet Game," *Games and Economic Behavior* 30, 163–182.

{% **Nash equilibrium discussion** %}

Dufwenberg, Martin & Johan Linden (1996) “Inconsistencies in Extensive Games,” *Erkenntnis* 45, 103–114.

{% %}
Dugundji, James (1966) “*Topology*.” Allyn and Bacon, Boston.

{% Imagine a Savage-style decision model, where we focus on countable additivity and ℝ is the outcome set. If there is an atom in the state space, then not all probability distributions over outcomes can be generated—none of them is atomless of course. If the state space is atomless, then all probability distributions over ℝ can be generated. The latter is called open-mindedness in this paper. The paper mainly examines this open-mindedness for multiple priors, giving theorems when a state space endowed with a set of priors is rich enough to generate all sets of priors over outcomes. This is of course useful to know, but the papers argues more that this is important than I can agree with. For instance, p. 664 has the following overstatement on the multiple prior approach to ambiguity: “In order for this approach to be effective, it is *necessary* that the set of priors be open-minded, that is, that the set can induce, via consequence-valued measurable functions, any closed, convex set of distributions on any compact metric space of consequences.” [Italics added.]

The authors, as do so many, equate ambiguity with sets of priors. For example, on p. 664: “Ambiguity is a separate kind of epistemic uncertainty. It can be captured by modeling decision makers as believing that actions lead to sets of possible distributions over outcomes.” %}
Dumav, Martin & Maxwell B. Stinchcombe (2021) “The Multiple Priors of the Open-Minded Decision Maker,” *Economic Theory* 71, 663–692. https://doi.org/10.1007/s00199-020-01262-4

{% **anonymity protection** %}
Duncan, George T. & Diane Lambert (1986) “Disclosure-Limited Data Dissemination,” *Journal of the American Statistical Association* 81, 10–28.

{% **total utility theory**; Greater Detroit area, housewives in 1955 and 1971 gave same experienced utility scores to income although real income had increased by 42% in 1971; compare Easterlin (1974) %}

Duncan, Otis D. (1975) “Does Money Buy Satisfaction?,” *Social Indicators Research* II, 267–274.

{% %}
Duncker, Karl (1941) “On Pleasure, Emotion, and Striving,” *Philosophy and Phenomenological Research* 1, 391–430.

{% **finite additivity**; IV.2.12, p. 240: the set of simple functions is supnorm-dense in the set of all measurable bounded functions. %}
Dunford, Nelson & Jacob T. Schwartz (1958) “*Linear Operators, Part I.*” Interscience Publishers, New York.

{% **PT, applications**, loss aversion, downward-sloping labor supply: On overtime puzzle, which is an application of loss aversion. Data of over 2,000 workers in seven labor markets. Their tradeoffs between labor time and income kind at their current position, as loss aversion predicts.

P. 449 2nd column: Workers are prepared to give up substantially more leisure to prevent a loss of income than to gain the equivalent amount of income. I did not find, in my superficial reading, similar statements about the labor time dimension. %}
Dunn, Lucia F. (1996) “Loss Aversion and Adaptation in the Labour Market: Empirical Indifference Functions and Labour Supply,” *Review of Economics and Statistics* 78, 441–450.

{% Asymmetric information in rational-agent framework can lead to similar phenomena as loss aversion. %}
Dupont, Dominique Y. & Gabriel S. Lee (2002) “The Endowment Effect, Status Quo Bias and Loss Aversion: Rational Alternative Explanation,” *Journal of Risk and Uncertainty* 25, 87–101.

{% **conservation of influence**; text that exchanging goods (or at least money) does not produce utility. “There is a cancellation; no utility is produced.” (Cited by Stigler, 1950, Footnote 36). %}

Dupuit, Jules (1934) "*De l'Utilité et de sa Mesure.*" La Fiforma Sociale, Torino (reprint of papers of 1844 and 1849)

{% **common knowledge**; French/American philosophers; ascribes invention of CK to David Lewis. %}

Dupuy, Jean-Pierre (1989) "Common Knowledge, Common Sense," *Theory and Decision* 27, 37–62.

{% %}

Duraj, Jetlir & Kevin He (2020) "Dynamic Information Design with Diminishing Sensitivity Over News," working paper.

{% **equity-versus-efficiency**: A complex within-subject design where subjects divide money over 20 others with or without themselves included, money earned or just gotten, with taxes imposed and various degrees of inefficiences assumed. Besides the obvious self-interest, risk aversion (if you don't know for sure what position in society you get) and social preferences (meaning about fairness/equity, I guess) impact decisions. Not knowing this literature well, it was not very clear to me what the contribution of this paper was. The authors allocate prior wealth over each group of 21 subjects pointing out that this corresponds with welfare allocation in the US, which is a real-world framing, and this is one contribution the authors mention. %}

Durante, Ruban, Louis Putterman, & Joël J. van der Weele (2014) "Preferences for Redistribution and Perception of Fairness: An Experimental Study," *Journal of the European Economic Association* 12, 1059–1086.

{% **survey on nonEU**: Survey of different ways to model uncertainty for multicriteria decision making, including decision analysis, fuzzy sets, and so on. Mentions and cites many approaches without defining them or saying what they do. %}

Durbach, Ian N. & Theodor J. Stewart (2012) "Modeling Uncertainty in Multi-Criteria Decision Analysis," *European Journal of Operational Research* 223, 1–14.

{% **natural-language-ambiguity**: Seems to argue that tolerance of ambiguity (in general natural-language sense) is not so much related to individual personality traits but rather is a situation-dependent/content-specific expression of psychological stress. %}

Durrheim, Kevin (1998) "The Relationship between Tolerance of Ambiguity and Attitudinal Conservatism: A Multidimensional Analysis," *European Journal of Social Psychology* 28, 731–753.

{% %}

Dutt, Varun, Horacio Arló-Costa, Jeffrey Helzner, & Cleotilde Gonzalez (2014) "The Description–Experience Gap in Risky and Ambiguous Gambles," *Journal of Behavioral Decision Making* 27, 316–327.

{% Axiomatization of poverty measures that depend on past poverty. %}

Dutta, Indranil, Laurence Roope, & Horst Zank (2013) "On Intertemporal Poverty Measures: The Role of Affluence and Want," *Social Choice and Welfare* 41, 741–762.

{% %}

Dutta, Jayasri & Stephen Morris (1997) "The Revelation of Information and Self-Fulfilling Beliefs," *Journal of Economic Theory* 73, 231–244.

{% If agent is ambiguity averse (maxmin EU), it can be advantageous to deliberately have ambiguity in contracts. If agent can mix, it disappears. %}

Dütting, Paul, Michal Feldman, Daniel Peretz, & Larry Samuelson (2024) "Ambiguous Contracts," *Econometrica* 92, 1967–1992. https://doi.org/10.3982/ECTA22687

{% Seem to find evidence for quasi-convexity w.r.t. probabilistic mixing, supporting convex probability weighting in RDU. Seems that subjects get the option to delegate their choice to an external device to avoid making decisions, and use this option. %}

Dwenger, Nadja, Dorothea Kübler, & GeorgWeizsäcker (2015) "Flipping a coin: Theory and Evidence." WZB Discussion Paper, No. SP II 2013-201r.

{% **gender differences in risk attitudes**: Find, as do other studies, that women are more risk averse than men. The authors write many things that are provocative for emancipation. Guess they wrote it tongue in cheek. For example, they write that the difference is partly (though not completely), due to knowledge disparity. So, women know less about the market!? In the conclusion, they suggest that, for women's best interest, they better not manage their own retirement investments. Oh well …!?!? %}

Dwyer, Peggy D., James H. Gilkeson, & John A. List (2002) "Gender Differences in Revealed Risk Taking: Evidence from Mutual Fund Investors," *Economics Letters* 76, 151–158.

{% **utility elicitation**; show that if joint distribution of returns and available assets is known, vNM utility can be recovered from assets demands. %}

Dybvig, Philip & Herakles M. Polemarchakis (1981) "Recovering Cardinal Utility," *Review of Economic Studies* 48, 159–166.

{% %}

Dyckerhoff, Rainer (1994) "Decomposition of Multivariate Utility Functions in Non-Additive Expected Utility Theory," *Journal of Multi-Criteria Decision Analysis* 3, 41–58.

{% %}

Dyckerhoff, Rainer (1993) "Choquet-Erwartungsnutzen und Anticipiertern Nutzen. Ein Beitrag zur Entscheidungstheorie bei Einem und Mehreren Attributen," PhD Dissertation, Universität der Bundeswehr Hamburg.

{% %}

Dyckerhoff, Rainer & Karl C. Mosler (1993) "Stochastic Dominance with Nonadditive Probabilities," *Methods and Models of Operations Research* 37, 231–256.

{% **utility elicitation** %}

Dyckman, Thomas R. & Roberto Salomon (1972) "Empirical Utility Functions and Random Devices: An Experiment," *Decision Science* 3, 1–13.

{% %}

Dyer, Douglas, John H. Kagel, & Dan Levin (1989) "A Comparison of Naive and Experienced Bidders in Common Value Offer Auctions: A Laboratory Analysis," *Economic Journal* 99, 108–115.

{% Discusses **AHP** (analytical hierarchy process)-model, followed by comments %}

Dyer, James S. (1990) "Remarks on the Analytic Hierarchy Process," *Management Science* 36, 249–258.

{% %}

Dyer, James S., Thomas Edmunds, John C. Butler, & Jianmin Jia (1998) "A Multiattribute Utility Analysis of Alternatives for the Disposition of Surplus Weapons-Grade Plutonium," *Operations Research* 46, 749–762.

{% %}

Dyer, James S., Peter C. Fishburn, Ralph E. Steuer, Jyrki Wallenius, & Stanley Zionts (1992) "Multiple Criteria Decision Making, Multiattribute Utility Theory: The Next Ten Years," *Management Science* 38, 645–654.

{% %}

Dyer, James S. & Jianmin Jia (2000) "Decision Making under Ambiguous Risk,"

{% %}

Dyer, James S. & Rakesh K. Sarin (1978) "On the Relationship between Additive Conjoint and Difference Measurement," *Journal of Mathematical Psychology* 15, 270–272.

{% %}

Dyer, James S. & Rakesh K. Sarin (1979) "Measurable Multiattribute Value Functions," *Operations Research* 27, 810–822.

{% **risky utility u = transform of strength of preference v, latter doesn't exist** %}
Dyer, James S. & Rakesh K. Sarin (1979) "Group Preference Aggregation Rules Based on Strenght of Preference," *Management Science* 25, 822–832.

{% **risky utility u = transform of strength of preference v**;
event/outcome driven ambiguity model: outcome driven: although this paper is on risk and not uncertainty, it does have the spirit of being outcome driven. %}
Dyer, James S. & Rakesh K. Sarin (1982) "Relative Risk Aversion," *Management Science* 28, 875–886.

{% **measure of similarity** %}
Dzhafarov, Ehtibar N. (2008) "Dissimilarity Cumulation Theory in Arc-Connected Spaces," *Journal of Mathematical Psychology* 52, 73–92.

{% **measure of similarity** %}
Dzhafarov, Ehtibar N. (2008) "Dissimilarity Cumulation Theory in Smoothly Connected Spaces," *Journal of Mathematical Psychology* 52, 93–115.

{% **measure of similarity** %}
Dzhafarov, Ehtibar N. & Hans Colonius (2007) "Dissimilarity Cumulation Theory and Subjective Metrics," *Journal of Mathematical Psychology* 51, 290–304.

{% %}
Earl, Peter E. (2018) "Richard H. Thaler: A Nobel Prize for Behavioural Economics," *Review of Political Economy* 30, 107–125.

{% Textbook on behavioral economics. %}
Earl, Peter E. (2022) "*Principles of Behavioral Economics*." Cambridge University Press, Cambridge UK.

{% Application of ambiguity theory; %}
Easley, David & Maureen O'Hara (2009) "Ambiguity and Nonparticipation: The Role of Regulation," *Review of Financial Studies* 22, 1817–1843.

{% Decision maker chooses between acts. Does not know what the state space is. Repeatedly chooses, each time finding out how good consequence is. (Reminds me of case-based decision theory, and somewhat of Erev's approach such as in Barron & Erev (2003).) %}

Easley, David & Aldo Rustichini (1999) "Choice without Beliefs," *Econometrica* 67, 1157–1184.

{% Famous paper proposing that emotional states characterized by high psychological arousal and negative valence narrow the scope of both perceptual and conceptual attention. %}

Easterbrook, James A. (1959) "The Effect of Emotion on the Range of Cue Utilization and the Organization of Behavior," *Psychological Review* 66, 183–201.

{% **total utility theory**

Cross-country comparison of self-rating of happiness. No correlation between average rating per country and per capita national income.

Compare Duncan (1975) %}

Easterlin, Richard A. (1974) "Does Economic Growth Improve the Human Lot? Some Empirical Evidence." *In*: Paul A. David & Melvin W. Reder (eds.) *Nations and Households in Economic Growth, Essays in Honor of Moses Abramowitz,* Academic Press, New York.

{% Confirms, with newer data, the 1974 findings, answering the question in the title with "no." %}

Easterlin, Richard A. (1995) "Will Raising the Incomes of All Increase the Happiness of All?," *Journal of Economic Behavior and Organization* 27, 35–48.

{% **Newcomb's problem** %}

Easwaran, Kenny (2021) "A Classification of Newcomb Problems and Decision Theories," *Synthese* 198 (Suppl 27), S6415–S6434.
https://doi.org/10.1007/s11229-019-02272-z

{% **DC = stationarity**; no real incentives, but flat payments.

Paper considers two factors in discounting: insensitivity and elevation. Insensitivity for this one-side-bounded scale means relatively low discounting (so, high weighting) of the near future and relatively high discounting (so, low weighting) of the far future. (For the two-side-bounded probability scale it means inverse S.) Manipulations such as giving subjects limited time leads to bigger insensitivity in discounting. It has sometimes been suggested that people in such situations resort to lexicographic manipulation of the most important dimension, but here apparently subjects designate time as the most important dimension but pay less and not more attention to it when having less time. Adding visual scales leads to bigger insensitivity. Such manipulations do not have a similar effect for the outcome scale, suggesting more insensivity for time than for outcomes. Experiment 1 does data fitting only for aggregate data. For this purpose, Experiments 3 and 4 do utility measurement through direct introspective rating, not by deriving from decisions, so, not revealed preference.

The paper proposes the constant sensitivity family, which is exponential discounting but t taken to some power. This family was generalized by Bleichrodt, Rohde, & Wakker (2009) who called it CRDI. Now I think unit invariance is a better name. On March 5, 2014, I discovered that Read (2001 JRU Eq. 16) proposed this basic family before.

Introduction seems to consider constant discounting to be complete insensitivity. I do not understand. The other kind of insensitivity, where only two categories of time are considered, being present versus all future timepoints, so that all future timepoints are weighted the same, be it less than the present, I agree with more.

End of paper mentions well-known problem that the rational (!?) constant discounting implies overly strong discounting of the far future, so that only zero discounting remains as possibility. %}

Ebert, Jane E.J. & Drazen Prelec (2007) "The Fragility of Time: Time-Insensitivity and Valuation of the Near and Far Future," *Management Science* 53, 1423–1438. https://doi.org/10.1287/mnsc.1060.0671

{% Gives necessary and sufficient conditions, in terms of moments, for prudence and other kinds of higher-order risk attitudes. %}

Ebert, Sebastian (2013) "Moment Characterization of Higher-Order Risk Preferences," *Theory and Decision* 74, 267–284.

{% Adds results on risk loving and prudence. Unfortunately, no proof is given of the main result. %}
Ebert, Sebastian (2013) "Even (Mixed) Risk Lovers are Prudent: Comment," *American Economic Review* 103, 1536–1537.

{% **dynamic consistency**; This paper derives a funny paradox for PT in dynamic decisions under naivite, as follows. Overweighting of small probabilities generates risk seeking for long shots. It does so for mixed prospects, as typically faced in financial markets, if the risk seeking induced by small probabilities overweights loss aversion. The latter happens for common parametric families of weighting functions because they have infinite derivatives at the extreme probabilities $p = 0$ and $p = 1$. It does so irrespective of utility curvature if utility is differentiable (outside status quo) because the latter means, for small amounts, that utility is approximately linear. Thus, people will never stay stable but always prefer to take long-shot risks if those are available. This also holds for dynamic decisions under naivity. A nice point is that long-shot lotteries of the kind preferred by PT are always available in complete financial markets, so that PT predicts that naive people always invest in those and never stay put.

The abstract of the paper writes that the above prediction of PT is unrealistic and the authors suggest abandoning probability weighting. I disagree here for two reasons: (i) in reality there do exist people that naive that they always keep on investing and keep on playing in casino as long as they can (until ruin). (ii) the result requires extreme steepness of w at extremes, which is not empirically realistic even if the parametric families common today have it (they have it because it allows for tractable formulas, not because it is empirically realistic).

Proposition 1, p. 1624, shows that a similar result cannot occur for EU even if risk seeking. This holds because EU is locally almost linear. This is similar to Arrow's result that under actuarially unfair coinsurance (loading factor in insurance premium) and EU with concave utility, no complete insurance is taken. The first-order nature of risk seeking of PT is essential for the results of this paper.

The negative effects of the referee system with referees having too much power is felt in the last para of the discussion (p. 1627), where an unsubstantiated negatively formulated criticism of PT comes out of the blue. The authors make clear in the usual way that a silly referee is to blame by "thanking" him/her in footnote 8. %}

Ebert, Sebastian & Philipp Strack (2015) "Until the Bitter End: On Prospect Theory in a Dynamic Context," *American Economic Review* 105, 1618–1633.

{% %}

Ebert, Sebastian & Daniel Wiesen (2011) "Testing for Prudence and Skewness Seeking," *Management Science* 57, 1334–1349.

{% %}

Ebert, Sebastian & Daniel Wiesen (2014) "Joint Measurement of Risk Aversion, Prudence, and Temperance," *Journal of Risk and Uncertainty* 48, 231–252.

{% P. 162, ℓ. 4/5 proves additive representability on rank-ordered cone in the wrong way as many did, with the from local to global step. Chateauneuf & Wakker (1993) discuss the issue in detail.

decreasing ARA/increasing RRA

- Theorem 3 presents the appealing derivation of rank-dependence with only comonotonic separability and invariance w.r.t. change of scale of outcomes. Miyamoto & Wakker (1996, Theorem 2) also obtained this result, unaware of Ebert's precedence.

- Theorem 4 presents the appealing derivation of rank-dependence with only comonotonic separability and invariance w.r.t. change of location of outcomes. Miyamoto & Wakker (1996, Theorem 1) also obtained this result, unaware of Ebert's precedence. %}

Ebert, Udo (1988) "Measurement of Inequality: An Attempt at Unification and Generalization," *Social Choice and Welfare* 5, 147–169. https://doi.org/10.1007/BF00735758

{% This paper proposes a rank-dependent form for welfare evaluations. It does not refer to other rank-dependent works such as by Weymark, Quiggin, or Yaari.

However, the simultaneous publication by Ebert in Social Choice and Welfare, which also considers rank-dependent forms, refers to Yaari (1986). %}

Ebert, Udo (1988) "Rawls and Bentham Reconciled," *Theory and Decision* 24, 215–223.

{% %}

Ebert, Udo (1995) "Income Inequality and Differences in Household Size," *Mathematical Social Sciences* 30, 37–55.

{% **tradeoff method**: Uses comonotonic tradeoff consistency to get RDU. Does it for the context of welfare. (s_1: x_1,…,s_n:x_n) refers to a society with n persons, where each person sj receives \$$x_j$. It is equivalent to a (1/n:x_1,…, 1/n:x_n) lottery in decision under risk. The paper has variable population size, i.e., all simple equally likely lotteries are present and, hence, all simple rational-probability lotteries. Theorem 2 on p. 429, the principle of progressive transfer (Def: p.428) is pretty and powerful. It means that transferring a small amount from a rich to a poor person (so small that the ranking is not changed) is always an improvement. Under compact continuity, it is necessary and sufficient for U being concave and w being convex. The principle is both weaker than aversion to mean-preserving spreads, and outcome-convexity, so, it shows that each of these is necessary and sufficient for convex w and concave U, having Chew, Karni, & Safra (1987) as corollary. Importantly, as pointed out on p. 430, the author, unlike CKS, does not need differentiability. So, it is a valuable result!

The aforementioned result is less new that the author is aware of. Chew & Mao (1995), for the context of decision under risk but also considering only simple equal-probability lotteries, define elementary risk aversion which is the same as the principle of progressive transfer. They also show that it is equivalent to the stronger aversion to mean-preserving risk, under continuity. Their Table II displays that under RDU this holds if and only if U concave and w convex. But they assume some smoothness differentiability there (although they do not say this very clearly); see my annotations there. %}

Ebert, Udo (2004) "Social Welfare, Inequality, and Poverty when Needs Differ," *Social Choice and Welfare* 23, 415–448.

{% Propose a measure of how far a dataset on choices from linear budget sets with uncertainty involved is from EU maximization. They consider how much first-order conditions must be perturbed. %}

Echenique, Federico, Taisuke Imai, & Kota Saito (2023) "Approximate Expected Utility Rationalization," *Journal of the European Economic Association* 21, 1821–1864.
https://doi.org/10.1093/jeea/jvad028

{% %}

Echenique, Federico, Masaki Miyashita, Yuta Nakamura, Luciano Pomatto, & Jamie Vinson (2022) "Twofold Multiprior Preferences and Failures of Contingent Reasoning," *Journal of Economic Theory* 202, 105448.

{% **conservation of influence**: Give necessary and sufficient conditions for SEU maximization with risk aversion for a very special preference set, which is relevant in finance: Assume a finite partition $E_1,\ldots,E_n$ of the universal event. One can invest in $1_{E_j}0$, yielding 1 contingent on event E_j, but the price of this is p_j per unit. An agent should optimally allocate some budget B. SEU means that he allocates $(b_1,\ldots,b_n)$ ($\sum_{j=1}^{n} p_j b_j = B$) to maximize $\sum_{j=1}^{n} q_j U(b_j)$, where U is his subjective utility function and the q_j are his subjective probabilities. The authors provide necessary and sufficient axioms that are restrictions of the revealed preference axioms (SARP). Because of risk aversion and the structure of the choice sets considered, they only need to consider the first-order optimality conditions at the point chosen. Hence, the axioms are of cancellation-axiom types, using duality in solving linear inequalities as in Scott (1964). In this way they can apparently escape from the ring inequalities that made Shapiro (1979) so difficult.

A question remaining is the uniqueness of their representation. Given the finiteness of their data, uniqueness will be more ugly than in the usual continuum models. Put differently, to what extent can their data discriminate expected utility from other models. They give some results with necessary and sufficient conditions for state-dependent expected utility and maxmin expected utility, with examples showing that these at least can be distinguished. Maxmin EU cannot be distinguished from EU for two states though, pointing to the problem of nonidentifiability. They also discuss probabilistic sophistication, for which they have no necessary and sufficient condition.

Kübler, Selden, & Wei (2014) obtained similar results with objective probabilities assumed available. This paper can be considered a generalization in the sense that probabilities are not assumed to be objectively available.

A difficulty is that the decision situations considered here in the axiomatization are not very realistic. Whereas in consumer demand theory, the choice from a budget set is somewhat realistic, a situation where one has to spend all of a budget in investing in linearly-priced state-contingent assets is not easy to imagine. Even if such assets are available in finance markets, it is hard to imagine a sitation where one has to spend exactly all of a given budget on this. Such situations occur in experiments, but are rare outside. %}

Echenique, Federico & Kota Saito (2015) "Savage in the Market," *Econometrica* 83, 1467–1495.

{% Axiomatize discounted utility and quasi-discounted utility, but do not take binary preference as primitive but, instead, a general choice function on demand sets derived from prices. Their axiomatization is like Echenique & Saito (2015), only with timepoint instead of state of nature. Constant discounting readily follows as a special case of expected utility with an extra condition, being stationarity.

They throughout assume concave utility. They also consider more general models, such as additive separability over time, and give the corresponding revealed-preference axioms. They nicely take a data set as a finite number of observations. Unfortunately, they try to give a formal meaning to rationality, following bad habits of the revealed preference literature.

Use their model to test data of Andreoni & Sprenger (2012), finding that quasi-hyperbolic does not fit better than constant discounting. %}

Echenique, Federico, Taisuke Imai, & Kota Saito (2020) "Testable Implications of Models of Intertemporal Choice: Exponential Discounting and Its Generalizations," *American Economic Journal; Microeconomics* 12, 114–143.

{% Reviewed use of **proper scoring rules** in academic testing situations

Proper scoring rules change reported judgments only to a minimal degree.

Confidence test means that not only an answer is chosen in tests and exams, but also a degree of confidence should be specified. %}

Echternacht, Gary J. (1972) "The Use of Confidence Testing in Objective Tests," *Review of Educational Research* 42, 217–236.

{% **gender differences in risk attitudes**: women more risk averse than men. %}

Eckel, Catherine C. & Philip J. Grossman (2002) "Sex Differences and Statistical Stereotyping in Attitudes toward Financial Risk," *Evolution and Human Behavior* 23, 281–295.

{% Very simple fivefold choice list to elicit risk attitudes; claimed to work better than other devises. Use real incentives, **losses from prior endowment mechanism** (money they urned for a little job).

gender differences in risk attitudes: women more risk averse than men. %}

Eckel, Catherine C. & Philip J. Grossman (2008) "Forecasting Risk Attitudes: An Experimental Study Using Actual and Forecast Gamble Choices," *Journal of Economic Behavior and Organization* 68, 1–17.

{% **gender differences in risk attitudes**: Women are more risk averse, and so are white and small people. Unlike Burks et al. (2009) and Dohmen et al. (2010) they find no relation between cognitive ability and risk aversion (**cognitive ability related to risk/ambiguity aversion**).

Study risk attitudes of children at schools, in particular in relation to school characteristics. N = 490 9^{th} – 11^{th} grade high-school children..

equate risk aversion with concave utility under nonEU: p. 206 ℓ. 6 uses this unfortunate terminology of equating "risk preferences" with utility.

Measure risk attitude using the very simple fivefold choice list of Eckel & Grossman (2008). Find more risk aversion than usual. %}

Eckel, Catherine C., Philip J. Grossman, Cathleen A. Johnson, Angela C. M. de Oliveira, Christian Rojas, & Rick K. Wilson (2012) "School Environment and Risk Preferences: Experimental Evidence," *Journal of Risk and Uncertainty* 45, 265–292.
http://dx.doi.org/10.1007/s11166-012-9156-2

{% %}

Eckel, Catherine C., Cathleen A. Johnson & Claude Montmarquette (2005) "Saving Decisions of the Working Poor: Short- and Long-Term Horizons." *In* Jeff Carpenter, Glenn W. Harrison, & John A. List (eds.) *Field Experiments in Economics: Research in Experimental Economics* 10, 219–260, JAI Press, Greenwich, CT.

{% %}

Eckel, Catherine, Jim Engle-Warnick & Cathleen Johnson (2005) "Adaptive Elicitation of Risk Preferences," Working paper.

{% Seem to measure risk attitudes very similarly to the bomb task of Crosetto & Filippin (2013), with subjects choosing chips instead of boxes. However, the authors did not publish by 2013, which is why Crosetto & Filippin found the method independently and can have/share priority. Crosetto & Filippin (2013) do cite this paper. %}

Eckel, Catherine C., Elke U. Weber, Rick K. Wilson (2003) "Four Ways to Measure Risk Attitudes," working paper.

{% %}

Eckel, Catherine C. & Rick K. Wilson (2004) "Is Trust a Risky Decision?," *Journal of Economic Behavior and Organization* 55, 447–465.

{% %}

Eckerlund, Ingemar, Magnus Johannesson, Per-Olov Johansson, Magnus Tambour, & Niklas Zethraeus (1995) "Value for Money? A Contingent Valuation Study of the Optimal Size of the Swedish Health Care Budget," *Health Policy* 34, 135–143.

{% Text by Jan Oegema, in Dutch newspaper Trouw of January 6 2006, probably citing Meister Eckhart, who lived from 1260 till 1328: "Daar waar de mens in zijn donkerte staart, daar ontmoet hij het ongeschapen, het onkenbare deel van zichzelf, dat wil zeggen: dat deel dat door de tijdruimte met ons is meegereisd vanaf het moment dat de godheid om haar moverende redenen de eerste enkelvoudige eenheid verbrak." %}

Eckhart, Meister

{% **updating: mistakes in using Bayes' formula**: not only medical doctors but also their teachers and textbooks fall victim to the base rate trap. %}

Eddy, David M. (1982) "Probabilistic Reasoning in Clinical Medicine: Problems and Opportunities." *In* Daniel Kahneman, Paul Slovic, & Amos Tversky (eds.) *Judgment under Uncertainty: Heuristics and Biases*, 3–23, Cambridge University Press, Cambridge.

{% Argues that problems in Oregon's method are not fundamental to C/E (cost-effectiveness) analysis but are due to specific technical details in the way it was applied. %}

Eddy, David M. (1991) "Oregon's Methods: Did Cost-Effectiveness Analysis Fail?," *JAMA* 266, 2135–2141.

{% Constructive view of preference: support the spirit of getting more out of fewer subjects. They analyze in some detail how subjects make mistakes in a traditional time tradeoff measurement (TTO), and present studies where interviewers did interact with subjects but in a minimal sense of only correcting obvious such as (apparent) violations of dominance. The recommend, to my joy, that experimenter intervention to avoid mistakes is desirable. %}

Edelaar-Peeters, Yvette, Anne M. Stiggelbout, & Wilbert B. van den Hout (2014) "Qualitative and Quantitative Analysis of Interviewer Help Answering the Time Tradeoff," *Medical Decision Making* 34, 655–665. https://doi.org/10.1177/0272989X14524989

{% To determine proper degree of inequality, the risk-based approach incorporates risk, à la Harsaniy. This paper proposes an iterative procedure to handle heterogeneity of individual risk attitudes. %}

Eden, Maya (2020) "Welfare Analysis with Heterogeneous Risk Preferences," *Journal of Political Economy* 130, 4574–4613. https://doi.org/10.1086/710561

{% On social discounting with overlapping generations. Presents a model where lower social discount rates are equivalent to weighing young people more.

Opening discusses social discount rate, citing studies arguing for 6% and for 1.5%. %}

Eden, Maya R. (2023) "The Cross-Sectional Implications of the Social Discount Rate," *Econometrica* 91, 2065–2088. https://doi.org/10.3982/ECTA20844

{% They consider prospects (my term) (m,p) where $m \in \mathbb{R}$ is income and p is a nonnegative price vector. Every of finitely many agents has a preference relation $\succcurlyeq_i$ over the prospects. The authors consider a model with a function U on prospects and functions u_i on prices, such that $\succcurlyeq_i$ is represented by $U(m,p) + u_i(p)$: a common utility function augmented by individual values of prices (the authors assume that it is indirect utility). A social welfare evaluation takes place through the social $\succcurlyeq$, aggregating the individual preferences $\succcurlyeq_i$. The authors consider a social welfare functional that is additively separable over the agents and takes a particular form, uniquely determined by the individual preferences, with unique inequality aversion. They provide a Pareto axiom and an anonymity axiom to derive the functional. %}

Eden, Maya & Luis Mota Freitas (2023) "Income Anonymity," working paper.

{% P. 7: Jevons distinguishes two dimensions in utility: Intensity and time. Unit of utility for Edgeworth is **just noticeable difference** (minimally perceptible threshold), somewhere brings in evolution. Edgeworth also brings in number of people.

P. 8 seems to write (I suspect typos below):

"You cannot spend sixpence utilitarianly, without having considered then something on number of people. Edgeworth is clearly aware of the unprovability of the axiom of interpersonal comparability. His axiom is that just noticeable difference is comparable across individuals."

P. 9 compares principle of maximizing utility with maximum-energy principles, says that motion in physics can be described as maximizing energy.

P. 14/15: man as a pleasure machine

Most of book sets up some calculations for economics.

P. 53 "settlements between contractors is the utilitarian arrangement of the articles of contract ... tending to the greatest possible total utility of the contractors. … utilitarian settlement may be selected, in the absence of any other principle of selection" continuing on p. 54:

“utilitarian equity.”

{footnote 2:

“Whereof the uconsciously implicit principle is: time-intensity units of pleasure are to be equated irrespective of persons.”

P. 77/78 suggests utilitarian foundation of larger pay for the more agreeable work of the aristocracy of skill and talent, and similarly for “supposed” superior capacity of the man (opposed to woman) for happiness, with some nice text on role of woman not always in 100% agreement with 20th century feminism.

Appendix II is called:

“On the importance of hedonical calculus.”

P. 97/98:

“greatest average happiness, these are no dreams of German metaphysics, but the leading thoughts of leading Englishmen and corner-stone conceptions, upon which rest whole systems of Adam Smith, of Jeremy Bentham, of John Mill, of Henry Sidgwick. Are they not all quantitative conceptions, best treated by means of the science of quantity?”

P. 98 discusses

P. 99 argues for taking “just perceivable increment” (so, **just noticeable difference**) as unit of utility:

“it is contended, not without hesitation, is appropriate to our subject.”

P. 100/101 argues that different perceptions of time should be incorporated in the intensity dimension; i.e., in instant utility.

P. 101 describes the “hedonimeter,” which is a machine to measure instant utility; described nicely the utility profiles and the integration into global utility:

“To precise the ideas, let there be granted to the science of pleasure what is granted to the science of energy; to imagine an ideally perfect instrument, a psychophysical machine, continually registering the height of pleasure experienced by an individual ... From moment to moment the hedonimeter varies; the delicate index now flickering with the flutter of the passions, now steadied by intellectual activity, low sunk whole hours in the neighbourhood of zero, or momentarily springing up towards infinity. The continually indicated height is registered by photographic or other frictionless apparatus upon a uniformly moving vertical plane. Then the quantity of happiness between two epochs is represented by the area contained between the zero-line, perpendiculars thereto at the points corresponding to the epochs, and the curve traced by the index;”

He “destroyed” the fun of Jevons, Walras, Menger, of using an additively

decomposable utility function by suggesting that it should be general. That is, the value of a commodity depends not only on the quantity of that commodity but also on the quantities of the other commodities. Seems to have introduced the technique of indifference curves.

Seems to write:

"if we suppose that capacity for pleasure is an attribute of skill and talent … we may see a reason deeper than Economics may afford for the larger pay, though often more agreeable work, of the aristocracy of skill and talent. The aristocracy of sex is similarly grounded upon the supposed superior capacity of the man for happiness. … Altogether … there appears a nice conciliance between the deductions from the utilitarian principle and the disabilities and privileges which hedge round modern womanhood."

Seems to have written:

"the first principle of Economics is that every agent is actuated only by self-interest."

Seems to have anticipated the ordinalist insight that often ordinal info is enough, by writing:

"atoms of pleasure are not easy to distinguish and discern … We cannot count the golden sands of life; we cannot number the 'innumerable smile' of seas of love; but we seem to be capable of observing that there is here a greater, there a less, multitude of pleasure-units, mass of happiness; *and that is enough*" [italics added]. %}

Edgeworth, F. Ysidro (1881) "Mathematical Physics, An Essay on the Application of Mathematics to the Moral Sciences."
Reprinted 1967, M. Kelley, New York.

{% **foundations of statistics** %}

Edwards, Anthony W.F. (1972) "*Likelihood.*" Cambridge University Press, New York.

{% %}

Edwards, Adrian & Glyn Elwyn (2006) "Inside the Black Box of Shared Decision Making: Distinguishing between the Process of Involvement and Who Makes the Decision," *Health Expectations* 9, 307–320.

{% Nice description of applications of decision analysis in the medical field. %}

Edwards, Adrian & Glyn Elwyn (1999) “The Potential Benefits of Decision Aids in Clinical Medicine” (editorial), *Journal of the American Medical Association* 282, 779–780.

{% **PT falsified**: §III.B lists some for original 1979 prospect theory.

Describes many empirical studies, oriented towards finance. Does not refer to Tversky & Kahneman (1992). Eqs. 1 & 2 give correct definitions of 1979 prospect theory.

risk averse for gains, risk seeking for losses: mentions several studies that find it. %}

Edwards, Kimberley D. (1996) “Prospect Theory: A Literature Review,” *International Review of Financial Analysis* 5, 18–38. https://doi.org/10.1016/S1057-5219(96)90004-6

{% %}

Edwards, Ward (1953) “Experiments on Economic Decision-Making in Gambling Situations,” *Econometrica* 21, 349–350. (Abstract)

{% **real incentives/hypothetical choice**: seems to investigate effects of real payments and seems to find differences but not counter-balanced, so may be the result of learning.

risk seeking for symmetric fifty-fifty gambles: probability-preference for 0.5 seems to be found. %}

Edwards, Ward (1953) “Probability-Preferences in Gambling,” *American Journal of Psychology* 66, 349–364.

{% A true classic. A marvelous survey of utility concepts in economics, conveying it to psychologists.

P. 380/381: economic decision theory is essentially an armchair method.

P. 381: end of 2nd para states that economists assume homo economicus (called economic man in this paper) to be rational.

P. 381, on infinite sensitivity: putting this nicely down as (too) technical;

P. 382, 2nd column, ℓℓ. 8-13 has a nice, soft, version of Friedman’s (1953) view: “The most useful thing to do with a theory is not to criticize its assumptions but rather to test its theorems. If the theorems fit the data, then the theory has at least heuristic merit." Edwards' thought is typical of empirically oriented people, who (cannot) learn from theoretical thinking and can only learn from what experiments show. It often bugs me if I use theoretical arguments to justify a new experimental measurement method, and meet experimental readers (referees …) who ignore those arguments.

p. 382: Probabilistic choice is not a modern concept. The text here already mentions it. P. 405: here is the special version of probabilistic choice that is sometimes called random utility: given utility, choice is deterministic, but still choice is random because utility is assumed random.

P. 385 explicitly links ordinal revolution in economics to behaviorist revolution in psychology. On Hicks & Allen (1934): "This paper was for economists something like the behaviorist revolution in psychology."

real incentives/hypothetical choice: p. 387: that economists don't like experiments with imaginary transactions.

P. 388 criticizes defense of intransitivity on the basis of **just noticeable difference** because latter is statistical concept

P. 390 suggests that message of Arrow (1951) is that one shouldn't do welfare theory at the ordinal level. (**Arrow's voting paradox ==> ordinality does not work**) I fully agree with this interpretation of Arrow's result.

P. 391 discusses **RCLA** (but not: second-order probabilities to model ambiguity)

P. 393-394: states Markowitz' (1952) reference dependence. So does p. 395 1st para penultimate para, and p. 400 1st column ℓ. −12.

P. 394: **risky utility u = transform of strength of preference v**: "Of course a utility function derived by von Neumann-Morgenstern means is not necessarily the same as a classical utility function … ."

P. 395 2nd column ℓ. 9-18 points out the basic difficulty of testing decision theories that only !one! real choice can be observed; see also p. 405

P. 395, very properly, and little understood in the field, points out that reference dependence is less plausible for nonmonetary outcomes: "This assumption is plausible for money, but it gets rapidly less plausible when other commodities with a less continuous character are considered instead."

real incentives/hypothetical choice: p. 396: Both real incentives and hypothetical choice is done. "It also turned out that on positive expected value bets, they were more willing to accept long shots when playing for real money than when just imagining or playing for worthless chips."

inverse S: for very small probabilities (**(very) small probabilities**), Edwards' following claim goes against it: p. 396: "subjects strongly preferred low probabilities of losing large amounts of money to high probabilities of losing small amounts of money—they just didn't like to lose."

utility measurement: **correct for probability distortion,** P. 396: suggests that measuring utility when nonlinear probability may be difficult. **tradeoff method** of Wakker & Deneffe (1996) show it's not so difficult! Edwards writes: "It may nevertheless be possible to get an interval scale of the utility of money from gambling experiments by designing an experiment which measures utility and probability preferences simultaneously. Such experiments are likely to be complicated and difficult to run, but they can be designed."

Pp. 396-398: S**EU = SEU** is properly discussed

P. 398 (e.g. Fig. 3): **biseparable utility**

P. 398 shows that prospect th. violates stoch. dom? No no no! Only that additivity implies that the probability transformation is the identity function. On basis of that argues that transformed probabilities should be interpreted as decision weights, not as expressions of probability.

P. 398 1st-2nd column: "One way of avoiding these difficulties is to stop thinking of a scale of subjective probabilities and, instead, to think of a weighting function applied to the scale of objective probabilities which weights these objective probabilities according to their ability to control behavior."

P. 400: argues for sign-dependence; i.e., different probability transformation for gains than for losses.

P. 401: the Samuelson game, people prefer sure outcome over gamble, but under 20 repetitions prefer the gamble. Erroneously considers this evidence against EU.

coherentism: p. 401: mentions that Allais and Coombs want to link probability and utility to psychophysical measurement.

P. 404: that intransitivity can be the result of indifference.

P. 405: that transitivity can never be really tested unless repeated [I add: or hypothetical] choice requiring constancy of choice.

game theory can/cannot be viewed as decision under uncertainty: p. 406:

"A scientist in his laboratory may be considered to be playing a game against Nature. (Note, however, that we cannot expect Nature to try to defeat the scientist.)" The last addition properly notes that there is a difference.

P. 409 criticizes maxmin approaches to uncertainty/ambiguity: "A very frequent criticism of the minimax approach to games against Nature is that Nature is not hostile, as is the opponent in a two-person game. Nature will not, in general, use a minimax strategy. For this reason, other principles of decision making have been suggested." %}

Edwards, Ward (1954) "The Theory of Decision Making," *Psychological Bulletin* 51, 380–417.
https://doi.org/10.1037/h0053870

{% **risk seeking for symmetric fifty-fifty gambles**: probability-preference for 0.5 seems to be found. %}

Edwards, Ward (1954) "Probability Preferences among Bets with Different Expected Values," *American Journal of Psychology* 67, 56–67.

{% **risk seeking for symmetric fifty-fifty gambles**: probability-preference for 0.5 seems to be found. %}

Edwards, Ward (1954) "The Reliability of Probability Preferences," *American Journal of Psychology* 67, 68–95.

{% **risk seeking for symmetric fifty-fifty gambles**: seems to find it. %}

Edwards, Ward (1954) "Variance Preferences in Gambling," *American Journal of Psychology* 67, 441–452.

{% nonlinearity in probabilities; Assumes, without further ado, that utility of receipt of N gambles is N times utility of one gamble (p. 203 3rd para). But this amounts to linear utility, contradicting the nonlinear utility assumed in this paper.

P. 201: "If it is reasonable to assume that subjective values of money should be substituted for objective values in Equation 1, it is equally reasonable to make the same assumption about probabilities."

linear utility for small stakes: argues that for small stakes (between −$50 and $50 in those days) utility is about linear, and probability transformation is more important than utility curvature

Edwards finds !!sign-dependence!! of probability weights

P. 209: Finds that people overestimate probabilities (enhancing risk seeking) for gains, and are about linear for probabilities of losing; says that is in agreement with common sense. Note that this is opposite to the current viewpoints.

Seems that no mixed gambles were considered, and that degree of loss aversion was simply positied. %}

Edwards, Ward (1955) "The Prediction of Decisions among Bets," *Journal of Experimental Psychology* 50, 201–214.

{% **updating: testing Bayes' formula** %}

Edwards, Ward (1961) "Probability Learning in 1000 Trials," *Journal of Experimental Psychology* 62, 385–394.

{% P. 120 etc: summary of his probability transformation exps.

P. 109: points out, very correctly, that for the fixed-outcome-probability-transformation model, utility should have a "true" zero; i.e., that location of utility is not free to choose.

SEU = SEU: P. 115 states explicitly that subjective probability !cannot! be function of objective probability alone. The author bases this on unpublished data where different events with same objective probability had different subjective probabilities depending on display etc. Also mentions that there would be logical difficulties; theorem 3 on p. 119, ascribed to Savage, gives a mathematical and appropriate theorem. This work is actually really good material on the **SEU = SEU** question. Savage's influences have clearly been useful here!

P. 116 uses the metaphor when a function (here subjective probability) depends on one variable (objective probability) but also on others, that there is a book with a page for each level of the other variables.

risk seeking for symmetric fifty-fifty gambles: P. 121: In gains, people prefer 50/50 gambles to others with same EV. In losses, subjects prefer small-prob-high-losses to others with same EV: this is all opposite to current empirical findings!

P. 126/127: "An old familiar finding in psychophysics is that the form of any subjective scale depends on the methods used to determine it. The same may be true for SP [subjective probability] and utility scaling." Voila framing, and a bit of the constructive view of

preference, avant la lettre.

P. 128 describes the kind of formulas needed for transformed probabilities. It distinguishes between entirely positive gambles, entirely negative ones, mixed ones. That is, quite already, exactly the distinction of prospect theory ’79!

biseparable utility %}

Edwards, Ward (1962) “Subjective Probabilities Inferred from Decisions,” *Psychological Review* 69, 109–135.

{% **updating: testing Bayes’ formula** %}

Edwards, Ward D. (1962) “Dynamic Decision Theory and Probabilistic Information Processing,” *Human Factors* 4, 59–73.

{% %}

Edwards, Ward (1962) “Utility, Subjective Probability, Their Interaction, and Variance Preferences,” *Journal of Conflict Resolution* 6, 42–51.

{% %}

Edwards, Ward (1992, ed.) “*Utility Theories: Measurement and Applications.*” Kluwer Academic Publishers, Dordrecht.

{% %}

Edwards, Ward, Harold R. Lindman, & Leonard J. Savage (1963) “Bayesian Statistical Inference for Psychological Research,” *Psychological Review* 70, 193–242.

{% No swing weights method %}

Edwards, Ward & J. Robert Neyman (1982) “*Multiattribute Evaluations.*” Sage, Beverly Hills.

{% **updating: mistakes in using Bayes’ formula** %}

Edwards, Ward; Lawrence D. Phillips, William L. Hays, & Barbara C. Goodman (1968) “Probabilistic Information Processing Systems: Design and Evaluation,” *IEEE Transactions on Systems, Man and Cybernetics* 4, 248–265.

{% %}

Edwards, Ward, David A. Schum, & Robert L. Winkler (1990) "Murder and (of?) the Likelihood Principle: A Trialogue," *Journal of Behavioral Decision Making* 3, 75–89.

{% %}

Edwards, Ward & Amos Tversky (1967, eds.) "*Decision Making: Selected Readings.*" Penguin, Harmondsworth.

{% %}

Eeckhoudt, Louis (1996) "Expected Utility Theory: Is It Normative of Simply "Practical"?," *Medical Decision Making* 16, 12–13.

{% **value of information** %}

Eeckhoudt, Louis, Philippe Godfroid, & Christian Gollier (2001) "Multiple Risks and the Value of Information," *Economics Letters* 73, 359–365.

{% Proposition 1: Assume stochastic background risk ε with only negative outcomes. Adding ε stochastically independent of all else always increases risk aversion iff decreasing absolute risk aversion. My alternative proof: Condition on every outcome of ε. Does not affect else because of stochastic independence, so, all conditional CEs (certainty equivalents) lower, so, unconditional CE lower too. Then result is extended to nonstochastic independence with Ross' (1981) extension, and to second stochastic dominance with prudence coming in. %}

Eeckhoudt, Louis, Christian Gollier, & Harris Schlesinger (1996) "Changes in Background Risk and Risk Taking Behavior," *Econometrica* 64, 683–689.

{% Do prudence, temperance, and so on, in a dual way, for Yaari's (1987) dual to EU. If the classical EU results can be proved on a comonotonic subdomain of acts, then the duality between EU on a comonotonic cone and Yaari's theory of Wakker & Yang (2021, IME) could be used.

The intro and first result of this paper show the following. Although preceding preference conditions in the literature for prudence in Eeckhoudt & Schlesinger

(2006) were presented in a model-free manner, they were still quite targeted towards EU. In particular, if imposed on Yaari's theory, they imply EU, i.e., subjective expected value. The authors write (p. x+2): "This result illustrates that while (primal) prudence and higher order risk attitudes are often presented as being model free, and rightfully so, they may have, at the same time, no specific meaning outside EU."

P. 3 last para: "A positive sign of the third derivative of the probability weighting function is consistent with an "inverse S-shape" ,"

Very unfortunately, the authors do not use the nowadays (1990-2023) common top-down integration, transforming decumulative probabilities ("starting with the best"), but the other way around, bottom-up, transforming cumulative probabilities ("starting with the worst"). Means that concavity of probability weighting in this paper is what is commonly convexity today. Also means that common parametric families such as Prelec's mean a different thing here than what they mean commonly. I encourage everyone to follow the current convention because otherwise citing their work is problematic. %}

Eeckhoudt, Louis R., Roger J.A. Laeven, & Harris Schlesinger (2020) "Risk Apportionment: The Dual Story," *Journal of Economic Theory* 185, 104971. https://doi.org/10.1016/j.jet.2019.104971

{% The title may at first seem to be not nice because praising itself, but it is a clever pun, as someone explained to me. Prudence is about putting two risks together or separate, so, putting them in the right place.

First para says that economists will not likely define risk aversion as a behavioral property. Second says that with prudence it is different and cites Gollier (2001) on a behavioral definition. The paper assumes EU. Although they don't say, [x,y] denotes a lottery (they do say it's equal-probability).

P. 282 (citing others for it): Prudence if $(I-k)_{0.5}(I+\varepsilon) \geq I_{0.5}(I-k+\varepsilon)$, where I denotes initial wealth, k>0 is a sure amount, and ε a random variable with 0 expectation. It is reminiscent of multiattribute risk aversion and is equivalent to $U''' \geq 0$. P. 287 points out that prudence is weaker than decreasing absolute risk aversion. This paper adds similar conditions with more complex ingredients than k and ε to characterize signs of higher-order derivatives of utility. Something like

$(0+B_{n-2})_{0.5}(\varepsilon+A_{n-2}) \leq (0+A_{n-2})_{0.5}(\varepsilon+B_{n-2})$ with all ε independent is equivalent

to alternating signs of derivatives. It is inductively, where An and Bn are defined by adding previously defined random variables. Pretty! %}

Eeckhoudt, Louis & Harris Schlesinger (2006) “Putting Risk in Its Proper Place,” *American Economic Review* 96, 280–289. https://doi.org/10.1257/000282806776157777

{% **updating: discussing conditional probability and/or updating** %}

Eells, Ellery (1982) “*Rational Decision and Causality*.” Cambridge University Press, New York, pp. 185–187.

{% **updating: discussing conditional probability and/or updating**; discussions about Jeffrey’s model. Conditional upon event E means when E is true, not necessarily when !you know that! E is true. Gives the famous Ramsey p. 180 reference to the issue. “Learning with detachment” means you hear in some way that E is true but do not know that you know it. Conditioning should be like learning with detachment. Examples that !knowing that E! can matter are based on hidden information such as in Kreps & Porteus (1978). %}

Eells, Ellery (1987) “Learning with Detachment: Reply to Maher,” *Theory and Decision* 22, 173–180.

{% **updating: discussing conditional probability and/or updating** %}

Eells, Ellery (1988) “On the Alleged Impossibility of Inductive Probability,” *British Journal for the Philosophy of Science* 39, 111–116.

{% **foundations of statistics** %}

Efron, Bradley (1998) “R.A. Fisher in the 21st Century,” *Statistical Science* 13, 95–122.

{% Study insensitivity regions. Discuss a heuristic of it, show the heuristic does not always work. We have $w(p) \geq w(p+r) - w(r)$ for all r in [0,b] if and only if $\inf_{r \in [0,b]}(w(p + w(r) - w(p+r)) \geq 0$ and the paper uses this as a starting point for necessary and sufficient conditions. %}

Egozcue, Martin, Luis Fuentes Garcia, & Ricardas Zitikis (2022) "The Slicing Method: Determining Insensitivity Regions of Probability Weighting Functions," *Computational Economics* 61, 1369–1402. https://doi.org/10.1007/s10614-022-10252-8

{% Analyzes time complexity of rank-dependent utility (RDU). For single lottery, is O(n). Dependence on parameter usually: O(n^3). Paper reduces the latter to O(n log n). Can do using spreadsheet. %}

Egozcue, Martin & Luis Fuentes Garcia (2024) "Time Complexity Analysis of Rank-Dependent Utility with Parameter Dependence with an Application to Hedging Strategies," working paper.

{% **proper scoring rules**; scoring rules for quantiles and the like can be written as convenient linear combinations. %}

Ehm, Werner, Tilmann Gneiting, Alexander Jordan, & Fabian Krüger (2016) "Of Quantiles and Expectiles: Consistent Scoring Functions, Choquet Representations and Forecast Rankings," *Journal of the Royal Statistical Society, Ser. B*, 78, 505–562.

{% Define self-protection as expenditure on reducing the probability of suffering a loss (crime-prevention, fire prevention, and so on), also called loss prevention, and to be distinguished from self-insurance (also called loss protection), which is the expenditure on reducing the severity of a loss. Cite earlier works on these concepts. The former can be complement to market insurance, whereas the latter is substitute. Self-protection (also called protective action) is the same as probabilistic insurance! Is also pointed out by Kahneman & Tversky (1979 p. 270). Pp. 639-640 point out that self-protection does not depend much on risk attitude, which is because they use EU to analyze risk, thus not capturing probabilistic risk attitudes. Self-protection was called probabilistic insurance by Kahneman & Tversky (1979) and by Wakker, Thaler, & Tversky (1997).

P. 641: moral hazard means that market insurance reduces value of self-protection. %}

Ehrlich, Isaac & Gary Becker (1972) "Market Insurance, Self-Insurance and Self-Protection," *Journal of Political Economy* 80, 623–648.

{% %}

Eichberger, Jürgen (1989) "A Note on Bankcuptcy Rules and Credit Constraints in Temporary Equilibrium," *Econometrica* 57, 707–715.

{% %}

Eichberger, Jürgen & Simon Grant (1997) "Dynamically Consistent Preferences with Quadratic Beliefs," *Journal of Risk and Uncertainty* 14, 189–207.

{% %}

Eichberger, Jürgen & Simon Grant (1997) "Dynamically Consistent Preferences, Quadratic Beliefs, and Choice under Uncertainty," Robert F. Nau, Erik Gr∅nn, Mark J. Machina, & Olvar Bergland (eds.) *Economic and Environmental Risk and Uncertainty*, 195–205, Kluwer, Dordrecht.

{% **dynamic consistency. NonEU & dynamic principles by restricting domain of acts**; %}

Eichberger, Jürgen, Simon Grant, & David Kelsey (2005) "CEU Preferences and Dynamic Consistency," *Mathematical Social Sciences* 49, 143–151.

{% **dynamic consistency**: **favors abandoning time consistency, so, favors sophisticated choice; updating: nonadditive measures**

Characterize the full Bayesian update for Choquet expected utility, using consequentialism and some other conditions. %}

Eichberger, Jürgen, Simon Grant, & David Kelsey (2007) "Updating Choquet Beliefs," *Journal of Mathematical Economics* 43, 888–899.

{% A didactical paper that presents some α-maxmin models. %}

Eichberger, Jürgen, Simon Grant, David Kelsey (2008) "Differentiating Ambiguity: An Expository Note," *Economic Theory* 36, 327–336.

{% **updating: nonadditive measures**: This paper examines updating under Choquet expected utility (I nowadays (1990-2023) prefer the name RDU also for uncertainty). Preceding works all built on the assumption of universal ambiguity aversion, which is violated empirically. This paper considers the empirically more realistic neo-additive capacities and an appealing but more mathematical variation, JP capacities (introduced by Jaffray & Philippe), and obtains consistency results for updating there (attitude to ambiguity is not affected by updating). As the authors point out in their footnote 1 (p. 240) there is no behavioral foundation of JP yet except for the special case of neo-additive. For JP capacities, consistency under updating can only be for the special case of neo-additive. Nice that this class is closed under generalized Bayesian updating (shown by the authors in 2010, EL, GBU is the updating of nonadditive measures favored by the authors).

P. 241 nicely relates consistency under updating to conjugacy in Bayesian statistics.

nonadditive measures are too general: p. 241 writes that general nonadditive measures are too general, growing exponentially in number of states. %}

Eichberger, Jürgen, Simon Grant, & David Kelsey (2012) "When is Ambiguity–Attitude Constant?," *Journal of Risk and Uncertainty* 45, 239–263. http://dx.doi.org/10.1007/s11166-012-9153-5

{% **dynamic consistency**: critically discuss the ordering of stages of events in the Anscombe-Aumann framework, and how modern papers make implicit assumptions about it. (**criticism of monotonicity in Anscombe-Aumann (1963) for ambiguity**) %}

Eichberger, Jürgen, Simon Grant, & David Kelsey (2016) "Randomization and Dynamic Consistency," *Economic Theory* 62, 547–566. https://doi.org/10.1007/s00199-015-0913-8

{% They show that for finite state spaces the α-maxmin model of Ghirardato, Maccheroni, & Marinacci (JET, 2004) only allows for $\alpha = 0$ or $\alpha = 1$, which takes the heart out of the model. %}

Eichberger, Jürgen, Simon Grant, David Kelsey, & Gleb A. Koshevoy (2011) "The Alpha-Meu Model: A Comment," *Journal of Economic Theory* 48, 1684–1698. https://doi.org/10.1016/j.jet.2011.03.019

{% **EU+a*sup+b*inf**. A generalized neo-additive capacity (GNAC) has a more rigid definition of the impossible and certain events where the capacity is 0 or 1, relative to Chateauneuf, Eichberger, & Grant (2007). Thus, it allows for a capacity flat 0 in a neighborhood of p = 0 and flat 1 in a neighborhood of p = 1, but then linear in between those flat parts. That is, it allows for oversensitivity. The authors axiomatize it under Choquet expected utility by some dynamic decision principles, via updating (**updating: nonadditive measures**). Such principles quickly restrict to SEU. Here, because null events are to be treated differently, they escape from SEU and this leads to GNAC.

P. 249 §4.3 1st line ascribes the term cavex to Wakker (2001), but Wakker learned the term from Jaffray. %}

Eichberger, Jürgen, Simon Grant, & Jean-Philippe Lefort (2012) "Generalized Neo-Additive Capacities and Updating," *International Journal of Economic Theory* 8, 237–257.

{% **CBDT**; generalize results of Billot, Gilboa, Samet, & Schmeidler (2005). %}

Eichberger, Jürgen & Ani Guerdjikova (2010) "Case-Based Belief Formation under Ambiguity," *Mathematical Social Sciences* 60, 161–177.

{% **CBDT**;. %}

Eichberger, Jürgen & Ani Guerdjikova (2013) "Ambiguity, Data and Preferences for Information— A Case-Based Approach," *Journal of Economic Theory* 148, 1433–1462.

{% **dynamic consistency**: **favors abandoning forgone-event independence, so, favors resolute choice**; end of §3 suggests that uncertainty aversion is the empirical finding. %}

Eichberger, Jürgen & David Kelsey (1996) "Uncertainty Aversion and Dynamic Consistency," *International Economic Review* 37, 625–640.

{% Argue that in one-stage approach there can be no universal preference for randomization, contrary to two-stage Anscombe-Aumann where Schmeidler used it to characterize convexity and ambiguity aversion etc. Wakker (2010, §11.6)

called Schmeidler's equation of ambiguity aversion with preference for probabilistic mixing a historical accident. %}

Eichberger, Jürgen & David Kelsey (1996) "Uncertainty Aversion and Preference for Randomisation," *Journal of Economic Theory* 71, 31–41.

{% Seem to axiomatize the ε-contamination model (subclass of maxmin EU) for linear utility. %}

Eichberger, Jürgen & David Kelsey (1999) "E-Capacities and the Ellsberg Paradox," *Theory and Decision* 46, 107–140.

{% %}

Eichberger, Jürgen & David Kelsey (2002) "Strategic Complements, Substitutes and Ambiguity: The Implications for Public Goods," *Journal of Economic Theory* 106, 436–466.

{% **game theory for nonexpected utility**; Equilibrium in two-person game with Dempster-Shafer updating (**updating: nonadditive measures**) %}

Eichberger, Jürgen & David Kelsey (2004) "Sequential Two-Player Games with Ambiguity," *International Economic Review* 45, 1229–1261.

{% This paper re-analyzes five of the ten games analyzed in the pretty (but not very innovative) Goeree-Holt (2001 American Economic Review) paper, being the five static ones. It reanalyzes those using the neo-additive ambiguity models. The new approach using those neo-additive ambiguity models can be formulated, and understood, without much knowledge of RDU or neo-additive: Everything as usual, with randomized strategies, the only difference being that in the EU calculations one adds overweighted the minimal and maximal "possible' (specified later) outcomes (also if probability 0 of happening). It is psychologically plausible and gives interesting new equilibria, as the paper shows. So, nice!

Formal details on RDU with neo-additive are: There are two ways to do neo-additive for uncertainty, with different interpretations of "possible." Both use a subjective probability measure. The first is probabilistically sophisticated where a neo-additive probability weighting function is applied. Then all events with probability 0 are ignored. (For infinitely many outcomes one'd have to take infimum and supremum over some minimal support, to be defined properly). The second is the one used in this paper, where the sup and inf outcomes of the whole image of the act are overweighted. Then events of probability 0 that are still logically possible (so, nonempty) do count as regards sup and inf outcome. For general nonadditive weighting functions the definition of support is problematic (decision weight 0 with one rank (or in one comonotonic set) need not be decision weight 0 in another). One can take support maximal (as soon as positive decision weight somewhere, like Savage) or minimal (ony if positive decision weight everywhere), or in a particular rank-dependent way. The problems are a bit less for neo-additive. The authors take support of the subjective probability measure. Equilibrium under ambiguity requires that all strategies in the support are optimal. Now optimal means SEU with extra weight for the sup and inf outcomes, which given finiteness of actions means max and min outcome. (**game theory as ambiguity**) %}

Eichberger, Jürgen & David Kelsey (2011) "Are the Treasures of Game Theory Ambiguous?," *Economic Theory* 48, 313–393.

{% Analyze games assuming CEU (Choquet expected utility), with Jaffray & Philippe (1997) weighting functions. Those are a convex combination of a pessimistic weighting function and its dual and, thus, can accommodate optimism. CEU with these is a special case of α maxmin. The authors propose a definition of support and analyze the existence of equilibria, generalizing previous results, in particular of their 2011 paper. They seem to show that with neo-additive capacities, an equilibrium always exists. %}

Eichberger, Jürgen & David Kelsey (2014) "Optimism and Pessimism in Games," *International Economic Review* 55, 483–505.

{% **game theory as ambiguity**: firm effects of ambiguity on strategy choices versus various opponents. %}

Eichberger, Jürgen, David Kelsey, & Burkhard C. Schipper (2008) "Granny versus Game Theorist: Ambiguity in Experimental Games," *Theory and Decision* 64, 333–362.

{% Allow subjects to express indifference. Use a beautiful incentivization of indifference: They then do not randomize choice (which would bring in risk and thus be a horrible confound in a study of ambiguity), but just give one option to half of the subjects, and another to the other half, and find no significant differences between the two treatments.

Just like Dominiak & Schnedler (2011), they do not find Schmeidler's (1989) ambiguity aversion. Wakker (2010, §11.6) called Schmeidler's equation of ambiguity aversion with preference for probabilistic mixing a historical accident.

ambiguous outcomes vs. ambiguous probabilities: Although the authors interpret uncertainty about outcomes as a different concept of uncertainty than what is captured in state spaces, I interpret this uncertainty as a more complex state space, with uncertainty both about the color of the ball drawn and the type of envelope.

In O (open envelope; subjects see if it contains €1 or €3) and R (random envelope, containing €1 or €3 fifty fifty) the authors find ambiguity aversion as usual, but in S (sealed envelope; €1 or €3 but subjects just don't know) they find less.

In treatment S, there is ambiguity everywhere because of the envelopes. In this treatment, also for urn H there is ambiguity. Given that the envelopes are ambiguous already, urn U does not add much ambiguity to it, and is close to urn H. So, then plausible that subjects are indifferent. In the other treatments, urn H has no ambiguity but urn U does, so, subjects prefer H. %}

Eichberger, Jürgen, Jörg Oechssler, & Wendelin Schnedler (2015) "How Do Subjects View Multiple Sources of Ambiguity?," *Theory and Decision* 78, 339–356. https://doi.org/10.1007/s11238-014-9428-1

{% Jaffray (1989 Operations Research Letters) introduced a beautiful framework for ambiguity, using belief functions. See my annotations there. Good thing that his framework be used more often. Gul & Pesendorfer (2014, 2015) basically used it.

This paper also does so. In particular, it uses different evaluations at various stages than Jaffray did. In the first stage, uncertainty is resolved with known probabilities, i.e., it is risk. Then in the second stage a case results of complete ignorance: one knows the set of possible outcomes, and nothing more.

Jaffray applied his model of complete ignorance in the spirit of Cohen & Jaffray (1980), where such a situation is evaluated by an α maxmin approach: A convex mix of the inf and supp utility, where the mixing weight reflects ambiguity aversion. This paper instead adopts the principle of insufficient reason for complete ignorance, taking average utility over the set of outcomes with utility function denoted $\varphi \circ u$. For the first-stage probabilities Jaffray does "just" expected utility maximization. This paper generalizes in a recursive expected utility (smooth utility) sense, by adding in an extra transformation, denoted φ^{-1}. Jaffray captures ambiguity attitude through α in the 2nd stage, and this paper through how the utility function in the 2nd stage differs from the 1st stage. Whereas in the smooth model ambiguity aversion corresponds with a more concave utility function in the 1st stage, this paper has that in the 2nd stage (Proposition 13).

I think that this paper is an improved version of the smooth model because the events conditioned on in the first stage here have objective probabilities, and such are better suited for conditioning on. This paper is a kind of reversed Anscombe-Aumann framework, as initiated by Jaffray. (**criticism of monotonicity in Anscombe-Aumann (1963) for ambiguity**)

P. 11 §2.1 mentions that Jaffray used a monotonicity axiom to axiomatize his α maxmin evaluation in the second stage, but does not discuss it further. Let me explain here how their average utility model violates it. Assume three events E_1, E_2, E_3, giving outcomes (in utility units) 1,8,9, respectively, giving average utility 6. Imagine we improve the outcome under event E_2 from 8 to 9. Now the outcome set is {1,9} giving average 5: monotonicity is violated. %}

Eichberger, Jürgen & Illia Pasichnichenko (2021) "Decision-Making with Partial Information," *Journal of Economic Theory* 198, 105369. https://doi.org/10.1016/j.jet.2021.105369

{% %}

Eichhorn, Wolfgang (1978) "*Functional Equations in Economics.*" Addison Wesley, London.

{% %}
Eichhorn, Wolfgang (1988, ed.) "*Measurement in Economics (Theory and Applications of Economic Indices).*" Physica-Verlag, Heidelberg.

{% **real incentives/hypothetical choice, for time preferences**: With Amazone gift certificates. Seems to use willingness to wait, and price list.

decreasing/increasing impatience: Seems to find opposite of presence effect, with constant discounting after. So, as quite some studies, the very opposite of quasihyperbolic discounting. %}
Eil, David (2012) "Hyperbolic Discounting and Willingness-to-Wait,"

{% **one-dimensional utility**; Ghanshyam Mehta told me on March 15, 2000: Eilenberg proved the Debreu (1954) result for connected separable topologies. Debreu refers to him and gives a different proof. The Debreu result for second countable topologies is not here. Much of the latter, in particular the gap idea, can be recognized in a work by Wold who did not elaborate. %}
Eilenberg, Samuel (1941) "Ordered Topological Spaces," *American Journal of Mathematics* 63, 39–45.

{% %}
Einav, Liran (2005) "Informational Asymmetries and Observational Learning in Search," *Journal of Risk and Uncertainty* 30, 241–259.

{% **violation of risk/objective probability = one source**: Consider how risk aversion is related for subjects across six different contexts, five insurance decisions and one investment decision. Use nice real data (health-related employer-provided insurance coverage decisions) with some N = 13,000 subjects. Find relations, but not very strong.

One analysis, theory-free, considers the ranking of subjects from most to least risk averse in each of the six contexts. That is, to what extent is the most risk averse subject in one context also so in another context? The authors argue that

this way they do not need the many assumptions to be made in theoretical (structural) analyses, such as what are the probabilities and losses for each subject in each context. But I think that this is also relevant for the theory-free analysis where it is now ignored. For example, the apparently most risk averse subject for health insurance may in reality not be risk averse at all there, but simply have bad probabilities there because of bad health.

The other analysis fits EU with CARA (and also CRRA) utility to fit the risky choices, bringing in things such as initial wealth, but I guess not other individual-specific info. For each individual and each context, an interval is calculated for the CRRA risk aversion parameters that accommodate the choices observed. Then it is inspected to what extent these intervals have overlap, so do not contradict each other.

The data set and questions considered are fascinating, but because of lacking info it is hard to interpret the results. %}

Einav, Liran, Amy Finkelstein, Iuliana Pascu, & Mark R. Cullen (2012) "How General Are Risk Preferences?: Choices under Uncertainty in Different Domains," *American Economic Review* 102, 2606–2638.

{% P. 26 bottom:

"this review has tried to place behavioral decision theory within a broad psychological context"

%}

Einhorn, Hillel J. & Robin M. Hogarth (1981) "Behavioral Decision Theory: Process of Judgement and Choice," *Annual Review of Psychology* 32, 53–88.

{% An impressive paper on ambiguity. Probably the first to seriously put forward the concept of likelihood insensitivity/ **inverse S**, although empirical studies such as Preston & Baratta (1948) had found the phenomenon before (in their case for risk). Those empirical studies did not discuss the concepts though.

They use an anchoring-and-adjustment model for ambiguity. Their theory is explained on pp. 436-439, but I find the details not so interesting. I next give an account that more easily gives the esssence, I think:

There is a first-best-guess probability p_A of the ambiguous event A. It will be modified into a weight, which they denote $S(p_A)$, because of ambiguity, with parameters as follows.

(1) Parameter theta captures the degree of ambiguity.

theta = 0: no ambiguity; theta = 1: maximal ambiguity.

(2) Parameter beta captures under/over weighting.

0 < beta < 1: underweighting; beta > 1: overweighting.

Decision-oriented economists and people exposed to rank-dependent models will now ask: Does the over/under weighting apply to weights of best or worst outcomes? This makes all the difference for the behavioral implications, about whether we get aversion or the exact opposite, seeking. The answer is: neither! The authors did not know about rank dependence. They had in mind the old Edwards-type transformation of separate-outcome probabilities (separable prospect theory), rather than cumulative probabilities. Their decision experiment, Experiment 3, only involves prospects with only one nonzero outcome. There, the old formulas agree with modern 1992 prospect theory, both for gains and losses, so that things are fine there. Their finding of inverse S, likelihood insensitivity, therefore agrees with modern findings. For general prospects, with two or more nonzero outcomes, the behavioral effect of over- underweighting can best be qualified as random. Those old formulas just were no good.

The total overweighting is increasing in theta and beta, as if it was their product, although the actual function is different than a product. If one wants to know exactly how the maths in their model works, one can study their Section “A descriptive model,” pp. 436-439, but I think that this is not worth one’s time. Must say that I found their formulas not very interesting. For completeness, here they are: The authors take $S(p_A) = (1-\theta)p_A + \theta(1-p_A^{\beta})$ (Eq. 6b, p. 437). The parameter θ reflects degree of inverse S (for $\beta = 1$ a large $\theta \leq 0.5$ moves the weight towards 0.5; the authors assume $\theta \leq 1$ but $\theta > 0.5$ does not make much sense, leading to weights decreasing in p_A for $\beta = 1$), and β reflects source preference.

They allow both parameters to depend on both the decision situation and the agent (p. 438 2nd column 2nd para), so, they do not commit to agent-independence of theta and situation-independence of beta, contrary to many ambiguity models popular in 2020, the year when I write this summary of their theory. (I have known this paper since 1989, when I worked in a psychology department in Nijmegen and a colleague recommended the paper to me.) But they do write, p. 437 clumn 1 ℓ. 12-13: "Attitude toward ambiguity is denoted by β,"

The anchoring-and-adjustment procedure makes sense for the stimuli that the authors use, where always an anchoring probability is salient; and it can be put on the x-axis for graphs. It does not hold for ambiguity in general, because in many situations of ambiguity there is no particular anchor probability. For virtually all ambiguity models popular in 2020, probabilities are specified in some sense still.

Inverse S is indeed perceptual/cognitive and not motivational, as confirmed by Hogarth (personal communication, March 9, 2007, 11:55 AM, in Barcelona): **cognitive ability related to likelihood insensitivity (= inverse S)**

P. 434 lines 6-10: the authors' model is descriptive, and not normative.

inverse S is found; **ambiguity seeking for unlikely**: p. 435 cites Ellsberg on it and p. 439 Gärdenfors & Sahlin (1982); their model also has it (e.g., Fig. 2). Tversky criticized this work because the authors do not properly reckon with statistical regression to the mean (e.g., p. 454 2nd column lines 7-9), and their inverse S may be just that.

uncertainty amplifies risk: p. 439: "Thus, although the domain of our theory is different from that of prospect theory [which then only concerned risk with known probabilities], we believe that it is not coincidental that the treatment of uncertainty is so similar." They do not really claim amplification, but, at least, similar spirit.

Their data "confirm" their model, though they don't discuss the issue of **ambiguity seeking for unlikely** explicitly in the results and discussion. That is, the paper does not make clear if there is ambiguity seeking for unlikely. P. 453: Judged probabilities show inverse S-shape, and choices suggest transformation downwards of judged probability.

When they use the term "source" they mean something like an expert, being a source of information about the uncertain states of nature. So, source does not have the same meaning as in the works initiated by Tversky in the early 1990s.

Most of their tests are on non-choice-based data. Experiment 3 tests predictions of their model for prospect choices, but uses a very weak test (whether their model is better than completely random choice).

biseparable utility: they do not clearly specify a decision theory with, for instance, weights related to best and not to worst outcomes or vice versa. They seem to have separate event weighting (like separable prospect theory but with events instead of probabilities) in mind.

event/outcome driven ambiguity model: event driven %}

Einhorn, Hillel J. & Robin M. Hogarth (1985) "Ambiguity and Uncertainty in Probabilistic Inference," *Psychological Review* 92, 433–461. https://doi.org/10.1037/0033-295X.92.4.433

{% **inverse S** is found; **ambiguity seeking for unlikely**: p. 230 states it; their model assumes it (see p. 232/233); for gains, their data don't find it clearly, a majority still prefers the unambiguous urn for p = .001, be it nonsigificantly (60, against 48 preferring the ambiguous urn, p = .144, see Table 1 on p. S237). Still, in the text the authors write as if ambiguity seeking for unlikely has been confirmed. This writing is misleading! For losses they find clear ambiguity aversion for unlikely, weaker but still significant at p = .5 (Table 1), and maybe some preference for p > .5 though only in the buyers paradigm (Tables 2 and 3, p. 242/243); so: mixed evidence on: **ambiguity seeking for losses**. They also repeat in many places that weighting functions should be sign-dependent and properly credit Edwards (1962) for that (e.g. p. S245). Dobbs (1991), footnote 1, points out that what the authors consider an ambiguous probability may be biased upwards. Heath & Tversky (1991) do that too.

reflection at individual level for ambiguity: Experiment 4 has losses, but also asymmetric info, and does not report on it. Dobbs (1991) says they did gain-loss between-subjects. %}

Einhorn, Hillel J. & Robin M. Hogarth (1986) "Decision Making under Ambiguity," *Journal of Business* 59, S225–S250.

{% **updating: discussing conditional probability and/or updating;** A classic it seems. %}

Einhorn, Hillel J. & Robin M. Hogarth (1992) "Order Effects in Belief Updating: The Belief-Adjustment Model," *Cognitive Psychology* 24, 1–55.

{% "the supreme goal of all theory is to make the irreducible basic element as simple and as few as possible without having to surrender the adequate representation of a single datum of experience." (p. 165 3rd para) %}

Einstein, Albert (1934) “On the Method of Theoretical Physics,” *Philosophy of Science* 1, 163–169.

{% %}

Eisenberg, John M. (1989) “A Guide to the Economic Analysis of Clinical Practices,” *Journal of the American Medical Association* 262, 2879–2886.

{% **natural sources of ambiguity**: For the natural event (performance of a stock) they take sum of WTP (the same for WTA) for event and its complement, which in a way a bit corrects for belief given linear utility.

N = 80; WTP-WTA both for positive gamble (on known urn, unknown urn, and two natural events) and on that gamble multiplied by −1.

ambiguity seeking for losses: Ambiguity aversion for both gain measurements, significant ambiguity aversion for one loss-measurement, and ambiguity neutrality for another. They were WTP WTA questions. The WTP-WTA ratio did not depend on ambiguity, and neither on sign, in support of reflection.

losses from prior endowment mechanism: Did random incentive system, with DM 10 prior endowment, so that they could cover losses. Use BDM (Becker-DeGroot-M **utility depends on probability**).

Find that WTP/WTA discrepancy does not interact with ambiguity. This is remarkable because most people would predict that the discrepancy increases with ambiguity. This is empirical evidence against Bewley’s (1982, 2002) model, and also weakly against: **uncertainty amplifies risk**.

P. 224 gives careful categorization of WTP/WTA whether it means giving away a gamble already possessed or otherwise, so, things that are often confused in the literature.

reflection at individual level for ambiguity: Although they have the within-subject data, they do not report it because they are only interested in WTP/WTA. Their WTA(+) versus WTA(−), especially their correlations, would have been a test of reflection at the individual level. (WTP(+) versus WTA(−) less so because they concern mixed prospects.) %}

Eisenberger, Roselies & Martin Weber (1995) “Willingness-to-Pay and Willingness-to-Accept for Risky and Ambiguous Lotteries,” *Journal of Risk and Uncertainty* 10, 223–233.
https://doi.org/10.1007/BF01207552

{% %}
Eisenführ, Franz & Martin Weber (1992) “*Rationales Entscheiden.*” Springer, Berlin. (3rd edn. 1999.)

{% %}
Eisenhauer, Joseph G. (2006) “How a Dummy Replaces a Student’s Test and Gets an F (Or, How Regression Substitutes for t tests and ANOVA),” *Teaching Statistics* 28, 78–80.

{% Surveys Stevens power law for subjective perceptions. For time perception seems to find $t^{0.9}$ as good fit. Nice for unit invariance model interpreting it as constant exponential discounting but with nonlinear perception of time $t \mapsto t^r$. %}
Eisler, Hannes (1976) “Experiments on Subjective Duration 1968-1975: A Collection of Power Function Exponents,” *Psychological Bulletin* 83, 1154–1171.

{% %}
Eisner, Robert & Robert H. Strotz (1961) “Flight Insurance and the Theory of Choice,” *Journal of Political Economy* 69, 350–368.

{% P. 102 seems to cite the mathematician Hector Sussman: “In mathematics, names are free. It is perfectly allowable to call a self adjoint operator an elephant, and a spectral resolution a trunk. One can then prove a theorem, whereby all elephants have trunks. What is not allowable is to pretend that this result has anything to do with certain large gray animals.” %}
Ekeland, Ivar (1990) “*Mathematics and the Unexpected*.” University of Chicago Press, Chicago.

{% Multivariate extensions %}
Ekeland, Ivar, Alfred Galichon, & Marc Henry (2012) “Comonotonic Measures of Multivariate Risks,” *Mathematical Finance* 22, 109–132.

{% %}
Ekholm, Gordon F. (1945) "Wheeled Toys in Mexico," *American Antiquity* 11. 222–228.

{% Shows that the power law for numerical matching can be considered a special case of Fechner's logarithmic law and cross-modality matching. (If c + d*ln* N is to be equated with a + b*ln* S then N = βS^r.), and that people may perceive numbers in a nonlinear manner. %}
Ekman, Gösta (1964) "Is the Power Law a Special Case of Fechner Law," *Perceptual and Motor Skills* 19, 730.

{% **updating: testing Bayes' formula**; nice experiment on updating, w.r.t. collecting from urns. Find mostly ignoring prior, and less conservativeness.
real incentives/hypothetical choice: it makes a difference. %}
El-Gamal, Mahmoud A. & David M. Grether (1995) "Are People Bayesian? Uncovering Behavioral Strategies," *Journal of the American Statistical Association* 90, 1137–1145.

{% **natural sources of ambiguity**: This paper, a followup on Kemel & Mun (224), but published very fast, measures the indexes of Baillon et al. (2018 Econometrica) by measuring matching probabilities of natural events. It also derives beliefs (a-neutral probabilities) as can be done. It uses source theory. A novelty is that it does so both for gains and losses, so that it can investigate sign dependence. It is desirable that beliefs are not sign dependent. The paper indeed does not find sign dependence of a-neutral probabilities. Because they get the a-neutral probabilities, they can see how these are mapped to matching probabilities (gambling-equivalent objective probabilities), and this mapping can be called the ambiguity function, fully capturing ambiguity attitudes (Dimmock, Kouwenberg, & Wakker 2016 Theorem 3.1). The authors find that ambiguity attitudes are not reflected between gains and losses, but that ambiguity aversion for gains corresponds with ambiguity aversion for losses. (**reflection at individual level for ambiguity**) Thus, the source function for losses is found to be the dual of

those for gains. They use the Goldstein-Einhorn family to fit data, which is my favorite parametric family.

The authors consider two different natural sources of uncertainty, but find similar attitudes and source functions between the two, although they are different than for the risky source (otherwise there would be ambiguity neutrality). %}

El Guide, Mohamed, Yassine Kaouane, Sonia Mun, & Hayat Zouiten (2025) "Attitudes towards Natural Sources of Uncertainty for Gains and Losses," *Theory and Decision*, forthcoming.
https://doi.org/10.1007/s11238-024-10018-8

{% The author argues that imprecise probabilities are irrational, by making simple book against it. In it, the author implicitly assumes a well-known additivity condition (see, e.g., Wakker 2010). This happens on p. 5 left column penultimate para. It is less implicit on p. 9, right column, 2nd half and, again, p.10 left column last para above §11. There the author mentions the condition but as if completely self-evident, not realizing how restrictive the condition is, in fact implying expected value maximization and, e.g., excluding any hedging considerations. %}

Elga, Adam (2010) "Subjective Probabilities Should Be Sharp," *Philosopher's Imprint* 10, 1–10.

{% Seems to have been the first to do risky utility measurement assuming response errors. %}

Eliashberg, Jehoshua R. & John R. Hausner (1985) "A Measurement Error Approach for Modeling Consumer Risk Preference," *Management Science* 31, 1–25.

{% Was presented at RUD 2011 under title; "A Variation on Ellsberg"

Consider Ellsberg 3-color urn, with 20 black chips and 40 red or yellow chips in unknown proportion. I regret that the authors did not follow Ellsberg in letting red be the known-probability color, but instead took black.

They consider correlated ambiguities, where a prize won for instance depends on the composition of then urn. A difficulty is that the results are not easy to interpret, because ambiguity neutral players will not be indifferent between the different stimuli.

Let there be r red balls. They consider ambiguous probability as usual (receive $20 if red), but also ambiguous outcome (receive $r if black), ambiguous time (receive $20 in r days), and positively correlated ambiguity in probability and outcome (receive $r if red). Ambiguous outcome is most ambiguous because the outcome can be anything between $40 and $0, and these outcomes in fact do have unknown probability (we do not know the probability of receriving $40, $39, and so on, because we do not know the probability of r having these values), and it indeed is the ambiguity most dispreferred. Note that here the meta-ambiguity, the uncertainty about r, plays a role. One could say that not only the color drawn, but also the composition of the urn, now is outcome-relevant, so that beliefs and uncertainty and most elementary state space become different.

Ambiguity in time is dispreferred the least. This is not just embiguity about the timepoint of receipt because for ambiguity about timing the timing is always related to the composition of the urn, so that always correlation comes in. Positively correlated ambiguity is specially liked by the subjects but this is no surprise and does not speak to ambiguity attitude: improving outcomes under likely events and worsening them under unlikely events is a good deal by any standard, even for ambiguity-neutral expected utility maximizers. %}

Eliaz, Kfir & Pietro Ortoleva (2016) "Multidimensional Ellsberg," *Management Science* 62, 2179–2197.

{% %}

Eliaz, Kfir & Efe A. Ok (2006) "Indifference or Indecisiveness? Choice-Theoretic Foundations of Incomplete Preferences," *Games and Economic Behavior* 56, 61–86.

{% Choice shifts in groups: If an individual prefers x to y, but in the group chooses y. In the group there is probability p that the individual's vote is pivotal, and in the group the individual chooses between px + (1-p)(qx + (1-q)y) versus py + (1-p)(qx + (1-q)y) where q and 1-q are the probabilities conditional on not being pivotal. So, choice shift corresponds with a violation of independence. %}

Eliaz, Kfir, Debray Ray, & Ronny Razin (2006) "Choice Shift in Groups: A Decision-Theoretic Basis," *American Economic Review* 96, 1321–1332.

{% **information aversion**; utility depends on (prior) choice set, and signals play a role. %}
Eliaz, Kfir & Ran Spiegler (2002) “Are Anomalous Attitudes to Information Explicable by Maximization of Expected Utility over Beliefs,”

{% Test axioms in loudness-ratio perception. Test Narens’ (1996) commutativity and multiplicativity. Cummutativity was satisfied, but multiplicativity (doubling and then tripling = sixfold) was violated. %}
Ellermeier, Wolfgang & Günther Faulhammer (2000) “Empirical Evaluation of Axioms Fundamental to Stevens’ Ratio-Scaling Approach: I. Loudness Production,” *Perception & Psychophysics* 62, 1505–1511.

{% **risky utility u = transform of strength of preference v**, latter does exist. P. 107 states, nicely: “The two dominant fallacies are the ‘fallacy of identity’ and the ‘fallacy of unrelatedness’.” %}
Ellingsen, Tore (1994) “Cardinal Utility: A History of Hedinometry.” *In* Maurice Allais & Ole Hagen (eds.) *Cardinalism; A Fundamental Approach*, 105–165, Kluwer Academic Publishers, Dordrecht.

{% %}
Ellingsen, Tore & Masgnus Johannesson (2007) “Paying Respect,” *Journal of Economic Perspectives* 21, 135–149.

{% **crowding-out**; cite empirical evidence and develop a principal-agent model with social esteem incorporated to explain it. %}
Ellingsen, Tore & Masgnus Johannesson (2008) “Pride and Prejudice,” *American Economic Review* 98, 990–1008.

{% %}
Elliott, Robert, David A. Shapiro, & Carol Mack (1999) “*Simplified Personal Questionnaire Procedure Manual.*” University of Toledo, Department of Psychology, Toldeo, OH.

{% %}

Elliott, Robert, Emil Slatick, & Michelle Urman (2001) "Qualitative Change Process Research on Psychotherapy: Alternative Strategies." *In* Jörg Frommer & David L. Rennie (eds.) *Qualitative Psychotherapy Research: Methods and Methodology,* 69–111, Lengerich: Pabst Science Publishers.

{% A voting theorem where under increasing population size the probability of the right candidate winning goes to 1, assuming SEU, is reanalized using maxmin EU, and then no longer holds.

The conclusion starts with the sentence "Theorem 1 shows that rational but ambiguity averse voters may …" Being a Bayesian, I will never co-author a paper with such a sentence! %}

Ellis, Andrew (2016) "Condorcet Meets Ellsberg," *Theoretical Economics* 11, 865–895.

{% **dynamic consistency**: Gives recent references on the Machina (1989) type dynamic decision principles to imply EU. It presents such a result assuming consequentialism (Assumption 1; like time invariance of Halevy 2015), dynamic consistency (Assumption 2; called time consistency by Halevy 2015), and a richness of domain assumption (Assumption 3; full support) with sufficient overlaps. I assume that the analog of RCLA or collapse independence (independence of reversal of order of events) is implicit. The uncertainty considered concerns the types of players in a game, and acts map type-vectors to outcome vectors. Nature is also there. The richness assumed is enough to get Gorman's (1968) theorem involved. The paper only considers payment vectors for type vectors, and no game-theoretic interactions are examined. P. 242 writes it: "I abstract away from the formal details of the game and equilibrium."

P. 241: "Theorem 1 shows that at least one of these properties [the EU dynamic decision principles] fails in (discretized versions of) nearly all of the literature on auctions and multi-agent mechanism design with ambiguity aversion"

P. 242: "the modeler faces the familiar trade-off between Consequentialism and DC"

P. 242: "while DC has very strong normative appeal, violations thereof are well documented."

Is somewhat: **dynamic consistency**: **favors abandoning forgone-event independence, so, favors resolute choice**.

P. 245: "For instance, if a player engages in forward-induction reasoning (e.g. Kohlberg and

Mertens, 1986), then she violates Consequentialism."

P. 245: "DC requires that no player has an incentive to deviate from her ex ante optimal strategy upon learning her type. This is the property that permits reduction of the strategic form to the normal form." %}

Ellis, Andrew (2018) "On Dynamic Consistency in Ambiguous Games," *Games and Economic Behavior* 111, 241–249.

{% Theorey and experiment on it, with budget sets of risky options. %}

Ellis, Andrew & David J. Freeman (2024) "Revealing Choice Bracketing," *American Economic Review* 114, 2668–2700.
https://doi.org/10.1257/aer.20210877

{% %}

Ellis, Andrew & Michelle Piccione (2017) "Correlation Misperception in Choice," *American Economic Review* 107, 1264–1292.

{% **foundations of statistics** %}

Ellis Chr. XI, my handwritten notebook p. 702.

{% **foundations of statistics**: improved tests for p-hacking and publication bias. %}

Elliott, Graham, Nikolay Kudrin, & Kaspar Wüthrich (2022) "Detecting p-Hacking," *Econometrica* 90, 887–906.

{% **convex utility for losses**: seems to find convex utility for losses up to −$1000. %}

Ellis, Randall P. (1989) "Employee Choice of Health Insurance," *Review of Economics and Statistics* 71, 215–233.

{% **risky utility u = transform of strength of preference v**, haven't checked if latter doesn't exist

Following Eq. 7.2, Ellsberg cites I.M.D. Little and explains that Little did not understand that risky utility functions should order riskless options the same way as riskless utility functions; i.e., the Gafni/ **HYE** mistake.

§§I and II write that Marshall (Principles of Economics) and Jevons thought that a person could find out about his strength of preference through introspection

(p. 530 5th para); this str. of pr. then could as well serve as vNM utility, certainly in a normative sense. For example, W. Stanley Jevons (1911) "*The Theory of Political Economy*." London, p. 36.

P. 537: ascribes vNM theorem to von Neumann solely

Nowhere Ellsberg says that vNM explicitly deny that risky=riskless utility. He only says, correctly, that vNM say they did not claim risky=riskless

P. 544: Ellsberg ascribes independence to Samuelson. He says, kind of, that independence is indisputable, and that the problems of EU lie elsewhere.

Whole Ch. V of Ellsberg's paper is on risky versus riskless utility. %}

Ellsberg, Daniel (1954) "Classic and Current Notions of 'Measurable Utility'," *Economic Journal* 62, 528–556.

{% Seems that pp. 1010-1011 alludes to it being reasonable to violate SEU. %}

Ellsberg, Daniel (1958) Book Review of: Donald Davidson, Patrick Suppes, & Sidney Siegel (1957) "Decision Making: An Experimental Approach." Stanford University Press, Stanford, CA; *American Economic Review* 48, 1009–1011.

{% **ambiguity attitude taken to be rational**

In the two-color urn the colors are Red and Black, in the three-color urn the known color is Red, and Black and Yellow are the unknown colors. I hope that everyone in the field will consistently use these colors! Is a convenient convention. The common payment for ambiguity is on Yellow and not on black (**suspicion under ambiguity**: just like that it will give the confound of suspicion).

About the works of Savage/Ramsey:

"the implication that—for a "rational" man—all uncertainties can be reduced to risks" (p. 645). This may have contributed to the unfortunate terminology where SEU for unknown probabilities is called risk. (**SEU = risk**)

P. 75 of Keynes (1921) presents the Ellsberg 2-color urns, says there is more probability error (meaning probability being more unknown) in the unknown than the known, but does not relate it to decision making. And not at all points out that those violate Savage's (1954) axioms, those not available at that time. I feel, therefore, that the priority goes to Ellsberg.

P. 645 points out that a problem arises in the distinction between beliefs (called relative expectations by Ellsberg, context shows it's beliefs) and utilities (called relative preferences for outcomes by Ellsberg) in revelations from choices: the **tradeoff method** of Wakker & Deneffe (1996) can do it!

P. 646 middle writes that Ellsberg is less interested in normative than in reflective (sort of prescriptive; decisions after reflection)

P. 646 seems to write, on Savage's axioms, that they gave "a useful operational meaning to the proposition that people do not always assign, or act 'as though' they assigned, probabilities to uncertain events." So, he uses axioms to criticize a model here.

P. 649, footnote 5, points out that the sure-thing principle, in the presence of known probabilities, reduces to the independence condition.

Pp. 651-652: Ellsberg's analysis of the two-urn example is not natural. He does not take the product space as state space, as most do and as is most natural, but he takes an urn that contains the union of the separate urns. Pfff! Here is a different way of showing that the two-urn example violates the sure-thing principle, which I hope is clearer.

P. 656 claims that Savage did the common Ellsberg preferences and, seeing that he violated his axioms, did not want to change his preferences, feeling reluctant about it. I do not believe this. It flies into the face of Savage's writings. Ellsberg writes himself to have been reluctant to ask Savage again and this adds to my disbelief. In a letter to Savage, Ellsberg later seems to write, again confirming my disbelief: "I see from a copy of your letter to Fellner that I haven't convinced you yet." (D. Ellsberg to L.J. Savage, May 21, 1962, LJS Papers, 11, 260.)

P. 657b says that in addition to utility and probability there is a third dimension (ambiguity).

P. 659: An individual … can always assign relative likelihoods to the states of nature. But how does he *act* in the presence of uncertainty? The answer to that may depend on another judgment, about the reliability, credibility, or adequacy of his information.

P. 663: "in situations where I really can't judge confidently among a whole range of possible distributions, this rule steers me toward actions whose expected values are relatively *insensitive* to the particular distribution in that range, without giving up too much in terms of the "best guess" distribution." Ellsberg writes entirely in the spirit of multiple priors, which I disagree with.

P. 664 ℓ. −2: **EU+a*sup+b*inf**

P. 667 uses, for common Ellsberg behavior, the term “pessimism” to refer to belief and “conservatism” to refer to decision attitude.

P. 667 bottom suggests a rank-dependent idea: “He “distorts” his best estimates of likelihood, in the direction of increased emphasis on the less favorable outcomes.” He then elaborates on an example with this. %}

Ellsberg, Daniel (1961) “Risk, Ambiguity and the Savage Axioms,” *Quarterly Journal of Economics* 75, 643–669.

{% Is a reply to Roberts’ comment. Essentially both agree that many emotional factors besides ambiguity attitude (he used the term vagueness which is actually better than ambiguity) play a role, and only disagree somewhat on the extent.

P. 342: “This is not to say that vagueness, as defined, is typically the sole factor underlying deliberate choices in conflict with the Savage postulates, even in the situations that I described, or that such choices reflect mainly a simple aversion to vagueness (though my article may have given those impressions). My own thinking has moved recently toward recognizing the influence of various dimensions of the decision problem under uncertainty that are strongly associated with vagueness but distinct from it;” %}

Ellsberg, Daniel (1963) “Risk, Ambiguity and the Savage Axioms: Reply,” *Quarterly Journal of Economics* 77, 336–342.

{% With an introduction by Isaac Levi and an updated bibliography by Mark Machina.

ambiguity seeking for unlikely: in 1962 version, pp. 268–270 and onwards, clearly and explicitly describes ambiguity seeking.

ambiguity seeking for unlikely: in 2001 version, p. 203 ℓ. 12-14: “… whereas a preference influenced significantly by extreme favorable possibilities is easily stigmatized as “wishful.” … Nevertheless, the deliberated preferences in this example of some individuals—including myself—seem to reflect in a systematic way both favorable and unfavorable positions in an ambiguous situation.” It is about a known urn K with 100 balls of 10 colors, each 10fold present, and an unknown urn A with 100 balls of 10 colors in unknown proportion, where Ellsberg prefers to gamble on not-Green from known to that from unknown, but prefers to gamble on Green-from-unknown to Green-from-known, so that he exhibits ambiguity preference regarding 1/10 probability. Ellsberg repeats his sympathy in footnote 1 on p. 206. He discusses at length on pp. 205-206 that not only the worst conceivable probability distribution receive extra weight, but also the best one. P. 206 2nd para: "…; in their own decision-making they wish to take *some* account also of favorable possibilities in ambiguous situations. These individuals will *not* exhibit a uniform tendency to "avoid ambiguity." "

P. 654 seems to write the same as p. 656 in Ellsberg (1961) on Savage in Ellsberg paradox. See my comments there. %}

Ellsberg, Daniel (2001) "*Risk, Ambiguity and Decision.*" Garland Publishers, New York. Original Ph.D. dissertation: Ellsberg, Daniel (1962) "Risk, Ambiguity and Decision." Harvard University, Cambridge, MA.

{% Ellsberg very explicitly considers the usual Ellsberg paradox behavior to be rational, and the sure-thing principle not to be rational.

P. 222 says that 2-color paradox came first to him, before 3-color. P. 223 writes that he discovered Keynes (1921) only in 1962, before his Ph.D.. But obviously after his 1961 paper. (P. 224: he did not know Allais paradox in 1961, but did in 1962 before thesis.)

natural sources of ambiguity: P. 223 writes, to my joy, what I interpret as a plea for investigating natural events and not to overstudy the Ellsberg urns as the field now (2013) does, with square brackets from the original:

"these urn experiments … it is long overdue to perform experiments that test for other forms of ambiguity. That shouldn't be hard; and they may well turn out to have interestingly differential effects."

P. 223 writes that Savage and Raiffa (two Bayesians) are the most clever people he ever met.

P. 225 does what many do today: Ambiguity is automatically equated with the multiple prior model where there are more than one possible probability measures: "ambiguity (where, one might say, more than one probability distribution over events seems reasonable)." I find this unsatisfactory, because there can be situations where there is nothing like a probability distribution in the mind of the agent, and the whole concept of "true" but unknown objective probability is questionable.

ambiguity seeking: P. 225 mentions that ambiguity seeking is to him as rational and normative as ambiguity aversion, also in his own urn examples, and that he has thought so from the beginning. He discusses it much for unlikely events (**ambiguity seeking for unlikely**), but not for losses.

ambiguity seeking: p. 226 gives a long plea against universal ambiguity aversion (italics added):

"I should have emphasized the last clause in the QJE article, but my failure to do so doesn't fully explain to me why nearly all later research has focused only on "ambiguity aversion," nor why most expositions have wrongly attributed the same *preoccupation* to me. It is as if the comments noted above—noting the occurrence of patterns of choice that clearly contradict "ambiguity aversion" even in these particular, frequently-replicated examples—had never appeared in the article. My long-term complaint is not about the mischaracterization of my own exposition but about the *general failure to explore this phenomenon* in subsequent experiments and analysis.

That is especially frustrating to me, because I happen to believe that this latter pattern will be much more frequent than the reverse in certain circumstances of payoffs and events other than the ones that were addressed explicitly in the QJE article and *almost exclusively investigated later*. Because these other circumstances (discussed in RAD, especially pp. 199–209) often characterize high-stakes political or economic decisions, I see it as being at least as significant empirically as "ambiguity aversion," if not more so; hence, certainly deserving of much more experimental and theoretical investigation than it has received." [Italics added here]

For reasons unclear to me, Ellsberg does not like the term ambiguity seeking for what I call ambiguity seeking for unlikely, but prefers something like hope, which may be something like optimism (he does not use this term). I will probably be imposing my views on his thinking if I conjecture that he is searching there for Tversky's concept of insensitivity, but does not grasp it. Here is his text that I am now referring to:

P. 225 (italics added): "What to call this pattern? "Ambiguity seeking" would be misleading; it doesn't relate to the subjective considerations of the decision makers, who reasonably don't see themselves as "preferring ambiguity" but simply as giving special weight in situations of ambiguity to more hopeful possibilities. Some would criticize this as "wishful," which may be why it has received less or no attention in discussions of normative criteria (*though that doesn't excuse the neglect of it as an empirical phenomenon*)." [Italics added here]

He goes on to argue for something like α-maxmin, which he calls restricted Bayes-Hurwicz criterion.

P. 227 very clearly argues for ambiguity seeking for unlikely, which he already expects with one of 10 colors, and expects more strongly with 1 of 100 or more colors.

uncertainty amplifies risk: I did not see this idea in his paper. %}

Ellsberg, Daniel (2011) "Notes on the Origins of the Ellsberg Urns (Introduction to the Symposium Issue)," *Economic Theory* 48, 221–227. http://dx.doi.org/10.1007/s00199-011-0653-3

{% **normal/extensive form** %}

Elmes, Susan & Philip J. Reny (1994) "On the Strategic Equivalence of Extensive Form Games," *Journal of Economic Theory* 62, 1–23.

{% %}

Elstein, Arthur S. (1996) "The Normative Status of Expected Utility Theory," *Medical Decision Making* 16, 7.

{% **simple decision analysis cases using EU**: bit complex. Suggest that an irrational decision not to prescribe estrogen may be caused by the overestimation of small probability of endometrial cancer. %}

Elstein, Arthur S., Gerald B. Holzman, Michael M. Ratvick, et al. (1986) "Comparison of Physicians' Decisions Regarding Oestrogen Replacement Therapy for Menopausal Women and Decisions Derived from a Decision Analytic Model," *American Journal of Medicine* 80, 246–258.

{% %}

Elster, John (1978, ed.) "*Logic and Society*." Wiley, New York.

{% %}

Elster, John (1979, ed.) "*Ulysses and the Syrens*." Cambridge University Press, New York; revised 1984.

{% %}

Elster, John (1983, ed.) "*Sour Grapes*." Cambridge University Press, New York.

{% **discounting normative**: Pp. 10-11: argues for 0 discounting. %}

Elster, John (1986) "Introduction." *In* John Elster (ed.) *Rational Choice*, 1–33, New York University Press, New York.

{% %}

Elster, John (1986, ed.) "*The Multiple Self.*" Cambridge University Press, New York.

{% %}

Elster, John (1986, ed.) "*Rational Choice.*" New York University Press, New York.

{% %}

Elster, John (1998) "Emotions and Economic Theory," *Journal of Economic Literature* 36, 47–74.

{% P. 11 seems to claim that ambiguity nonneutrality is normative and seems to write: "Farmers deciding on a crop mix or doctors deciding whether to operate act under risk. They can rely on well-defined probabilities derived from past frequencies. Stock market speculators, soldiers and others who have to act in novel situations cannot rely on frequencies. If they have sufficient information and good judgement, they may be able to make good probability estimates to feed into the expected utility calculus. If they have little information or poor judgement, rationality requires them to abstain from forming and acting upon such estimates [PW: no alternative is given …]. To attempt to do so would, for them, be a form of hyperrationality." Same page: "Here is a case in which objective probabilities and judgemental, subjective probabilities are equally out of reach." Again on page 16;

P. 22 (footnote 51)/23, is negative on idea that one can choose one's beliefs so as to maximize utility (as in Brunnermeier & Parker 2005): "the pleasure of wishful thinking is of brief duration, like the warmth provided by pissing in one's pants."

P. 26, on elicitation, seems to write: "It is always possible to devise questions that will force a person to reveal his preferences or subjective probabilities, but often there is no reason to believe in the robustness of the results. If the outcome depends on the procedures of elicitation, there is nothing "out there" which is captured by the questions."

P. 58 seems to write: "Bayesian decision theory itself is an expression of the desire to have reasons for everything; P. 90: desire to have decisions based on reasons;" %}

Elster, John (1989) "*Solomonic Judgements.*" Cambridge University Press, New York.

{% %}

Elster, John & George F. Loewenstein (1992) "Utility from Memory and Anticipation." *In* George F. Loewenstein & John Elster (1992) *Choice over Time,* 213–234, Russell Sage Foundation, New York.

{% §8, pp. 70-72: Denote by F the Cantor function. F is nondecreasing and continuous and, hence, differentiable almost everywhere. Yet, its derivative is 0 almost everywhere. F is not absolutely continuous. Taking F as a distribution function gives an atomless function assigning probability 1 to a Lebesgue null set. We can get a strictly increasing function G with the same properties as follows: Let $[a_n,b_n]$ count the countably many intervals in $\mathbb{R}$ with rational endpoints. Define $G(x) = \sum_{j=1}^{\infty} F_n(x)$ with $F_n(x) = 2^{-n}F(\frac{x-a_n}{b_n-a_n})$. %}

Elstrodt, Jürgen (2011) "*Maß- und Integrationstheorie*; 8th edn." Springer, Berlin.

{% **free will/determinism**: not precisely this, but rather combining chance with determinism (**foundations of probability**). %}

Emery, Nina (2015) "Chance, Possibility, and Explanation," *British Journal for the Philosophy of Science* 41, 141–142.

{% This paper opens with discussions of regression models with errors in the independent variables. It then uses this to analyze choice lists. Mostly, when choice lists are used, subjects are forced to be consistent in having only one switch, and in the right direction. This is easier for subjects and gives cleaner data. However, there are also pros to allowing for multiple switches: Those give info about the degree to which subjects are understanding. One can then, for instance, remove subjects with too many choice switches. This paper also allows for multiple switches and uses those to get better estimates of the errors in the regressions. %}

Engel, Christoph & Olivier Kirchkamp (2019) "How to Deal with Inconsistent Choices on Multiple Price Lists," *Journal of Economic Behavior and Organization* 160, 138–157.

{% %}

Engel, Yagil & Michael P. Wellman (2010) "Multiattribute Auctions Based on Generalized Additive Independence," *Journal of Artificial Intelligence Research* 37, 479–525.

{% %}

Engelbrecht-Wiggans, Richard & Elena Katok (2008) "Regret and Feedback Information in First-Price Sealed-Bid Auctions," *Management Science* 53, 808–819.

{% **PT, applications**, loss aversion: Dependency of household mobility on house prices is hard to explain by classical models. Equity cannot explain it very well, but loss aversion can. %}

Engelhardt, Gary V. (2003) "Nominal Loss Aversion, Housing Equity Constraints, and Household Mobility: Evidence from the United States," *Journal of Urban Economics* 53, 171–195.

{% %}

Engelmann, Dirk & Guillaume Hollard (2010) "Reconsidering the Effect of Market Experience on the 'Endowment Effect'," *Econometrica* 78, 2005–2019.

{% **equity-versus-efficiency**: Let subjects choose between (x,y,z), where y is their own payment, and x and z are payments for two anonymous others. P. 862 last para: The Fehr & Schmidt model performs poorly regarding its predictions of Pareto-dominance violations. Efficiency (I think this is the sum total x+y+z) and maximin, as in a model by Charness & Rabin (2002) explain much of the data. What Fehr-Schmidt contributes in addition is not significant. A model by Bolton & Ockenfels (2000) performs poorly. %}

Engelmann, Dirk & Martin Strobel (2004) "Inequality Aversion, Efficiency, and Maximin Preferences in Simple Distribution Experiments," *American Economic Review* 94, 857–869.

{% Wishful thinking,: not for gains, only for losses. Subjects less correctly identify patterns giving negative outcome (shock/loss). Stronger under ambiguity. (**uncertainty amplifies risk**) %}

Engelmann, Jan B., Maël Lebreton, Nahuel A. Salem-Garcia, Peter Schwardmann, & Joël J. van der Weele (2024) "Anticipatory Anxiety and Wishful Thinking," *American Economic Review* 114, 926–960. https://doi.org/10.1257/aer.20191068

{% %}
Engers, Maxim, Joshua S. Gans, Simon Grant, & Stephen P. King (1999) "Articles - First-Author Conditions," *Journal of Political Economy* 107, 859–883.

{% **conservation of influence**: suggests with mathematical derivations that self-replicating systems are the best at disippating energy. %}
England, Jeremy L. (2013) "Statistical Physics of Self-Replication," *Journal of Chemical Phsics* 139, 121923. http://dx.doi.org/10.1063/1.4818538

{% **updating under ambiguity with sampling**; In a first experiment, risk and ambiguity aversion are measured. For the risk attitude, consider lotteries L_j = $\big(0.5{:}(13-j\times 3), 0.5{:}(13+j\times 4.5)\big)$, $j = 0,\ldots,4$. Choice situation j gives a choice between L_{j-1} and L_j, $j = 1,\ldots,4$. Note that, under EU, a subject with utility function $U(\alpha) = (\alpha-13)^r$ has the same preference in all four situations, exhibiting constant relative risk aversion w.r.t. outcomes $\alpha-13$. For the ambiguity attitude, subjects chose five times, each time between L_j and an ambiguous version of it, where the probability 0.5 is replaced by an unknown two-color Ellsberg urn. Subjects could choose the winning color (p. 77 1st para; **suspicion under ambiguity**). The authors seem to suggest that subjects only once switch from risky to safe, and from ambiguous to risky, or vice versa, as j increases, but I do not understand why, and neither which direction of switch the authors have in mind. But this point is not important for the rest of the paper.

P. 78, §2.6: The authors took the number safe vs. risky choices as index of risk aversion, and number of risky vs ambiguous choices as index of ambiguity aversion. These are atheoretical indexes, with all the pros and cons of those. (For example, no need to commit to a theory, but no direct comparability with other experiments or existing indexes.) It is not clear to me why the authors restrict to

expected utility for risk, or the smooth model for ambiguity, in the first part of their paper, because their indexes are atheoretical. For the smooth model they assume that the second-order distribution is uniform over all probability compositions.

In a second experiment done a month later, the same subjects could play a game with ambiguous choices where they could pay to receive extra info, I think a drawing from the unknown distribution. Ambiguity averse subjects are willing to pay more. I would of course be interested in a relation between a(mbiguity)-generated insensivitity and willingness to pay for extra info, but the experiment, with only 05-05 uncertainties, does not give the data to investigate this. It would accrdingly have interested me much if ambiguity attitudes had also been measured with a(mbiguity)-neutral probabilities 0.1 and 0.9. %}

Engle-Warnick, Jim & Sonia Laszlo (2017) "Learning-by-Doing in an Ambiguous Environment," *Journal of Risk and Uncertainty* 55, 71–94.

{% **foundations of statistics**: discusses it for sociology, arguing against classical statistics. %}

Engman, Athena (2013) "Is there Life after P<0.05? Statistical Significance and Quantitative Sociology," *Quality and Quantity* 47, 257–270.

{% http://www.nber.org/papers/w26518; **inverse S:** They consider preference models where decision makers have a sort of meta-uncertainty, being uncertainty about what their (I guess not "the") preference is. It induces a regression to the mean whereby preferences come closer to some anchor point. It may contribute to inverse S probability weighting, and related pheomena in updating. The authors present a model with uncertainty about preference incorporated and apply it to probability weighting, source functions for ambiguity, probability estimates, and updating. They bring out the common inverse S nature of these phenomena. **cognitive ability related to likelihood insensitivity (= inverse S)**; (**uncertainty amplifies risk**) Subjects' uncertainty about their preferences is simply measured introspectively, how sure people are about their certainty equivalent, their probability estimate, and so on. %}

Enke, Benjamin & Thomas Graeber (2023) "Cognitive Uncertainty," *Quarterly Journal of Economics* 138, 2021–2067.

https://doi.org/10.1093/qje/qjad025

{% %}
Enke, Benjamin, Thomas Graeber, & Ryan Oprea (2023) "Confidence, Self-Selection, and Bias in the Aggregate," *American Economic Review* 113, 1933–1966. https://doi.org/10.1257/aer.20220915

{% Many anomalies in intertemporal choice can be explained by complexity attitudes. %}
Enke, Benjamin, Thomas Graeber, & Ryan Oprea (2025) "Complexity and Time," *Journal of the European Economic Association*, forthcoming. https://doi.org/10.1093/jeea/jvaf009

{% Show the title experimentally, as an effect beyond complexity. Reminds me of something that Jan Magnus told me: If people receive information from one source, they do not pay much attention to it. But if they receive it from two *independent* sources, then they do. %}
Enke, Benjamin & Florian Zimmermann (2019) "Correlation Neglect in Belief Formation," *Review of Economic Studies* 86, 313–332.

{% Quick surveys based on telephonic interviews. %}
EOS Gallup Europe (2002) "Euro Attitudes—Euro Zone," Flash Eurobarometer no. 121/3, June 2002.

{% Seems that stoicism, most fundamentally, says that we have no control over what happens to us, we only control how we respond.
Epicturs was a Greek philosopher living a century after Christ. Some of his ideas survived in writings by his student Arrian.
conservation of influence: quotes:
"There is only one way to happiness and that is to cease worrying about things which are beyond the power of our will."
"Don't demand that things happen as you wish, but wish that they happen as they do happen, and you will go on well." %}

Epictetus (2017) “The Philosophy of Epictetus: Golden Sayings and Fragments.” Dover Thrift Editions.

{% Written by his student Arrian.
conservation of influence: quotes:
“In life our first job is this, to divide and distinguish things into two categories: externals I cannot control, but the choices I make with regard to them I do control.”
“The chief task in life is simply this: to identify and separate matters so that I can say clearly to myself which are externals not under my control, and which have to do with the choices I actually control. Where then do I look for good and evil? Not to uncontrollable externals, but within myself to the choices that are my own” —Epictetus, Discourses, 2.5.4–5 %}
Epictetus (108) “*Discourses*.”

{% This paper, together with Bénabou & Tirole (2016), is the first I read on motivated reasoning. As a novice reading this literature, I have many difficulties.
1. Everything we ever do is motivated (say by evolutionary procedures), including rational beliefs we seek to have objectively. Probably the field means: beliefs that deviate from the info we have because we feel interests in believing different things than what is the truth.
2. It seems to be assumed that our beliefs are distorted in the direction of what we like. But pessimists systematically believe bad things, and insecure doubting persons believe too much opposite info.
3. Much of the utility of info is not utility of the info itself, but of its content. The authors in their 2nd para give as example a researcher having as much impact as Kahneman. However, I would not want this as info/belief about myself, but as fact about myself.
4. If I speak too positive about a candidate I vote on, this is not my belief, but my communication to convince others (p. 135 2nd para).
5. The field faces the danger of the **ubiquity fallacy**: erroneously thinking that one’s field can explain everything. %}
Epley, Nicholas & Thomas Gilovich (2016) “The Mechanics of Motivated Reasoning,” *Journal of Economic Perspectives* 30, 133–140. http://dx.doi.org/10.1257/jep.30.3.133

{% Find clear positive relation between wealth and discounting, stable over time and so on. Do so for a large sample in Denmark. The authors write that discounting predicts wealth. Causally, wealth may be predicting discounting.

P. 1180 last para discusses measuring discounting with money versus consumption, and argues for using money, e.g., writing "This result is consistent with evidence of "narrow bracketing" whereby subjects do not integrate their choices in an experiment into their broader choice set." (**time preference, fungibility problem**) %}

Epper, Thomas, Ernst Fehr, Helga Fehr-Duda, Claus Thustrup Kreiner, David Dreyer Lassen, Søren Leth-Petersen, & Gregers Nytoft Rasmussen (2020) "Time Discounting and Wealth Inequality," *American Economic Review* 110, 1177–1205.
https://doi.org/10.1257/aer.20181096

{% **restrictiveness of monotonicity/weak separability**: When dealing with time and risk, Andreoni & Sprenger (2012; A&S) implicitly first aggregated over timepoints (conditioning on risky events). This implies a sort of weak separability, i.e., separability of each single risky event which, in particular, precludes hedging considerations across different timepoints (called "intertemporal diversification" in this paper). It also requires correlated lotteries for different timepoints, and A&S's mistake was that in their experiment they instead implemented the lotteries stochastically independently.

This paper analyzes correlations/dependencies to properly reckoning with hedging possibilities, and first aggregating over risky events rather than over timepoints. Thus, things can well be reconciled with prospect theory and probability weighting, contrary to A&S's claims. The authors write in the closing para: "Overall, RDU can explain all of the major findings in CTB experiments and provides the most convincing explanation of the evidence. The model respects first-order stochastic dominance, it can handle general boundary effects aside from the certainty effect, and correctly predicts behavior under different correlation structures. Thus, RDU and its cousins are an attractive modeling choice not only in atemporal, but also in intertemporal situations."

Related comments were made by Chenug (2015 AER) and Miao & Zhong (AER 2015). %}

Epper, Thomas & Helga Fehr-Duda (2015) "Risk Preferences Are not Time Preferences: Balancing on a Budget Line: Comment," *American Economic Review* 105, 2261–2271.

{% Propose a model with risk and time where for all future timepoints there is a probability of dying before, so that all future outcomes are risky, a variation of Baucells & Heukampt (2012). They assume rank-dependent utility with probability weighting as model for risk. Then standard models, with a central role for subproportionality of probability weighting, can very efficiently accommodate a large number of anomalies. They accommodate reduction of certainty effect due to delay, reduction of present bias due to risk, that the order of integration over time or risk first matters, and many other things. Regarding order of integration, they have nonzero outcomes at only one timepoint, which, under normal circumstances, would imply that the order of aggregation, first over time or first over risk, would not matter. However, the authors in fact have three levels, because the survival probability is treated as an extra level, and it works differently in one order of integration than in the other. %}

Epper, Thomas & Helga Fehr-Duda (2024) "Risk in Time: The Intertwined Nature of Risk Taking and Time Discounting," *Journal of the European Eonomic Assoiation* 22, 310–354.
https://doi.org/10.1093/jeea/jvad041

{% **real incentives/hypothetical choice, for time preferences**: RIS with one risky choice, but also one intertemporal choice, paid for real (p. 174). So, a bit of income effect. Subjects got a voucher to collect their money either next day, or in two months, or in four months.

P. 177 points out that not paying every subject may interfere with purpose of no risk perception in intertemporal choice.

Use relative risk premium: (EV–CE)/EV (p. 181).

P. 181: **risk seeking for small-probability gains**: they find this (supports also **inverse S** although they did not try to fit other curves than inverse S).

risky utility u = strength of preference v (or other riskless cardinal utility, often called value): Use risky utility to calculate discounting, as did Andersen,

Harrison, Lau, & Rutstrom (2008), but use the more realistic prospect theory rather than EU (the latter, using EU, was done by Andersen et al.). Wakker (1994, Theory and Decision) argued for such use of one utility for all fields, coppled with nonEU to be descriptively realistic.

P. 182, §3.1: 17% of subjects reveal increasing impatience, and 54% reveal decreasing impatience.

P. 184: Show that, if future consumption is always endowed with uncertainty as is reasonable, then hyperbolic discounting can be generated by probability weighting. Find strong correlations between inverse S probability weighting and hyperbolic discounting, confirming their relation. Find no relation between degree of convexity of probability weighting and discounting, or between utility curvature and discounting. Discounting correlated in fact with nothing else, not with demographic variables and not with Frederick's (2005) cognitive ability score. (**cognitive ability related to discounting**)

linear utility for small stakes: find it because they capture much of risk attitude through probability weighting.

Argue that decreasing impatience may be generated by uncertainty. P. 193: "Arguably, the future is uncertain by definition." %}

Epper, Thomas, Helga Fehr-Duda, & Adrian Bruhin (2011) "Viewing the Future through a Warped Lens: Why Uncertainty Generates Hyperbolic Discounting," *Journal of Risk and Uncertainty* 43, 163–203.

{% Seems to considers EU where consequences are streams of outcomes. In this framework, gives conditions implying that the utility function over outcomes is constant discounting. %}

Epstein, Larry G. (1983) "Stationary Cardinal Utility and Optimal Growth under Uncertainty," *Journal of Economic Theory* 31, 133–152.

{% Nice survey of the recursive betweenness literature;

dynamic consistency (= constant tastes).

P. 1 defines risk in the traditional way where probabilities should be known: "…individual behavior under risk where, following Knight (1921), risk is defined as randomness with a known probability distribution."

Expresses a strong preference for betweenness theories over other

nonexpected utility models such as rank-dependent theories, prospect theory, etc. for normative and tractability reasons. See, for example,

(1) P. 6:

"There are a number of alternative axiomatically based generalizations of expected utility theory that have been developed, but the one which seems to me to strike the optimal balance between generality and tractability, at least for the applications that I will consider, is the *betweenness* theory due to …" and references follow [italics from original]. §4 considers applications to consumption and asset returns, §5 to sequential choice and game theory. Endnote 2, concerning the text just cited and given on p. 52, writes: "rank-dependent expected or anticipated utility …, the nontransitive regret theory … these alternative models are not particularly useful for the applications in §§4 and 5. The same comment applies to prospect theory (Kahneman & Tversky, 1979). The latter also suffers, in comparison with expected utility and the other models mentioned, from more ambiguous predictions because of the lack of a precise theory of the framing and editing processes."

(2) §3.4 on normative considerations on p. 24 2nd paragraph suggests normative appeal and also tractability.

(3) End of §5.1 also for sequential choice (no physical time)

P. 21 defines stationarity.

(4) p. 48 for applications to game theory.

On dynamic decision principles, this paper strongly favors the approach that keeps forgone-event independence (mostly called consequentialism) and update-consistency (mostly called dynamic consistency) and abandons **RCLA**, in the context of "intertemporal utility" where intertemporal means that there can be consumptions at intermediate nodes, so there is physical time:

(a) P. 19, ℓ. 10-13: "The route corresponding to the middle branch … has been by far the most productive to date and will be the focus of the remaining discussion of intertemporal utility and applications. Here the middle branch designates what I described above.

(b) d**ynamic consistency: favors abandoning RCLA when time is physical**: "Introspection suggests that one might care about the temporal resolution of risk even in the absence of any implications for planning."

In sequential choice where there is no physical time, the paper considers RCLA to be natural (p. 43).

§2.4 is on first-order risk aversion

P. 18 writes on violation of forgone-branch independence: "Such dependence is not irrational, ... disappointment or relief"

P. 25 top points out (for recursivity) that verification of a condition at the individual level does not imply the same condition at the aggregate level. Then writes: "We are left with the familiar "excuse" for representative agent modeling, namely the current lack of a superior alternative."

P. 44 suggests that Hammond (1988) and Machina (1989) use the term consequentialism in the same sense (which they don't).

P. 50: **quasi-concave so deliberate randomization** %}

Epstein, Larry G. (1992) "Behavior under Risk: Recent Developments in Theory and Applications." *In* Jean-Jacques Laffont (ed.) *Advances in Economic Theory* II, 1–63, Cambridge University Press, Cambridge.

{% **equilibrium under nonEU**: discusses rationalizability and equilibrium for some nonEU theories. %}

Epstein, Larry G. (1997) "Preference, Rationalizability and Equilibrium," *Journal of Economic Theory* 73, 1–29.

{% This paper explains the author's views on ambiguity. It reflects impressive, deep, and consistent thinking. However, I disagree with many intuitive directions chosen. The "finishing touch" for the author's aims, endogenizing the definition of unambiguous events, is given later by Epstein & Zhang (2001, Econometrica), but most of the ideas, concepts, and interpretations are here. I will use the term ambiguity hereafter for what the author often calls uncertainty.

The author considers it to be desirable to endogenize many things such as probabilities.

On p. 582, bottom, Epstein tries to push his student Zhang, writing: "… Each of {R,B} and {G,B} is unambiguous, but {B} is ambiguous … This important insight is due to Zhang (1997) ..." However, this elementary point had been known longtime to specialists, and I have known it since the 1980s. It every now and then came up in my conversations with Rakesh Sarin who had a "flip-flop" example to illustrate it. It is too elementary to be credited.

P. 583, Eq. 2.2, describes the "standard" definition of risk neutrality (and, hence, risk aversion) and the expectation involved therein not with respect to given objective probabilities as is common, but with respect to endogenous probabilities (Eq. 2.2), because there is a "for some" quantifier for the probability measure m. m is called subjective. In several places, for instance p. 585 below Eq. 2.5, the author equates "risk" with subjective rather than objective probabilities (**SEU = risk**). There are many economists who have done so since Savage (1954), including prominent ones. However, I think that this is an unfortunate and still minority terminology, and that risk better be related to objective probabilities only. By the way, in the latter way it was also defined by the author himself in Epstein (1992, p. 1)!

P. 584 1st para equates indifference-to-ambiguity with absence-of- ambiguity.

P. 584, Eq. 2.3, defines between-person more ambiguity averse as less favorable comparisons of ambiguous acts to unambiguous ones. If for every act a certainty equivalent exists then the condition amounts to same certainty equivalents for unambiguous acts and lower certainty equivalents for other acts. So, the comparison is defined only for people with same unambiguity preferences, Yaari-type.

Ambiguity neutrality is defined as probabilistic sophistication. I argued in Wakker (2001, Econometrica, pp. 1051-1052) that such endogenous definitions are not tractable; they are hard to observe empirically. The same criticism holds for the definition by Ghirardato & Marinacci (2001, 2002), where not probabilistic sophistication but subjective expected utility is taken as ambiguity neutrality. They have the same basic problem as Epstein. All of them can't take the right, straight, road of going to exogenous probabilities. Epstein then goes too broad by taking probabilistic sophistication, and Ghirardato and Marinacci go too narrow by taking subjective expected utility, where they are explicit, but not as much as I would have wanted, on their extra assumption that they have expected utility for risk. Epstein argues on p. 585 that his definition is consistent with common practice, but this is not so. Surely everyone who did experiments knows that common practice is that non-ambiguity is exogenously given (so, directly observable!), by known probabilities/compositions. What may add to the confusion is that some authors (still a minority) confusingly argued that Savage (1954) is risk, rather than uncertainty. See my keyword **SEU = risk**. From this terminology Epstein's and Ghirardato & Marinacci's desire becomes more understandable. Dean & Ortoleva (2017, Theoretical Economics, Footnote 31, especially last sentence) will nicely and properly point out that ambiguity neutrality means probabilistic sophistication *when also objective probabilities are* *present*. The implied agreement with objective probabilities (an exogenous concept) is the bigger half of it, and probabilistic sophistication the smaller half.

Epstein then goes on to define ambiguity aversion as EXISTENCE of a hypothetical ambiguity neutral (= probabilistic sophistication) person who is less ambiguity averse than the real agent considered. Again, this existence clause makes the concept hard to observe. The probability measure of probabilistic sophistication is interpreted as index of belief. In general this need not be unique. It worries me that ambiguity aversion is a necessary prerequisite for defining beliefs. It also assumes that beliefs must still be quantifiable through Bayesian objective probabilities.

The author is well aware of the desirability of making ambiguity aversion observable. He provides impressively deep results on event differentiability to mitigate this problem. If a person satisfies event-wise differentiability of preferences, then eventwise local linear approximations of the preferences exist, which are probabilistically sophisticated. If this derivative is the same at every event ("coherence"), then ambiguity aversion holds if and only if it holds with respect to the derivative mentioned (Theorem 4.3, p. 599). Given the difficulty of observing probabilistic sophistication, and the depth of the ideas, this is an admirable achievement. However, it is not a complete solution to the observability problem because deriving event derivatives from preferences is hard work, and the requirement that this derivative be the same at every event is very restrictive.

Another difficulty with the definition of belief is that it is completely ordinally driven. I think that in many situations there is more-than-ordinal information on beliefs, such as if we know that Choquet expected utility holds and we know the capacity at a more-than-ordinal level. Then we want to use that non-ordinal info for beliefs, rather than confine ourselves to the model-free ordinal info.

Under Choquet expected utility, a person is commonly (though not by me) taken to be ambiguity averse if the CORE of the capacity is nonempty, and each element of the CORE can serve the purpose of index of belief in the probabilistically sophisticated model. In the multiple prior model, any prior in the set of priors can serve this purpose. It shows that under these models, the indexes of belief and ambiguity neutrality are not unique.

Nonuniqueness will give conceptual problems when endogenizing unambiguous (as in Epstein & Zhang 2001). If there are two sources of uncertainty (say urns), and the agent is probabilistically sophisticated with respect to both, then which is to be taken as ambiguity neutral? It may matter for what we designate as ambiguity averse or not. This issue is discussed more in Epstein & Zhang (2001, Econometrica), pp. 281-282.

Section 5 seeks to criticize the Anscombe-Aumann framework, and Schmeidler's (1989) definition of ambiguity aversion through convexity, but remains too vague, probably because the author wants to be diplomatic. %}

Epstein, Larry G. (1999) "A Definition of Uncertainty Aversion," *Review of Economic Studies* 66, 579–608.
https://doi.org/10.1111/1467-937X.00099

{% Shows the logical possibility of falsifying probabilistic sophistication from consumer choices: If the asset demand contingent on s exceeds that on t even though the price at s exceeds that at t also, then s must be more probable than t. No contradictions should result from such observations. An obvious research question is whether there exists empirical evidence of this kind. %}

Epstein, Larry G. (2000) "Are Probabilities Used in Markets?," *Journal of Economic Theory* 91, 86–90.

{% Uses the maxmin EU model à la Gilboa & Schmeidler (1989) in a two-period two-consumer model. Is positive about the model, mentions tractability and potential fruitfulness. %}

Epstein, Larry G. (2001) "Sharing Ambiguity," *American Economic Review, Papers and Proceedings* 91, 45–50.

{% **dynamic consistency**; **updating under ambiguity**; Anscombe-Aumann framework where both prior probabilities and method of updating are chosen subjectively. It builds on Gul & Pesendorfer. %}

Epstein, Larry G. (2006) "An Axiomatic Model of Non-Bayesian Updating," *Review of Economic Studies* 73, 413–436.

{% Three-period model with anxiety and so on generated by past consumption, axiomatized. It can lead to information-aversion (**information aversion**).

Considers RDU and the relative shape of probabililty weighting at different timepoints. %}

Epstein, Larry G. (2008) “Living with Risk,” *Review of Economic Studies* 75, 1121–1141.

{% A short, critical, summary is in Baillon, Driesen, & Wakker (2012) p. 486:

“Epstein (2010) started by criticizing the problematic empirical status of the endogenous two-stage decomposition of KMM. His first example shows that KMM is not able to model ambiguity *within* a stage, which is related to our criticism of KMM’s use of expected utility within each stage. Epstein’s second example shows that KMM is not able to model different degrees of ambiguity within a stage, which naturally follows from his first example. His §3 criticizes KMM for deviating from multiple priors.“

I next give details:

This paper criticizes the famous KMM model (Klibanoff, Marinacci, & Mukerji 2005, Econometrica) of smooth ambiguity. I first list some weak points of the KMM model:

1. The status of the two-stage decomposition.

1.1. If it is endogenous, as suggested by most of the KMM paper and needed for its interpretations, then it is almost impossible to observe, for one reason because it brings too much richness.

1.2. If it is exogenous (not derived from preference but just imposed by the experimenter, often explicitly to subjects or otherwise imposed when analyzing), as assumed in virtually all applications, then it is simply a two-stage model with a Kreps & Porteus’ (1978) representation; i.e., it then is recursive expected utility.

2. It assumes EU within each stage, which surely for empirical applications is subject to EU violations such as Allais’ paradox.

3. It models ambiguity attitude through (utility of) outcomes, but ambiguity attitude should primarily depend on the events considered, and not on the outcomes, as per the fourfold pattern of ambiguity (Trautmann & van de Kuilen 2015).

4a. It commits to violation of RCLA, which is controversial.

4b. It commits to the dynamic principles of backward induction for nonexpected utility, similarly do all models that use the Anscombe-Aumann framework. However, this is controversial for nonEU with, for instance, Machina

(1989, JEL) strongly arguing against it. KMM do not discuss this point.

5. Their condition of smooth ambiguity aversion is not directly observable and is not a preference condition because it takes !!subjective!! probabilities as input, which is the same regarding observability as taking utility as input.

6. Their whole model is targeted towards aversion to ambiguity, as are most models today, but it does not consider the empirically important likelihood insensitivity. It cannot do the latter because one then has to distinguish likely from unlikely events, which one cannot do if going by outcomes rather than by events.

Epstein targets the first two points 1. and 2. explicitly, and the 3rd somewhat implicitly (in a lecture at HEC, April 2009, Paris, he once explicitly stated the 3rd point, so, he also agrees with it). He does not discuss the other points.

So, I agree that these points deserve criticizisms. But I do not agree with the way in which Epstein's paper does so.

The paper starts with an example of an exogenous two-stage case where the 2nd stage has Ellsberg events, making the EU model there questionable (hence, also, that second-order acts are evaluated by EU that cannot capture the ambiguity within that stage, which Epstein then contrasts with the modeling of ambiguity for Savagean acts depending on the 1st stage). I think that in essence Epstein is right here, and there is no reason for KMM to assume EU for the 2nd stage. But KMM can try a defense, being that they can handle Ellsberg in 2nd stage as they do it everywhere: By adding a stage on top, which here would lead to 3 stages. (So, for descriptive purposes, Allais would be better to criticize EU within a stage.) But then Epstein, replying to this defense in §2.3, goes on to argue that then they take their model endogenous making it unobservable. He could have made this point immediately, skipping the path through Ellsberg's example. The presence of the Ellsberg example in his paper can be further explained by the history of this paper:

> HISTORY. In a first version of this paper (July 6, 09) it reacted to the defense mentioned by saying that then he could assume Ellsberg events in a 3rd level. That, always if KMM resort to an n-level model, Epstein could assume Ellsberg events in the nth level. That always KMM have to add 1 level. That, continuing this way, it could become very complex with many levels. Then, however, Epstein would consider that

complexity to be an argument against KMM. I would say that it is an argument against Epstein's example. In the published version of Epstein's paper this discussion has been dropped but the Ellsberg paradox has remained as a left-over.

Obviously, if KMM cannot handle ambiguity within the 2nd stage, then they can neither distinguish between different degrees of ambiguity in the 2nd stage. This is the topic of Epstein's example in §2.4. I don't see what it adds to the first example.

In the reply of Klibanoff, Marinacci, & Mukerji (2012, Econometrica), KMM12 henceforth, KMM12 indeed defend by adding the extra, I would say 3rd, stage. They next collapse what I would call the 1st and 2nd stage into what usually is their 1st stage state space. Weak point in their defense is, at this point, how can users of the KMM model know whether we should remodel or not? KMM12 argue, p. 1307, citing Marschak & Radner, that "all relevant info" should be incorporated into the (1st order) state space. I think that KMM12 interpret this requirement too strictly. Meta-info about what the proper probabilities over the state space are, for instance, should not be part of the state space. (What I write here is often violated, for instance, by Aumann, who took Savage's unfortunate requirement of the state space specifying all info too literally, leading to circular definitions.) KMM12 use similar reasonings to reply to Epstein's §2.4. Their footnote 8 p. 1309, again shows this overly strict interpretation of the Marschak & Radner citation, as does their final sentence in §2.3.

§2.5 presents a nice thought experiment: Imagine we have the KMM model with the two-stage decomposition and μ endogenous. Then the subject is informed that there is a, now exogenous, two-stage decomposition with the same μ, but now μ objectively given. Would the subject change behavior? I think that KMM would say "yes" because it now has changed into a regular two-stage model with no ambiguity perceived at all. But Epstein argues that behavior then should not change.

§3 is strange. It presents a thought experiment with two indifferent Anscombe-Aumann acts f_1 and f_2 generated by mutually independent ambiguous events. It argues that then the probabilistic mix $½f_1 + ½f_2$ should be indifferent to f_1 and f_2. I expect that most readers will find $½f_1 + ½f_2$ on p. 2095 less ambiguous and less aversive than f_1 and f_2, in agreement with the intuition of KMM cited by Epstein. (KMM12 also argue for this, and cite an experiment where it is apparently shown.) Epstein disagrees. Very strangely, the only argument he puts forward is that, apparently, "the" multiple prior model (MP) (and its restricted way of modeling hedging) implies his claimed indifference. Epstein here and throughout seems to assume as self-evident that the MP model is the gold standard. This is also suggested by the citation of Epstein & Schneider (2010) on pp. 2096-2097 who survey a "growing" literature on "fruitful" applications of MP in finance. So, KMM are being criticized here for not being MP ...

§4, with concluding remarks, suggests that MP is "tighter" than KMM, but it only shows that the MP model uses fewer parameters than KMM, not that it is a subset. %}

Epstein, Larry G. (2010) "A Paradox for the "Smooth Ambiguity" Model of Preference," *Econometrica* 78, 2085–2099.

{% Do an Epstein & Zin type quantitative assessment.

information aversion: seem to discuss it. %}

Epstein, Larry G., Emmanuel Farhi, & Tomasz Strzalecki (2014) "How Much Would You Pay to Resolve Long-Run Risk?," *American Economic Review* 104, 2680–2697.

{% This paper considers a new kind of ambiguity: Ambiguity about correlations (term in title), or let me write relations (term used in paper). Assume two 2-color Ellsberg urns with black and red balls of unknown composition. A ball is drawn from each independently. Hence, the aforementioned relation does not concern the drawings themselves, which are independent as they always are. Instead, the relation concerns the composition of the urns. These compositions may be related and, althouh subjects know that there may be such a relation, they do not know how it is. Maybe, the two urns have the same composition, or opposite, or anything in between. This relation between the compositions, while known to possibly exist, is unknown and ambiguous. Whether the relation comes from related drawings or from related compositions is not fundamentally different for one single draw (although it gives different updatings under repetitions). But, anyway, the relation is assumed to concern the compositions here. If a subject

prefers (in betting sense)
(Red from urn 1) > same color from both urns
and
(Black from urn 1) > different color from both urns
then the subject has what I call source preference for a single urn over the relation.

A special case of the topic of this paper occurs when each urn in isolation is unambiguous with known composition, so that there also is no relation between the compositions, but the drawings are related in an unknown ambiguous manner, so that intersections of drawings are ambigous. So, then, red from each urn has objective probability 0.5, but their intersection is ambiguous. That this can happen, and that the collection of unambiguous events is not intersection-closed, was pointed out by Zhang (2002), but had been known long before.

The authors do careful experiments. P. 673: They have a nice way of observing indifferences versus strict preferences, by not only asking for bets with equal stakes but also when the stake for one event is raised by $1 but for the other event not. Assuming symmetry of events such as Red/Black, these choices give upper and lower bounds on indifferences and strict preferences. Raising the stakes a bit for the ambiguous urn to rule out indifference was also done by Oechssler & Roomets (2015).

P. 668 writes: "distinction between risk (where information is perfect and confidence is complete) and ambiguity is". This is typical of mainstream thinking today. I have an opposite opinion: In Ellsberg 2-color, the known urn is the LOWEST state of information. Oh well.

P. 669, and also abstract and conclusion, suggest that uncertainty about relations is a third kind of uncertainty, besides risk and ambiguity, but I think that it is only a particular kind of ambiguity and should not receive its own separate class.

Pp. 669-670 (and again §6.1 later) writes on economic implications, but I find these texts uninteresting. It is clear enough that ambiguity about relations is worthwhile and relevant. For instance, hedging is all about such relations. Virtually all uncertainties faced in real life are joint, and in this sense the topic of this paper is important with wide implications. But this broadness can also be a drawback. We cannot expect to find very general rules or insights. The experiment only studies how subjects expect one unknown urn, organized for an experiment by some researchers, is related to another unknown urn organized by that same team of researchers. It does not say much about how people think about joint uncertainties in a market and the corresponding (im)possibilities to hedge, for instance.

P. 672 footnote 5: The experiment used jars and blue and green marbles. Fortunately, the paper writes about Ellsberg urns and black and red marbles. It is a good convention to stick with Ellsberg's stimuli, making the reading of papers easier.

P. 684 1st para criticizes the Anscombe-Aumann framework for not being natural, citing Kreps (1988) for it, and I fully agree with it. Epstein & Halevy write: "This disconnect in the literature between Anscombe-Aumann acts and descriptive modeling in the field suggests (to us) that tests of preference models that refer only to Savage-style acts are more relevant to the potential usefulness of these models outside the laboratory."

Appendix A.2.4 gives evidence that subjects do not do hedging in RIS in the experiment, which, if it had happened, would be a problem for RIS. The authors used a version of RIS where, prior to the experiment, subjects received an envelope containing the no. of the choice implemented for real at the end, which, as the authors argue, reduces the risk of hedging. The same procedure was used by Loomes, Starmer, & Sugden (1989 EJ), and it is similar to the Prince method of Johnson et al. (2021 JRU). However, it crucially differs and loses several pros of Prince, as explained in my annotations at Johnson et al. (2021 JRU).

P. 675: the authors find evidence that subjects have no color preferences.

P. 675: here and elsewhere, the authors ue the terms ambiguity attitude and ambiguity aversion interchangeably, showing no awareness of insensitity, as with most people in the field.

The authors do both pairwise choice and CE elicitation using choice lists, and find considerable differences between them, which is a bit discouraging (but, again, a thorough job done by these authors!), their explanation being left as topics of future research.

P. 679 footnote 17 explains that predictive prior refers to beliefs about the outcome-relevant state space, and priors to beliefs about the parameters.

testing color symmetry in Ellsberg urn: they confirm it.

P. 680, §5.2 refers to the source method for what it does. But it is a bit different. The authors use sets of priors and multi stages, which is not common in the source method. Here is how I would use the source method:

Take as the universal state space {BB, BR, RB, RR}.

- Source 1 (urn 1) concerns the algebra generated by { {BB, BR}, {RB, RR} }.

- Source 2 (urn 2), not used below, concerns urn 2, and the algebra generated by { {BB, RB}, {BR, RR} }.

- Source 3 concerns the relation between the urns, and concerns the algebra generated by { {BB, RR}, {BR, RB} }.

Take RDU (also known as CEU) with v denoting the weighting function, and v(BB, BR) = v(RB, RR) = 0.4, v(BB, RR) = v(BR, RB) = 0.3. This person is ambiguity averse for the unknown Ellsberg urn, but even more ambiguity averse regarding the relation between the urns. As chosen here, the person considers the event same ({BB, RR}) to be as likely as the event different ({BR, RB}).

It may be argued that this modeling is more accommodating than explaining, but still it gives the terminology and concepts needed, and is way simpler than the models that the authors put forward. It avoids reference to multi-stages which (for me) are highly problematic under nonEU, and it also needs no reference to the (for me) problematic concept of sets of priors containing candidates for the (for me) problematic concept of true existing but unknown objective probability. %}

Epstein, Larry G. & Yoram Halevy (2019) “Ambiguous Correlation,” *Review of Economic Studies* 86, 668–693.
https://doi.org/10.1093/restud/rdy008

{% The authors examine ambiguous signals, and attitudes towards that ambiguity. An ambiguoous urn contains 10 balls, either 1 Red and 9 Black, or 1 Black and 9 Red. First subjects determine matching probabilities (MPs) a priori. Then subjects receive a signal and again give MPs. The ambiguous signal is as follows. N black balls and N white balls are added to a copy of the urn, a signal urn. Subjects know that either N=0 or N=45, but they don’t know which it is. Then a ball is drawn from the signal urn, and its color is told to the subject. Then the subject’s MP is measured again. Of course, if N=0 and the subject were to know so, then the signal would be very informative. If n=45 the signal gives very little information. The authors consider also risky signals, where subjects know what the signal is.

Comparing risky with ambiguous signal gives attitude towards ambiguity of signal. An early equation suggests that the authors do something different: Compare the average MP after good/bad signal with the prior MP. As far as I can judge, this captures ambguity only under the assumption that there are no other deviations from EU, i.e., that we have EU under risk. The authors do indeed state explicitly that they assume EU under risk, which I regret. Another problem is that the signal is contrived, and subjects may dislike it just for that reason.

Important: There is never dynamics in any situation. Dynamics under nonEU are always problematic. Thus, to be sure on this, during the measurent of the prior MP subjects do not yet know that later signals will come.

I did not see a clear conclusion of what the results give.

The authors cite several other papers that investigate ambiguous signals.

second-order probabilities to model ambiguity: Sometimes, when the authors want to generate ambiguity, they do it by using 2nd order probabilities. They argue that this is OK. They argue that regular ambiguity can have problems with symmetry of colors (I think this is unlikely) and being distorted by interaction of the RIS with ambiguity (e.g. hedging). However, the violation of RCLA that they build on, can also have problems with symmetry of colors (also unlikely) and interaction with RIS (not hedging of course but otherwise). %}

Epstein, Larry G. & Yoram Halevy (2020) "Hard-to-Interpret Signals,"

{% **dynamic consistency**: **favors abandoning forgone-event independence, so, favors resolute choice**,

information aversion (p. 11/12); propose the term "independence from unrealized alternatives," for forgone-branch independence (often called consequentialism).

foundations of statistics: p. 4 suggest that choice -time independence (p. 11) and collapse independence (p. 12) are natural in statistics, and that forgone-event independence should be abandoned. %}

Epstein, Larry G. & Michel Le Breton (1993) "Dynamically Consistent Beliefs Must Be Bayesian," *Journal of Economic Theory* 61, 1–22. https://doi.org/10.1006/jeth.1993.1056

{% They consider an assumption such as an event existing with W(A) + W(S−A) = 1 (S universal event; this is a symmetry-of-capacity condition for A), so that under RDU for this event we have SEU. %}

Epstein, Larry & Massimo Marinacci (2001) "The Core of Large Differentiable TU Games," *Journal of Economic Theory* 100, 235–273.

{% %}

Epstein, Larry G. & Massimo Marinacci (2007) "Mutual Absolute Continuity of Multiple Priors," *Journal of Economic Theory* 137, 716–720.

{% **state space derived endogeously**: Continuing on the Kreps idea of demand for flexibility and choices from menus. The state space is then derived endogenously. %}

Epstein, Larry G., Massimo Marinacci, Kyoungwon Seo (2007) "Coarse Contingencies and Ambiguity," *Theoretical Economics* 2, 355–394.

{% This paper uses a recursive maxmin EU ambiguity model. It allows for a different set of priors, also within-subject, for domestic stocks than for foreign stocks, thus using ambiguity theory to accommodate the home bias of finance. More generally, they accommodate the difference between more or less familiar. This can be taken as a special case of source dependence, and the authors cite Heath & Tversky (1991) for it. Because they use recursive maxmin EU, they cannot differentiate between aversion and insensitivity/perception. They use the general term "greater ambiguity" for bigger sets of priors.

A citation from p. 1254: "Thus our model can be viewed as a formalization of the suggestion by French and Poterba (1991) that equity home bias may be due to differences in beliefs. They speculate (p. 225) that investors 'may impute extra "risk" to foreign investments because they know less about foreign markets, institutions and Hrms'. They also cite evidence in Heath and Tversky (1991) that 'households behave as though unfamiliar gambles are riskier than familiar gambles, even when they assign identical probability distributions to the two gambles'. The widespread tendency to invest in the familiar has been documented recently in Huberman (2001), with the home country bias being just one instance; see also Grinblatt and Keloharju (2001). We formalize the difference between the familiar and less familiar as a difference in ambiguity." %}

Epstein, Larry & Jianjun Miao (2003) “A Two-Person Dynamic Equilibrium under Ambiguity,” *Journal of Economic Dynamics & Control* 27, 1253–1288.

{% **dynamic consistency. NonEU & dynamic principles by restricting domain of acts**

Strongly argue that **dynamic consistency** is normative. Give up RCLA. Their recursive multiple priors was considered before by Sarin & Wakker (1998, JRU, pp. 87–119), Theorem 2.1. Sarin & Wakker also used what Epstein & Schneider call rectangular, calling it the reduced family. Hansen, Sargent, Turmuhambetova, & Williams (2006, p. 78) argued that this family is too restrictive. A mathematical mistake is pointed out and corrected by Wakai (2007). %}

Epstein, Larry & Martin Schneider (2003) “Recursive Multiple Priors,” *Journal of Economic Theory* 113, 1–31.

{% %}

Epstein, Larry & Martin Schneider (2003) “Learning under Ambiguity,” *Review of Economic Studies* 74, 1275–1303.

{% Use maxmin EU, focusing on ambiguity generated during the processing of new information that may be of low quality. Then derive implications for topics of interest in finance. %}

Epstein, Larry G. & Martin Schneider (2008) “Ambiguity, Information Quality, and Asset Pricing,” *Journal of Finance* 63, 197–228.

{% %}

Epstein, Larry G. & Martin Schneider (2010) “Ambiguity and Asset Markets,” *Annual Review of Financial Economics* 2, 315–346.

{% **PT, applications**: nonadditive measures, excess volatility in security markets; **dynamic consistency** %}

Epstein, Larry G. & Tan Wang (1994) “Intertemporal Asset Pricing under Knightian Uncertainty,” *Econometrica* 62, 283–322.

{% **PT, applications**: nonadditive measures, excess volatility in security markets %}

Epstein, Larry G. & Tan Wang (1995) “Uncertainty, Risk-Neutral Measures and Security Price Booms and Crashes,” *Journal of Economic Theory* 67, 40–82.

{% **games with incomplete information**; do Mertens & Zamir (1985) for general nonEU where there need not even be a separable component reflecting belief. Hence, a hierarchy of preferences, instead of hierarchy of beliefs, results.

P. 1344: “In Savage’s model, states of the world logically *precede* the specification of axioms.” Specify complications about asssuming **common knowledge** etc. in the description of states of the world, refer then to Aumann (1987), in a formulation that is not explicit about whether they criticize Aumann for it or not.

P. 1345: preferences need not even have a separable component that can be thought of as “beliefs;”

P. 1351: Not only first-order uncertainty but also how DM feels about that, and feels about that feeling, etc., is incorporated in states of nature. So, an infinite hierarchy. (Compare to **conservation of influence**) %}

Epstein, Larry G. & Tan Wang (1996) “ “Beliefs about Beliefs” without Probabilities,” *Econometrica* 64, 1343–1374.

{% %}

Epstein, Larry G. & Jiankang Zhang (1995) “Expected Utility with Inner Measures,” Dept. of Economics, University of Toronto, Canada. Rewritten as Zhang, Jiankang (1997) “Subjective Ambiguity, Probability and Capacity,” Dept. of Economics, University of Toronto, Canada.

{% Propose least convex transform of capacity as index of belief, least concave function representing riskless preference as riskless attitude, and rest as “willingness to bet.” Defines likelihood relation over events through bets *on* events. %}

Epstein, Larry G. & Jiankang Zhang (1999) “Least Convex Capacities,” *Economic Theory* 13, 263–286.

{% Wakker (2008, New Palgrave) gives counterexamples to their definition of unambiguous. The most elementary: for every Anscombe-Aumann model with two ambiguous horses, the horses are unambiguous according to their definition.

The set of unambiguous events is a lambda system. There they impose qualitative probability and probabilistic sophistication à la Machina & Schmeidler (1992). Event T is, therefore, unambiguous if the more-likely-than relation, conditioned on T^c, between two subsets A and B of T^c, with the act on $T^c \backslash (AuB)$ a fixed act h, does not depend on the fixed outcome at T. More likely is defined from bets on, not against, events (e.g., p. 273, 280), as in Sarin & Wakker (1992).

They emphasize much that their definition of unambiguous is not exogenous but endogenous; i.e., derived from preference.

If there are two sources of uncertainty, say two different urns, and we find probabilistic sophistication for both in isolation but, say, a different probability transformation for one than for the other (so, no probabilistic sophistication when joining the two), then it is not clear which source is to be taken as ambiguity neutral. Maybe one is ambiguity averse and the other ambiguity neutral, but maybe the one is ambiguity neutral and the other ambiguity seeking. This paper discusses this issue on pp. 281-282 and 295. Ambiguity of an event depends on the other events available (also visible in the role of A and B in the definition of unambiguous on p. 273). This point, defended by the authors on p. 295, is different, for example, for risk, where risk neutrality (EV maximization) w.r.t. a partition is determined by gambles on that partition and is not affected by the presence of other events.

The authors confound absence of ambiguity and neutrality towards ambiguity. They discuss this issue on p. 283 penultimate paragraph, comparing their treatment of ambiguity with risk. But the comparison is not proper: For risk it IS possible that I really perceive of risk and risk is not absent, but yet I am risk neutral. In the approach of Epstein & Zhang it is not possible that I really perceive of ambiguity but yet am neutral with respect to it. Absence of ambiguity, and neutrality towards it, are really confounded.

The second part of Corollary 7.4(a) on p. 287, claiming a characterization of risk aversion under rank-dependent utility, is not correct. Concavity of u is not necessary. This was pointed out by Chateauneuf & Cohen (1994, JRU, Corollary 2 on p. 86).

Footnote 18, p. 279 is also incorrect because the capacity need only be a transformation of an additive measure, and need not be additive, as one readily verifies. The transformation may very well be nonlinear, making the capacity nonadditive on the algebra mentioned. It implies that, contrary to the authors' claim in 2nd para of p. 279, Axiom 6 need not be satisfied by CEU (Choquet expected utility). Also contrary to the authors' claim, this axiom is rather restrictive, capturing a considerable part of probabilistic sophistication in addition to their unambiguity axiom.

For example, assume that:

S = [0,1] x [0,1]; for f and g probability transformation functions, we have:

for all A x [0,1] capacity W is the f-transform of the Lebesgue measure (the usual additive measure assigning to each interval its length, so that W([a,b]) = f(b−a)); and

for all [0,1] x B capacity W is the g-transformation of the Lebesgue measure.

Let A_1 = [0,1/n] x [0,1] ,…, A_i = ((i–1)/n, i/n] x [0,1], …,

A_n = ((n–1)/n, 1] x [0,1].

Let B_1 = [0,1] x [0,1/n], …, B_i = [0,1] x ((i–1)/n, i/n], …,

B_n = [0,1] x ((n–1)/n, 1].

If f(1/n) = g(1/n), then W(A_i) = W(B_j) for all i,j, and strong-partition-neutrality implies that W of the union of j A-events agrees with W of the union of j B-events, so that f(j/n) = g(j/n) for all j. This is very restrictive. Assume next for some $\varepsilon > 0$ that f and g coincide on $[0,\varepsilon)$. It then easily follows, first for all rational numbers and then by continuity throughout the domain, that f and g coincide throughout their domain [0,1]. Because of the erroneous footnote 18, the authors apparently were not aware of the existence of example as above with nonlinear and different f and g. In a RUD 2006 conference in Paris, Epstein explained in public during my lecture that this paper had been developed to handle the three-color Ellsberg urn and not the two-color urn.

§9.1, p. 293, discusses the case where we have only one urn available, and find probabilistic sophistication satisfied there. The authors argue that intuitively it may not be clear whether the urn is unambiguous, but there is no behavioral evidence for ambiguity and, *hence*, they formally call it unambiguous. If behavioral info can't show if there is ambiguity or not, then I would prefer to leave it unspecified and not to "randomly" choose one option.

P. 269, end of penultimate para writes: "This argument is due to Zhang (1997), whose major finding in this regard we proceed to outline." I criticized this crediting in my annotations to Epstein (1999). %}

Epstein, Larry G. & Jiankang Zhang (2001) "Subjective Probabilities on Subjectively Unambiguous Events," *Econometrica* 69, 265–306.

{% **dynamic consistency**

DC = stationarity

Recursive utility: backward induction, CE-substitution (certainty equivalent substitution), see (3.4); they first aggregate over states and only then over time. They resolve the usually considered undesirable equation of risk- and intertemporal attitude by using a Kreps-Porteus (1978) model, where first a u function is used to aggregate over risk and then a nonlinear transform of this u function to aggregate over time.

below: "recursive structure immediately implies the intertemporal consistency of preferences (in the sense of Johnsen & Donaldsen (1985) ... and the stationarity of preference (in the sense of Koopmans (1960), for example)."

Paper assumes special (parametric) families of utility; also considers, in "Class 3," the Chew/Dekel betweenness family %}

Epstein, Larry G. & Stanley E. Zin (1989) "Substitution, Risk Aversion, and the Temporal Behavior of Consumption and Asset Returns: A Theoretical Framework," *Econometrica* 57, 937–969.

{% %}

Epstein, Larry G. & Stanley E. Zin (1990) " 'First-Order' Risk Aversion and the Equity Premium Puzzle," *Journal of Monetary Economics* 26, 387–407.

{% %}

Epstein, Larry G. & Stanley E. Zin (1991) "Substitution, Risk Aversion, and the Temporal Behavior of Consumption and Asset Returns: An Empirical Analysis," *Journal of Political Economy* 99, 263–286.

{% Paper was finished around 1991, not published then, but now published in a special issue of the journal dedicated to valuable unpublished works. %}
Epstein, Larry G. & Stanley E. Zin (2001) "The Independence Axiom and Asset Returns," *Journal of Empirical Economics* 8, 537–572.

{% Seems that:
real incentives/hypothetical choice, for time preferences %}
Epstein, Leonard H., Jerry B. Richards, Frances G. Saad, Rocco A. Paluch, James N. Roemmich, & Caryn Lerman (2003) "Comparison between two Measures of Delay Discounting in Smokers," *Experimental and Clinical Psychopharmacology* 11, 131–138.

{% **conservation of influence; dynamic consistency**: Roese worked life-long on counterfactual thinking. %}
Epstude, Kai, & Neil J. Roese (2008) "The Functional Theory of Counterfactual Thinking," *Personality and Social Psychology Review* 12, 168–192.

{% **risk averse for gains, risk seeking for losses** was found in context of drugs with side effects. %}
Eraker, Stephen A. & Harold C. Sox (1981) "Assessment of Patients' Preferences for Therapeutic Outcomes," *Medical Decision Making* 1, 29–39.

{% Given to me by Palli Sipos; **foundations of quantum mechanics**, in deterministic way. %}
d'Espagnat, Bernard (1979) "The Quantum Theory and Reality," *Scientific American* 241, Nov. 1979, 158–167, 171–181.

{% %}
Erdös, Paul & Peter Fishburn (1997) "Distinct Distances in Finite Planar Sets," *Discrete Mathematics* 175, 97–132.

{% %}
Erdös, Paul, Peter C. Fishburn, & Zoltán Füredi (1991) "Midpoints of Diagonals of Convex n-GONS," *SIAM Journal on Discrete Mathematics* 4, 329–341.

{% %}
Erev, Ido (1998) "Signal Detection by Human Observers: A Cutoff Reinforcement Learning Model of Categorization Decisions under Uncertainty," *Psychological Review* 105, 280–298.

{% Review of DFE with consequential full feedback clicking %}
Erev, Ido, & Ernan Haruvy (2016) "Learning and the Economics of Small Decisions." *In* John H. Kagel & Alvin E. Roth (eds.) *The Handbook of Experimental Economics* Vol. 2, 638–716, Princeton University Press, Princeton, NJ.

{% Find that subjects who express their uncertainties in terms of probabilities, behave worse in a number of cases (e.g., violate dominance more, in Experiment 2). The tasks are somewhat complex, e.g. there is a game in Experiment 1 where they state probabilities over opponents' moves and there are income effects etc. in the lottery choices of Experiment 2, so, it is not very easy to decide on the real causes for the findings.

natural sources of ambiguity: P. 91 last para points out that most of our decisions are taken without knowing probabilities, and knowing probabilities is the unusual situation. It may decrease decision quality. Although the authors only claim more irrationality and not more aversion, they are not far from suggesting what I believe: If anything, people will have more ambiguity seeking than aversion for natural events. Ambiguity aversion happens in situations like the Ellsberg urn, where info is deliberately and artificially kep secret for no good reason that one can think of. This was suggested and found by Wakker, Timmermans, & Machielse (2007). %}
Erev, Ido, Gary Bornstein, & Thomas S. Wallsten (1993) "The Negative Effect of Probability Assessments on Decision Quality," *Organizational Behavior and Human Decision Processes* 55, 78–94.

{% Their famous choice prediction, with choices under risk and ambiguity, but taking almost only choice situations with known paradoxes; see their Table 1, p. 370.
Abstract: "The distinct anomalies can be captured by assuming high sensitivity to the expected return and 4 additional tendencies: pessimism, bias toward equal weighting, sensitivity to payoff

sign, and an effort to minimize the probability of immediate regret. Importantly, feedback increases sensitivity to probability of regret." Their BEAST program predicts best. The abstract writes on it: "Unlike the popular models, BEAST does not assume subjective weighting functions or cognitive shortcuts. Rather, it assumes the use of sampling tools and reliance on small samples, in addition to the estimation of the expected values." The points they mention here all refer to sampling for their decision from experience (DFE), and not to risk attitude for decision from description (DFD). One general problem for DFE under risk is that it concerns ambiguity rather than risk, contrary to how it is usually analyzed.

Note that the aforementioned pessimism can be captured by pessimistic probability weighting, and bias toward equal weighting by inverse S probability weighting, under rank dependence. Aydogan (2021 *Management Science*) gives an economic view on DFE. %}

Erev, Ido, Eyal Ert, Ori Plonsky, Doron Cohen, & Oded Cohen (2017) "From Anomalies to Forecasts: Toward a Descriptive Model of Decisions under Risk, under Ambiguity, and from Experience," *Psychological Review* 124, 369–409. https://doi.org/10.1037/rev0000062

{% The authors present a model for decision making based on reliance on small samples of past experiences, such as the sample-of-5 model, to explain all kinds of choice anomalies.

P. 648: The PAS model reckons with expectations prior to sampling and in this sense is like Aydogan (2021 *Management Science*).

P. 651: 1992 prospect theory does not do well. (**PT falsified**). %}

Erev, Ido, Eyal Ert, Ori Plonsky, & Yefim Roth (2023) "Contradictory Deviations From Maximization: Environment-Specific Biases, or Reflections of Basic Properties of Human Learning?," *Psychological Review* 130, 640–676. https://doi.org/10.1037/rev0000415

{% Posted a first data set on internet, that people could use to calibrate their preferred model. Many researchers were invited to try out their preferred model in this competition. Then it was inspected which model best predicted the data in a second data set. An exemplary way of comparing models! For what they call decisions from description, a stochastic variation of prospect theory did best. For

what they call decisions from experience, a small-sample model did best. The first three authors organized it, and the last seven were from winning teams. A nice enterprise! %}

Erev, Ido, Eyal Ert, Alvin E. Roth, Ernan Haruvy, Stefan M. Herzog, Robin Hau, Ralph Hertwig, Terrence Stewart, Robert West, & Christian Lebiere (2010) "A Choice Prediction Competition: Choices from Experience and from Description," *Journal of Behavioral Decision Making* 23, 15–47.

{% P. 577 suggests that the loss aversion parameter of prospect theory can be replaced by utility curvature; i.e., that these are collinear. However, I disagree. They have many different empirical implications, even if not for the particular choice problems considered by the authors. The Katz (1964) experiment with its many repetitions concerns repeated choice that is subject to the law of large numbers, and not to one-shot decisions. %}

Erev, Ido, Eyal Ert, & Eldad Yechiam (2008) "Loss Aversion, Diminishing Sensitivity, and the Effect of Experience on Repeated Decisions," *Journal of Behavioral Decision Making* 21, 575–597.

{% Consider their usual setup of risky/uncertain prospects that the subjects must get to know through sampling (DFE). Then, investigate when subjects overweight rare events and when they neglect/underweigh them. They do the St. Petersburg paradox truncated after five times, and find, as predicted by prospect theory because of the overweighting of small probabilities, risk seeking rather than the conventionally assumed risk aversion (§2.4; hypothetical payment). They did this paradox with different framings, finding results depending on the framing. %}

Erev, Ido, Ira Glozman, & Ralph Hertwig (2008) "What Impacts the Impact of Rare Events," *Journal of Risk and Uncertainty* 36, 153–177.

{% **preferring streams of increasing income** %}

Erev, Ido, Shlomo Maital, & Ori Or-Hof (1997) "Melioration, Adaptive Learning and the Effect of Constant Re-evaluation of Strategies." *In* Gerrit Antonides, W. Fred van Raaij, & Shlomo Maital (eds.) *Advances in Economic Psychology*, Wiley, New York.

{% %}

Erev, Ido & Alvin E. Roth (1998) "Predicting how People Play Games: Reinforcement Learning in Experimental Games with Unique, Mixed Strategy Equilibria," *American Economic Review* 88, 848–881.

{% **ubiquity fallacy**: This is the text of a lecture and, hence, was not submitted to usual criteria. It is an advertisement of decision from experience (DFE), the topic that Ido Erev worked much on, and in the spirit of the learning that Roth worked much on. As usual, people make their field look broader than it is. I think that DFE is an interesting topic, but just one among many, and as remote from real life as most of the work that we researchers do. However, this paper positions it as an alternative to all of behavioral economics and oversells it too much. The abstract writes: "That is, the assumption of rational behavior is useful in understanding the ways in which many successful economic institutions function, although it is also true that actual human behavior falls systematically short of perfect rationality. We consider a possible explanation of this apparent inconsistency, suggesting that mechanisms that rest on the rationality assumption are likely to be successful when they create an environment in which the behavior they try to facilitate leads to the best payoff for all agents on average, and most of the time ..." That is, they put up a particular finding in DFE as a general answer to the role of irrationalities in general!

P. 1st column writes: "The most basic rational model, the expected value rule, models people as assigning cash equivalents to possible outcomes, and then selecting the option that maximizes their expected return." That is, they take decision under risk/uncertainty (the only thing that EV speaks to) as if all of life.

P. 1 2nd column writes: "It generalizes the expected value rule by adding one psychological parameter: risk aversion or diminishing returns, as axiomatized by von Neumann and Morgenstern (5). Expected utility theory was generalized to subjective expected utility theory by Savage (6) and others. Subsequent modern contributions (e.g., refs. 2 and 7–9) added parameters that capture loss aversion, oversensitivity to rare events, other regarding preferences, and similar psychological tendencies." The authors seem to not understand that other regarding preferences are just a different thing than expected utility, tangential to it.

After these general claims, there is a detailed survey of many findings from DFE. Note that recent (2019) papers challenge the claim that DFE gives underweighting of rare events. %}

Erev, Ido & Alvin E. Roth (2014) "Maximization, Learning, and Economic Behavior," *Proceedings of the National Academy of Sciences* 10818–10825.

{% Propose the ENO of a theory. ENO is the equivalent number of observations. So, how many observations would give equally good information as the theory. Reminds me of the value of prior info in inductive reasoning of Carnap. This paper does it in the context of games and regressions. %}

Erev, Ido, Alvin E. Roth, Robert L. Slonim, & Greg Barron (2007) "Learning and Equilibrium as Useful Approximations: Accuracy of Prediction on Randomly Selected Constant Sum Games," *Economic Theory* 33, 29–51.

{% **risk averse for gains, risk seeking for losses**. Subjects had to play many repeated (single-person) games and were told that the purpose was to maximize total earning. That is income effect to an extreme degree. That was further enhanced because total score was always displayed. Any theory will then recommend that in each single game one should maximize expected value. It turned out that subjects came closest to the EV maximization if no probabilities were given or jugded, less so if they had to give their subjective probability assessments first, and worst if they were given the objective probabilities. This result is puzzling by !any! weakly-rational theory. Additionally given/judged probabilities may have caused confusion and overflow of information?

If the results came from single-choices, Exhibit 4 would provide counterevidence against the Tversky & Wakker (1995) claim of higher sensitivity towards chance than towards uncertainty. However, given the repeated choices and income effect, this experiment is a different ball game. %}

Erev, Ido & Thomas S. Wallsten (1993) "The Effect of Explicit Probabilities," *Journal of Behavioral Decision Making* 6, 221–241.

{% A classic paper. If objective probability is predicted from subjective we see overconfidence, but if subjective probability is predicted from objective we see underconfidence. %}

Erev, Ido, Thomas S. Wallsten, & David V. Budescu (1994) "Simultaneous Over- and Underconfidence: The Role of Error in Judgment Processes," *Psychological Review* 101, 519–527.

{% Decision from experience (DFE) has been done using past decisions with outcomes received, or with sampling to collect info without outcomes received. This paper considers doing both, and finds strong interactions, with a reduction of effect in Study 1 and even a reversal in Study 2. The authors propose a face-or-cue model for it.

It was interesting for me to read the current general views of the authors in their first pages. Highly interesting was a text on p. 585. The early papers on DFE claimed a reversal of effects claimed by prospect theory (PT) in the sense that rare events were not overweighted, as PT has it, but underweighted. Several recent studies, including Aydogan (2021), found that rare events are not underweighted under DFE, but still overweighted. Only, less so than in other framings, which does not go against PT. The authors now side with that. (**DFE-DFD gap but no reversal**) They write in the main text the still neutral sentence "The term underweighting of rare events refers to a tendency to prefer that option that pays more with higher probability when this option does not maximize expected return." But then there is a footnote that fully explains:

> These definitions imply that the existence of the gap does not imply underweighting of rare events in decisions from experience. for example, consider an experiment that studies decisions between R "10 with probability 0.9, 0 otherwise" and S "9 for sure" using the sampling and the description paradigms. Assume that the R-rate (the choice rate of the option that pays more with higher probability) is 40% in the sampling paradigm, and 10% in the description paradigm. The gap in this example is large (40% - 10% = 30%), but the results do not exhibit underweighting of rare events in the sampling paradigm (as the choice rate of the option that pays more with higher probability is lower than 50%).

I think that this way it cannot be taken as evidence against PT. PT does not say that overweighting of rare events is always the same in different informational circumstances. %}

Erev, Ido, Ofir Yakobi, Nathaniel J. S. Ashby, & Nick Chater (2022) "The Impact of Experience on Decisions Based on Pre-Choice Samples and the Face-or-Cue Hypothesis," *Theory and Decision* 92, 583–598.
https://doi.org/10.1007/s11238-021-09856-7

{% The authors use richness in state space. That is, assume that the grand (Savage) state space is a product of the two issues/sources, issue b with B events and issue a with A events. They take the decomposition as exogenous and not as endogenous as KMM did. So, all events involved are observable. Here is a typical prospect yielding outcome x_{ij} for event A_i-intersection-B_j.

x_{11}	…	x_{1m}	A_1
. …	.		
. …	.		
x_{n1}	…	x_{nm}	A_n
B_1		B_m	

For their basic theorem, I reinterpret their central axiom 5b (a|b strong comparative probability) so as to make clear that in each partition into B-events each single B event is assumed separable (weak separability w.r.t. the B-partition; can do CE substtution for each B event), implying folding back/backward induction for the B events, something that their paper does not state clearly I think. P. 906 has a far-fetched way of saying that backward induction on B's precludes backward induction on the A's. (Otherwise the aggregation theorem, a corollary of Gorman 1968, would give total complete separability and, essentially, EU).

For prospects with outcomes depending only on A events, they impose all the Machina & Schmeidler axioms, giving probabilistic sophistication there. Then they assume all B events separable, i.e., we can do folding back (= backward induction) with respect to those events. !!!This assumption follows immediately from their Axiom 5b by taking event B_2 empty.!!! Such implications of separability have been known since the 1950s at least, with Strotz (1957; not his famous time consistency paper but another pearl he produced) a nice paper on it. Moreover, Ergin & Gul assume that every preference conditional on any B event agrees with the unconditional preference over the A events (also their Axiom 5b). (This also implies in a way that the events of the two sources are statistically independent.) Then we may as well replace all acts conditioned on any B event (such conditioned acts are then acts with outcomes depending only on the A events; i.e., columns in the above matrix) by what I interpret as a fixed outcome. The latter would be a conditional certainty equivalent if there was richness (continuum) of outcomes. The authors do not assume the latter, but they assume richness of events. Then, with a maximal prize X and a minimal prize x, we can replace every act with outcomes dependent on A events by an equivalent X_Ax, which can be equated with the event A conditional on which the big prize is obtained, denoted (A:X). Assume that this way we have $(A_1{:}x_{1j}, \ldots, A_n{:}x_{nj}) \sim (A_{bj}{:}X)$ for each j for appropriate event A_{bj}. The above displayed matrix prospect can then be replaced by the equivalent

$(B_1{:}(A_{b1}{:}X), \ldots, B_m{:}(A_{bm}{:}X))$.

On these acts all Machina-Schmeidler axioms are imposed (mainly Axiom 5b again). A recursive probabilistic sophistication model results.

The authors have thus axiomatized a version of a two-stage Anscombe-Aumann framework where probabilistic sophistication holds for both stages, with subjective probabilities for both stages.

§3 considers axioms concerning second-order risk aversion in some versions that in general are not equivalent but, as the authors show, are equivalent if we impose probabilistic-sophistication rank-dependent utility. Unfortunately, these axioms use probabilities as inputs (as do KMM in their smooth ambiguity aversion). Probabilities are subjective here, so, not directly observable, and conditions that use them I prefer not to call preference conditions. They have the same observability status as conditions that use utility numbers as inputs. So, Theorem 2 (p. 911) in this paper, while mathematically and logically correct, does not really give preference conditions. Papers co-authored by Gul more often have this problem. Another point here is that the authors consider source preference only in an Anscombe-Aumann two-stage setup, whereas it can easily be done for general sources with no need to have a two-stage statistically independent setup.

Theorem 3 shows that if we reinforce the Machina-Schmeidler probabilistic sophistication axioms into the Savage axioms, then we get an axiomatization of recursive expected utility. Theorem 4 gives a result with RDU.

Interesting is the introduction showing that the Ellsberg 3-color paradox can be considered as involving two sources. A nice alternative view of Ellsberg's three-color example: The three balls are numbered 1,2, and 3, with 3 the number of the known color Red. At a first stage there is uncertainty about the color composition of the urn, at the 2nd about the number of the ball drawn. These two

together determine the color. Gambling on known color is gambling on only stage 2 uncertainty, gambing on unknown color involves also stage-1 uncertainty. It does not allow for a completely disjoint source-approach to Ellsberg 3-color. %}

Ergin, Haluk & Faruk Gul (2009) "A Theory of Subjective Compound Lotteries," *Journal of Economic Theory* 144, 899–929.

{% On choices between menus. %}

Ergin, Haluk & Todd Sarver (2010) "A Unique Costly Contemplation Representation," *Econometrica* 78, 1285–1339.

{% Generalize Kreps-Porteus (1978) by considering choices of menus and hidden actions. %}

Ergin, Haluk Ergin & Todd Sarver (2015) "Hidden Actions and Preferences for Timing of Resolution of Uncertainty," *Theoretical Economics* 10, 489–541.

{% %}

Erickson, Tim (2017) "Beginning Bayes," *Teaching Statistics* 39, 1–38. https://doi.org/10.1111/test.12121

{% Asked academics to judge value of abstracts, where for each in one treatment they had added a nonsensical sentence with an equation, and in the second treatment they had not. The ones with eq. received higher evaluations. Reminds me of the finding "equations reduce citations." of Fawcett & Higginson (2012). %}

Eriksson, Kimmo (2013) "The Nonsense Math Effect," *Judgment and Decision Making* 7, 746–749.

{% A whole issue on ceteris paribus. %}

Erkenntnis (2002), Volume 57 Issue 3.

{% **ordering of subsets**: Consider finitely many observed comparative probability judgments, and investigate the set of solutions, i.e., probability measures compatible with the observations. Related may be the noncited

Fishburn, Peter C. (1996) "Finite Linear Qualitative Probability," *Journal of*

Mathematical Psychology 40, 64–77

and

Alon, Shiri & Ehud Lehrer (2014) "Subjective Multi-Prior Probability: A Representation of a Partial Likelihood Relation," *Journal of Economic Theory* 151, 476–492.

They relate it to sets of priors as in Walley's theories on imprecise probabilities. Sets of priors can serve to capture incomplete preferences, as in Bewley (1986, 2002). They present a graphical approach. %}

Erreygers, Alexander & Enrique Miranda (2021) "A Graphical Study of Comparative Probabilities," *Journal of Mathematical Psychology* 104, 102582. https://doi.org/10.1016/j.jmp.2021.102582

{% **risk seeking for symmetric fifty-fifty gambles**; Show that loss aversion is volatile. Their 2013 paper is more extensive. %}

Ert, Eyal & Ido Erev (2008) "The Rejection of Attractive Gambles, Loss Aversion, and the Lemon Avoidance Heuristic," *Journal of Economic Psychology* 29, 715–723.

{% Add further evidence that loss aversion is volatile. The authors go further and seriously question the prevalence of loss aversion, and provide balanced evidence to support their view.

They show that six factors can increase risk aversion and, hence, loss aversion: (1) framing safe alternative as status quo (formulating choice as accept/reject lottery rather than binary choice); (2) focusing on probability of gain, 0, and loss; (3) high stakes; (4) high nominal amounts; (5) highly attractive risky prospects elsewhere in experiment creating contrast effect; (6) fatiguing subjects (difficult long experiment and difficult stimuli).

Study 3 finds central tendency effect (tendency to choose answer in the middle) for choice lists.

Relative loss aversion means that gain prospects, after being translated into mixed prospects, give more risk aversion, confirmed by the well-known Payne, Laughhunn, & Crum (1980, 1981). The present paper finds the opposite in several choices, providing the strongest evidence against loss aversion in the literature that I am aware of. Thus, the summary at the end, p. 229, writes that

they find "weaker risk aversion in choice between mixed prospects than in choice between gains."

An explanation can be that this is always in situations where in the gains-choices the risky gain lottery has a possibility of yielding 0, which generates special aversion. Or it can be that the stakes were so small that joy of gambling came in, but this is admittedly not a strong counter because joy of gambling is hard to model or to give predictions.

P. 227 2nd column 2nd para: much risk neutrality for small stakes (**linear utility for small stakes**)

risk seeking for symmetric fifty-fifty gambles: not found on p. 220 penultimate para. %}

Ert, Eyal & Ido Erev (2013) "On the Descriptive Value of Loss Aversion in Decisions under Risk: Six Clarifications," *Judgment and Decision Making* 8, 214–235.

{% **updating under ambiguity with sampling**; 24 subjects chose between risky and ambiguous options the usual way. 32 subjects got the chance to first sample unlimitedly from the ambiguous option before choosing. In the former case we have the usual likelihood insensitivity and a-insensitivity with preference for ambiguous urn if unlikely and opposite if likely. Still the case is different here because if, for instance, the objective probability is 1/10, the ambiguous urn is described just as unknown prob of win or lose, so, dichotomous, so, like ambiguous 0.5 probability, which makes it natural that also Bayesians prefer ambiguous for unlikely and risk for likely.

In second treatment subjects can sample from ambiguous. Then those who happened to have favorable sample will prefer ambiguous, and the others the opposite. Introspective measurements of beliefs suggest that preferences are not due to belief generated by sampling. Hence, it may be due to motivation. %}

Ert, Eyal & Stefan T. Trautmann (2014) "Sampling Experience Reverses Preferences for Ambiguity," *Journal of Risk and Uncertainty* 49. 31–42.

{% Consider game situations. %}

Esponda, Ignacio & Emanuel Vespa (2014) "Hypothetical Thinking and Information Extraction in the Laboratory," *American Economic Journal: Micro* 6, 180–202.

{% The authors discuss the sure-thing principle and relate it to contingent thinking: conditioning on not the event of the common outcome occurring. What McClennen called the de novo tree. Savage used the term sure-thing principle in an informal manner, not only concerning P2 but also his P3 and P7. We nowadays (2024) formally equate it with P2. The authors' Footnote 2 take a strong position on s.th.pr. only referring to contingent thinking and not capturing all of P2 but it is hard for me to imagine how the authors' sure-thing principle could hold without all of P2. I can more easily imagine that all of P2 holds but not ccontingent thinking, in a similar way as statisticians sometimes distinguish between conditional probability and updating. E.g., if the actual receipt of info is a surprise. %}

Esponda, Ignacio & Emanuel Vespa (2024) "Contingent Thinking and the Sure-Thing Principle: Revisiting Classic Anomalies in the Laboratory," *Review of Economic Studies* 91, 2806–2813.
https://doi.org/10.1093/restud/rdad102

{% Subjects invest in ambiguous and risky treatment. For ambiguous, they guess probabilities. The authors finds less responsiveness (I would say insensitivity) for ambiguity. I think their study fits well with source theory. %}

Esponda, Ignacio & Leshan Xu (2024) "An Experimental Framework for Decisions under Uncertainty: Separating Prediction Errors from Ambiguity Attitudes," working paper.

{% **EU+a*sup+b*inf**: extends the Cohen security/potential model to nonsimple lotteries. %}

Essid, Samir (1997) "Choice under Risk with Certainty and Potential Effects: A General Axiomatic Model," *Mathematical Social Sciences* 34, 223–247.

{% %}

Essl, Andrea & Stefanie Jaussi (2017) "Choking under Time Pressure: The Influence of Deadline-Dependent Bonus and Malus Incentive Schemes on Performance," *Journal of Economic Behavior and Organization* 133, 127–137.

{% ISBN: 9789462982802 %}

Ester, Peter & Arne Maas (2016) "*Silicon Valley: Planet Startup. Disruptive Innovation, Passionate Entrepreneurship & High-tech Startups*." Amsterdam University Press, Amsterdam.

{% %}
Estes, William K. (1956) "The Problem of Inference from Curves Based on Group Data," *Psychological Bulletin* 53, 134–140.

{% Strongly argue for cognitive revolution. %}
Estes, William K., Allen Newell, John R. Anderson, John Seely Brown, Edward A. Feigenbaum, James Greeno, Patrick J. Hayes, Earl Hunt, Stephen H. Kosslyn, Mitchell Marcus, Shimon Ullman (1983) "*Report of the Research Briefing Panel on Cognitive Science and Artificial Intelligence*," Research Briefings 1983. National Academy Press, Washington DC.

{% **dynamic consistency** %}
Etchart, Nathalie (2002) "Adequate Moods [Models] for Non-EU Decision Making in a Sequential Framework," *Theory and Decision* 52, 1–28.

{% **PT: data on probability weighting**;
decreasing ARA/increasing RRA: bit less risk seeking for large losses than for small.
concave utility for gains, convex utility for losses: the latter is found;
utility elicitation;
inverse S is found for losses, both large and small; also upper and lower subadditivity are.
No real incentives, but flat payment.
N = 35 subjects. Considers loss outcomes. **tradeoff method**: Uses that to elicit utility for losses. It is mostly convex, but less so than others (p. 224). With utility for losses given, use CE (certainty equivalent) questions to measure the probability weighting function. Does it for small (down to −$1200) and large (down to −$14000) losses. Finds more pessimism/risk aversion for large losses than for small. For small probabilities, significantly more pessimistic for large

losses, for other probabilities no significant differences. That probability weighting does not depend much on outcomes is good news for PT. (**probability weighting depends on outcomes**)

P. 218: nice citation of Allais (1988), that risk is too complex to expect one fixed probability weighting function. %}

Etchart, Nathalie (2004) “Is Probability Weighting Sensitive to the Magnitude of Consequences? An Experimental Investigation on Losses,” *Journal of Risk and Uncertainty* 28, 217–235.

{% **tradeoff method**;

Uses the method of Abdellaoui (2000) to measure probability weighting. N = 30 subjects, all interviewed individually. Flat payment. §3.1 suggests that shallow probability weighting in the middle can, besides cognitive, also be strategic, in cases where the distinction does not matter for decisions. I did not fully understand this because it suggests that probability weighting cannot be identified. Probably it means, differently, that the payoff differences were so small that subjects just did not care at all. Something sometimes called the peanut effect.

Basic treatment is with small losses. Change of level means adding a negative constant to all outcomes (as with constant absolute risk aversion), making losses worse without changing differences. It had little effect except some more underweighting near p = 1. Change of spacing means, roughly, not precisely, multiplying the outcomes by a positive constant > 1 (as with constant relative risk aversion), making all distances bigger. It led to more pessimism and much more sensitivity except at small probabilities. (**probability weighting depends on outcomes**)

Utility is fitted using exponential utility, expo-power utility, or an uncommon inverse S family (the latter may capture that utility can get concave again for very serious losses, often thought to happen near ruin). The utility family chosen may affect the results on probability weighting. For instance, under power utility, subtracting a constant from all amounts leads to more linear utility, forcing probability weighting to capture more risk aversion and pessimism. But then, it is hard to avoid such things.

losses from prior endowment mechanism: properly criticized on p. 51

middle for, for instance, generating house money effect.

inverse S: is confirmed.

§4.2, p. 58, retrospectively gives another interpretation for a deviating finding in her 2004 paper. That paper may have mixed level and spacing effects.

§ 4.2, p. 59, top, again discusses cognitive interpretation of inverse S. (**cognitive ability related to likelihood insensitivity (= inverse S)**)

§4.1, p. 57 bottom, says that TO method assumes that probability weighting remains constant during the experiment. This is common to any theory. If EU is used, then it is not assumed that utility can change halfway the analysis or experiment. %}

Etchart, Nathalie (2009) "Probability Weighting and the 'Level' and 'Spacing' of Outcomes: An Experimental Study over Losses," *Journal of Risk and Uncertainty* 39, 45–63.
https://doi.org/10.1007/s11166-009-9066-0

{% **losses from prior endowment mechanism**: A beautiful study, of central importance to real incentives for losses. They use RIS. Do a treatment with real losses! So, they really provide the gold standard to assess other incentive schemes. Compare it with hypothetical choice and losses from **prior endowment mechanism**; within-subject, the three measurements at least 15 days apart each. Find no differences. Us choice list for gains, finding CEs (certainty equivalents). Biggest loss was €20.

real incentives/hypothetical choice: They do find differences for gains (also showing that their design does have power) with, as usual, more risk aversion under real incentives. In the real loss treatment, 17 subjects actually lost money. However, there were two other sessions (within subjects it was) where they could make up. In the end, after the three sessions, 2 subjects had really lost money (p. 69 footnote 9). They had small-probability losses and found mostly risk aversion (p. 72).

Use the semiparametric measurement of PT of Abdellaoui et al. (2008).

risk averse for gains, risk seeking for losses: utility is slightly concave for gains and also slightly concave for losses.

inverse S: their nonparametric estimations of probability weighting confirm inverse S for both gains and losses.

convex utility for losses: When they fitted PT (probability weighting and utility) utility was slightly convex but close to linear (p. 75). For gains, utility was concave.

inverse S: this their probability weighting function is both for gains and for losses, based on fitting at p-values 0.05, 0.25, 0.50, 0.75, 0.95.?

reflection at individual level for risk: they have the within-individual data but do not report on this.

They seem to test for order effects of first presenting gains or losses but find no order effects. %}

Etchart, Nathalie & Olivier l'Haridon (2011) "Monetary Incentives in the Loss Domain and Behavior toward Risk: An Experimental Comparison of Three Reward Schemes Including Real Losses," *Journal of Risk and Uncertainty* 42, 61–83.

{% Propose a new preference condition, fatalism. Consider two prospects $\gamma_p\beta$ and $(\gamma-\delta)_{p+\varepsilon}(\beta-\delta)$, the first yielding good outcome γ with probability p and bad outcome β with probability 1–p. δ and ε are posaitive, so the second prospect has worse outcomes but better probabilities. If

$(\gamma-\delta)_{p+\varepsilon}(\beta-\delta) \succcurlyeq_1 \gamma_p\beta \;\Rightarrow$

$(\gamma-\delta)_{p+\varepsilon}(\beta-\delta) \succcurlyeq_2 \gamma_p\beta$

then $\succcurlyeq_2$ is more fatalistic than $\succcurlyeq_1$. $\succcurlyeq_2$ appreciates the improvement in probability less than $\succcurlyeq_1$ does. Under RDU for agents with the same utility functions, the condition is necessary and sufficient for $w_2'(p) \le w_1'(p)$.

While formally different than insensitivity (inverse S), the condition is very similar in spirit. The authors do not refer to insensitivity. They have a nice application: it reflects willingness to invest in prevention. (**inverse S negatively related to prevention**) %}

Etner, Johanna & Meglena Jeleva (2014) "Underestimation of Probabilities Modifications: Characterization and Economic Implications," *Economic Theory* 56, 291–307.

{% The theoretically study the α maxmin EU model. The uncertain events are formulated as climat change events, a fancy application of ambiguity theories. They show that different attitudes towards ambiguity can lead to different policy decisions, and also to different reactions to new info. %}

Etner, Johanna, Meglena Jeleva, & Natacha Raffin (2021) “Climate Policy: How to Deal with Ambiguity?,” *Economic Theory* 72, 263–301. https://doi.org/10.1007/s00199-020-01284-y

{% **survey on nonEU**; a useful concise survey; I focus below on details that I see differently.

Survey mostly theoretical models of ambiguity, but no axioms. Review some empirical findings too. They use terms uncertainty and ambiguity interchangeably. My preference is that uncertainty is general, and ambiguity is the difference between uncertainty and risk. The same concept, although with different terminology, is in Cohen, Jaffray, & Said (1987). The authors cite Wald for the deterministic maxmin. Although Wald also introduced maxminEU, characterized by Gilboa & Schmeidler (1989), they do not cite him for it.

P. 242, cumulative prospect theory (I prefer not to write the term cumulative), unfortunately the authors do not reflect the weighting for losses. Hence, what they call the weighting function for losses is the dual of Tversky & Kahneman (1992).

P. 242, §3.2.1 first line: The authors do not know that Wald, Luce & Raiffa (1957 Ch. 13), and Gärdenfors & Sahlin, for instance, and a whole “imprecise probability” community including Walley (1991), extensively discussed α maxmin EU way before Choquet expected utility was introduced. Thus, they call CEU “first generation” in the beginning of §3.2, and multiple priors a follow-up in the beginning of §3.2.1. Multiple priors existed way before CEU!

P. 248: As many do, the authors give priority to Segal for using multistage probabilities for ambiguity. But many did it before (Gärdenfors 1979; Gärdenfors & Sahlin 1983; Kahneman & Tversky 1975 p. 30 ff.; Larson 1980; Yates & Zukowski 1976). §3.2.1 takes multiple priors endogenous, and §3.3 considers multiple priors with priors exogenous. §3.4 cites Chew & Sagi on sources. But Tversky initiated it, with 1995 papers with me (Wakker) and Fox on it. Chew

worked with Tversky in the early 1990s, although they did not finish a paper, and this is how Tversky influenced Chew as he influenced me.

§4.3, p. 254 last para, erroneously claims that Epstein wanted unambiguous to be exogenous. Epstein was very strong on it having to be endogenous (with me disagreeing much).

§§4.5.1-4.5.3 discuss concepts of ambiguity and ambiguity aversion but cannot give a clear picture because they fall victim to what I called a historical accident in my book Wakker (2010, §11.6): As in Schmeidler 1989, they take EU as given, and equate convex (pessimistic) weighting function with ambiguity aversion and Ellsberg. I think that convexity of the weighting function, an absolute property, is better related to the Allais paradox. The Ellsberg paradox and ambiguity aversion concern a relative concept: More pessimism/convexity for uncertainty than for risk. Because they take EU as given, being more convex for uncertainty than for risk happens to coincide with being convex, and the relative and absolute concepts get confused.

P. 259, on rectangularity of Epstein & Schneider (2003): Sarin & Wakker (1998, JRU, pp. 87–119), Theorem 2.1 had it before, calling it the reduced family. %}

Etner, Johanna, Meglena Jeleva, & Jean-Marc Tallon (2012) "Decision Theory under Ambiguity," *Journal of Economic Surveys* 26, 234–270.

{% %}

Ettlin, Nicolas, Walter Farkas, Andreas Kull, & Alexander Smirnow (2020) "Optimal Risk-Sharing across a Network of Insurance Companies," *Insurance: Mathematics and Economics* 95, 39–47.

{% %}

European Commission (2002) "Eurobarometer—Public Opinion in the European Union." Report no. 57, Spring 2002.

{% On use of behavioral economics in Europe. %}

European Commission (2013) "Applying Behavioural Sciences to EU Policy-Making (2013),

{% I dislike expressions of nationalism in research. Accordingly, I think that it was a big marketing mistake calling this measure “EUROQOL.” %}

EuroQol Group (1990) “EuroQol: A New Facility for the Measurement of Health-Related Quality of Life,” *Health Policy* 16, 199–208.

{% Ismail Mehmet pointed out to me in 2017 that maybe this paper, rather than Zermelo (2013), was the first to use backward induction to prove that chess is determined. The author later became world champion chess (1935-1937). So, he applied his theorem skillfully. %}

Euwe, Max (1929) “Mengentheoretische Betrachtungen Über das Schachspiel,” *Koninklijke Akademie van Wetenschappen*, Proceedings XXXII, no 5, 633–642.

{% %}

Evans, Anthony M. & Joachim I. Krueger (2017) “Ambiguity and Expectation-Neglect in Dilemmas of Interpersonal Trust,” *Judgment and Decision Making* 12, 584–595.

{% %}

Evans, Chris D.H., John Hughes, & Julia Houston (2002) “Significance-Testing the Validity of Ideographic Methods: A Little Derangement Goes a Long Way,” *British Journal of Mathematical and Statistical Psychology* 55, 385–390.

{% Paper elicits certainty equivalents of gambles through BDM (Becker-DeGroot-Marschak) in individual choice. Also elicits prices people pay for buying gambles, through fifth-price sealed-bid auctions, which should reveal true willingness to pay. The latter is called market level. At the market level, there are fewer violations of betweenness than at the individual level. The author points out that the analysis suggests that the phenomenon is due to statistical effects, not due to differences in the individual behavior. It may be the center-of-distribution-orientedness of the market procedure rather than true betweenness that does it.

Another point is that the choices are repeated. The subjects receive prior endowment and pay/win sequentially in several gambles. Any theory, prospect theory, betweenness, EU, etc., recommends expected value maximization in often-repeated-choice-with-the-sum-of-gains-to-be-maximized, because of the law of large numbers. Subjects may be doing something between that and isolated evaluations. %}

Evans, Dorla A. (1997) "The Role of Markets in Reducing Expected Utility Violations," *Journal of Political Economy* 105, 622–636.

{% %}

Evans, Dylan (2012) "*Risk Intelligence: How to Live with Uncertainty*." London: Atlantic Books.

{% Seems to write that a correlation exceeding 0.7 is "high." %}

Evans, James D. (1996) "*Straightforward Statistics for the Behavioral Sciences*." Brooks/Cole, Pacific Grove, CA.

{% An early version of betrayal aversion, with owners getting disutility from managers misusing their property. %}

Evans, John H, III; Vicky B. Heiman-Hoffman, & Stephen E. Rau (1994) "The Accountability Demand for Information," *Journal of Management Accounting Research; Sarasota* 6, 24–42.

{% %}

Evans, Michael J. (2013) "What Does the Proof of Birnbaum's Theorem Prove?," *Electronic Journal of Statistics* 7, 2645–2655.

{% **foundations of statistics**; presents measure-theoretic tools to extend results of their 86 paper to infinite case. %}

Evans, Michael J., Donald A.S. Fraser, & George Monette (1985) "On Regularity for Statistical Models," *Canadian Journal of Statistics* 13, 137–144. https://doi.org/10.2307/3314794

{% A later paper is Gandenberger (2015).

foundations of statistics; Proves a beautiful result. It proves (for discrete sample space) that the likelihood principle follows from conditionality principle alone, without needing sufficiency postulate. It, therefore, reinforces Alan Birnbaum's famous result. The trick is not to condition on two different values of an ancillary statistic as does Birnbaum's proof, but instead on values of two different ancillary statistics.

After presenting its beautiful result reinforcing the force of the likelihood principle, the paper in fact argues against the likelihood principle. I do not understand the criticism. For instance, if the llh. principle says that models M, M', and M'' are equivalent the authors argue that the llh. principle says that different models are appropriate and that therefore the llh. principle gives contradictory recommendations. Am I missing something? %}

Evans, Michael J., Donald A.S. Fraser, & George Monette (1986) "On Principles and Arguments to Likelihood" (with discussion), *Canadian Journal of Statistics* 14, 181–199.
https://doi.org/10.2307/3314794

{% %}

Even, Shimon (1979) "*Graph Algorithms*." Pitman, London.

{% Generalizates Choquet integral. Not only top-down or bottom-up, but other arrangements are considered. The concave integral is the infimum over all arrangements. %}

Even, Yaarit & Ehud Lehrer (2014) "Decomposition-Integral: Unifying Choquet and the Concave Integrals," *Economic Theory* 56, 33–58.

{% Examines the vNM EU axioms without completeness. %}

Evren, Özgür (2008) "On the Existence of Expected Multi-Utility Representations," *Economic Theory* 35, 575–592.

{% Modifies Dubra, Maccheroni, & Ok (2004) by also maintaining strict preference. Applications to game theory. %}

Evren, Özgür (2014) "Scalarization Methods and Expected Multi-Utility Representations," *Journal of Economic Theory* 151, 30–63.

{% This paper uses Segal's (1987) two-stage model of ambiguity, which I describe there. It is two-stage with backward induction and the same nonEU risk functional used at each stage ("time neutrality").

P. 286 5th para (“As I noted earlier …”) improves upon many papers by acknowledging the empirical finding of **ambiguity seeking for unlikely**, deviation from the global ambiguity aversion studied in this paper. Then defends against it.

P. 287 3rd para: cites papers studying ambiguity in strategic situations.

P. 287 4th para: A pro of Segal’s ambiguity model is that one can use results for risk attitudes to analyze ambiguity. This it shares with the source method!

P. 287-288 compares Segal’s ambiguity model with the smooth model, similarly as I do in my annotations of Segal (1987).

P. 290, Definition 3, defines more-ambiguity-averse-than as is most common in the literature, being Yaari-like lower certainty equivalents but adding the assumption of identical risk attitudes. This is equivalent to stronger preference for risky options over general (ambiguous) options. Ambiguity aversion means more averse than some ambiguity neutral attitude, which is equated with probabilistic sophistication (with objective probabilities present; this is a crucial specification of Epstein’s definition.)

P. 291, the main result, Theorem 1: Global ambiguity aversion iff negative certainty equivalence (NCI) of Dillenberg (2010), the main axiom of cautious utility (Cerreia-Vioglio, Dillenberger, & Ortoleva 2015). Global ambiguity aversion means that the risk nonEU functional is such that ambiguity aversion, as defined before, occurs for every state space and two-stage configuration. P. 293 top points out that, as NCI is imcompatible with RDU, so is global ambiguity aversion. Gul’s (1991) disappointment aversion can be reconciled.

P. 293, Corollary 1, 3 lines below: Unfortunately, the author and journal did not publish the proof, meaning that we cannot trust this result. One should never drop proofs from publications for the purpose of saving space.

P. 294, §4, discussed increasing ambiguity, using one of several conceivable ways of defining mean-preserving spreads of the 2nd order distribution.

P. 298 end of 1st para of §4.3: “Similarly, it is hard to imagine a satisfactory method that can separate ambiguity from ambiguity attitudes within Segal’s (1987) model.” The preceding para discussed the pro of the smooth model of giving such a separation. Drawbacks of that separation in the smooth model are, first, that it is only based on speculation and, second, that it is unobservable to the extent that the two-stage decomposition is unobservable. 2 paras later: “Obviously, ambiguity attitudes are also

non-separable from risk preferences in Segal's (1987) theory." I can agree with this claim to the extent that one takes the two-stage framework as exogenously given, rather than as endogenous as (formally, although never in practice) in the smooth model. %}

Evren, Özgür (2019) "Recursive Non-Expected Utility: Connecting Ambiguity Attitudes to Risk Preferences and the Level of Ambiguity," *Games and Economic Behavior* 114, 285–307.

{% **information aversion**: people may avoid info because of image concerns, even self-image concerns. This paper refines the original Dana et al. (2007) and then finds that the role of such concerns is smaller than thought. %}

Exley, Christine L. & Judd B Kessler (2023) "Information Avoidance and Image Concerns," *Economic Journal* 133, 3153–3168. https://doi.org/10.1093/ej/uead058

{% **probability communication**: Present probabilities numerically, using icon arrays (matrices with little bars, and part of bars highighted), and using spinners. Numerical probabilities fare worse. Several studies have shown that people are bad at estimating angles so that pie charts and spinners will not be so good. %}

Eyler, Rachel F., Sara Cordes, & Benjamin R. Szymanski (2017) "Utilization of Continuous "Spinners" to Communicate Risk," *Medical Decision Making* 37, 725–729.

{% **probability elicitation**: they extend the binarized scoring rule of Hossain & Okui (2013) from measuring single values to measuring many values, having efficiency gains. %}

Eyting, Markus & Patrick W. Schmidt (2021) "Belief Elicitation with Multiple Point Prediction," *European Economic Review* 135, 2021.

{% "known composition mapping result" with quasi-concave instead of concave functions %}

Fabella, Raul V. (1992) "Quasi-Concave (Composition) Functions with Nonconcave Argument Functions," *International Economic Review* 33, 473–477.

{% Quantiles are the only functionals that commute with all increasing and continuous transforms. %}
Fadina, Tolulope, Peng Liu, & Ruodu Wang (2023) "One Axiom to Rule Them All: A Minimalist Axiomatization of Quantiles," *SIAM Journal on Financial Mathematics* 14, 644–662.
https://doi.org/10.1137/22M1531567

{% r**eal incentives/hypothetical choice**: seems to be on it %}
Faff, Robert., Daniel Mulino, & Dniel Chai (2008) "On the Linkage between Financial Risk Tolerance and Risk Aversion," *Journal of Financial Research* 31, 1–23.
https://doi.org/10.1111/j.1475-6803.2008.00229.x

{% Show that every inner measure is a belief function. A belief function can be mapped isomorphically into another space where it is an inner measure. %}
Fagin, Ronald & Joseph Y. Halpern (1991) "Uncertainty, Belief, and Probability," *Computational Intelligence* 7, 160–173.

{% **three-doors problem**;
updating: nonadditive measures: Propose a way to update belief functions, and prove in Theorem 3.5 that this method, unlike the Dempster/Shafer method, will again yield a belief function. The result was obtained independently by Jaffray (1992), who added the more complicated other direction of implication. %}
Fagin, Ronald & Joseph Y. Halpern (1991) "A New Approach to Updating Beliefs." *In* Piero P. Bonissone, Max Henrion, Laveen N. Kanal, & John F. Lemmer (eds.) *Uncertainty in Artificial Intelligence* 6, 347–374, Elsevier, Amsterdam.

{% Criticizes Arkes (1991), who confused framing and reflection. Thus, this paper properly criticizes the mistake of **loss aversion: erroneously thinking it is reflection** %}
Fagley, Nancy S. (1993) "A Note Concerning Reflection Effects versus Framing Effects, *Psychological Bulletin* 113, 451–452.

{% %}

Fagley, Nancy S. & Paul M. Miller (1987) "The Effects of Decision Framing on Choice of Risky versus Certain Options," *Organizational Behavior and Human Decision Processes* 39, 264–277.

{% Argue that risk attitude w.r.t. mechanical risk can be different than in trust game, where it involves giving up control to another human being acting by conscious choice. They measure risk attitude in a mechanical context and in a "risky trust game," which is a trust game but with probability of deception given. The two risk attitudes are uncorrelated, and only the second predicts behavior in the standard trust game. %}

Fairley, Kim, Alan Sanfey, Jana Vyrastekova, & Utz Weitzel (2016) "Trust and Risk Revisited," *Journal of Economic Psychology* 57, 74–85.

{% Uses Global Preference Survey (GPS), survey data set of time preference, risk preference, positive and negative reciprocity, altruism, and trust from 80,000 people in 76 countries. Find much heterogeneity, within and between countries, more between, so that country is not very important variable. Risk aversion and impatience are positively related, and so are prosocial reciprocity, trust, and altruism, but no relations between these two categories (Table IV).

Women are more impatient, less risk-tolerant (**gender differences in risk attitude**), and more prosocial than men. Cognitive skills are uniformly positively linked to patience, risk taking, and social preferences, and all preferences are subject to age patterns (**cognitive ability related to discounting**; **cognitive ability related to risk/ambiguity aversion**; **relation age-risk attitude**). Report several relations with demographic variables. Cognitive ability is negatively related with risk aversion.

They measure risk attitude through $y \sim x_{0.50}0$ with five levels of x to approximate indifference, and also with a general introspective attitude question.

Footnote 23 suggests misbehavior of one of their referees, pushing being cited.

P. 1680: risk aversion is negatively related to self-employment, starting own business, and smoking.

P. 1684: no relation between income and risk aversion. %}

Falk, Armin, Anke Becker, Thomas Dohmen, Benjamin Enke, David Huffman, & Uwe Sunde (2018) "Global Evidence on Economic Preferences," *Quarterly Journal of Economics* 133, 1645–1692.
https://doi.org/10.1093/qje/qjy013

{% **questionnaire versus choice utility**: For risk aversion, time discounting, trust, altruism, and positive and negative reciprocity, they develop introspective questionnaire measurements that correlate well with incentived revealed preferences. They do so for a sample of German students. Abdellaoui, Barrios, & Wakker (2007) argued that this is a good way to validate nonchoice measurements for economics. %}

Falk, Armin, Anke Becker, Thomas Dohmen, David Huffman, & Uwe Sunde (2023) "The Preference Survey Module: A Validated Instrument for Measuring Risk, Time, and Social Preferences," *Management Science* 69, 1935–1950.
https://doi.org/10.1287/mnsc.2022.4455

{% %}

Falk, Armin & James J. Heckman (2009) "Lab Experiments Are a Major Source of Knowledge in the Social Sciences," *Science* 326, 23 Oct., 535–538.

{% **crowding-out**: bit like that: if employer controls employees, performance decreases because employees feel it as sign of distrust. %}

Falk, Armin & Michael Kosfeld (2006) "The Hidden Cost of Control," *American Economic Review* 96, 1611–1630.

{% Thought-provoking experiment on markets eroding moral values.

Here letting mouse live means that an experimental mouse that would normally have been killed, is given a decent life (average: 2 years). It need not be desirable in the sense that other people had apparently decided that this life is not worth living, and the money it takes, but now they get forced to still do it.

TREATMENT 1. A subject can choose individually: (a) €10, but mouse will be killed; (b) the mouse will live but no money;

TREATMENT 2 (bilateral market). A pair of subjects can choose: (a) They let one (one!) mouse live and get no money; (b) They agree on dividing €20 and the mouse will be killed. They can take 210 rounds of bidding.

In this treatment 2, one of the two subjects is called seller and is told "the life of the mouse is entrusted to your care," but this is only framing without any strategic implication; the life of the mouse is in fact a public good and not a consumption commodity.

TREATMENT 3 (multilateral market). 9 subjects are called sellers and 7 are called buyers. Sellers must state a minimum prize x, meaning that they accept any division of x or more for them and 20-x for a buyer. Buyers must state a maximum prize y, meaning that they accept any division of 20-y for themselves and y for the other. Note that the difference is only a matter of framing (whether you should say z or 20-z), and not strategic. Sellers and buyers are coppled by market mechanisms. Whenever a trade is made, a mouse is killed for it. They can take 210 rounds of bidding. Because there is a lack of buyers, with the firmest two sellers left alone, buyers are in a power position and selling prices of sellers (used as index in the analysis) will be relatively low.

As Figure 1 shows, the price for a mouse is highest in Treatment 3, then in Treatment 2, and lowest in Treatment 1.

The authors conclude that markets erode moral values. Points for discussion:

(1) Treatment 2 is in fact a bargaining problem, with mouse surviving the disagreement outcome (which need not be unfavorable). Strategic considerations and fairness play a role. Also, the bargaining distracts from the moral issue, especially if experimenter demand comes in. Here also the tradeoff is between money or HALF responsibility rather than, as in treatment 1, full responsibility. I expect that in Treatment 2 most subjects simply took the fair 10-10 division of money; this number is not reported in the paper.

(3) In Treatment (3), market considerations similarly complicate the case, where further the strategic disadvantage of the sellers complicates. Here the responsibility for a mouse's life is quite small because a seller can think: if I don't sell, then another seller will and the mouse will die anyhow (p. 708 2nd column bottom).

The authors have a control treatment (p. 708 top of 2nd column) with a market for a consumption good where market and individual price do not differ, but this

is very different (e.g. it is zero sum) from the bargaining problem of the public good of the mouse-life.

The authors have a control treatment (p. 710 1st column top) where individuals do not receive €10 for sure, but a 50-50 lottery, but this 50-50 lottery will not distract the same way as the bargaining situation.

The authors have a control treatment (p. 709 3rd column middle) where an individual decides, but not only he but some nondeciding other gets €10 if the money is chosen. Here indeed it is €20 per mouse life in total, and the welfare difference between Treatments (1) and (2) is controlled for, but the shared- versus single-responsibility difference between Treatments (1) and (2) is not controlled for. %}

Falk, Armin & Nora Szech (2013) "Morals and Markets," *Science* 340, 707, 10 May 2013, 707–711.
http://dx.doi.org/10.1126/science.1231566

{% Extends Hölder to case of maximal and minimal elements. %}

Falmagne, Jean-Claude (1971) "Bounded Versions of Hölder's Theorem with Application to Extensive Measurement," *Journal of Mathematical Psychology* 8 495–507.

{% %}

Falmagne, Jean-Claude (1975) "A Set of Independent Axioms for Positive Hölder Systems," *Philosophy of Science* 42, 137–151.

{% %}

Falmagne, Jean-Claude (1976) "Random Conjoint Measurement and Loudness Summation," *Psychological Review* 83, 65–79.

{% **restricting representations to subsets**: Criticizes another paper that misuses Cauchy's functional equation, by having it only on a finite domain where it need not imply linear representation. %}

Falmagne, Jean-Claude (1981) "On a Recurrent Misuse of a Classical Functional Equation Result," *Journal of Mathematical Psychology* 23, 190–193.

{% **error theory for risky choice**: Ch. 11 about probabilistic choices %}
Falmagne, Jean-Claude (1985) "*Elements of Psychophysical Theory*." Oxford University Press, New York.

{% %}
Falmagne, Jean-Claude (2004) "Meaningfulness and Order-Invariance: Two Fundamental Principles for Scientific Laws," *Foundations of Physics* 34, 1341–1384.

{% r**eal incentives/hypothetical choice**: seems to be on it %}
Fan, Chinn- Ping (2002) "Allais Paradox in the Small," *Journal of Economic Behavior & Organization* 49, 411–421.
https://doi.org/10.1016/S0167-2681(02)00012-4

{% Seems to have introduced the Sugeno integral already for the special case of additive measures. It seems to be known as the Ky Fan distance. This was pointed out to me by Denneberg. %}
Fan, Ky (1944) "Entfernung Zweier Zufälliger Grössen und die Konvergenz nach Warscheinlichkeiten," *Mathematische Zeitschrift* 49, 681–683.

{% %}
Fan, Ky (1956) "On Systems of Linear Inequalities." *In* Harold W. Kuhn & Albert W. Tucker (eds.) *Linear Inequalities and Related Systems*, 99–156, Princeton University Press, Princeton, NJ.

{% Show how many **proper scoring rules** can be derived from general functions, which is what arbitrary value function in their title refers to. They assume expected value (see end of §1.1). %}
Fang Fang, Maxwell B. Stinchcombe, & Andrew B. Whinston (2010) "Proper Scoring Rules with Arbitrary Value Functions," *Journal of Mathematical Economics* 46, 1200–1210.

{% P. 1043: DC = **stationarity**

They fit quasi-hyperbolic discounting to data on single women with children and estimate utility losses resulting from it. %}

Fang, Hanming & Dan Silverman (2009) "Time-Inconsistency and Welfare Program Participation: Evidence from the Nlsy," *International Economic Review* 50, 1043–1077.

{% This paper introduces, on p. 1050, QALYs (without using the term), and on p. 1047 the TTO method. It precedes Torrance's work.

P. 1024 gives a nice survey on preceding ways of quantifying health outcomes.

P. 1043: proposes variation of TTO, where a health state is however followed by perfect health not by death, to measure quality of life.

P. 1044 proposes person tradeoff method to measure quality of life.

P. 1047 proposed really Torrance's TTO.

P. 1050 formulates the QALY calculation method. %}

Fanshel, Sol & James W. Bush (1970) "A Health-Status Index and Its Application to Health Servics Outcomes," *Operations Research* 18, 1021–1066.
https://doi.org/10.1287/opre.18.6.1021

{% **ratio-difference principle** %}

Fantino, Edmund & Jay N. Goldshmidt (2000) "Differences, Not Ratios, Control Choice in an Experimental Analogue to Foraging," *Psychological Science* 3, 229–233.

{% Does not assume reference point known, but derives it by fitting data for each taxi driver separately. Assumes linear utility and no probability weighting. Finds that after reaching reference income level the taxi drivers indeed almost always stop. However, 2/3 don't reach the reference income level before the shift is over and behavior is more complex. For instance, the reference level changes day by day. Thus, the author concludes that the role of reference dependence is not so clear. %}

Farber, Henry S. (2008) "Reference-Dependent Preferences and Labor Supply: The Case of New York City Taxi Drivers," *American Economic Review* 98, 1069–1082.

{% Propose nonparametric method for market consumer preference measurement. Provide arguments against parametric fitting (can have wrong family, and can either under or overfit, although I think that nonparametric fitting will only overfit more. %}

Farias, Vivek F., Srikanth Jagabathula, & Devavrat Shah (2013) "A Nonparametric Approach to Modeling Choice with Limited Data," *Management Science* 59, 305–322.
http://dx.doi.org/10.1287/mnsc.1120.1610

{% **PT, applications**, loss aversion, politics!!! %}

Farnham, Barbara (1994, ed.) "*Avoiding Losses/Taking Risk; Prospect Theory and International Conflicts*." University of Michigan Press, Ann Arbor.

{% %}

Faro, David & Yuval Rottenstreich (2006) "Affect, Empathy, and Regressive Mispredictions of Others' Preferences under Risk," *Management Science* 52, 529–541.

{% Ch. 1 introduces, Ch. 2 introduces the model later published by Chateauneuf & Faro (2009, JME), which is the multiplicative version of the variational model by Maccheroni, Massimo & Rustichini (2006). Ch. 3 provides a sign-dependent generalization, assuming ambiguity aversion (pessimism) also for losses. Ch. 4 applies it to incomplete markets. %}

Faro, José H. (2005) "On the Choices under Ambiguity," Ph.D. dissertation, Instituto Nacional de Matemática Pura e Aplicada, Rio de Janeiro.

{% Considers Bewley (1986, 2002) type incomplete preferences and maxmin preferences where a homotheticity axiom implies that utility is Cobb-Douglas. %}

Faro, José H. (2013) "Cobb-Douglas Preferences under Uncertainty," *Economic Theory* 54, 273–285.

{% Generalizes Bewley (1986, 2002) by adding the variational probability-distribution-dependent punishment term of the variational model to it. Does in in the Anscombe-Aumann framework. %}

Faro, José H. (2015) "Variational Bewley Preferences," *Journal of Economic Theory* 157, 699–729.

{% Reconsiders Luce's (1959) probabilistic choice model, but with a correction for when different choice options are just replicas of each other. %}

Faro, José Heleno (2023) "The Luce Model with Replicas," *Journal of Economic Theory* 208, 105596. https://doi.org/10.1016/j.jet.2022.105596

{% **updating under ambiguity**

Study updating for the appealing model by Gilboa, Maccheroni, Marinacci, & Schmeidler (2010) with multiple priors and then the unanimous decisions as objectively rational, and the maxmin as subjectively rational. %}

Faro, José H. & Jean-Philippe Lefort (2019) "Dynamic Objective and Subjective Rationality," *Theoretical Economics* 14, 1–14.

{% **updating under ambiguity**

They consider updating of Bewley incomplete preferences. Extend it to completeness where they get full Bayesian updating for variational preferences. %}

Faro, José Heleno & Ana Santos (2023) "Updating Variational (Bewley) Preferences," *Economic Theory* 75, 207–228. https://doi.org/10.1007/s00199-021-01397-y

{% %}

Faro, José Heleno & Flávia Teles (2020) "Independence and Variational Bewley Preferences: A Note," *Revue Economique* 71, 337–347.

{% %}

Farquhar, Peter H. (1975) "A Fractional Hypercube Decomposition Theorem for Multiattribute Utility Functions," *Operations Research* 23, 941–967.

{% %}

Farquhar, Peter H. (1977) "A Survey of Multiattribute Utility Theory and Applications." *In* Martin K. Starr & Milan Zeleny (eds.) *Multiple Criteria Decision Making*, Vol. 6 of TIMS Studies in the Management Sciences, 59–90, North-Holland, Amsterdam.

{% **utility elicitation**; extensive survey for unidimensional utility. For multiattribute, Fishburn (1967 Management Science) and Fishburn (1968 Management Science) are nice companions. The paper assumes risk and expected utility (EU). One can take that as multiattribute utility still, with every state of nature (generating a probability) as an attribute.

The paper uses the old term "chained" measurement for what is nowadays (2024) more often called "adaptive."

Table 1, p. 1285, distinguishes whether one uses certainty equivalents, probability equivalents, indifferences between two risky lotteries, and so on, and whether one varies probability or outcome to get the indifference.

The paper discusses what to do about violations of EU, inconsistencies, detected through crosschecks, with p. 1285 mentioning resolutions through modifications of previous answers. P. 1285 bottom mentions the impact of the decision analyst. Sections 5 and 6, pp. 1288-1293, have more on it.

P. 1286 states already what Loomes, Starmer, & Sugden (2003 EJ) call the shaping hypothesis, and what has also been called "coherent arbitrariness," for coherent choices that are coherent biases rather than coherent genuine preference: "In complicated or unfamiliar decision problems, consistent responses with a single assessment procedure may result primarily from a convenient heuristic rule or from a salient contextual effect."

Table 3 distiguishes different starting positions (status quos). Section 5.2 distinguishes matching ("direct estimation") from choice-based procedures ("convergence techniques" or "bounding techniques"). It does not discuss incentive compatibility, which is no issue in prescriptive applications, the primary interest in this paper.

P. 1289 below Eq. 4 recommends avoiding probabilities near 0 and 1, because they give most deviations.

PE doesn’t do well: p. 1290 2d para, strangely enough, claims the opposite.

Table 3, p. 1294, nicely organizes the many utility measurement procedures.

%}

Farquhar, Peter H. (1984) “Utility Assessment Methods,” *Management Science* 30, 1283–1300.

https://doi.org/10.1287/mnsc.30.11.1283

{% %}

Farquhar, Peter H. & Peter C. Fishburn (1981) “Equivalence and Continuity in Multivalent Preference Structures,” *Operations Research* 29, 282–293.

{% %}

Farquhar, Peter H. & Peter C. Fishburn (1982) “Finite-Degree Utility Independence,” *Mathematics of Operations Research* 7, 348–353.

{% %}

Farquhar, Peter H. & Peter C. Fishburn (1983) “Indifference Spanning Analysis.” *In* Bernt P. Stigum & Fred Wenstop (eds.) *Foundations of Utility and Risk Theory with Applications*, 443–459, Reidel, Dordrecht.

{% **strength-of-preference representation**: not representation but nice discussion. %}

Farquhar, Peter H. & L. Robin Keller (1989) “Preference Intensity Measurement,” *Annals of Operations Research* 19, 205–217.

{% **utility families parametric**; for further comments see Bell (1988 MS) %}

Farquhar, Peter H. & Yutaka Nakamura (1987) “Constant Exchange Risk Properties,” *Operations Research* 35, 206–214.

{% %}

Farquhar, Peter H. & Anthony R. Pratkanis (1993) "Decision Structuring with Phantom Alternatives," *Management Science* 39, 1214–1226.

{% %}
Farrell, Joseph & Matthew Rabin (1996) "Cheap Talk," *Journal of Economic Perspectives* 10 no. 3, 103–118.

{% Properly points out the main error in the silly Lorenz et al. (2011 PNAS) paper. The letter in a diplomatic manner ignores the many silly details of Lorenz et al., but focuses on the main points. %}
Farrell, Simon (2011) "Social Influence Benefits the Wisdom of Individuals in the Crowd: Letter," *Proceedings of the National Academy of Sciences* 108, E6256.

{% Compare PT with EU for politicians; they replicate experiments by Quattrone & Tversky (1988), but now with 32 experts in politics, and they do not replicate most things, for reasons unclear. Simply, framing is volatile. They write, nicely and honestly, on p. 192: "Therefore, we must admit that our results are somehow inconclusive as we cannot offer any coherent economic, sociological or psychological theory to account for our data." %}
Fatas, Enrique, Tibor Neugebauer, & Pilar Tamborero (2007) "How Politicians Make Decisions: A Political Choice Experiment," *Journal of Economics* 92, 167–196.

{% %}
Faulí-Oller, Ramon, Efe A. Ok, & Ignacio Ortuño-Ortín (2003) "Delegation and Polarization of Platforms in Political Competition," *Economic Theory* 22, 289–309.

{% **law and decision theory**: discusses implications of behavioral findings for law. %}
Faure, Michael G. (2009) "The Impact of Behavioural Law and Economics on Accident Law," Inaugural lecture, Erasmus University, Rotterdam, the Netherlands.

{% Supports the saying “Equations reduce citations.” Eriksson (2013) finds that adding equation increases respect. %}

Fawcett, Tim W. & Andrew D. Higginson (2012) “Heavy Use of Equations Impedes Communication among Biologists,” *Proceedings of the National Academy of Sciences USA, Applied Mathematical Sciences* 109, 11735–11739.

{% **real incentives/hypothetical choice**: seems to consider that, and to find more risk aversion under real incentives. %}

Feather, Norman T. (1959) “Subjective Probability and Decision under Uncertainty,” *Psychological Review* 66, 150–164.

{% Seems to be considered birth of modern psychology. Seems to have proposed logarithmic perceptions.

First to propose **just noticeable difference** as unit of cardinal measurement, according to Stigler (1950) and Luce (1958, p. 214); seems that pp. 236–237 gives utility as an example of his law.

Seems that he used the method of limits, top-bottom or bottom-top, as analog of choice lists, to find subjective values. Dixon & Mood (1948) introduced the staircase method, which is bisection, to avoid biases. %}

Fechner, Gustav Th. (1860) “*Elemente der Psychophysik.*” Von Breitkopf und Härtel, Leipzig.

2nd edn. 1889

Reprinted 1964, Bonset, Amsterdam. Translated into English as “Elements of Psychophysics,” by Helmut E. Adler, Davis H. Howes, & Edwin G. Boring (1966), Rinehart and Winston, New York.

{% Nice citations of Keynes, Knight, their differences, and de Finetti. On insurance de Finetti seems to take the usual rigid position, ignoring asymmetric information. %}

Feduzi, Alberto, Jochen Runde, & Carlo Zappia (2012) “De Finetti on the Insurance of Risks and Uncertainties,” *British Journal for the Philosophy of Science* 63, 329–356.

{% Discuss new nuance of de Finetti’s views on uncertainty and risk. %}

Feduzi, Alberto, Jochen Runde, & Carlo Zappia (2014) "De Finetti on Uncertainty," *Cambridge Journal of Economics* 2014, 1–21.

{% Consider cases where the status-quo health state of people improves and consider health states that originally were above the status quo but are below now. They assume that utility is concave above the status quo and convex below (which, strictly speaking, is not defined for the nonquantitative outcomes considered here; but this problem can be fixed). This aspect of prospect theory, if taken in isolation, would imply that the health states considered have lower utility now than they had before. The authors test this hypothesis for 14 subjects. For 8 subjects they find higher utility now, contrary to the hypothesis, for 6 the same utility, and for 0 lower. They conclude that prospect theory is violated. (**PT falsified**)

It would be interesting to analyze the case considering loss aversion. Loss aversion is stronger than the concavity/convexity effect considered below. If I see things right, loss aversion will decrease the utility of outcomes that originally were closely above the status quo and now are considerably below, but will increase the utility of outcomes that originally were considerably above the status quo but now are closely below. In a complete analysis of prospect theory, also probability weighting would be incorporated. Thus, for a complete analysis of prospect theory it is not clear if the data of this paper confirm or reject it.

There are also intertemporal dependencies different than prospect theory that are effective here. %}

Feeny, David & Ken Eng (2006) "A Test of Prospect Theory," *International Journal of Technology Assessment in Health Care* 21, 511–516.

{% %}

Feferman, Solomon (1989) "Infinity in Mathematics: Is Cantor Necessary?," *Philosophical Topics* 17, 23–45.

{% %}

Fehr, Ernst (2002, January 17) "The Economics of Impatience," *Nature* 415, 269–272.

{% %}
Fehr, Ernst (2009) "On the Economics and Biology of Trust," *Journal of the European Economic Association* 7, 235–266.

{% %}
Fehr, Ernst, Urs Fischbacher, Bernhard von Rosenbladt, Jürgen Schupp, & Gert G. Wagner (2003) 2"A Nation-Wide Laboratory: Examining Trust and Trustworthiness by Integrating Behavioral Experiments into Representative Survey," Schmollers Jahrbuch 122, 519–542.

{% Classical preference model cannot explain findings. Reference dependence with loss aversion and diminishing sensitivity can. %}
Fehr, Ernst & Lorenz Götte (2007) "Do Workers Work More if Wages Are High? Evidence from a Randomized Field Experiment," *American Economic Review* 91, 298–317.

{% Although flexible contracts dominate rigid contracts under standard assumptions, they perform worse which may be explained by workers taking contracts as reference points. %}
Fehr, Ernst, Oliver Hart, & Christian Zehnder (2011) "Contracts as Reference Points—Experimental Evidence," *American Economic Review* 101, 493–525.

{% Edgeworth (1881): "For between the two extremes Pure Egoistic and Pure Universalistic there may be an indefinite number of impure methods; wherein the happiness of others as compared by the agent (in a calm moment) with his own, neither counts for nothing, nor yet counts for one, but counts for a fraction." %}
Fehr, Ernst & Klaus Schmidt (1999) "A Theory of Fairness, Competition and Cooperation," *Quarterly Journal of Economics* 114, 817–868.

{% %}
Fehr, Ernst & Jean-Robert Tyran (2001) "Does Money Illusion Matter?," *American Economic Review* 91, 1239–1262.

{% Criticize Petersen & Winn (2014). %}

Fehr, Ernst & Jean-Robert Tyran (2014) “Does Money Illusion Matter?: Reply,” *American Economic Review* 104, 1063–1071.

{% They consider models where individual irrationality is driven out in the market, but as well models where this need not happen at all. %}
Fehr, Ernst & Jean-Robert Tyran (2005) “Individual Irrationality and Aggregate Outcome,” *Journal of Economic Perspectives* 19, 43–66.

{% Experiment shows that money illusion can affect equilibrium choice. %}
Fehr, Ernst & Jean-Robert Tyran (2007) “Money Illusion and Coordination Failure,” *Games and Economic Behavior* 58, 246–268.

{% **decreasing ARA/increasing RRA**
inverse S: confirm it both for gains and for losses, using Goldstein & Einhorn (1987) two-parameter family

risk averse for gains, risk seeking for losses: find it well confirmed.

reflection at individual level for risk: they have it in their data but do not report it.

Experiment in Bejing 2005 with real incentives for Chinese students (N = 153), and CEs (certainty equivalents) of 56 lotteries, using a finite mixture regression model. Stakes were like 1-hour wage (low-stake) versus 40-hour wages (high-stake). Always choice between sure outcome and 2-outcome prospect in choice lists to get CEs. Use the Goldstein & Einhorn (1987) two-parameter family for probability weighting, and power-utility.

Unfortunately, they implemented two choices for real for each subject, being one for high-stake and one for low-stake (the high-low stake comparison is within-subject), giving an income effect. It will, unfortunately, amplify a contrast effect with subjects simply taking low-stakes not very seriously. Not much can be done about this (other than do between-subject).

P. 154 footnote 5 properly points out that loss aversion does not affect choices between losses under PT; this paper only considers nonmixed prospects.

Point out that measurements of utility and risk aversion, and investigations of whether risk aversion is decreasing or increasing and whether concavity of utility is decreasing or increasing, cannot be settled properly if there is no correction for

probability weighting and other things. Find increase in relative risk aversion for gains, but find that this is primarily driven by different probability weighting for high outcomes than for low. The latter entails a violation of prospect theory (**PT falsified; probability weighting depends on outcomes**). No increase or decrease but constant attitude is found for losses.

Losses with real incentives are implemented in an unconventional way: For each gain-choice there was a corresponding loss-choice that consisted of first a (choice-situation-dependent!) prior endowment and then the losses-choice, such that after integration of the endowment with the loss-choice the loss-choice was the same as the gain-choice. So, differences between gains and losses are a matter of framing, and this is how the authors often refer to it. Discussion of it on p. 170.

P. 151 top references several studies showing that heterogenous models can be really off. They find 1/4 subjects doing EV, and 3/4 PT. %}

Fehr-Duda, Helga, Adrian Bruhin, Thomas Epper, & Renate Schubert (2010) “Rationality on the Rise: Why Relative Risk Aversion Increases with Stake Size,” *Journal of Risk and Uncertainty* 40, 147–180.

{% **survey on nonEU**: well on probability weighting it is. Describes many implications of nonlinear probability weighting.

P. 568 penultimate para gives an unconventional interpretation of disappointment aversion as probability weighting.

P. 571 Table 1 the authors take 1st order risk aversion as desideratum for nonEU (thus arguing against the smooth model although they do not mention it, focusing on risk).

P. C.2, Figure 2, nicely depicts indifference curves of RDU and disappointment aversion in the probability triangle, to show their different characteristics, mosty with the DA indifference curves being linear (but not parallel), as they are for every betweenness model.

P. 576 end of §3.4 mentions some aspects in which the disappointment aversion model is more tractable than RDU.

P. 577 footnote 6 senses correctly that there are difficulties in identifying loss aversion, but incorrectly claims that one will have to add gain prospects to mixed prospects to do it. From mixed prospects one can entirely identify preferences over non-mixed prospects (under continuity), so, nonmixed prospects cannot really help.

P. 578 top rightfully criticizes power probability weighting functions. My main criticism is that they can't accommodate inverse S. The authors point out, right so, that it can't accommodate the common ratio effect, so, neither the certainty-effect version of it as in Allais' common ratio paradox. But it can accommodate the certainty effect in the common-consequence effect and in that version of Allais paradox.

Unfortunately, that the weighting function of T&K'92 is not strictly increasing for their parameter $\gamma < 0.279$ is called a drawback. Every parametric family imposes restrictions on its parameters. Linear-exponential (CARA) utility $U(\alpha) = \mu(1 - \exp(-\theta\alpha))$ under EU restricts its parameter values such that it is strictly increasing too (by requiring $\mu\theta > 0$). Is it a drawback that there are other parameter values ($\mu\theta < 0$) that have it decreasing? The second drawback, that relations between elevation and inverse S are assumed, cannnot be avoided for one-parameteric families, and a negative relation is plausible. (Its main drawback is I think that it overweights small probabilities too much. And, as the second drawback just mentioned, that two parameters are desirable to separate elevation and inverse S, agreeing with the authors claim opening up §3.6.2 on p. 579.)

P. 579 suggests that the intersection point of probability weighting may exceed 0.37. I think it usually is below. They find it to exceed in their experiments, especially with general populations. Thus, they do find strong evidence for **inverse S.**

P. 583 2^{nd} para nicely explains that one-nonzero prospects cannot identify utility and probability weighting (I add: Because their common power is unidentfiable). Then, people may have them identifiable if they assume parameteric families that do not leave the power free. But then the functional assumed a prori, rather than the data, determine the common power of utility. Some people deliberately assumed linear utility for this purpose, not as a confusion but deliberately. (This also often happens in intertemporal choice when estimating discounting with one-time-outcomes.) This annotated bibliography in 2013 signals the problem for Benhabib, Bisin, & Schotter (2010, p. 218 middle the estimate of power utility), Glaser, Trommershäuser, Mamassian, & Maloney (2012, Psychological Science), and Zeisberger, Vrecko, & Langer (2012, see

Figure 1).

§5, p. 586 ff., nicely lists many findings outside the lab that support probability weighting.

Prospect theory/Rank-Dependent Utility most popular for risk: §6 %}

Fehr-Duda, Helga & Thomas Epper (2012) "Probability and Risk: Foundations and Economic Implications of Probability-Dependent Risk Preferences," *Annual Review of Economics* 4, 567–593. https://doi.org/10.1146/annurev-economics-080511-110950

{% **inverse S:** fourfold pattern is found clearly.

Zurich 2003, CEs (certainty equivalents) of 50 lotteries

reflection at individual level for risk: they have it in their data but do not report it.

Use certainty equivalents (choice list and random incentive system) and data fitting with power utility and Goldstein & Einhorn (1987) probability weighting family to fit data, for gains and losses, but not mixed. For women in good mood, utility and likelihood sensitivity parameters are not affected, but probability elevation parameter is, becoming more optimistic (**gender differences in risk attitudes; inverse S (= likelihood insensitivity) related to emotions**). With men quite many did EV, so, there was too little power to find much there. %}

Fehr-Duda, Helga, Thomas Epper, Adrian Bruhin, & Renate Schubert (2011) "Risk and Rationality: The Effects of Mood and Decision Rules on Probability Weighting," *Journal of Economic Behavior and Organization* 78, 14–24.

{% **inverse S:** find it, and more pronounced for women than for men (**gender differences in risk attitudes**).

Experiment in August 2003, N = 204. Dropped 23 subjects. 50 lotteries. Argue that the two parameters of Goldstein & Einhorn (1987) are well separated and that the model fits better than the T&K'92 one-parameter family. Do not discuss the Prelec (1998 CI) family. %}

Fehr-Duda, Helga, Manuele de Gennaro, & Renate Schubert (2006) "Gender, Financial Risk, and Probability Weights," *Theory and Decision* 60, 283–313.

{% **proper scoring rules**: A charlatan single expert can manipulate any calibration test. If there are multiple experts, then "cross-calibration" tests can be devised that will identify the charlatans. There is much literature on these issues. %}
Feinberg, Yossi & Colin Stewart (2008) "Testing Multiple Forecasters," *Econometrica* 76, 561–582.

{% Consider linear and geometric opinion pooling. Discuss decision weights. Use meta-induction and scoring rules, achieving big generality. %}
Feldbacher-Escamilla, Christian J. & Gerhard Schurz (2023) "Meta-Inductive Probability Aggregation," *Theory and Decision* 95, 663–689. https://doi.org/10.1007/s11238-023-09933-z

{% **equity-versus-efficiency** %}
Feldman, Allan M. & Alan P. Kirman (1974) "Fairness and Envy," *American Economic Review* 64, 996–1005.

{% **Z&Z** %}
Feldman, Roger & Bryan Dowd (1991) "Must Adverse Selection Cause Premium Spirals?," *Journal of Health Economics* 10, 349–357.

{% **Z&Z** %}
Feldman, Roger & Bryan Dowd (1991) "A New Estimate of the Welfare Loss of Excess Health Insurance," *American Economic Review* 81, 297–301.

{% Apply prudence, temperance, and so on, in the context of a medical test. %}
Felder, Stefan & Thomas Mayrhofer (2014) "Risk Preferences: Consequences for Test and Treatment Thresholds and Optimal Cutoffs," *Medical Decision Making* 34, 33–41.

{% **Z&Z** %}
Feldstein, Martin S. (1971) "Hospital Cost Inflation: A Study in Nonprofit Price Dynamics," *American Economic Review* 61, 853–872.

{% %}

Feller, William (1966) “*An Introduction to Probability Theory*, Vol. II.” Wiley, New York.

{% Seem to find competence effect. %}
Fellner, Gerlinde, Werner Güth, Boris Maciejovsky (2004) “Illusion of Expertise in Portfolio Decisions: An Experimental Approach,” *Journal of Economic Behavior and Organization* 55, 355–376.

{% Discuss several ways to measure risk aversion. %}
Fellner, Gerlinde & Boris Maciejovsky (2007) “Risk Attitude and Market Behavior: Evidence from Experimental Asset Markets,” *Journal of Economic Psychology* 28, 338–350.

{% Suggests “slanted” (= distorted, or nonadditive) probabilities for ambiguity.

P. 672 suggests that subjective probability judgments relating to different “processes” (Amos would say sources) are not directly comparable. Suggests that there is a probability estimation stage, and next a transformation into decision weights (as in source theory). The estimated probabilities are called “corrected probabilities,” or “true subjective probabilities,” the transformed ones “uncorrected probabilities.”

P. 673 2nd para discusses the Ellsberg two-color urns where the matching probability of an ambiguous color is 0.3.

P. 674/675 discusses in quite some detail that probabilities of gains are more natural entities to be transformed than probabilities of staying in the initial position. A similar argument for losses would suggest that probabilities for losses are to be considered there. These two viewpoints nicely support the method of Choquet integration adopted by Tversky & Kahneman (1992)—top-down for gains and bottom-up for losses—so, symmetric about the origin as the Šipoš (Sipos) integral. Because if only singles out the reference point, it also fits well with 1979 prospect theory.

utility measurement: **correct for probability distortion**: p. 676 points out that, when subjects (pessimistically) transform probabilities of gains downward, then common methods of measuring utility give overly concave utilities and then first the subject’s transforming of probabilities should be incorporated. So, it

pleas for correcting for probability transformation.

P. 676 nicely explains that it is a modeling issue whether the deviation from expected utility is ascribed to probability transformation or to utility: "for pragmatic reasons we may sometimes wish to channel the impurity into the utility concept itself rather than catch it at the level of the weighting system. In this case the distortion of probabilities gives the appearance of a distortion of the utility concept rather than of the probabilities."

P. 679 raises the income effect.

P. 680, **paternalism/Humean-view-of-preference**: "… leaving an otherwise rational person alone who consistently prefers three dollars to *quatre* [four] *dollars*. This latter person needs to be supplied with a dictionary rather than to be assured of our respect for his preference scales."

§II argues that deviations from expected utility generated by psychological costs etc. may be rational.

uncertainty amplifies risk: p. 684 suggests that nonadditivity is more pronounced for uncertainty than for risk.

P. 680 gives a nice argument against consumer sovereignty and for paternalism: "But the question still remains whether leaving him alone is not like leaving an otherwise rational person alone who consistently prefers three dollars to *quatre dollars* [French for "four dollars"]. This latter person needs to be supplied with a dictionary rather than to be assured of our respect for his preference scales. He is making a mistake."

P. 685 suggests correction factor; i.e., how much added probabilities fall short of 1, as measure of degree of "slanting." Is common and, for instance, also used by Schmeidler (1989).

Other than that, §§II (rationality) and III (a little experiment) were not interesting to my current interests. P. 681 tries to defend nonEU, also for risk, and finds little appreciation from a Bayesian like me.

%}

Fellner, William (1961) "Distortion of Subjective Probabilities as a Reaction to Uncertainty," *Quarterly Journal of Economics* 75, 670–689. https://doi.org/10.2307/1884325

{% %}

Fellner, William (1965) "Slanted Subjective Probabilities and Randomization: Reply to Howard Raiffa and K.R.W. Brewer," *Quarterly Journal of Economics* 77, 676–690.

{% Seems to recommend nonadditive probabilities in the Ellsberg paradox; seems to say that regret should be modeled as attribute of consequences. %}
Fellner, William (1965) "Probability and Profit: A Study of Economic Behavior along Bayesian Lines: A Study of Economic Behavior along Bayesian Lines." Homewood, Richard D. Irwin, Illinois.

{% Empirical tests of bargaining solutions %}
Felsenthal, Dan S. & Abraham Diskin (1982) "The Bargaining Problem Revisited: Minimum Utility Point, Restricted Monotonicity Axiom, and the Mean as an Estimate of Expected Utility," *Journal of Conflict Resolution* 26, 664–691.

{% This paper was never completed. %}
Fennema, Hein (1999) "Effects of Event-Spreading: When Less Is More."

{% %}
Fennema, Hein (2000) "Decision Making with Transformed Probabilities," Ph.D. dissertation, Dept. of Psychology, University of Nijmegen, the Netherlands.

{% **Risk seeking for losses**; **tradeoff method**.
decreasing ARA/increasing RRA: use power utility;
Economists usually assume that utility for losses is concave, psychologists that it is convex. Previous tests were parametric. This paper is the first parameter-free investigation. It finds that utility for losses is convex and not concave.
data set %}
Fennema, Hein & Marcel A.L.M. van Assen (1998) "Measuring the Utility of Losses by Means of the Tradeoff Method," *Journal of Risk and Uncertainty* 17, 277–295.

{% %}
Fennema, Hein & Peter P. Wakker (1994) "An Explanation and Characterization for the Buying of Lotteries." *In* Sixto Rios (ed.) *Decision Theory and Decision Analysis: Trends and Challenges*, 163–175, Kluwer Academic Publishers, Dordrecht.

Direct link to paper

Correction of Footnote 4

{% **PT: data on probability weighting**; **PT falsified**; **coalescing** %}

Fennema, Hein & Peter P. Wakker (1996) "A Test of Rank-Dependent Utility in the Context of Ambiguity," *Journal of Risk and Uncertainty* 13, 19–35.
https://doi.org/10.1007/BF00055336
Direct link to paper

{% **PT: data on probability weighting**;
People sometimes cite this paper for the formula $(p_1{:}x_1;\ldots;p_n{:}x_n)$ --> $w(p_1)U(x_1) + \ldots + w(p_n)U(x_n)$, supposedly extending the original '79 prospect theory to many outcomes. However, our paper does not claim so. It only suggests so for MIXED prospects, with both positive and negative outcomes. Let me emphasize that it does not propose this formula for nonmixed prospects. %}

Fennema, Hein & Peter P. Wakker (1997) "Original and Cumulative Prospect Theory: A Discussion of Empirical Differences," *Journal of Behavioral Decision Making* 10, 53–64.
https://doi.org/10.1002/(SICI)1099-0771(199703)10:1<53::AID-BDM245>3.0.CO;2-1
Direct link to paper

{% Describe software for analysing Bayesian networks. %}

Fenton, Norman & Martin Neil (2012) "*Risk Assessment and Decision Analysis with Bayesian Networks*." CRC Press, Boca Raton, FL.

{% **discounting normative**: Their paper seems to end, on p. 274, with

"Our result suggests that the search for a fair rate of discount is a vain one. Instead of searching for the right number, i.e. 'the' social rate of discount, we must look to broader principles of social choice to incorporate ideas of intertemporal equity. Once found, these principles might be used as side conditions in a discounting procedure to rule out gross inequities that can arise with discounting, even with a low discount rate." %}

Ferejohn, John & Talbot Page (1978) "On the Foundations of Intertemporal Choice," *American Journal of Agricultural Economics* 60, 269–275.

https://doi.org/10.2307/1240059

{% **coherentism**: seem to have the representational view of utility. %}
Ferejohn, John & Debra Satz (1994) “Rational Choice and Social Theory,” *Journal of Philosophy* 91, 71–87.

{% **social sciences cannot measure**
In the late 1930s, a British committee of prominent researchers was organized to decide for once and for all whether or not measurement was possible in the social sciences. It seems that they came to conclude that it was not, because social sciences do not have a natural addition operation. Oh well ...
Campbell & Irwin seem to have written on p. 338: “Why do not psychologists accept the natural and obvious conclusion that subjective measurements of loudness in numerical rems (like those of length or weight or brightness) ... are naturally inconsistent and cannot be the basis of measurement?”
Campbell, Norman R. (1920) seems to have argued the same. %}
Ferguson, Allan (chairman), C.S. Meyers (Vice Chairman), R.J. Bartlett (Secretary), H. Banister, Frederic C. Bartlett, William Brown, Norman R. Campbell, Kenneth J.W. Craik, James Drever, J. Guild, Robert A. Houstoun, Joseph O. Irwin, George W.C. Kaye, Stanley J. Philpott, Lewis F. Richardson, John H. Shaxby, T. Smith, Robert H. Thouless, & William S. Tucker (1940) “Quantitative Estimates of Sensory Events. The Advancement of Science.” *Report of the British Association for the Advancement of Science* 2, 331–349.

{% %}
Ferguson, Thomas S. (1967) “Mathematical Statistics: A Decision Theoretic Approach. Probability and Mathematical Statistics, Vol. 1.” Academic Press, New York.

{% Seems to have said:
“It does not say in the Bible that all laws of nature are expressible linearly.” %}
Fermi, Enrico (date unknown)

{% Unfortunately, the authors use the faulty approach of Andersen, Harrison, Lau, & Rutstrom (2008) to measure risk and time attitudes. They assume expected utility to measure the constant relative risk aversion index, assuming logpower (CRRA) utility. It is better to just assume linear utility than to use the Andersen et al. utility correction because EU utility is more distorted by nonEU risk factors than that it brings true utility for risk, let be for intertemporal. Thus, the authors confound time attitude with risk attitude and its noise. This is extra unfortunate because the authors want to study the relations between time and risk atttitudes.

The novelty of this paper is a one-blow Bayesian hierarchical fitting rather than the two-stage fitting of Anderson et al. %}

Ferecatu, Alina & Ayse Öncüler (2016) "Heterogeneous Risk and Time Preferences," *Journal of Risk and Uncertainty* 53, 1–28.
https://doi.org/10.1007/s11166-016-9243-x

{% The authors tested decision under risk in three monkeys, using many 1000s of choices over extended periods. In particular, they tested common ratio and common consequence violations of expected utility's independence axiom, so, the usual Allais paradox tests. They did data fitting with new 1992 prospect theory (**PT falsified**: not!), i.e., rank-dependent probability weighting. They, properly, do top-down integration in rank-dependence, as is the convention these days (2023).

inverse S: They find that probability weighting better fits and predicts choices than utility. However, the patterns of violation are opposite to those found among humans. (**PT falsified**) They go against the certainty effect and give S-shaped, rather than inverse S-shaped, probability weighting, and more concave than convex probability weighting. They also find convex rather than concave utility. How come this difference they do not discuss much. Reminds me of Decision from Experience, which is what one has to do with monkeys.

They test not only direct violations of independence, which they call preference reversals and of which they do not find much, but also what they call preference changes. Those are the proportion of common Allais-violations versus the reversed Allais violations. Those gave more significant statistics.

I usually use statistical tests that assume between-subject stochastic

independence but not within-subject stochastic independence. Then, with N = 3, only three monkeys, not much statistics is possible. %}

Ferrari-Toniolo, Simone, Leo Chi U. Seak, & Wolfram Schultz (2022) “Risky Choice: Probability Weighting Explains Independence Axiom Violations in Monkeys,” *Journal of Risk and Uncertainty* 65, 319–351. https://doi.org/10.1007/s11166-022-09388-7

{% %}

Ferreira, Jose L., Itzhak Gilboa, & Michael Maschler (1995) “Credible Equilibria in Games with Utilities Changing During the Play,” *Games and Economic Behavior* 10, 284–317.

{% Show that aroused anger carries over to more risk taking (through BART measurement), especially for men. The paper ends with the usual clichés: “the present findings may have important implications. In everyday life” and then the final sentence asking for future research. %}

Ferrer, Rebecca A., Alexander Maclay, Paul M. Litvak & Jennifer S. Lerner (2017) “Revisiting the Effects of Anger on Risk-Taking: Empirical and Meta-Analytic Evidence for Differences between Males and Females,” *Journal of Behavioral Decision Making* 30, 516–526. https://doi.org/10.1002/bdm.1971

{% %}

Ferrer-i-Carbonell, Ada (2002) “Income and Well-Being: An Empirical Analysis of the Income Comparison Effect,” Tinbergen Institute Discussion Paper TI 2002-019/3, Amsterdam, the Netherlands.

{% Seem to argue that happiness scores are cardinally interpersonally comparable, because people have a common understanding. %}

Ferrer-i-Carbonell, Ada, & Paul Frijters (2004) “How Important Is Methodology for the Estimates of the Determinants of Happiness?,” *Economic Journal* 114, 641–659.

{% r**eal incentives/hypothetical choice**: seems to be on it %}

Ferrey, Anne E. & Sandeep Mishra (2014) "Compensation Method Affects Risk-Taking in the Balloon Analogue Risk Task," *Personality and Individual Differences* 64, 111–114. https://doi.org/10.1016/j.paid.2014.02.008

{% %}

Festinger, Leon (1957) "*A Theory of Cognitive Dissonance.*" Stanford University Press, Stanford, CA.

{% %}

Festinger, Leon (1962) "Cognitive Dissonance," *Scientific American* 207 (4), 93–107.

{% **real incentives/hypothetical choice**: cognitive dissonance: Students (1st) had to do a tedious task, (2nd) had to convince another student to participate by arguing the task was interesting and fun, (3rd) were paid for participation, and then, (4th) and finally, were asked to evaluate how much they liked or disliked carrying out the task. ½ students got paid $1; other ½ got paid $20. Surprisingly, the $1 group evaluated their task higher than the $20 group! It is related to the **crowding-out** effect. I guess that the $1 group was also more willing to repeat the task. %}

Festinger, Leon & James M. Carlsmith (1959) "Cognitive Consequences of Forced Compliance," *Journal of Abnormal and Social Psychology* 58, 203–210.

{% Measure risk attitudes for monetary outcomes, and waiting time. Do it hypothetical with no real incentives, for good reasons well explained in §7.2. Measure prospect theory parameters by measuring certainty equivalents and then semi-parametric fitting (fitting w(0.5) and then using that in calculations). They find that probability weighting and loss aversion are the same for time and money. Unsurprisingly, utility curvature is not the same for time and money. For both time and money, they generate a reference point by emphatetically specifying an expected value, and whether things are above or below. P. 54 cites literature on risk attitudes for time.

A nice point is on p. 65: "individuals believe they will have more time —but not more money — in a few months' time" %}

Festjens, Anouk, Sabrina Bruyneel, Enrico Diecidue, & Siegfried Dewitte (2015) “Time-Based versus Money-Based Decision Making under Risk: An Experimental Investigation,” *Journal of Economic Psychology* 50, 52–72.

{% **decreasing ARA/increasing RRA**: gives psychological arguments for power utility;

marginal utility is diminishing: Discuss diminishing sensitivity as a general principle of numeric sensitivity, use term “psychophysical numbing” for it. Also for **Christiane, Veronika & I.**

ratio-difference principle: Nice illustration that people usually do something between differences and proportions, for example when deciding how much money to spend to save X lives from Y endangered. For instance, Fig. 3 finds 16 subjects who do constant proportion, 47 do the (rational) constant number, and the great majority, 91, do something in between. %}

Fetherstonhaugh, David, Paul Slovic, Stephen M. Johnson, & James Friedrich (1997) “Insensitivity to the Value of Human Life: A Study of Psychophysical Numbing,” *Journal of Risk and Uncertainty* 14, 283–300.

{% **foundations of quantum mechanics**; Probability in Quantum mechanics %}

Feynman, Richard P. (1951) “The Concept of Probability in Quantum Mechanics.” *In* Jerzy Neyman (ed.) *Second Berkeley Symposium on Mathematical Statistics and Probability*, University of California Press, Berkeley.

{% %}

Feynman, Richard P. et al. (eds.) recorded lectures, I don’t know which. Maybe for his famous text book?

{% Vol. I §§37-4, 37-5, 37-6, and 37-7 + Vol. III Ch. I.

conservation of influence: Seems that in Vol. 1 Ch. 4 he explains conservation of energy through an example of a little boy named “Dennis the Menace” (or a boy like him? Dennis the Menace was a boy in famous American stories, a boy doing all kinds of naughty things) playing with 28 blocks. At the end of the day, his mother counts the blocks to make sure there are still 28 of them. Dennis hides blocks in a box that his mother is not allowed to look into, in dirty bath water, etc.

Always his mother recovers the blocks by weighing the box, measuring the volume of the water, etc. %}

Feynman, Richard P. et al. (eds.) (1963, 1975) "*The Feynman Lectures in Physics*."

{% Probably in early 1960s.

The same can be said about how economics differs from mathematics. %}

Feynman, Richard P. (rrr) "What Differs Physics from Mathematics." Lecture at https://www.youtube.com/watch?v=B-eh2SD54fM

{% Probably in early 1960s.

Argues that if two theories (for now) have the same empirical implications, they can still be different, where one gives more what Feyman calls "understanding." I take the liberty of taking this as a plea for homeomorphic theories, going against some claims by Friedman (1953), and going against **coherentism**. %}

Feynman, Richard P. (rrr) "Knowing and Understanding." Lecture https://www.youtube.com/watch?v=NM-zWTU7X-k

{% https://www.feynmanlectures.caltech.edu/flptapes.html has info on Feynman's lectures.

10 June 1961 %}

Feynman, Richard P. (1961) "Conservation of Energy."

{% **preference for flexibility**: An agent has to select one alternative from a choice set. Can do with as many intermediate rounds as he wants. At each stage, does not know for sure the true preference and may with some probability perceive a random preference instead. At each stage, forgets past and only info is set of alternatives left. If very risk averse, main interest is not to choose the worst alternative. If very risk averse, main interest is to choose the best alternative. Hence (Proposition 1), an extremely risk averse subject at each choice removes only one alternative, being the one perceived as worst; so, takes as many nontrivial rounds as possible. A very risk seeking subject immediately chooses one (the one perceived as best) alternative, so, takes as few nontrivial rounds as possible (Proposition 2, p. 413). %}

Ficco, Stefano & Vladimir A. Karamychev (2009) “Preference for Flexibility in the Absence of Learning: The Risk Attitude Effect,” *Economic Theory* 40, 405–426.

{% Compare numerical presentation of probability with a sort of spatial presentation. The latter seems to enhance sensitivity toward probability and, thus, reduce or even reverse **inverse S**, similarly to the experienced approach (DFE) by Erev et al. %}
Fiedler, Klaus & Christian Unkelbach (2011) “Lottery Attractiveness and Presentation Mode of Probability and Value Information,” *Journal of Behavioral Decision Making* 24, 99–115.

{% Duggie Fields (1990 approximately). In 1969 he was a painter and a roommate of Syd Barret, the member of the pop band Pink Floyd from 1965 or so till 1968. Duggie, verbatim, explained the following about Syd’s depressions in a documentary about Syd made around 1990. It describes a preference for liberty of choice, and how this leads to a loss of utility and how it is not optimal from a consequentialist point of view. In the second half of the citation, every word is perfect, such as “limited presence” (**conservation of influence**!).

> I think he spent quite a while lying in bed—I used to be in the next room and, eh, I’d be painting, and it was kind of like the wall in between us would sort of cease to exist. And, I knew he was lying in bed sort of thinking, and my my interpretation was that he was thinking that while he lay there, eh, he had the possibility of doing anything in the world that he chose. But the minute he made a choice he was limiting his possibilities, so, he lay there as long as he could, so, he had this unlimited future. Ah, but of course that’s a very limited presence when you do that, and a very depressing one ultimately. %}

Fields, Duggie (1990 approximately), in tv-documentary on Syd Barret.

{% A 2n-tuple reflects n-income vector in one year and then in next year. The pair is evaluated according to its income mobility. Axioms specify particular income mobility functions. %}

Fields, Gary S. & Efe A. Ok (1996) "The Meaning and the Measurement of Income Mobility," *Journal of Economic Theory* 71, 349–377.

{% %}

Fields, Gary S. & Efe A. Ok (1999) "Measuring Movement of Incomes," *Economica* 99, 455–471.

{% **law and decision theory** %}

Fienberg, Stephen E. (1989, ed.) "*The Evolving Role of Statistical Asssessments as Evidence in the Courts*." Springer, Berlin.

{% **foundations of statistics** %}

Fienberg, Stephen E. (1992) "A Brief History of Statistics in Three and One-Half Chapters: A Review Essay," *Statistical Science* 7, 208–225.

{% **foundations of statistics**; nice historical account describing roles of people like Good, Schlaiffer, early acts of Savage, especially in §5. It focuses on the use of the term Bayesian. %}

Fienberg, Stephen E. (2006) "When Did Bayesian Inference Become "Bayesian"?," *Bayesian Analysis* 1, 1–40.

{% **foundations of statistics**, not about the Bayes-NP controversy %}

Fienberg, Stephen E. & Judith M. Tanur (1996) "Reconsidering the Fundamental Contributions of Fisher and Neyman on Experimentation and Sampling," *International Statistical Review* 64, 237–253.

{% %}

Figner, Bernd, Daria Knoch, Eric J Johnson, Amy R Krosch, Sarah H Lisanby, Ernst Fehr, & Elke U. Weber (2010) "Lateral Prefrontal Cortex and Self-Control in Intertemporal Choice," *Nature Neuroscience* 13, 537–538. http://dx.doi.org/10.1038/nn.2516

{% **relation age-risk attitude**: see title.

questionnaire for measuring risk aversion: The Columbia card task is a nice

risk taking task, and probably an improvement of the balloon task (BART): There are 32 cards, face down, n among them losing cards, the rest (32−n) gaining cards, a gain G, and a loss L. Subjects can turn around cards (that were not turned around before, so, it is drawing without replacement), one by one. After each gaining card, G is added to their gains, and subjects can choose to continue or stop. (For the next round the loss probability increases.) After a losing card, L is subtracted from subjects' gains and they must stop. Because the data are truncated after a loss, it is probably best to ask beforehand how many cards subjects want to be turned around if the chance (strategy method).

This paper considers both where subjects must announce beforehand how any cards they want turned (the cold treatment), and where they turn around one by one being informed immediately about each result (the hot treatment). The authors conjecture that the former, cold, treatment will trigger our rational system, and the latter, hot, treatment will trigger our emotional system. The hot treatment will usually deliver censored data, after a loss. Therefore, unfortunately, the authors rigged the experiment, letting the losing cards be the last to come. (See p. 713. Among 54 experimental questions, rigged this way, they added 9 tasks with early losing cards deliberately generated.) This is deception, which is unfortunate. (**deception when implementing real incentives**) Comes to it that subjects who try some, will get encouraged to become more risk seeking.

The authors do ANOVAs within subjects (p. 712 bottom of 1st column), apparently assuming independence of choices within subjects. By this collapsing of data per subject into significant or nonsignificant (a sort of median split) much power is lost.

The authors consider both overall degree of risk aversion, being how many cards turned in total, and information sensitivity by seeing how the number of cards turned depends on the number n of loss cards, the gain G, and the loss L.

%}

Figner, Bernd, Rachael J. Mackinlay, & Friedrich Wilkening (2009) "Affective and Deliberative Processes in Risky Choice: Age Differences in Risk Taking in the Columbia Card Task," *Journal of Experimental Psychology: Learning, Memory, and Cognition 35*, 709–730.

https://doi.org/10.1037/a0014983

{% Risk attitude depends on person, situation, affect versus deliberation, purpose of decision, and many other things (**relation age-risk attitude?**, **cognitive ability related to discounting**?; **gender differences in risk attitude?**) and their interactions. The paper reviews literature. Pp. 211-212:

"This review integrates a very rich and exciting literature on risk taking by using examples from our own work to illustrate the importance of individual differences, contextual influences, and their interaction …" %}

Figner, Bernd & Elke U. Weber (2011) "Who Takes Risks when and why?," Determinants of Risk Taking," *Current Directions in Psychological Science* 20, 211–216.
https://doi.org/10.1037/a0014983

{% Consider incomplete preferences, with sets of representing functions (à la Bewley (1986, 2002) and Dubra, Maccheroni, & Ok, JET, 2004) where necessary preference refers to unanimity of utilities, and possible preference to existence of at least one utility function that gives the preference. They take a strength of preference relation >* as primitive (which implies an ordinal preference x > y iff xx >* yx) and show how additive value functions can be constructed for those by solving linear programming and so on. %}

Figueira, José Rui, Salvatore Greco, & Roman Slowinski (2009) "Building a Set of Additive Value Functions Representing a Reference Preorder and Intensities of Preference: GRIP Method," *European Journal of Operational Research* 195, 460–486.

{% Survey on Roy's ELECTRE. %}

Figueira, José Rui, Salvatore Greco, Bernard Roy, & Roman Słowiński (2013) "An Overview of ELECTRE Methods and Their Recent Extensions," *Journal of Multi-Criteria Decision Analysis* 20, 61–85.

{% **gender differences in risk attitude**: A meta-analysis.

Prospect theory not cited: They focus on EU-logpower fitting of indifferences, often named after Holt-Laury. But their Footnote 1 at least mentions the point,

starting with providing the readers with the following information: "The application by Holt and Laury (2002) of a multiple price list is not the first to elicit risk preferences in decisions under risk." They then cite Cohen & Jaffray (1987) and Tversky & Kahneman (1992) as alternatives. But then they defend their restriction: "However, at the present time, the HL task constitutes the most widely known implementation of the multiple price list approach applied to risk" However, the Nobel-awarded Tversky & Kaheman (1992) is cited 2.5 times more than Holt & Laury (2002), and it also used choice lists. Kahneman & Tversky (1979) is even the most-cited paper ever in an economic journal.

They find little gender difference. In their study of details and specifics that may interact, in §5, it is a big pity that they do not distinguish utility curvature, pessimism, insensitivity, and loss aversion, but go with only one index, of risk aversion. I did not understand much of, and guess I disagree with, many claims in the discussion of probability weighting on p. 3154. Have the impression that the authors equate risk aversion with utility curvature also if probability weighting is present, a confusion found in many places in the literature. %}

Filippin, Antonio & Paolo Crosetto (2016) "A Reconsideration of Gender Differences in Risk Attitudes," *Management Science* 62, 3138–3160. https://doi.org/10.1287/mnsc.2015.2294

{% Subjects rather gamble on black (versus white) in an urn with 1000 balls than with 10 balls, thinking they have "more chances," whereas rationally speaking it should not matter. This finding holds both for urns with known and for urns with unknown composition, and is a special case of the ratio bias (**ratio bias**). The ratio bias is stronger under ambiguity than under risk (**uncertainty amplifies risk**), and can affect ambiguity aversion. %}

Filiz-Ozbay, Emel, Huseyin Gulen, Yusufcan Masatlioglu, & Erkut Ozbay (2021) "Comparing Ambiguous Urns with Different Sizes," *Journal of Economic Theory* 109, 105224.

{% **foundations of probability** %}

Fine, Terrence L. (1973) "*Theories of Probability*." Academic Press, New York.

{% **Z&Z**: nice explanation of what Medicare is: Compulsory partial public health insurance program for elderly, being people aged 65 or older. Topic of this paper: Medicare is public and compulsory insurance which is meant to reduce adverse selection. However, it is partial insurance, covering less than half of all expenses. What is effect of Medicare regarding adverse selection for uncovered expenses? It is in principle conceivable that for those it would more than double the adverse selection, so that in total Medicare would increase rather than reduce adverse selection. However, they find that Medicare does not seem to affect drugs use, and adverse selection, regarding residual costs. %}

Finkelstein, Amy (2004) "The Interaction of Partial Public Insurance Programs and Residual Private Insurance Markets: Evidence from the US Medicare Program," *Journal of Health Economics* 23, 1–24.

{% Econometric measurement of **state-dependent utility** à la Karni, depending on health state (although no uncertainty in the latter explicitly modeled and in this sense different than Karni's models.) %}

Finkelstein, Amy, Erzo F.P. Luttmer & Matthew J. Notowidigdo (2009) "Approaches to Estimating the Health State Dependence of the Utility Function," *American Economic Review, Papers and Proceedings* 99, 116–121.

{% **cognitive ability related to risk/ambiguity aversion**: Allais-violation of EU is enhanced by less education and experience. N = 180 farmers. %}

Finkelshtain, Israel & Eli Feinerman (1997) "Framing the Allais Paradox as a Daily Farm Decision Problem: Tests and Explanations," *Agricultural Economics* 15, 155–167.

{% Two monkeys received visual stimuli indicating that they might receive a liquid reward after two seconds. Distinct stimuli indicated probabilities of 0, 0.25, 0.50, 0.75, or 1. The monkeys apparently learned to distinguish the stimuli, for one reason because anticipatory licking was different for them. The brain activities of the monkeys were measured.

Phasic activation of dopamine neurons after receipt of reward decreased with reward probability. After no reward, neuronal activity was suppressed, tending to increase with probability, though hard to measure given the low level of spontaneous activity. So, after both reward and no reward, seems that neuronal activity decreases with reward probability and, thereby, increases with elation (difference between predicted and actual reward), apparently in agreement with earlier findings (p. 1898 last column gives several references).

P. 1898 end of 2nd column:

"It is only through a rich representation of probabilities that an animal can infer the structure of its environment and form associations between correlated events."

And references to support this are given.

New in this study is the measurement of sustained activation between signal and reward. This activation was maximal at p = 0.5, and absent at p = 0 and p = 1. In time it was maximal at time of reward, and in reward it was maximal in discrepancy between good and bad reward.

inverse S: The symmetry of sustained activity of dopamine neurons around 0.5 is reminiscent of inverse S and cognitive factors, although the dependency on reward size makes clear that it is not merely cognitive. (**cognitive ability related to discounting**)

Phasic and sustained activities seem to be independent. All of the observed activities disappeared for motivationally irrelevant activities. In the last two columns the authors speculate on sustained activation playing a role in learning, attention, intrinsic utility of learning, etc. %}

Fiorillo, Christopher D., Philippe N. Tobler, & Wolfram Schultz (2003) "Discrete Coding of Reward Probability and Uncertainty by Dopamine Neurons," *Science* 299, 1898–1902.

{% The intro opens with: "To be relevant and credible, scientific results have to be verifiable. The integrity of academic endeavors rests on reproducibility, wherein independent researchers obtain consistent results using the same methodology and data, and replicability, which involves the application of similar procedures to new data. The significance of these twin principles for scientific research is commonly agreed upon." %}

Fišar, Miloš, Ben Greiner, Christoph Huber, Elena Katok, Ali I. Ozkes, and the Management Science Reproducibility Collaboration (2024) "Reproducibility in Management Science," *Management Science* 70,:1343–1356. https://doi.org/10.1287/mnsc.2023.03556

{% %}
Fischbacher, Urs (2007) “Z-Tree: Zurich Toolbox for Ready-Made Economic Experiments,” *Experimental Economics* 10, 171–178.

{% Seem that they introduced the statistical method of detecting lies. Subjects throw a die and see its number between 1 and 6, but no-one else sees it. Then they are said that some randomly chosen number between 1 and 6, say 3, is winning. They are asked if their number was 3. More than 1/6 will claim so. For no single subject can one prove that the subject lied, but in the group one can significantly reject the H_0 of no-one lying. Most researchers take lying of subjects as immoral. I disagree. I as a subject would lie. I am then not immoral. The experiment is immoral, in rewarding lying and punishing honesty. %}
Fischbacher, Urs & Franziska Föllmi-Heusi (2013) “Lies in Disguise—An Experimental Study on Cheating,” *Journal of the European Economic Association* 11, 525–547.
https://doi.org/10.1111/jeea.12014

{% **utility elicitation** %}
Fischer, Gregory W. (1975) “Experimental Applications of Multiattribute Utility Models.” *In* Dirk Wendt & Charles A.J. Vlek (eds.) *Utility, Probability, and Human Decision Making*, 7–46, Reidel, Dordrecht.

{% **utility elicitation**; **risky utility u = transform of strength of preference v**: choose sure job or gamble on better?
A nice study that does conjoint measurement à la Krantz et al. (1971), MAUT à la Keeney & Raiffa (1976), linear regression, and compares it al.
Found high convergence between risky and riskless utility.
Tested additive independence for three-dimensional car-evaluation problem; does convergent validation (if predictions model agree with intuitive holistic preferences). %}
Fischer, Gregory W. (1976) “Multidimensional Utility Models for Risky and Riskless Choice,” *Organizational Behavior and Human Performance* 17, 127–146.

{% **utility elicitation**; **risky utility u = transform of strength of preference v** %}

Fischer, Gregory W. (1977) "Convergent Validation of Decomposed Multi-Attribute Utility Assessment Procedures for Risky and Riskless Decisions," *Organizational Behavior and Human Performance* 18, 295–315.

{% **utility elicitation**; For simple attributes intuitive = MAUT, for more dimensions more difference %}
Fischer, Gregory W. (1979) "Utility Models for Multiple Objective Decisions: Do They Accurately Represent Human Preferences," *Decision Science* 10, 451–479.

{% **probability elicitation**; shows that with log. proper sc.rule, people stay away from extreme values; group aggregation of probabilities
Effect of feedback to students about predictions through truncated log. scoring rule. %}
Fischer, Gregory W. (1982) "Scoring Rule Feedback and the Overconfidence Syndrome in Subjective Probability Forecasting," *Organizational Behavior and Human Performance* 29, 357–369.

{% %}
Fischer, Gregory W. (1995) "Range Sensitivity of Attribute Weights in Multiattribute Utility Assessment," *Organizational Behavior and Human Performance* 62, 252–266.

{% **bisection > matching**: Compared direct matching, binary choice, and choice-based matching. The latter was done openly, not hidden. They find that then it is as open to the prominence effect as direct matching. The authors, hence, recommend hidden choice-based matching. Show that choice can enhance prominence effect of overweighting prominent attribute. So, binary choice need not be superior to matching. %}
Fischer, Gregory W., Ziv Carmon, Dan Ariely, & Gal Zauberman (1999) "Goal-Based Construction of Preferences: Task Goals and the Prominence Effect," *Management Science* 45, 1057–1075.

{% Found evidence supporting that complicated probabilistic relation between relevant attribute, and proxy, can cause systematic biases. %}

Fischer, Gregory W., Nirmala Damodaran, Katheryn B. Laskey, & David Lincoln (1987) “Preferences for Proxy Attributes,” *Management Science* 33, 198–214.

{% People pay more attention to compatible dimensions (??) %}
Fischer, Gregory W. & Scott A. Hawkins (1993) “Strategy Compatibility, Scale Compatibility, and the Prominence Effect,” *Journal of Experimental Psychology: Human Perception & Performance* 19, 580–597.

{% P. 1067 gives refs to cases where additive representations, or multiplicative, MAU representations worked well;
P. 1082 mentions Rasch model as statistical tool for analyzing data when choices are made in several experimental settings.
paternalism/Humean-view-of-preference: P. 1082 also argues for the rationality of loss aversion etc. “In many situations, the human nervous system seems inherently disposed to respond more to changes in stimulus features than to absolute levels of these features … A form of prescriptive analysis that ignores the impact of reference outcomes on emotional experience might lead to decisions that leave the decision maker less satisfied, on the average, than if he ignored the analysis and went with his intuition.” %}
Fischer, Gregory W., Mark S. Kamlet, Stephen E. Fienberg, & David A. Schkade (1986) “Risk Preferences for Gains and Losses in Multiple Objective Decision Making,” *Management Science* 32, 1065–1086.

{% Seems to find **information aversion**. %}
Fischhoff, Baruch (1982) “Hindsight ≠ Foresight: The Effect of Outcome Knowledge on Judgment under Uncertainty,” *Journal of Experimental Psychology: Human Perception and Performance* 1, 288–299.

{% **paternalism/Humean-view-of-preference**? Surveys many suggestions for avoiding biases. P. 437: “Trainers’ willingness to do whatever it takes to get an effect has tended to make training efforts rather complex manipulations whose effective elements are somewhat obscure.” %}
Fischhoff, Baruch (1982) “Debiasing.” *In* Daniel Kahneman, Paul Slovic, & Amos Tversky (eds.) *Judgment under Uncertainty: Heuristics and Biases*, 422–444, Cambridge University Press, Cambridge.

{% Study into what reference points are. Tests choices between sure amounts and fifty-fifty prospects, asking subjects what are natural frames (reference points). Predictions at individual level did not work well, but at group level they did. %}

Fischhoff, Baruch (1983) "Predicting Frames," *Journal of Experimental Psychology: Learning, Memory, and Cognition* 9, 103–116.

{% referaat Anne Stiggelbout 21 April 1993. **paternalism/Humean-view-of-preference**? Three filosophies:

1. philosophy of basic values (people have only a limited number of simple values and complicated decisions have to be derived from there),

2. philosophy of articulated values (people have sophisticated values, also for complicated things), and

3. philosophy of partial perspectives (intermediate form), are compared.

Imagine that a researcher follows the philosophy of articulated values but reality is partial perspectives, then what goes wrong? Etc. This is a nice enterprise.

For many years, many aspects of the paper escaped me. I felt confusion between the dimension of whether or not values of people EXIST, and the dimension of whether of not people KNOW them given that they exist. In April 2005 people told me that Fischhoff is strictly and exclusively considering the second dimension. That is, he assumes throughout that preferences and values about what is best for a person really do exist. He only considers the dimension of whether or not people know their own values. Thus, the extreme form of the constructive view of preference of people saying that values and preferences (except very basic) simply do not exist; plays no role in Fischhoff's text. With this explanation, I reread and then understood what his sentences are saying.

I think that many nuances of the literature get lost in this paper by not considering nonexistence of values. For instance, economists who believe that true values and utilities exist and also that people know them well ("consumer sovereignty") are lumped together with the extremely different view of psychologists who do not believe that any value exists. These two groups have in common, indeed, that they see no discrepancy between what exists and what is known and, hence, will refrain from paternalism. Decision analysts are put at the other extreme of the continuum, as basic values, which they are only in the sense that they may be more open to paternalism. They believe strongly and extremely that true values do exist, and in this sense are close to many economists and far remote from psychologists.

P. 844: "What might be called anthropology's great truth is that we underestimate how and by how much others see the world differently than we do." %}

Fischhoff, Baruch (1991) "Value Elicitation - Is there Anything in There?," *American Psychologist* 46, 835–847.

{% **principle of complete ignorance**: Part of the overestimation of small probabilities may be caused by people replying fifty-fifty just to say that they have no idea. This paper shows that the latter occurs more with open questions than when scales are offered to reply. %}

Fischhoff, Baruch & Wändi Bruine de Bruin (1999) "Fifty-Fifty = 50%?," *Journal of Behavioral Decision Making* 12, 149–163.

{% **probability elicitation**: People were first asked probability judgments; they exhibited overconfidence. Then they were asked to play gambles. That they did in agreement with their stated probabilities! %}

Fischhoff, Baruch, Paul Slovic & Sarah Lichtenstein (1977) "Knowing with Certainty: The Appropriateness of Extreme Confidence," *Journal of Experimental Psychology: Human Perception and Performance* 3, 552–564.

{% **coalescing**: collapse effect in probability judgment (à la unpacking of support theory I assume) %}

Fischhoff, Baruch, Paul Slovic & Sarah Lichtenstein (1978) "Fault Trees: Sensitivity of Estimated Failure Probabilities to Problem Representation," *Journal of Experimental Psychology: Human Perception and Performance* 4, 330–344.

{% **risky utility u = transform of strength of preference v**, haven't checked if latter doesn't exist. %}

Fischhoff, Baruch, Paul Slovic & Sarah Lichtenstein (1980) "Knowing What You Want: Measuring Labile Values." *In* Thomas S. Wallsten (ed.) *Cognitive*

Processes in Choice and Decision Behavior, 119–141, Erlbaum, Hillsdale NJ, Ch. 7.

{% His full name is Peter Clingerman Fishburn. %}
Fishburn, Peter C. (1964) “*Decision and Value Theory*.” Wiley, New York.

{% Eq. 5 exactly and precisely defines marginal independence for simple distributions. Theorems 1 and 3 show that it is enough to do it for probabilities 0.5. %}
Fishburn, Peter C. (1965) “Independence in Utility Theory with Whole Product Sets,” *Operations Research* 13, 28–45.

{% Additive conjoint measurement on denumerable product set. Assumes functional (instead of pref. rel.) given, with an additivity property à la Horst & I, assumed at the outset in Condition 2. The strong convergence axiom 3 implies that the infinite sums converge. Then the functional must be additively decomposable. %}
Fishburn, Peter C. (1966) “Additivity in Utility Theory with Denumerable Product Sets,” *Econometrica* 34, 500–503.

{% %}
Fishburn, Peter C. (1967) “Bounded Expected Utility,” *Annals of Mathematical Statistics* 38, 1054–1060.
https://www.jstor.org/stable/2238824

{% Contrary to what the title suggests, this paper is on axiomatizations of expected utility. First three paras of §3.8 (p. 1607), concisely define the modern (2025) two-stage version of the Anscombe-Aumann framework, with their first stage of probabilistic mixing removed and lotteries assigned to horses. Theorem 3, p. 1608, derives subjective expected utility in this framework.

§7 discusses axiomatizations that do not need much richness, but only briefly so. %}
Fishburn, Peter C. (1967) “Preference-Based Definitions of Subjective Probability,” *Annals of Mathematical Statistics* 38, 1605–1617.

https://www.jstor.org/stable/2238639

{% Lists many (26) methods for estimating additively decomposable utility, distinguishing whether some or all factors are discrete/continuous, whether we use preferences/indifferences, probabilities, and so on, but not doing much more than mentioning them.

p. 447 explains how we can make "flight of stairs" between two indifference curves in Re^2 and get standard sequences on both attributes. P. 450 depicts saw-tooth method, which is giving standard sequences as in the tradeoff method. (**tradeoff method**) %}

Fishburn, Peter C. (1967) "Methods of Estimating Additive Utilities," *Management Science* 13, 435–453.
https://doi.org/10.1287/mnsc.13.7.435

{% **restricting representations to subsets**; considers his additivity-condition for MAUT on subsets of product sets. %}

Fishburn, Peter C. (1967) "Additive Utilities with Incomplete Product Sets: Application to Priorities and Assignments," *Operations Research* 15, 537–542.

{% **survey on utility**: Mostly how to get cardinal utility; §3 gives short list of topics considered, with utility in multiattribute (§5), time preference (§6), even-chance (§7), EU for risk (§8), EU + multiattribute (§9), SEU (§10), Social choice (§11), and next sections give more formalities. %}

Fishburn, Peter C. (1968) "Utility Theory," *Management Science*14, 335–378.
https://doi.org/10.1287/mnsc.14.5.335

{% %}

Fishburn, Peter C. (1969) "A General Theory of Subjective Probabilities and Expected Utilities," *Annals of Mathematical Statistics* 40, 1419–1429.

{% **ordering of subsets** %}

Fishburn, Peter C. (1969) "Weak Ordering of Subsets on Finite Sets," *Annals of Mathematical Statistics* 40, 2118–2126.

{% Hupman & Simon (2023 p. 2): "the superb and widely praised book Utility Theory for Decision Making (Fishburn 1970a)". The book indeed is superb.

cancellation axioms: P. 41 Theorem 4.1B gives necessary and sufficient conditions for additive representation of finitely many preferences.

P. 74 ℓ. 6: those recangles don't have to fit together.

p. 76 first para: big step. I do not see what continuity implies what is claimed there. If g is defined on $V \cup V' \cup V''$ and represents on $V \cup V'$ and on $V' \cup V''$, then it does not have to be representing on $V \cup V' \cup V''$.

restricting representations to subsets: P. 74. On April 2, 1990, I sent a letter to Fishburn explaining that I do not see in point 5 on p. 74 how one can be sure that the rectangles as constructed in Figure 5.3 behave as "nicely" as depicted there, having Axiom Q1 only globally not getting indifference curve k directly. I also asked about the reasoning in lines 2/3 on p. 76, deriving global additivity from local additivity on a domain that is not a Cartesian product. I gave further details. In a letter of April 16, 1990, Fishburn answered that he did not really remember how to justify these parts. I also wrote that Debreu's (1960) function g at the end of his proof has the same problems as Fishburn's function g.

strength-of-preference representation: Ch. 6.

P. 82: **risky utility u = transform of strength of preference v, latter doesn't exist**.

Pp. 92-94: Fishburn never gets $\sum_{j=1}^{n} u_i$ in general under continuity. His mixing of continuity assumption present and absent (as in Theorem 7.3) covers this omission up.

Kirsten&I: Theorem 7.5, p. 96, does constant discounted utility for finitely many timepoints.

Section 13.1: Good reference for the modern two-stage horse-race-roulette version of Anscombe-Aumann (1963). Before, it was in the first three paras of §3.8 (p. 1607), of Fishburn (1967 Annals of Mathematical Statistics) and before in Chernoff (1954). It can also be recognized in Arrow (1951 Econometrica pp. 431-432).

criticisms of Savage's basic framework; p. 161, §12.1, describes an example where acts and consequences are naturally given and states of nature are defined from those. P. 166, §12.2, suggests that the case where the consequence sets are conditional on each state are disjoint as "does not seem unusual," for the reason that consequences are complete descriptions of what might occur. P. 168, end of §12.2, again pleas for this model on the basis of residual uncertainty not specified in the states descriptions and describes state-dependent expected utility in Eq. 12.7.

P. 192, §14.1, Fishburn has a somewhat weaker version of P7 than Savage, only taking strict preferences rather than weak as premise. However, the axiom readily implies Savage's. That is, under P1, P2, & P6, Fishburn's P7 implies Savage's P7; i.e., they are equivalent. Liu (2023) demonstrated this point.

P. 193, §14.1, erroneously claims that the state space S in Savage's model has to be countable. When I was a Ph.D. student, I sent a letter to Fishburn writing that it can be countable, giving an example. Ten years later, in a plenary lecture in 1990 in Irvine, Fishburn acknowledged me for this in public. A dear memory!

derived concepts in pref. axioms: p. 192: formulates P3 and P7 use the derived concept of conditional pref. %}

Fishburn, Peter C. (1970) "*Utility Theory for Decision Making.*" Wiley, New York.

{% (1) small variation on Arrow; (2) If indifference is nontransitive %}

Fishburn, Peter C. (1970) "The Irrationality of Transitivity in Social Choice," *Behavioral Science* 15, 119–123.

{% **restricting representations to subsets** %}

Fishburn, Peter C. (1971) "Additive Representations of Real-Valued Functions on Subsets of Product Sets," *Journal of Mathematical Psychology* 8, 382–388.

{% **completeness criticisms**: seems to give that. %}

Fishburn, Peter C. (1971) "One-Way Expected Utility with Finite Consequence Spaces," *Annals of Mathematical Statistics* 42, 572–577.

{% %}

Fishburn, Peter C. (1972) "Subjective Expected Utility with Mixture Sets and Boolean Algebras," *Annals of Mathematical Statistics* 43, 917–927.

{% %}

Fishburn, Peter C. (1972) “Even-Chance Lotteries in Social Choice Theory,” *Theory and Decision* 3, 18–40.

{% **maths for econ students**. %}

Fishburn, Peter C. (1972) “*Mathematics of Decision Theory*.” Mouton, The Hague.

{% %}

Fishburn, Peter C. (1973) “A Mixture-set Axiomatization of Conditional Subjective Expected Utility,” *Econometrica* 41, 1–24.

{% %}

Fishburn, Peter C. (1973) “*The Theory of Social Choice*.” Princeton University Press, Princeton, NJ.

{% %}

Fishburn, Peter C. (1974) “Von Neumann-Morgenstern Utility Functions on Two Attributes,” *Operations Research* 22, 35–45.

{% %}

Fishburn, Peter C. (1974) “Lexicographic Orders, Utilities and Decision Rules: A Survey,” *Management Science* 20, 1442–1471.

{% %}

Fishburn, Peter C. (1974) “On the Foundations of Decision Making under Uncertainty.” *In* Michael S. Balch, Daniel L. McFadden, & Shih-Yen Wu (eds.) *Essays on Economic Behaviour under Uncertainty*, 25–56, North-Holland, Amsterdam.

{% P. 894 Axiom 5´ is not optimally efficient because it takes, after truncation, the conditional expectation. That is, the residual probability mass is evenly distributed over all that was there before. A better axiom results when all residual probability mass is alloced to the value at which the truncation takes place, and this is done in Wakker (1993, MOR). %}

Fishburn, Peter C. (1975) “Unbounded Expected Utility,” *Annals of Statistics* 3, 884–896.
https://www.jstor.org/stable/3035514

{% A Nicer version of Theorem 3, Fishburn’s main result, is in Kim (1996). An also nicer, but less so, result is in Border (1992).

Finding representations of expected utility (EU) for risk amounts to solving linear equalities and inequalities, so that duality theorems or, equivalently, separating hyperplane theorems can give necessary and sufficient conditions. Scott (1964) is a beautiful paper showing it for general additive representations, not focusing on risk. This (Fishburn’s) paper, positioned as mostly expository, does a similar thing focusing on EU for risk, not citing Scott. I find it less appealing, although still useful. In particular, this paper does not make the step towards cancellation axioms. Theorem 3 seems to offer a characterization of EU-maximization for a finite collection of weak and strict preferences. But it uses heavy notation and is not presented nicely. Fishburn just states the duality condition with no attempt to give a nice preference interpretation. He also has results for incomplete preferences with several EU functionals and then unanimous representations by those, and lexicographic representations. %}

Fishburn, Peter C. (1975) “Separation Theorems and Expected Utilities,” *Journal of Economic Theory* 11, 16–34.
https://doi.org/10.1016/0022-0531(75)90036-8

{% **restricting representations to subsets** %}

Fishburn, Peter C. (1976) “Utility Independence on Subsets of Product Sets,” *Operations Research* 24, 245–255.

{% **risky utility u = transform of strength of preference v, latter doesn’t exist** %}

Fishburn, Peter C. (1976) “Cardinal Utility: An Interpretive Essay,” *Rivista Internazionale di Scienze Economiche e Commerciali* 23, 1102–1114.

{% %}

Fishburn, Peter C. (1976) “Unbounded Utility Functions in Expected Utility Theory,” *Quarterly Journal of Economics* 90, 163–168.

https://doi.org/10.2307/1886093

{% **game theory can/cannot be viewed as decision under uncertainty**: Considers rectangular game situation, where set of probability distributions over outcomes need not be convex. Adapts vNM EU characterization to such a domain, giving a multilinear representation. Argues that this result is more relevant for game theory. %}

Fishburn, Peter C. (1976) "Axioms for Expected Utility in *n*-Person Games," *International Journal of Game Theory* 5, 137–149.

{% A didactical paper introducing decision theory, starting from choice functions, with also probabilistic choice, and then giving some basic theoorems. The paper only gives maths. %}

Fishburn, Peter C. (1977) "Models of Individual Preference and Choice," *Synthese* 36, 287–314.
https://www.jstor.org/stable/20115231

{% Separate treatment of gaines and losses (well, target instead of status quo); seems that **risk averse for gains, risk seeking for losses** %}

Fishburn, Peter C. (1977) "Mean-Risk Analysis with Risk Associated with Below-Target Returns," *American Economic Review* 67, 116–126.

{% P. 324 suggests that Edwards (1954, p. 308) already had the basic idea but this is not so. Edwards shows only that w is the identity if it is presupposed that $p_1 + \ldots + p_n = 1$ implies $w(p_1) + \ldots + w(p_n) = 1$. For the special case of overestimation of small probabilities, the result of this note was described before by Rosett (1971, p. 482, last paragraph). %}

Fishburn, Peter C. (1978) "On Handa's "New Theory of Cardinal Utility" and the Maximization of Expected Return," *Journal of Political Economy* 86, 321–324.
http://dx.doi.org/10.1086/260670

{% %}

Fishburn, Peter C. (1980) "Multilinear Expected Utility," *Mathematics of Operations Research* 5, 502–509.

{% **utility of gambling**; p. 437 discusses a bit the probabilistic reduction principle (this term is not used), which Assumption 2.1.2 in Wakker (2010) calls decision under risk. %}

Fishburn, Peter C. (1980) "A Simple Model for the Utility of Gambling," *Psychometrika* 45, 435–448.

{% **criticisms of Savage's basic framework**

Impressive survey on expected utility for uncertainty. Discussing several different frameworks such as R.C. Jeffrey's and so on.

P. 141 para −2, §2.2 on general primitives in frameworks of uncertainty: "Moreover, it is usually presumed that the 'true' state, or state that obtains (e.g., 'rain' or 'no rain', 'heads' or 'tails'), which is initially unknown by the individual, cannot be changed by the individual's actions." %}

Fishburn, Peter C. (1981) "Subjective Expected Utility: A Review of Normative Theories," *Theory and Decision* 13, 139–199. https://doi.org/10.1007/BF00134215

{% %}

Fishburn, Peter C. (1981) "Uniqueness Properties in Finite-Continuous Additive Measurement," *Mathematical Social Sciences* 1, 145–153.

{% %}

Fishburn, Peter C. (1982) "Nontransitive Measurable Utility," *Journal of Mathematical Psychology* 26, 31–67.

{% %}

Fishburn, Peter C. (1982) "Foundations of Risk Measurement. II. Effects of Gains on Risk," *Journal of Mathematical Psychology* 22, 226–242.

{% **Dutch book**s: Theorem 10.1.

Pp. 85-98 on multilinear utility on products of mixture sets seems to be on (**game theory can/cannot be viewed as decision under uncertainty**). %}

Fishburn, Peter C. (1982) "*The Foundations of Expected Utility*." Reidel, Dordrecht.

{% %}
Fishburn, Peter C. (1983) "Research in Decision Theory: A Personal Perspective," *Mathematical Social Sciences* 5, 129–148.

{% %}
Fishburn, Peter C. (1983) "Transitive Measurable Utility," *Journal of Economic Theory* 31, 293–317.

{% **ordering of subsets** %}
Fishburn, Peter C. (1983) "Ellsberg Revisited, A New Look at Comparative Probability," *Annals of Statistics* 11, 1047–1059.

{% %}
Fishburn, Peter C. (1984) "On Harsanyi's Utilitarian Cardinal Welfare Theorem," *Theory and Decision* 14, 21–28.

{% %}
Fishburn, Peter C. (1984) "Multiattribute Nonlinear Utility Theory," *Management Science* 30, 1301–1310.

{% %}
Fishburn, Peter C. (1984) "SSB Utility Theory and Decision-Making under Uncertainty," *Mathematical Social Sciences* 8, 253–285.

{% For one thing, it describes pref. reversals through SSB. %}
Fishburn, Peter C. (1984) "SSB Utility Theory: An Economic Perspective," *Mathematical Social Sciences* 8, 63–94.

{% It describes pref. reversals through SSB. %}
Fishburn, Peter C. (1985) "Nontransitive Preference Theory and the Preference Reversal Phenomenon," *Rivista Internazionale di Scienze Economiche e Commerciali* 32, 39–50. Journal name can be translated as: I*nternational Review of Economics and Business*

{% **ordering of subsets** %}

Fishburn, Peter C. (1986) "The Axioms of Subjective Probability," *Statistical Science* 1, 335–358.

{% DUU with SSB and a sort of nonadditive probabilities. Taking only the transitive case of SSB, what it amounts to is a combination of EU and not variance but, instead, a weighted sum of absolute values of utility differences, so, $(s_1{:}x_1,\ldots,s_n{:}x_n)$ is evaluated by its EU plus a weighted sum of $|U(x_i) - U(x_j)|$. No axiomatization is given, only some necessary conditions. I am not sure to what extent the model satisfies monotonicity.

biseparable utility: for two states of nature the transitive version of Fishburn's model amounts to the rank-dependent model, as is well known nowadays (Wakker 2010 Exercise 10.6.1). %}

Fishburn, Peter C. (1986) "A New Model for Decisions under Uncertainty," *Economics Letters* 21, 127–130.
https://doi.org/10.1016/0165-1765(86)90050-9

{% %}

Fishburn, Peter C. (1986) "Implicit Mean Value and Certainty Equivalents," *Econometrica* 54, 1197–1205.

{% %}

Fishburn, Peter C. (1987) "Interdependent Preferences." *In* John Eatwell, Murray Milgate, & Peter K. Newman (eds.) *The New Palgrave: A Dictionary of Economic Theory and Doctrine*, Vol. 2, 874–877, The MacMillan Press, London.

{% P. 830 argues that many people may feel nonindifference caused by regret between two gambles on 10 states of nature that generate the same probability distribution over outcomes. Fishburn does not explicitly state his own opinion on the case.

P. 835 on utility being applied to changes w.r.t. present wealth w:

"In what follows, I shall omit w for convenience and write just v(x) for the utility of an increment x to present wealth." %}

Fishburn, Peter C. (1987) "Reconsiderations in the Foundations of Decision under Uncertainty," *Economic Journal* 97, 825–841.

{% **survey on nonEU**; %}

Fishburn, Peter C. (1988) "*Nonlinear Preference and Utility Theory.*" Johns Hopkins University Press, Baltimore, MD.

{% P. 273 argues that many people may feel nonindifference caused by regret between two gambles on 10 states of nature that generate the same probability distribution over outcomes. Fishburn does not state explicitly what his own opinion is on the case. %}

Fishburn, Peter C. (1988) "Expected Utility: An Anniversary and a New Era," *Journal of Risk and Uncertainty* 1, 267–283.

{% Values, in Anscombe-Aumann framework, acts by some of SSB plus terms that reflect variance of outcomes; i.e., a weighting sum of absolute values of utility differences of outcomes. The latter can reflect aversion towards ambiguity. In transitive case model can become special case of Schmeidler's CEU (Choquet expected utility). No preference axiomatization is given. %}

Fishburn, Peter C. (1988) "Uncertainty Aversion and Separated Effects in Decision Making under Uncertainty." *In* Janus Kacprzyk & Mario Fedrizzi (eds.) *Combining Fuzzy Imprecision with Probabilistic Uncertainty in Decision Making*, Springer, Berlin.

{% **risky utility u = transform of strength of preference v**, haven't checked if latter doesn't exist

I disagree with the claim on p. 131, 2^{nd} para, that Pareto sided with the ordinalists. Pareto, very properly, said that IF all we want to do is discuss market buying and selling and prices, then ordinal utility is enough. The premise is crucial and means that Pareto does not state it as a general fact.

conservation of influence: P. 137 indicates that vNM distinguish between utility and its numerical value. They use terms such as numerical utility and

numerical valuation (values) of utility, and u to denote utility and v(u) to denote its numerical value. %}

Fishburn, Peter C. (1989) "Retrospective on the Utility Theory of von Neumann and Morgenstern," *Journal of Risk and Uncertainty* 2, 127–158.

{% **ordering of subsets** %}

Fishburn, Peter C. (1989) "Human Decision Making and Ordered Sets." *In* Ivan Rival (ed.) *Algorithms and Order*, Kluwer, Dordrecht.

{% %}

Fishburn, Peter C. (1989) "Generalization of Expected Utility Theories: A Survey of Recent Proposals," *Annals of Operations Research* 19, 3–28.

{% %}

Fishburn, Peter C. (1990) "Continuous Nontransitive Additive Conjoint Measurement," *Mathematical Social Sciences* 20, 165–193.

{% %}

Fishburn, Peter C. (1990) "Additive Non-Transitive Preferences," *Economics Letters* 34, 317–321.

{% %}

Fishburn, Peter C. (1990) "Unique Nontransitive Additive Conjoint Measurement on Finite Sets," *Annals of Operations Research* 23, 213–234.

{% Add transitivity to Theorem 2: alternative for my book Ttm. IV.2.7.

Axiom 4 (order consistency): close to TO consistency

Axiom 5 (additive consistency): alternative to TO consistency

These give proportionality of additive value functions. %}

Fishburn, Peter C. (1990) "Skew Symmetric Additive Utility with Finite States," *Mathematical Social Sciences* 19, 103–115.

{% %}

Fishburn, Peter C. (1991) "Subjective Expected Utility with a Topological Twist, Review of "Peter P. Wakker (1989) "Additive Representations of Preferences: A New Foundation of Decision Analysis," *Journal of Mathematical Psychology* 35, 403–409.

{% %}

Fishburn, Peter C. (1991) Review of SKLT (1989) "Additive Representations of Preferences: A New Foundation of Decision Analysis," *American Statistical Association* 86, 823–824.

{% P. 128: "SEU elegantly axiomatized by Wakker;" hurray! %}

Fishburn, Peter C. (1991) "Nontransitive Preferences in Decision Theory," *Journal of Risk and Uncertainty* 4, 113–134.

{% %}

Fishburn, Peter C. (1991) "Nontransitive Additive Conjoint Measurement," *Journal of Mathematical Psychology* 35, 1–40.

{% %}

Fishburn, Peter C. (1991) "Decision Theory: The Next 100 Years," *Economic Journal* 101, 27–32.

{% Treats "more ambiguous than" as primitive and imposes axioms on it to imply a representation through a nonnegative function a(.) that is 0 at the unambiguous events, such as the empty and universal events. Imposes a concavity condition a(AnB) + a(AuB) ≤ a(A) + a(B) that does not seem to be reasonable. We can easily have cases with A and B unambiguous, but their intersection and union ambiguous. The reversed inequality is also easily conceivable. %}

Fishburn, Peter C. (1991) "On the Theory of Ambiguity," *International Journal of Information and Management Sciences* 2, 1–16.

{% %}

Fishburn, Peter C. (1992) “Additive Differences and Simple Preference Comparisons,” *Journal of Mathematical Psychology* 36, 21–31.

{% %}

Fishburn, Peter C. (1992) “Multiattribute Signed Orders,” *Journal of Multi-Criteria Decision Analysis* 1, 3–16.

{% %}

Fishburn, Peter C. (1992) “A General Axiomatization of Additive Measurement with Applications,” *Naval Research Logistics* 39, 741–755.

{% **ordering of subsets;** considers finite sets with cancellation axioms and infinite ones with then Archimedeanity added. %}

Fishburn, Peter C. (1992) “Utility as an Additive Set Function,” *Mathematics of Operations Research* 17, 910–920.

{% **ordering of subsets**; %}

Fishburn, Peter C. (1992) “Signed Orders and Power Set Extensions,” *Journal of Economic Theory* 56, 1–19.

{% %}

Fishburn, Peter C. (1992) “Induced Binary Probabilities and the Linear Ordering Polytope: A Status Report,” *Mathematical Social Sciences* 23, 67–80.

{% %}

Fishburn, Peter C. (1992) “On Nonstandard Nontransitive Additive Utility,” *Journal of Economic Theory* 56, 426–433.

{% %}

Fishburn, Peter C. (1992) “Additive Differences and Simple Preference Comparisons,” *Journal of Mathematical Psychology* 36, 21–31.

{% %}

Fishburn, Peter C. (1993) “The Axioms and Algebra of Ambiguity,” *Theory and Decison* 34, 119–137.

{% **foundations of probability**
R.C. Jeffrey model %}
Fishburn, Peter C. (1994) “Tales of a Radical Bayesian,” Book Review of: R.C. Jeffrey (1992) “Probability and the Art of Judgment,” Cambridge University Press, Cambridge; *Journal of Mathematical Psychology* 38, 135–144.

{% P. 1421 argues for nonindifference resulting from regret between two gambles on a die that generate same probability distribution over outcomes. %}
Fishburn, Peter C. (1994) “Utility and Subjective Probability.” *In* Robert J. Aumann & Sergiu Hart (eds.) *Handbook of Game Theory*, Vol. 2, 1397–1435, Elsevier, Amsterdam.

{% **ordering of subsets** %}
Fishburn, Peter C. (1996) “Finite Linear Qualitative Probability,” *Journal of Mathematical Psychology* 40, 64–77.

{% **cancellation axioms**: on minimal number of cancellation axioms to generally guarantee existence of additive representation in finite sets. %}
Fishburn, Peter C. (1997) “Failure of Cancellation Conditions for Additive Linear Orders,” *Journal of Combinatorial Designs* 5, 353–365.

{% %}
Fishburn, Peter C. (1998) “Utility of Wealth in Nonlinear Utility Theory.” *In* Cornelia E. Dowling, Fred S. Roberts, & Peter Theuns (eds.) *Recent Progress in Mathematical Psychology,* Erlbaum, Hillsdale NJ.

{% %}
Fishburn, Peter C. (1999) “Preference Structures and Their Representations,” *Theoretical Computer Science* 217, 359–383.

{% Describes the important contributions of the late 1940s and early 1950s, in particular 1954 %}

Fishburn, Peter C. (1999) "The Making of Decision Theory." *In* James C. Shanteau, Barbara A. Mellers, & David A. Schum (eds.) *Decision Science and Technology: Reflections on the Contributions of Ward Edwards,* 369–388, Kluwer, Dordrecht.

{% %}

Fishburn, Peter C. (2001) "Cancellation Conditions for Finite Two-Dimensional Additive Measurement," *Journal of Mathematical Psychology* 45, 2–26.

{% **Kirsten&I**;**dynamic consistency**, gives several references to stationarity etc.; **discounting normative**; countably many timepoints; **standard-sequence invariance**: Axiom 8 is Krantz et al.'s (1971) version in which one can recognize an endogenous utility midpoint (**endogenous midpoints**). %}

Fishburn, Peter C. & Ward Edwards (1997) "Discount-Neutral Utility Models for Denumerable Time Streams," *Theory and Decision* 43, 139–166. https://doi.org/10.1023/A:1004943925179

{% %}

Fishburn, Peter C. & Ralph L. Keeney (1974) "Seven Independence Concepts and Continuous Multiattribute Utility Functions," *Journal of Mathematical Psychology* 11, 294–327.

{% %}

Fishburn, Peter C. & Ralph L. Keeney (1975) "Generalized Utility Independence and Some Implications," *Operations Research* 23, 928–940.

{% **decreasing ARA/increasing RRA**: power utility fitted somewhat better than others

utility elicitation; **concave utility for gains, convex utility for losses**: was found; somewhat more convex for losses (18) than concave for gains (16); this is concluded on p. 511; power utility fits best. %}

Fishburn, Peter C. & Gary A. Kochenberger (1979) "Two-Piece von Neumann-Morgenstern Utility Functions," *Decision Sciences* 10, 503–518.

{% %}
Fishburn, Peter C. & Irving H. LaValle (1987) "A Nonlinear, Nontransitive and Additive-Probability Model for Decisions under Uncertainty," *Annals of Statistics* 15, 830–844.

{% Argue for regret-like violation of gambles on die. %}
Fishburn, Peter C. & Irving H. LaValle (1988) "Context-Dependent Choice with Nonlinear and Nontransitive Preferences," *Econometrica* 56, 1221–1239.

{% %}
Fishburn, Peter C. & Irving H. LaValle (1988) "Transitivity Is Equivalent to Independence for States-Additive SSB Utilities," *Journal of Economic Theory* 44, 202–208.

{% %}
Fishburn, Peter C. & Irving H. LaValle (eds.) *Choice under Uncertainty*, Annals of Operations Research 19, J.C. Baltzer AG., Basel.

{% %}
Fishburn, Peter C. & Irving H. LaValle (1991) "Nonstandard Nontransitive Utility on Mixture Sets," *Mathematical Social Sciences* 21, 233–244.

{% %}
Fishburn, Peter C. & Irving H. LaValle (1992) "Multiattribute Expected Utility without the Archimedean Axiom," *Journal of Mathematical Psychology* 36, 573–591.

{% Assume EU, weighted utility, and SSB for lotteries where prizes are subsets. Make utility-independence-like assumptions and see what these imply. %}
Fishburn, Peter C. & Irving H. LaValle (1993) "Subset Preferences in Linear and Nonlinear Utility Theory," *Journal of Mathematical Psychology* 37, 611–623.

{% %}

Fishburn, Peter C. & Irving H. LaValle (1993) "On Matrix Probabilities in Nonarchimedean Decision Theory," *Journal of Risk and Uncertainty* 7, 283–299.

{% %}
Fishburn, Peter C. & Irving H. LaValle (1996) "Signed Orders in Linear and Nonlinear Utility Theory," *Theory and Decision* 40, 79.

{% %}
Fishburn, Peter C. & Irving H. LaValle (1996) "Binary Interactions and Subset Choice," *European Journal of Operational Research* 92, 182–192.

{% %}
Fishburn, Peter C. & R. Duncan Luce (1995) "Joint Receipt and Thaler's Hedonic Editing Rule," *Mathematical Social Sciences* 29, 33–76.

{% %}
Fishburn, Peter C. & Bernard Monjardet (1992) "Norbert Wiener on the Theory of Measurement (1914, 1915, 1921)," *Journal of Mathematical Psychology* 36, 165–184.

{% %}
Fishburn, Peter C. & Yutaka Nakamura (1991) "Nontransitive Measurable Utility with Constant Threshold," *Journal of Mathematical Psychology* 35, 471–500.

{% **ordering of subsets** %}
Fishburn, Peter C. & Aleksandar Pekec (2004) "Bundle Valuations," AT&T Shannon Laboratory, Information Sciences Research, Florham Park, NJ, USA.

{% **ordering of subsets**; consider finite sets and then see how many relationships suffice to determine the whole additive relation. P. 228 suggests that, if the set contains six elements, then the minimum number is 27 or 28. %}
Fishburn, Peter C., Aleksandar Pekec, & James A. Reeds (2002) "Subset Comparisons for Additive Linear Orders," *Mathematics of Operations Research* 27, 227–243.

{% %}
Fishburn, Peter C. & Fred S. Roberts (1988) “Unique Finite Conjoint Measurement,” *Mathematical Social Sciences* 16, 107–143.

{% **Kirsten&I**; Pp. 682-3 and Figure 1 show how to construct standard sequences for intertemporal choice. Consider pairs (x,t) with x an outcome and t the timepoint of receipt. Assume the usual weak ordering, continuity, and some monotonicities. Then stationarity $\big((x,t) \geq (y,s) \Rightarrow (x,t+a) \geq (y,s+a)\big)$ implies a representation of the form $e^{-rt}U(x)$ where r and the power of U are jointly undetermined. The nice thing is that stationarity alone implies additive (here multiplicative) representability. %}
Fishburn, Peter C. & Ariel Rubinstein (1982) “Time Preference,” *International Economic Review* 23, 677–694.

{% %}
Fishburn, Peter C. & Rakesh K. Sarin (1991) “Dispersive Equity and Social Risk,” *Management Science* 37, 751–769.

{% **restrictiveness of monotonicity/weak separability**: They give the definition of stochastic dominance for general outcome sets. They call it nondimensional stochastic dominance in §2.21. They do it only for a finite outcome set where no two outcomes are equivalent, define it in words below Eq. 2.65 (p. 98). This uses the subjective preference relation over outcomes. Such a condition, not using an objective noncontroversial relation such as ≤ over money, is quite more restrictive and is rather weak separability than monotonicity. %}
Fishburn, Peter C. & Raymond G. Vickson (1978) “Theoretical Foundations of Stochastic Dominance.” *In* George A. Whitmore & Merlin C. Findlay (eds.) *Stochastic Dominance: An Approach to Decision Making under Risk*, 39–113, Lexington Books, D.C. Heath, Lexington, Mass.: Heath.

{% Here is an explanation that for the general idea of separability, of which independence is one variation, I would like to give priority to Samuelson (1940). %}

Fishburn, Peter C. & Peter P. Wakker (1995) "The Invention of the Independence Condition for Preferences," *Management Science* 41, 1130–1144. https://doi.org/10.1287/mnsc.41.7.1130
Direct link to paper

{% Tools for numerically handling likelihood functions. %}

Fisher, Christopher R., Joseph W. Houpt, & Glenn Gunzelmann (2022) "Fundamental Tools for Developing Likelihood Functions within ACT-R," *Journal of Mathematical Psychology* 107, 102636.

{% Discusses the restrictive implications of Nataf's (1948) result, and ways around it. Explains that Nataf's result can best be derived from Leontief (1947), who already had Gorman's (1968) famous result under differentiability. %}

Fisher, Franklin M. (1969) "The Existence of Aggregate Production Functions," *Econometrica* 37, 553–577.
https://doi.org/10.2307/1910434

{% Preface (p. 4/5) says that Edgeworth's Mathematical Physics "has gone far astray" on one point; i.e., in taking **just noticeable difference** as unit of utility.

P. 11 §I.I.1, dissociates itself from psychology.

P. 67 seems to explain that, in absence of additive representability, the total utility curve of milk, and the tradeoffs of milk, will not be the same or even proportional for different levels of beer or bread.

Fisher does assume in Part I that utility of each commodity is independent of all other commodities. It is never really specified (in terms of preferences) what that means. But it can be seen from the analysis of marginal utility that it must mean additive decomposability. Thus, §4 of Ch. 1 defines marginal utility of bread through tradeoffs with other commodities (oil). However, it considers infinitesimal tradeoffs, so, derivatives. It shows how the quotient of marginal utilities of two commodities can be measured by tradeoffs with a third commodity.

questionnaire versus choice utility: Fisher does not want Benthamite utility, see for example end of §1.5.

Uses the nice terms competing and completing goods.

P. 102 in 1937-book: proposed consequentialistic approach to commodity bundles in sense that for articles of fashion such as diamonds one incorporate quantities consumed/produced by all persons in the market.

"This limitation has many analogies in physics. The attraction of gravity is a function of the distance from the center of the earth. A more exact analysis makes it a function of the revolution of the earth, of the position and mass of the moon (theory of tides) and finally of the position, and mass of every heavenly body."

P. 18 of 1937 book, on arbitrary scale: "Any unit in mathematics is valuable only as a divisor for a second quantity and constant only in the sense that the quotient is constant, that is independent of a third quantity. If we should awaken to-morrow with every line in the universe doubled, we should never detect the change, if indeed such can be called a change, nor would it disturb our sciences or formulae."

Edn. of 1892/1962 seems to write on insurance, not ascribe it to risk aversion in pure sense but also to argument of planning budget: "To buy too much or too little, to sell too cheap or too dear will be equally sure to diminish gain. Herein lies the virtue of insurance and the vice of gambling."

risky utility u = transform of strength of preference v, haven't checked if latter doesn't exist: Doesn't relate it to risk but writes, on p. 23, end of §14 of Ch. 1: "Utility" is the heritage of Bentham and his theory of pleasures and pains. For us his *word* is the more acceptable, the less it is entangled with his *theory*. [Italics from original]

§II.IV.8, p. 89, already stated concisely and perfectly, ordinalism (note the premise that puts it all in the right perspective!!!!). It is the whole Part II, Ch. IVC, §8.

"Thus if we seek only the causation of the *objective facts of prices and commodity distributions* four attributes of utility as a quantity are entirely unessential, (1) that one man's utility can be compared to another's, (2) that for the same individual the marginal utilities at one consumption-combination can be compared with those at another, or at one time with another, (3) even if they could, total utility and gain might not be integratable, (4) even if they were, there would be no need of determining the constants of integration." %}

Fisher, Irving (1892) “Mathematical Investigations in the Theory of Values and Prices,” *Transactions of Connecticut Academy of Arts and Sciences* 9, 1–124. Reprinted as book in 1965 (1st edn. 1925), Yale University Press, New Haven.

{% %}

Fisher, Irving (1916) “Is ‘Utility’ the Most Suitable Term for the Concept It Is Used to Denote?,” *American Economic Review* 8, 335–337.
Reprinted in Alfred N. Page (1968), *Utility Theory: A Book of Readings*, Wiley, New York, 49–51.

{% On the possibility to use interpersonal comparisons of utility he seems to have written, p. 179-180: “To all these questions I would answer ‘yes’—approximately at least. But the only, or only important, reason I can give for this answer is that, in actual practice human life, we do proceed on just such assumptions.” And then some later comes the, beautiful: “Philosophical doubt is right and proper, but the problems of life cannot, and do not, wait.” Reminds me of I often point out to philosophers and ivory-tower researchers that I worked eight years in a hospital. The next para on that p. 180: “So economists cannot afford to be too academic and shirk the great practical problems pressing upon them merely because these happen to touch on unsolved, and perhaps unsoluble, philosophical problems. The psychologist has set the example by becoming a “behaviorist.” [new in 1920s] He can thereby deal practically with phernomena the essentialnature of which he confesses he cannot fanthom.”

P. 159 cites J. Willard Gibbs:

“The whole is simpler than its parts.”

Obtains cardinal utility by imposing additive decomposability.

Assume oddland and evenland, with different prizes and budget for two families with identical pref. rels. Assume two commodities, one and two. Assume (y_1,x_2) is what a family in evenland buys. The marginal utility of money spent on first commodity must be equal to that spent on second, there; it is the marginal utility of money there. In oddland we have two observations for different prize/budget combinations, leading to (x_1,x_2) and (y_1,y_2), respectively. Comparing the prize ratios of the 2nd commodity at (x_1,x_2) in oddland and (y_1,x_2) in evenland shows the ratio of marginal utility of money in those two cases, comparing the prize ratios of the 1st commodity at (y_1,y_2) in oddland and (y_1,x_2) in evenland shows the ratio of marginal utility of money in those two cases. So, we obtain the ratio of marginal utility of money at (x_1,x_2) and (y_1,y_2) in oddland, so, at two different levels of wealth, having used evenland as a measuring rod/yardstick. P. 187 says that these observations can be extended to more levels: give the family in evenland budget/prices so that it buys (z_1,y_2), in oddland so that it buys (z_1,z_2), and the marginal utility of money at (z_1,z_2) can be related to the others; etc.

Pp. 175-176 nicely explains how the group of food commodities may be separable.

Discussion on pp. 179-181 is in fact a nice discussion of the many assumptions underlying a preference relation.

Seems to assume also comparability of utilities for different persons, in order to achieve concrete results applicable to income taxation.

P. 181 seems to argue that individual data on utility contains too much noise.

P. 180, about people who doubt about cardinal utility: "Philosophic doubt is right and proper, but the problems of life cannot, and do not, wait."

P. 181:

"Even the philosophic doubter, if himself taxed unfairly, would be apt to know it!"

P. 187 etc. looks similar to standard sequences and TO method, with p. 189 l. 3 mentioning yardstick, but it looks like not and the text is too complicated for me to find out further. %}

Fisher, Irving (1927) "A Statistical Method for Measuring "Marginal Utility" and Testing the Justice of a Progressive Income Tax." *In* Jacob H. Hollander (ed.) *Economic Essays Contributed in Honor of John Bates Clark*, 157–193, MacMillan, New York.

{% %}

Fisher, Irving (1927) "*The Making of Index Numbers.*" Houghton-Mifflin, Boston. (3rd edn. 1967, Augustus M. Kelley, New York.)

{% %}

Fisher, Irving (1928) "*The Money Illustion.*" Adelphi, New York.

{% Seems that this book introduced discounted utility; I doubt. Nonconstant discounting has surely been known before, constant discounted utility did Fisher

impose it, or was Samuelson the first? Benzion, Rappoport, & Yagill (1989) and the Nobel committee (2017) suggest this book. More likely that it introduced discounted value!?

On **time preference** and d**iscounting normative**: P. 67: "It seems preferabe ... first to find the principles which fix the terms on which present and future goods exchange, without restricting ourselves in advance to the thesis that, always and necessarily, present goods command a premium over future goods." (citation taken from Weibull, 1985). Seems that Fisher also makes clear that in a perfect free market present money can be equated completely with market-discounted future money, which can serve as a serious confound in experiments to measure intertemporal preference. (**time preference, fungibility problem**:) %}

Fisher, Irving (1930) "*The Theory of Interest.*" MacMillan, New York.

{% Seems to stress likelihood and sufficiency. %}

Fisher, Ronald A. (1922) "On the Mathematical Foundations of Theoretical Statistics," *Philosophical Transactions of the Royal Society of London*, Part A, 222, 309–368.

{% Seems to be a major paper introducing ancillarity, in an informal manner just by examples. Seems that '34 and '35 he also wrote on ancillarity. %}

Fisher, Ronald A. (1925) "Theory of Statistical Estimation," *Proceedings of the Cambridge Philosophical Society* 22, 200–225.

{% **conservation of influence**: seems to have proposed expected number of offspring as. %}

Fisher, Ronald A. (1930) "*The Genetic Theory of Natural Selection.*" Oxford University Press, New York.

{% %}

Fisher, Ronald A. (1935) "*The Design of Experiments.*" Oliver and Boyd, Edinburgh.

{% **foundations of statistics**: argues against Neyman's classical statistics. %}

Fisher, Ronald A. (1955) "Statistical Methods and Scientific Induction," *Journal of the Royal Statistical Society, Series B (Methodological)* 17, 69–78.

{% Discussed BY Zabell (1992). In this book Fisher thought to justify his fiducial approach through “recognizable subsets.”

Seems to write (p. 77; p. 81 in 3rd, 1973, edn.): “the only populations that can be referred to in a test of significance have no objective reality, being exclusively the product of the statistician’s imagination through the hypotheses he has decided to test.”

Seems to have proposed the likelihood principle (earlier by Barnard 1947, 1949). %}

Fisher, Ronald A. (1956) “*Statistical Methods and Scientific Inference.*” Oliver and Boyd, Edinburgh. (3rd edn. 1973, Hafner Press, New York.)

{% %}

Fiske, Alan P. & Tetlock, Philip E. (1997) “Taboo Trade-Offs: Reactions to Transactions that Transgress Spheres of Justice,” *Political Psychology* 18, 255–297.

{% **equity-versus-efficiency**: measure opinions on this of a large American sample %}

Fisman, Raymond, Pamela Jakiela, Shachar Kariv, & Silvia Vannutelli (2023) “The Distributional Preferences of Americans, 2013–2016,” *Experimental Economics* 26, 727–748.
https://doi.org/10.1007/s10683-023-09792-z

{% %}

Fleischer, Isidore (1961) “Numerical Representation of Utility,” *Journal of the Society of Industrial and Applied Mathematics* 9, 48–50.

{% Show how error theory can be introduced to test a Varian (1983) condition for consumer demand functions necessary and sufficient for concave additive decomposable utility. %}

Fleissig, Adrian R. & Gerald A. Whitney (2007) “Testing Additive Separability,” *Economics Letters* 96, 215–220.

{% Test weak separability from econometric data and find that any violations are probably just errors in data. %}
Fleissig, Adrian R. & Gerald A. Whitney (2008) "A Nonparametric Test of Weak Separability and Consumer Preferences," *Journal of Econometrics* 147, 275–281.

{% %}
Fleming, J. Marcus (1952) "A Cardinal Concept of Welfare," *Quarterly Journal of Economics* 66, 366–384.

{% %}
Fleming, J. Marcus (1957) "Cardinal Welfare and Individualistic Ethics: A Comment," *Journal of Political Economy* 65, 355–357.

{% Seems to discuss that people perceive probabilities 0 and 1 categorically differently than other probabilities %}
Fleming, Stephen M., Laurence T. Maloney, & Nathanial D. Daw (2013) " The Irrationality of Categorical Perception," *Journal of Neuro-Science* 33, 19060–19070.

{% %}
Fleurbaey, Marc (2010) "Assessing Risky Social Situations?," *Journal of Political Economy* 118, 649–680.

{% **Harsanyi's aggregation**: ex post welfare can depend on ex ante prospects and counterfactuals. %}
Fleurbaey, Marc, Thibault Gajdos, Stéphane Zuber (2015) "Social Rationality, Separability, and Equity under Uncertainty," *Mathematical Social Sciences* 73, 13–22.

{% **risky utility u = transform of strength of preference v**: This paper does not consider risky utility, but considers the history of cardinal-ordinal utility in welfare theory. In particular, to what extent Arrow' impossibility theorem was a death sentence to ordinal welfare theory (**Arrow's voting paradox ==> ordinality does not work**). Samuelson and others argued otherwise.

The basic issue is as follows. Assume two agents. We only know their *ordinal* utilities U_1 and U_2. We define a social welfare function $W(x) = w(U_1(x),U_2(x))$. Assume $w(U_1(x),U_2(x)) = w(U_1(y),U_2(y))$. Can we say that we made an interpersonal comparison of utility difference, with $U_1(x)–U_1(y) = U_2(y)–U_2(x)$? Strictly mathematically speaking, we can just deny it. %}

Fleurbaey, Marc & Philippe Mongin (2005) “The News of the Death of Welfare Economics is Greatly Exaggerated,” *Social Choice and Welfare* 25, 381–418. https://doi.org/10.1007/s00355-005-0010-1

{% They assume given for riskless alternatives, a social utility function that is a sum of individual functions. Then they show that under some reasonable axioms, in Harsanyi’s (1955) setup, the vNM social utility function must be that same sum and, thus, a linear combination of individual vNM utilities. %}

Fleurbaey, Marc & Philippe Mongin (2016) “The Utilitarian Relevance of the Aggregation Theorem,” *American Economic Journal: Microeconomics* 8, 289–306.

{% Use the Bernheim-Rangel approach, extending it to incomplete prererences and distributive issues. %}

Fleurbaey, Marc & Erik Schokkaert (2013) “Behavioral Welfare Economics and Redistribution,” *American Economic Journal: Microeconomics* 5, 180–205.

{% Consider a weakening of Arrow’s independence of irrelevant alternatives (in its social-choice meaning, and not its revealed-preference meaning) to independence only of alternatives not actually available. Still get some impossibility results. Give economic interpretations. %}

Fleurbaey, Marc & Koichi Tadenuma (2007) “Do Irrelevant Commodities Matter?,” *Econometrica* 75, 1143–1174.

{% %}

Flom, Merton C., Frank W. Weynouth, & Daniel Kahneman (1963) “Visual Resolution and Contour Interaction,” *Journal of the Optical Society of America* 53, 1026–1032.

{% %}

Florens, Jean-Pierre & Michel Mouchart (1988) "Bayesian Specification Tests," CORE discussion paper 8831.

{% **foundations of statistics**; contains many useful references. %}

Florens, Jean-Pierre & Michel Mouchart (1993) "Bayesian Testing and Testing Bayesians." *In* Gangadharrao S. Maddala, C. Radhakrishna Rao, & Hriskikesh D. Vinod (eds.) *Handbook of Statistics* 11, Elsevier Science Publishers, Amsterdam.

{% Derive quality of life (for multiattribute health states) not from trading it off against life duration, but by letting people choose repeatedly and using an error theory, where the probability of choosing a health state is led into a cardinal value scale. They cite two papers that introduced this method and use it to do something about health states worse than death. %}

Flynn, Terry N., Jordan J. Louviere, Anthony A.J. Marley, Joanna Coast & Tim J. Peters (2008) "Rescaling Quality of Life Values from Discrete Choice Experiments for Use as QALYs: A Cautionary Tale," *Population Health Metrics* 6/1/6.

{% Cetuximab gave patients with lung cancer and metastases on average 1.2 months more life duration, with serious decrease in quality of life, but costs $80,000 per patient. Nevertheless it was accepted as treatment in the US (based on a study that did not measure or incorporate quality of life). The authors argue that this is too expensive. They propose $129,000 as maximum price per QALY (healthy year). The UK seems to take 30,000 pound per year. %}

Fojo, Tito & Christine Grady (2009) "How Much Is Life Worth: Cetuximab, Non–Small Cell Lung Cancer, and the $440 Billion Question," *Journal of the National Cancer Institute* 101, 1044–1048.

{% %}

Fokkema, Sipke D. & Arie Dirkzwager (1960) "A Comparison of Subjective and Objective Methods for Observation of Discussion Groups in Personnel Selection," *Acta Psychologica* 17, 55–79.

{% Seems to have nice comments on continuity conditions for preferences. %}

Foldes, Lucien (1972) "Expected Utility and Continuity," *Review of Economic Studies* 39, 407–421.

{% Seems to use subadditivity much. %}

Föllmer, Hans & Alexander Schied (2016) "*Stochastic Finance: An Introduction in Discrete Time*." (Fourth Edition) Walter de Gruyter, Berlin.

{% %}

Foltz, Gregory S., Steven E. Poltrock, & George R. Potts (1984) "Mental Comparison of Size and Magnitude: Size Congruity Effects," *Journal of Experimental Psychology: Learning, Memory and Cognition* 10, 442–453.

{% Discusses a number of indexes of risk aversion that are relevant in different decision situations, such as when considering small absolute stakes (Pratt-Arrow), a small chance of a great gain, or a small chance of ruin. The latter is U(x)/U´(x), a measure introduced by Aumann & Kurz (1977). %}

Foncel, Jérôme & Nicolas Treich (2005) "Fear of Ruin," *Journal of Risk and Uncertainty* 31, 289–300.

{% Seems to argue that any theory of choice under uncertainty should encompass risk. %}

Ford, James L. (1987) "*Economic Choice under Uncertainty: A Prespective Theory Approach*." Edward Elgar, Aldershot.

{% P. 688, last paragraph: Majority of Shackle's work concerns presence of uncertainty in economics; replace expected utility by Shackle's original concepts, "potential surprise" and focus-outcomes of competing action-choices. Refs are given. %}

Ford, James L. (1993) "G.L.S. Shackle (1903-1992): A Life with Uncertainty," *Economic Journal* 103, 683–697.

{% %}

Ford, James L. & Sudip Ghose (1995) "Shackle's Theory of Decision-Making under Uncertainty: The Findings of a Laboratory Experiment," Discussion Paper (University of Birmingham, Department of Economics)

{% Study implications of neo-additive capacities in financial markets. %}
Ford, Jim L., David Kelsey, & Wei Pang (2013) "Information and Ambiguity: Herd and Contrarian Behaviour in Financial Markets," *Theory and Decision* 75, 1–15.

{% Counterexample to footnote 14 of Aumann (1987), Econometrica 55, 1–18 %}
Forges, Françoise (1990) "Correlated Equilibrium in Two-Person Zero-Sum Games," *Econometrica* 58, 515.

{% %}
Forges, Françoise (1993) "Five Legitimate Definitions of Correlated Equilibrium in Games with Incomplete Information," *Theory and Decision* 35, 277–310.

{% Does revealed preference à la Varian, but, what I like, allowing for much more general budget sets than linear. Mainly, comprehensiveness. Generalizing bargaining game theory by also allowing nonconvexity. The paper starts well with citing my favorite reference in revealed preference: Richter (1966). It claims that Richter's derivation is nonconstructive, needing Zorn's lemma, whereas the Afriat-Varian approach is constructive for finite data sets. I doubt about this. I thought that Richter's approach is just as constructive for finite data sets, and only using Zorn's lemma for extension to infinite sets. %}
Forges, Françoise & Enrico Minelli (2009) "Afriat's Theorem for General Budget Sets," *Journal of Economic Theory* 144, 135–145.

{% **AHP**; Paper mostly seems to propagates the software develpoped by the author, and to defend against criticisms, rather than to give a didactical exposition. %}
Forman, Ernest H. & Saul I. Gass (2001) "The Analytical Hierarchy Process—An Exposition," *Operations Research* 49, 469–486.

{% **Christiane, Veronika & I**: p. 542 seems to pay subjects in francs/pesos instead of dollars or cents so as to encourage better decisions, apparently through the higher numbers. %}

Forsythe, Robert, Thomas R. Palfrey, & Charles R. Plott (1982) "Asset Valuation in an Experimental Market," *Econometrica* 50, 537–568.

{% Take utility linear for gains but quadratic for losses, to model a kind of loss aversion where extreme losses are disliked much. They explain nicely in the intro that there is much interest in measures for downside risks, with VaR most well known. They relate to mean-variance analysis, and analyze optimization problems. %}

Fortin, Ines & Jaroslava Hlouskova (2015) "Downside Loss Aversion: Winner or Loser?," *Mathematical Methods of Operations Research* 81, 181–233. https://doi.org/10.1007/s00186-015-0493-1

{% Seems to be a paradox essentially different than Cox' conditioning paradox. Estimating mean of normal distribution with known variance, then conditions on observed variance. %}

Foster, Dean P. & Edward I. George (1996) "A Simple Ancillarity Paradox," *Scandinavian Journal of Statistics* 23, 233–242.

{% Aumann & Serrano (2008, JPE) define a measure of riskiness of a prospect (lottery) g that has both positive and negative outcomes as the risk tolerance (reciproke of measure of absolute risk aversion, which has the nice property of having monetary unit as its unit; in other words, of being a money amount) at which the person is indifferent between taking the prospect or the 0 prospect. That is, with $U(x) = 1–\exp(-\alpha x)$, $EU(g) = EU(0) = 0$, and then α is the index.

This paper does the same thing but with a different utility family, being the logarithmic family defined by $U(x) = \log(\alpha + x)$, where α is the parameter. The authors show this definition of their measure only in Section VI.B, following Eq. 5. Their defining Eq. 1 is equivalent, as readily follows from substitution. They denote the measure by R(g). They interpret α as wealth level, as this is often done. Beause log(0) is $-\infty$ (we approximate for x to 0 from above), this should always be avoided and dominates all else, and R(g) should exceed the minimal outcome. If I understand right, this simply means that R(g) is the liminf of the support of g. Thus, if there is a minimal outcome and it has positive probability, then R(g) is this outcome.

The authors put this interpretation, of avoiding bankruptcy, central in many discussions in the first part of the paper. They derive many properties in Section V Proposition 1, such as homogeneity, which follows from CRRA, subadditivity, and so on. It reminds me of the Kelly criterion (Kelly 1956), maximizing logarithm of wealth, which is optimal if in repeated investment decisions one want to minimize the risk of ruin/extinction.

P. 800 3rd para criticizes Rabin (2000) on the ground that the extreme risk aversion that Rabin derives agrees with the authors' criterion of R(g). R(g) is indeed the most pessimistic and risk averse one can think of. The authors judge R(g) and its extreme risk aversion to be plausible (I disagree). Hence, they disagree with the implausibility claim that Rabin assigns to extreme risk aversion. %}

Foster, Dean P. & Sergiu Hart (2009) "An Operational Measure of Riskiness," *Journal of Political Economy* 117, 785–814.

{% Axiomatize the measures of riskiness of Aumann & Serrano (2008) and Foster & Hart (2009). %}

Foster, Dean P. & Sergiu Hart (2013) "A Wealth-Requirement Axiomatization of Riskiness," *Theoretical Economics* 8, 591–620.

{% Seems that they introduced calibration into game theory. %}

Foster, Dean P. & Rakesh V. Vohra (1997) "Calibrated Learning and Correlated Equilibrium," *Games and Economic Behavior* 21, 40–55.

{% Seems to be a classic in the sense that it was first to show that charlatan can pass calibration tests as soon as experts can. %}

Foster, Dean P. & Rakesh V. Vohra (1998) "Asymptotic Calibration," *Biometrica* 85, 379–390.

{% Gekregen van Moulin op 18 mei 1990 %}

Foster, James E. (1985) "Inequality Measurement." *In* H. Peyton Young (eds.) *Fair Allocation*, Proceedings of Symposia in Applied Mathematics, American Mathematical Society, Providence.

{% %}

Foster, James E. & Efe A. Ok (1999) "Lorenz Dominance and the Variance of Logarithms," *Econometrica* 67, 901–907.

{% Debreu's (1960) additive decomposability theorem with some interpretations added. %}

Foster, James E. & Anthony F. Shorrocks (1991) "Subgroup Consistent Poverty Indices," *Econometrica* 59, 687–709.

{% %}

Fountain, John (2002) "Eliciting Beliefs from Risk Averse Forecasters Using a Log Scoring Rule," University of Canterbury, Christchurch, New Zealand.

{% %}

Fountain, John & Michael McCosker (1993) "Fans, Frames and Risk Aversion: How Robust is the Common Consequence Effect ?"- University of Canterbury; Department of Economics and Operations Research.

{% Treatment variation: For a group of patients, 93% of urologists consider radical prostatectomy to be the optimal treatment, 72% of radiation oncologists consider surgery and external beam radiotherapy as equivalent. The authors conclude: "specialists overwhelmingly recommend the therapy that they themselves deliver." %}

Fowler, Floyd J., Jr., Mary McNaughton Collins, Peter C. Albertsen, Anthony Zietman, Diana B. Elliot, & Michael J. Barry (2000) "Comparison of Recommendations by Urologists and Radiation Oncologists for Treatment of Clinically Localized Prostate Cancer," *JAMA (Journal of the American Medical Association*) 283, 3217–3222.

{% %}

Fox, Craig R. (1990) “From Risk to Uncertainty: Exploring the Effects of Ambiguity and Source Preference on Decision Weights,” Stanford University, Dept. of Psychology.

{% %}
Fox, Craig R. (1999) “Strength of Evidence, Judged Probability, and Choice under Uncertainty,” *Cognitive Psychology* 38, 167–189.

{% %}
Fox, Craig R. (2006) “The Availability Heuristic in the Classroom: How Soliciting More Criticism Can Boost Your Course Ratings,” *Judgment and Decision Making* 1, 86–90.

{% %}
Fox, Craig R. & Richard Birke (2002) “Forecasting Trial Outcomes: Lawyers Assign Higher Probabilities to Scenarios That Are Described in Greater Detail,” *Law and Human Behavior* 26, 159–173.

{% They demonstrate clear bias of probability estimations towards the neutral distribution with respect to the partition chosen. %}
Fox, Craig R. & Robert T. Clemen (2005) “Subjective Probability Assessment in Decision Analysis: Partition Dependence and Bias toward the Ignorance Prior,” *Management Science* 51, 1417–1432.

{% **survey on nonEU**
Focuses on decision under risk with a bit on ambiguity.

Not primarily a complete survey but rather a didactical account giving the main ideas, with some nicely written sentences. For example, p. 51, on Rabin’s paradox: “by way of analogy, if one could perceive the curvature of the earth by walking the length of a football field, then the earth must be implausibly small.”

loss aversion: erroneously thinking it is reflection: This paper of course does NOT make this mistake. It usefully lists it as the first of some misunderstandings (top p. 55): “A few points of common confusion are worth highlighting at this juncture. First, loss aversion is not the same as risk seeking for losses. …Second, decision

weights are not generally interpreted as a measure of belief. … Third, the concavity (convexity) of the value function is not the same as risk aversion (risk seeking), and overweighting low-probability gains (losses) is not the same as risk seeking (risk aversion)."

P. 58 brings up the two-stage model of PT for ambiguity, in the spirit of Tversky that I know well, having discussed it so much with him: There is belief and risk-probability weighting in the first para, with no space for the typical Ellsberg source preference. The latter is considered a relatively unimportant phenomenon much driven by contrast effects beyond individual choice, and reluctantly showing up in the 2nd para. Tversky convinced me of this and it has underlied my work on ambiguity ever after. Tversky mostly discussed these things with Craig and me.

PT falsified: Pp. 59-63 lists violations. The 2nd part of this paper is on external validity from lab to field, giving procedures to work on this.

P. 79 (conclusion) (**Prospect theory/Rank-Dependent Utility most popular for risk**):

"Despite its limitations, we find that prospect theory is the most successful general purpose model currently available for predicting, describing, and interpreting decisions under risk; to our reading alternative models that we reviewed outperform prospect theory only under specific conditions."

%}

Fox, Craig R., Carsten Erner, & Daniel J. Walters (2015) "Decision under Risk: From the Field to the Laboratory and back." *In* Gideon Keren & George Wu (eds.), *The Wiley Blackwell Handbook of Judgment and Decision Making*, 43–88, Blackwell, Oxford, UK.

{% For the meaning of epistemic vs. aleatory, see my annotations at Walters et al. (2023, Management Science) who discuss it themselves on pp. 2762-2763. %}

Fox, Craig R., Michael Goedde Goedde, & David Tannenbaum (2022a) "Ambiguity Aversion Is Aversion to Epistemic Uncertainty," Working paper, Anderson School of Management, University of California, Los Angeles.

{% %}

Fox, Craig R. & Liat Hadar (2006) "Decisions from Experience = Sampling Error + Prospect Theory: Reconsidering Hertwig, Barron, Weber & Erev (2004)," *Judgment and Decision Making* 1, 159–161.

{% %}

Fox, Craig R. & Julie R. Irwin (1998) “The Role of Context in the Communication of Uncertain Beliefs,” *Basic and Applied Social Psychology* 20, 57–70.

{% %}

Fox, Craig R. & Daniel Kahneman (1992) “Correlations, Causes and Heuristics in Surveys of Life Satisfaction,” *Social Indicators Research* 27, 221–234.

{% Does belief reversals analogously to preference reversals, with choices revealing different orderings of likelihood than matching judgments. A greater proportion of subjects rate the more familiar event as more likely than assigning a higher probability to that event. %}

Fox, Craig R. & Jonathan Levav (2000) “Familiarity Bias and Belief Reversal in Relative Likelihood Judgment,” *Organizational Behavior and Human Decision Processes* 82, 268–292.

{% %}

Fox, Craig R. & Jonathan Levav (2004) “Partition-Edit-Count: Naïve Extensional Reasoning in Conditional Probability Judgment,” *Journal of Experimental Psychology: General* 133, 626–642.

{% %}

Fox, Craig R. & Russell A. Poldrack (2008) “Prospect Theory on the Brain: Studies on the Neuroeconomics of Decision under Risk.” *In* Paul W. Glimcher, Colin F. Camerer, Ernst Fehr, & Russell A. Poldrack (eds.), *Handbook of Neuroeconomics*, 145–173, Elsevier, New York.

{% %}

Fox, Craig R., Rebecca K. Ratner, & Daniel Lieb (2005) “How Subjective Grouping of Options Influences Choice and Allocation: Diversification Bias and the Phenomenon of Partition Dependence,” *Journal of Experimental Psychology: General* 134, 538–551.

{% **PT: data on probability weighting**; **natural sources of ambiguity**
ambiguity seeking for unlikely; **inverse S** Option traders do EV for given probabilities, and subadditivity for unknown probabilities; ascribe it to subadditivity in judged probability.

P. 7: "Note that risk can be viewed as a special case of uncertainty where probability is defined *via a standard chance device* so that the probabilities of outcomes are known," [italics added] Important: the italicized part shows that risk (I add: Ambiguity neutrality) refers to a neutral emotionless implementation of risk. The same statement is in Tversky & Fox (1995).

The value function is elicited by asking for equivalences
(p, x; q, c; 1–pzq, 0) ~ (p, a; q, b; 1–p–q,0),
x > a > b > c,
where all values except x were set by the experimentor and subjects should provide x. For example, this paper took a = \$100, b = \$50, b = \$25. Expt. 1: p = q = 1/6. The median answer found was x = \$125.

The authors conclude that that implies a linear value function under cumulative prospect theory (p. 8, ℓ. 15–18). However, that need not be true in general. It will depend on p and q chosen and, no matter what p and q are, on the probability weighting function (which may be different for different individuals).

linear utility for small stakes: their findings remain unaffected if they assume linear utility.

real incentives: **random incentive system** %}

Fox, Craig R., Brett A. Rogers, & Amos Tversky (1996) "Options Traders Exhibit Subadditive Decision Weights," *Journal of Risk and Uncertainty* 13, 5–17.
https://doi.org/10.1007/BF00055335

{% %}

Fox, Craig R., & Yuval Rottenstreich (2003) "Partition Priming in Judgment under Uncertainty," *Psychological Science* 14, 195–200.

{% They introduce monadic testing for the Ellsberg urn test of ambiguity aversion. That is, they do not let subjects choose between known and unknown urn, but present each in isolation and ask for evaluations (certainty equivalents), thus avoiding contrast effects. Ambiguity aversion may not be genuine, but may be just a contrast effect. They indeed find that ambiguity aversion then disappears, although later studies primarily by Chow & Sarin (2001, 2002) suggested that the truth is in the middle: ambiguity aversion is reduced but does not disappear under monadic testing.

ambiguity seeking: The paper finds source preference for betting on football over chance, but less sensitivity for football. So, source sensitivity and preference do not always covary.

Study 4 compares WTP both for event and for its complement. But they do not test uniform dominance (source preference), but only sums of WTP, so that it is not really **source preference directly tested**. P. 893 mentions cases where there is uniform dominance (both the event and its complement have higher CE (certainty equivalent)) for medians. So, this is at the median level but not directly at the individual level.

Studies 2 & 3 have real incentives, studies 1,4,5,6 are hypothetical.

P. 600: "the conclusion that the Ellsberg phenomenon is an inherently comparative effect." The next para argues that it is not clear which is more rational, the finding of the comparative test shows or of the monadic test.

inverse S: Argue that nonadditive models can describe source sensitivity but not so easily source preference because the latter may be a comparative effect, see P. 601: "This suggests that models based on decision weights or nonadditive probabilities (e.g., Quiggin [1982]; Gilboa [1987]; Schmeidler [1989]; Tversky & Wakker [1995, Econometrica]) can accommodate source sensitivity, but they do not provide a satisfactory account of source preference because they do not distinguish between comparative and noncomparative evaluation."

This paper shows Amos' preference to use the term chance for known probabilities.

P. 601 footnote 1 emphasizes the importance to control for "subjective probability" (their term) before drawing inferences about ambiguity attitudes.

P. 602 criticizes Dow and Werlang [1991] and Epstein and Wang [1994] for treating source preference in a noncomparative manner. %}

Fox, Craig R. & Amos Tversky (1995) "Ambiguity Aversion and Comparative Ignorance," *Quarterly Journal of Economics* 110, 585–603. https://doi.org/10.2307/2946693

{% **PT: data on probability weighting**; **inverse S**; **ambiguity seeking for unlikely**; **coalescing; natural sources of ambiguity**

The model for uncertainty in this paper, called the two-stage model, assumes introspectively based belief judgments, on which the probability weighting function of prospect theory for risk is applied. This assumes that everything of ambiguity is cognitive, i.e., comes from belief! I like this interpretation of ambiguity, although it deviates from the prevailing views these days (2021). Beliefs are assumed to be captured by support theory. This implies binary additivity (Eq. 2): The belief in an event and in its complement add to 1. It precludes source preference.

The model predicts that matching probabilities are identical to introspective beliefs (Eq. 5).

The value function is elicited by asking for equivalences

(.25, x; .25, c; .50, 0) ~ (.25, a; .25, b; .50, 0),

x > a > b > c,

where all values except x were set by the experimentor and subjects should provide x. They conclude from that that, for value function v, v(x) + v(c) = v(a) + v(b). This is correct !because! they do this only if expected utility is assumed. It would not be true had they claimed this under cumulative prospect theory! The abstract is confusing in writing that they assume prospect theory for risk. (It would also be correct under original 1979 prospect theory, which deviates from the new 1992 version here.)

P. 879 1st column claims: "the classical theory [axiomatic decision theories] .. does not correspond to the common intuition that belief precedes preference." I disagree. Axiomatic theories take no stance on what precedes what, decisions or beliefs/attitudes. I agree on the plausibility of belief preceding, being prior to, preference.

1998, p. 883, first column, third paragraph, opening sentence, suggests that what they do is independent of probability weighting. This is not correct. (Other parts of the text also suggest this incorrect claim but less explicitly than the sentence on p. 883.) What follows, in particular the identification of risk attitude with utility, is correct only under expected utility.

real incentives: Do **random incentive system** in study 1, not in study 2 it seems.

P. 885: They use the terms risk averse / risk neutral /risk seeking as equivalent to concave / linear / convex utility. This is, again, only because they are doing the analysis in the context of expected utility there.

P. 893 penultimate exhibits the usual enthusiasm about own results, focusing on this journal Management Science: "The two-stage model may have important implications for the management sciences and related fields." %}

Fox, Craig R. & Amos Tversky (1998) "A Belief-Based Account of Decision under Uncertainty," *Management Science* 44, 879–895.
Reprinted with minor changes *in* Daniel Kahneman & Amos Tversky (2000, eds.) *Choices, Values and Frames,* Ch. 6, pp. 118–142, Cambridge University Press, New York.
https://doi.org/10.1287/mnsc.44.7.879

{% For the meaning of epistemic vs. aleatory, see my annotations at Walters et al. (2023, Management Science) who discuss it themselves on pp. 2762-2763. %}

Fox, Craig R. & Gülden Ülkümen (2011) "Distinguishing Two Dimensions of Uncertainty." *In* Wibecke Brun, Gideon Keren, Geir Kirkebøen, Henry Montgomery (eds.) *Perspectives on Thinking, Judging, and Decision Making*, 21–35, Universitetsforlaget, Oslo, Norway.

{% **utility elicitation** %}

Fox, Craig R. & Peter P. Wakker (1999) "Value Function Elicitation: A Comment on Craig R. Fox & Amos Tversky, "A Belief-Based Account of Decision under Uncertainty"." This paper was rejected by the editor Martin Weber of the journal *Management Science* and by the *Journal of Risk and Uncertainty*.
Link to paper

{% **natural sources of ambiguity**: Extend the comparative ignorance hypothesis. Uncertain gambles are more attractive if preceded by less familiar items. Nicely, the gambles are also less attractive if subjects are provided with diagnostic information that they do not know how to use. An additional experiment considers games against more or less competent opponents, where strategic complications enter the picture. (**game theory as ambiguity**)

P. 493 discusses the evaluability hypothesis of Christopher Hsee as alternative

explanation.

source preference directly tested: Study 1 takes WTP for bets on events both from events and their complements, but then compares their sums across sources and does not report uniform dominance of the two CEs (certainty equivalents). %}

Fox, Craig R. & Martin Weber (2002) "Ambiguity Aversion, Comparative Ignorance, and Decision Context," *Organizational Behavior and Human Decision Processes* 88, 476–498.
https://doi.org/10.1006/obhd.2001.2990

{% %}

Foxall, Gordon R. (1986) "Theoretical Progress in Consumer Psychology: The Contribution of a Behavioural Analysis of Choice," *Journal of Economic Psychology* 7, 393–414.

{% Intro to special issue on behavioral economics in managerial economics. %}

Foxall, Gordon R. (2016) "Operant Behavioral Economics," *Managerial and Decision Economics* 37, 215–223.

{% Show that subjects with high numeracy have weaker status quo effect, so, weaker loss aversion. (**cognitive ability related to risk/ambiguity aversion**) So, relates a bias to cognitive sophistication. %}

Fraenkel, Liana, Meaghan Cunningham, & Ellen Peters (2015) "Subjective Numeracy and Preference to Stay with the Status Quo," *Medical Decision Making* 35, 6–11.
https://doi.org/10.1177/0272989X14532531

{% Hartmann (2020) did not exactly copy Savage's P5 and P6, but made the former some weaker and the latter some stronger. However, neither of these mistakes is consequential, not affecting the truth of any theorem stated because the axioms are equivalent to Savage's in the presence of the other axioms. This paper just mentions this point. Frahm & Hartmann (2025, Theory and Decision) elaborates on these points, providing proofs. %}

Frahm, Gabriel & Lorenz Hartmann (2023) "Erratum to 'Savage's P3 is Redundant'," *Econometrica* 91, 33.

https://doi.org/10.3982/ECTA21641

{% This paper provides some variations of Savage's (1954) famous representation theorem. There were some loose ends in the literature, following up on Hartman's (2000) important contribution, and this paper fixes them. What is missing in the literature, concerns Hartmann's (2000) Footnote 4. That is, that Savage's P7 is implied by Hartmann's (2000) P7′ without using Savage's P3. The authors show it, also doing without P4 and P5. This is useful as addition to Hartmann (2020). %}

Frahm, Gabriel & Lorenz Hartmann (2025) "Some Notes on Savage's Representation Theorem," *Theory and Decision* 98, 85–93.
https://doi.org/10.1007/s11238-024-10003-1

{% Mathematical paper using capacities, recommended to me by Jaffray. %}

Frank, Andras & Eva Tardos (1988) "Generalized Polymatroids and Submodular Flows," *Mathematical Programming* 42, 489–563.

{% Cost of decision making à la Marschak is considered. It plays a role in whether it is better to just give patient policy/based treatment or to make individual-patient based decision. %}

Frank, Richard G. & Richard J. Zeckhauser (2007) "Custom-Made versus Ready-to-Wear Treatments: Behavioral Propensities in Physicians' Choices," *Journal of Health Economics* 26, 1101–1127.

{% %}

Frank, Robert H. (1988) "*Passions within Reason: The Strategic Value of the Emotions*." Norton, New York.

{% **preferring streams of increasing income**; **time preference** %}

Frank, Robert H. (1989) "Frames of Reference and the Quality of Life," *American Economic Review* 79, 80–85.

{% **conservation of influence**: the utility function’s evolutionary role is to reward people with good feelings when they make progress toward survival and reproduction. %}

Frank, Robert H. (1992) “Frames of Reference and the Intertemporal Wage Profit.” *In* George F. Loewenstein & John Elster (1992) *Choice over Time*, 371–382, Russell Sage Foundation, New York.

{% %}

Frank, Robert H. (1992) “The Role of Moral Sentiments in the Theory of Intertemporal Choice.” *In* George F. Loewenstein & John Elster (1992) *Choice over Time*, 265–286, Russell Sage Foundation, New York.

{% **total utility theory**; On psychological measurements of well-being. %}

Frank, Robert H. (1997) “The Frame of Reference as a Public Good,” *Economic Journal* 107, 1832–1847.

{% %}

Frank, Robert H. (2005) “*Microeconomics and Behavior*.” McGraw-Hill, 6th edn. (ISBN: 0071115498)

{% **dominance violation by pref. for increasing income**: seem to find it. %}

Frank, Robert H. & Robert M. Hutchens (1993) “Wages, Seniority, and the Demand for Rising Consumption Profiles,” *Journal of Economic Behavior and Organization* 21, 251–276.

{% **value of information**: The paper is on that. It takes value of information from the posterior perspective, after actual receipt of the info. It takes the instrumental value, being how much more (conditioned on the info received!) expected utility one gets by choosing optimal thanks to the info relative to the perceived optimum without that info. It then formulates some abstract mathematical properties, endowed with the strange name validity, and proves some theorems on it.

Because the topic interests me much, I tried to understand this paper, but I failed. I failed immediately in the definitions in §I.A on p. 3652. When the authors write that a belief is a distribution I gamble that they mean a probability

distribution. A signal realization is what I would call a signal, and what they call a signal is the corresponding prior anticipation/ random variable (?). After quite some thinking about the first three lines of the 2nd para, I came to understand that signal is as follows: (1) There are finitely many possible signal realizations $r_1, \ldots, r_m$. One takes a finite partition of the state space $\{E_1, \ldots, E_n\}$. For every E_j there is a conditional probability p_{ij} of receiving signal realization r_i conditional on E_j. Therefore, after receiving the signal realization, one can update the probabilities of E_j by Bayes formula.

However, I got lost at the last sentence of that para. A signal is a random variable. Is S the image or (I guess) the range (set of images)? But what is the domain? [0,1]? If it is S x [0,1], then the domain has not been endowed with a probability measure yet, so one cannot use the term random variable. I gave up trying to really understand.

P. 3653: At first I did not understand the first displayed formula because p and q were not explained. Only 8 lines below they get explained.

If we can quantify the value of info, then we can define the degree of nuncertainty in a situation as minus the value of perfect info, and we can readily define value of info conversely. The authors make a big point of this relation.

P. 3656 defines validity of a measure of info as the EXISTENCE of a decision situation such that the measure of info is the value of info there. This is a strange definition because the decision situation may be weird and practically irrelevant. There is a corresponding definition of validity of measure of uncertainty. Theorem 2 will show that validity of a measure of uncertainty holds iff the measure is (regular and) concave, further showing that this is just a mathematical property. What the authors call validity is something like a very minimal requirement for validity. %}

Frankel, Alexander & Emir Kamenica (2019) "Quantifying Information and Uncertainty," *American Economic Review* 109, 3650–3680.

{% I took from Wikipedia in Dec. 2022:

In a 1772 letter to Joseph Priestley, Franklin laid out the earliest known description of the Pro & Con list, a common decision-making technique, now sometimes called a decisional balance sheet: ...

"my Way is, to divide half a Sheet of Paper by a Line into two Columns, writing over the one Pro,

and over the other Con. Then during three or four Days Consideration I put down under the different Heads short Hints of the different Motives that at different Times occur to me for or against the Measure. When I have thus got them all together in one View, I endeavour to estimate their respective Weights; and where I find two, one on each side, that seem equal, I strike them both out: If I find a Reason pro equal to some two Reasons con, I strike out the three. If I judge some two Reasons con equal to some three Reasons pro, I strike out the five; and thus proceeding I find at length where the Ballance lies; and if after a Day or two of farther Consideration nothing new that is of Importance occurs on either side, I come to a Determination accordingly." %}

Franklin, Benjamin (1772)

{% Predictions of econometric models are contrasted with those of experts. They propose a new model to make the comparison. %}

Franses, Philip-Hans, Michael McAleer, & Rianne Legerstee (2009) "Expert Opinon versus Expertise in Forecasting," *Statistica Neerlandica* 63, 334–346.

{% §7.1: truncated regression %}

Franses, Philip-Hans & Richard Paap (2001) "*Quantitative Models in Marketing Research*." Cambridge University Press, Cambridge, UK.

{% %}

Fraser, Donald A.S. (1964) "Local Conditional Sufficiency," *Journal of the Royal Statistical Society, Ser. B*, 26, 52–62.

{% P. 62 refers to Cournot and someone called Divisia that, for practice, very small probabilities (**(very) small probabilities**) may be assumed to be zero. %}

Fréchet, Maurice (1948) "L'Estimation Statistique des Paramètres" (Abstract), *Econometrica* 16, 600–602.

{% Seems to shows that, with marginals given, correlation is maximal under comonotonicity. Seems to be shown before by Hoeffding (1940). %}

Fréchet, Maurice (1951) "Sur les Tableaux de Correlation dont les Marges Sont Donnés," *Annales de l'Université de Lyon Sect. A*, Series 3, 14, 53–77.

{% %}

Frederick, Shane (1999) “Discounting, Time Preference, and Identity,” Ph.D. Thesis, Department of Social and Decision Sciences, Carnegie Mellon University.

{% **discounting normative**: Mentions philosophical debates about it, with central the question of the extent to which your future self is to be identified with your present self. But then does what psychologists typically do: Does an experiment asking people how similar they are to their future selves, on a 0-100 scale. Has correlation 0 with their discounting (all hypothetical). Probably because meaningless questions. The paper ends with a funny argument, maybe a joke, raised by Parfit apparently. It is that, even if it is not irrational to discount, it may be immoral because it is unfair to your future self. Next step would then be that you sue your future self knowing it will misbehave? %}

Frederick, Shane (2003) “Time Preference and Personal Identity.” *In* George F. Loewenstein, Daniel Read, & Roy F. Baumeister (2003, eds.) *Time and Decision: Economic and Psychological Perspectives on Intertemporal Choice*, 89–113, Russell Sage Foundation, New York.

{% **Compare different measurement methods**: Compares several elicitation techniques for temporal choice, such as choice, matching, rating, and others. Finds strong discrepancies. %}

Frederick, Shane (2003) “Measuring Intergenerational Time Preference: Are Future Lives Valued Less?,” *Journal of Risk and Uncertainty* 26, 39–53.

{% **paternalism/Humean-view-of-preference**: nice discussion. More than that, it is one of the nicest papers I ever read on this topic. (Another nice paper on this topic is Tversky & Kahneman (1981), my no 1 paper in all of decision theory.)

Paper considers simple cognitive test (with clearly correct/incorrect answers) and correlates these with choices. Pp. 26/27 starts nicely with a simple question where subjects with correct answer discounted clearly less. Pp. 28-30 gives references. The paper nicely on each occasion challenges the unfruitful “De gustibus non est disputandem” and consumer sovereignty by taking examples of overly extreme discounting (rather $3400 this month than $3800 next month; p. 31) and overly extreme risk aversion (rather $500 for sure than (0.15: 1 million;

0.85: 0)) that are so clearly over-extreme that the consumer sovereignty people will have a very hard time.

cognitive ability related to discounting

cognitive ability related to risk/ambiguity aversion: p. 32: Fewer studies have been done for risk than for intertemporal choice on correlations with cognitive tasks, but then cites some for risk. This paper finds, strangely enough, that intelligent people not only are more risk seeking when this means going for expected value (which can be taken to be rational), but also when this means going against expected value (which can be taken to be irrational). Unfortunately for me, no data/discussion on inverse S, and only on risk aversion.

gender differences in risk attitudes: p. 38: "expressed loosely, being smart makes women patient and makes men take more risks."

I like in particular the very balanced discussion section (p. 38 ff.). The author makes clear that he prefers what I call the paternalistic approach of decision theory, however without ever crossing the line of just shouting out own opinions as other less-nuanced authors may do (am worried that I may belong to the latter category sometimes). Nice discussion with many references to people discussing that de gustibus EST disputandem (so, I dropped the "non" from the known saying).

P. 41 explains that it is good to follow your brilliant neighbor on mortgage choice, but not necessarily so to follow Einstein in preference for apples over oranges. I like in particular the discussion that the preference

$500 > (0.15: 1 million; 0.85: 0)

most probably does not signal that utility is way flatter above $500 than below, but rather that it is "more reasonable" (the author's words) that this choice is to be overridden. The concluding sentence (whatever stance on paternalism, the correlation between intelligence and decision attitude calls for some explanation) nicely gets back the consumer-sovereignty readers.

A detail: P. 40 suggests that Savage (1954) coined the term reflective equilibrium, but I am not aware of this term appearing in Savage's book. Rawls (1971) is usually credited for having coined it. %}

Frederick, Shane (2005) "Cognitive Reflection and Decision Making," *Journal of Economic Perspectives* 19, 25–42.

https://doi.org/10.1257/089533005775196732

{% Survey with table on pp. 378-379 indicating whether **real incentives/hypothetical choice, for time preferences**; P. 358: D**C** = **stationarity**;

Pp. 362-363 gains are discounted more than losses.

P. 381: Measurements of discounting usually assume linear utility. P. 382 suggests measuring utility separately and then using it to estimate discounting. %}

Frederick, Shane, George F. Loewenstein, & Ted O'Donoghue (2002) "Time Discounting and Time Preference: A Critical Review," *Journal of Economic Literature* 40, 351–401.

{% Introduced duration neglect? %}

Fredrickson, Barbara L. & Daniel Kahneman (1993) "Duration Neglect in Retrospective Evaluations of Affective Episodes," *Journal of Personality and Social Psychology* 65, 45–55.

{% **Dutch book**; sent to me by Tversky in Feb. 93 %}

Freedman, David A. & Roger Purves (1969) "Bayes' Method for Bookies," *Annals of Mathematical Statistics* 40, 1177–1186.

{% **tradeoff method** citation: seems to argue that making tradeoffs is a crucial aspect of high-quality, rational decision making. %}

Freeman, A. Myrick III (1993) "*The Measurement of Environmental and Resource Values*." Resources for the Future, Washington DC.

{% Criticizes the Safra & Segal criticism of the Rabin's calibration theorem because they assume RCLA. Shows that without RCLA, say with recursive nonEU, nonEU can accommodate Rabin's paradox. %}

Freeman, David (2015) "Calibration without Reduction for Non-Expected Utility," *Journal of Economic Theory* 158, 21–32.

{% They test Random Incentive System (RIS) for measurement of risk attitude. Do choice lists with all made visible to subjects at the same time, to maximize possibility of interaction and violation of isolation. They do find such violations, being reduction of certainty effect. As common in experimental economics, they take the one single choice treatment as gold standard (can be debated!) and recommend adding such as control in experiments. %}

Freeman, David, Yoram Halevy, & Terri Kneeland (2019) "Eliciting Risk Preferences Using Choice Lists," *Quantitative Economics* 10, 217–237.

{% %}

Freeman, David & Guy Mayraz (2019) "Why Choice Lists Increase Risk Taking," *Experimental Economics* 22, 131–154.
https://doi.org/10.1007/s10683-018-9586-z

{% **homebias**; they may have introduced it.

P. 225: "Another important behavioral insight concerns the perception of risk in equity markets. Investors may not evaluate the risk of different investments based solely on the historical standard deviation of returns. They may impute extra "risk" to foreign investments because they know less about forein markets institutions, and firms.[footnote 4]" Then footnote 4 writes: "Amos Tversky and Chip Heath (1991) present evidence that households behave as though unfamiliar gambles are riskier than familiar gambles, even when they assign identical probability distributions to the two gambles."

These citations quite capture the spirit of the source method. %}

French, Kenneth R. & James M. Poterba (1991) "Investor Diversification and International Equity Markets," *American Economic Review* 81, 222–226.

{% %}

French, Simon (1985) "Groups Consensus Probability Distributions: A Critical Survey." *In* Jose M. Bernardo, Morris H. DeGroot, Dennis V. Lindley, & Adrian F.M. Smith (eds.) *Bayesian Statistics 2: Proceedings of the Second Valencia International Meeting*, North-Holland, Amsterdam.

{% %}

French, Simon (1986) "*Decision Theory (An Introduction to the Mathematics of Rationality)*." Ellis Horwood Limited/Wiley, New York.

{% %}

French, Simon & Marilena Vassiloglou (1986) "Strength of Performance and Examination Assessment," *British Journal of Mathematical and Statistical Psychology* 39, 1–14.

{% Point out that it can be nice for different biases if they neutralize each other. This is a central point in Bleichrodt (2002, Health Economics. %}

Frenkel, Sivan, Yuval Heller, & Roee Teper (2018) "The Endowment Effect as Blessing," *International Economic Review* 59, 1159–1186.

{% **intuitive versus analytical decisions**: The following cite is ascribed to Freud on p. vii of preface of the book Reik, Theodor (1948) "*Listening with the Third Ear*." Farrar, Straus & Giroux Inc, New York: "When making a decision of minor importance, I have always found it advantageous to consider all the pros and cons. In vital matters, however, such as the choice of a mate or a profession, the decision should come from the unconscious, from somewhere within ourselves. In the important decisions of personal life, we should be governed, I think, by the deep inner needs of our nature." %}

Freud, Sigmund

{% %}

Freudenthal, Hans (1965) Review of Kyburg & Smokler (1964) *Nieuw Archief voor Wiskunde* 13, 168–173.

{% %}

Freudenthal, Hans (1981) "L.E.J. Brouwer—Topoloog, Intuitionist, Filosoof," *Nieuw Archief voor Wiskunde* 29, 249–253.

{% Thom says it's a magnificant book for learning statistics.

Bit too "steep," i.e., too fast for psychology students. Does correlation only at the back, after hypothesis testing. %}

Freund, John E. (1952) "*Modern Elementary Statistics*." Prentice/Hall, London.

{% Political economy model with loss aversion and reference dependence, with implications for protection, lobbying, free trade, explaining protections of the US steel industry since 1980. %}

Freund, Caroline & Özden, Çağlar (2008) "Trade Policy and Loss Aversion," *American Economic Review* 98, 1675–1691.

{% **real incentives/hypothetical choice**: part I is on the **crowding-out** effect; i.e., that real incentives can destroy intrinsic motivation. %}

Frey, Bruno S. (1997) "*Not Just for the Money; An Economic Theory of Personal Motivation*." Edward Elgar Publishing, Brookfield, US.

{% **crowding-out**: seems to show/argue that distrustful public laws reduce tax morale and, thereby, enhance tax evasion. %}

Frey, Bruno S. (1997) "A Constitution for Knaves Crowds Out Civic Virtues," *Economic Journal* 107, 1043–1053.

{% %}

Frey, Bruno S. (2008) "*Happiness. A Revolution in Economics.*" The MIT Press, Cambridge.

{% %}

Frey, Bruno S., & Reiner Eichenberger (1989) "Should Social Scientists Care About Choice Anomalies?," *Rationality and Society* 1, 101–122.

{% **crowding-out**: Extensive review. §3.2.1 mentions extensive investigations from the psychological literature. Mentions, for example, the meta-analytic study by Deci, Koestner, & Ryan (1999) on 128 studies. Throughout the paper many examples from the economic literature are given. %}

Frey, Bruno S. & Reto Jegen (2001) "Motivation Crowding Theory: A Survey of Empirical Evidence," *Journal of Economic Surveys* 15, 589–611.

{% **crowding-out**: seem to find crowding-out for finding sites for locally unwarranted projects. %}

Frey, Bruno S. & Felix Oberholzer-Gee (1997) "The Cost of Price Incentives: An Empirical Analysis of Motivation Crowding-Out," *American Economic Review* 87, 746–755.

{% **questionnaire versus choice utility**: P. 920: "However, there is a lot of indirect evidence that cardinalism and interpersonal comparability are much less of a problem practically than theoretically." And arguments are given.

People in Switzerland who could vote were more happy over outcomes than people who could not vote. Under the assumption that the outcomes are not systematically better for one group than for the other, the finding can be ascribed to procedural utility generated by voting.

P. 925: "Among the economic variables, higher income correlates with higher happiness in a statistically significant way. However, the differences in subjective well-being are rather small." %}

Frey, Bruno S. & Alois Stutzer (2000) "Happiness, Economy and Institutions," *Economic Journal* 110, 918–938.

{% %}

Frey, Bruno S. & Alois Stutzer (2002) "What Can Economics Learn from Happiness Research?," *Journal of Economic Literature* 40, 403–435.

{% %}

Frey, Bruno S. & Alois Stutzer (2005) "Beyond Outcomes: Measuring Procedural Utility," *Oxford Economic Papers* 57, 90–111.

{% Argue that a problem for paternalism can be that governments have incentives to manipulate. But then, what do do against that anyhow? Section 4.3, opening sentence, argues that welfarist approaches rest on the implicit assumption that governments cannot manipulate measurements. Oh well. %}

Frey, Bruno S. & Alois Stutzer (2012) "The Use of Happiness Research for Public Policy," *Social Choice and Welfare* 38, 659–674.

{% The authors use two introspective risk attitude questionnaires and test them on a US sample with N > 3000 subjects, testing person-dependence and domain-dependence, and to see if there are types of subjects and so on. The authors are enthusiastic and dedicate a sentence to it, the last one, in their abstract: "the typological perspective proposed in this article has important implications for current theories of risk preference and the measurement of individual differences therein."

They find that 66% of subjects can be described well with four basic risk profiles: Profile I (21%) "cautious" more risk-averse in all domains except social & ethical, where average; Profile II (18%) "recreational adventurers" more risk-averse in general but more risk-seeking in recreational domain; Profile III (15%) "financial gamblers" more risk-seeking regarding financial investments and gambling more risk-averse regarding health, and average elsewhere; Profile IV (13%) "daredevils" more risk-seeking in most domains, except investment (average) and social (more risk-averse). They relate demograhics; e.g., older people are about half as likely to be daredevil rather than cautious (**relation age-risk attitude**). Men were 5.87 times more likely to be daredevil rather than cautious (**gender differences in risk attitude**). %}

Frey, Renato, Shannon M. Duncan, & Elke U. Weber (2023) "Towards a Typology of Risk Preference: Four Risk Profiles Describe Two-Thirds of Individuals in a Large Sample of the U.S. Population," *Journal of Risk and Uncertainty* 66, 1–17. https://doi.org/10.1007/s11166-022-09398-5

{% Different introspective items correlate reasonably well and seem to capture a risk aversion scale in human beings (the authors did not consider insensitivity). Behavioral measures do not correlate well with these.

The authors are enthusiastic about the importance of their work, writing on p. 8, last para of 1st column: "The present findings have wide-ranging scientific and practical implications:" And, later: "These results have implications for both basic and applied research because a solid measurement of risk preference will be needed to uncover both its biological basis and its consequences for many momentous decisions in the real world." %}

Frey, Renato, Andreas Pedroni, Rui Mata, Jörg Rieskamp, & Ralph Hertwig (2017) "Risk Preference Shares the Psychometric Structure of Major Psychological Traits," *Science Advances* 3: e1701381. https://doi.org/10.1126/sciadv.1701381

{% The authors consider a variation of α maxmin using the rationality concept of Gilboa, Maccheroni, Marinacci, & Schmeidler (2010, Econometrica). Whereas the regular α maxmin model has some problems of identifiability and its axiomatization, if there is an objective subpart as here, using the Bewley incomplete model to handle the rationality part, things become identifiable and axiomatizations can come. The paper also considers updating (**updating under ambiguity**). The paper cites an alternative approach for identification in the α maxmin model by Hill (2019). %}

Frick, Mira, Ryota Iijima, & Yves Le Yaouanq (2022) "Objective Rationality Foundations for (Dynamic) α-MEU," *Journal of Economic Theory* 200, 105394.

{% Overestimation of small probabilities %}

Fricker, Janet (1997) "Baboon Xenotransplant Fails but Patient Improves," *Lancet* 347, 457.

{% **ambiguity seeking for losses**: well, neutrality they seem to find. %}

Friedl, Andreas, Katharina Lima Ide Miranda, & Ulrich Schmidt (2014) "Insurance Demand and Social Comparison: An Experimental Analysis," *Journal of Risk and Uncertainty* 48, 97–109.

{% Consider correlated ambiguity and uncorrelated ambiguity. Men are more ambiguity averse for correlated, but for women it is the same. %}

Friedl, Andreas, Patrick Ring, & Ulrich Schmidt (2017) "Gender Differences in Ambiguity Aversion under Different Outcome Correlation Structures," *Theory and Decision* 82, 211–219.

{% %}

Friedman, Daniel (1989) "The S-Shaped Value Function as a Constrained Optimum," *American Economic Review* 79, 1243–1248.

{% **three-doors problem**; If subjects are shown many resolutions of the game they learn that switching is better. %}

Friedman, Daniel (1998) "Monty Hall's Three Doors: Construction and Deconstruction of a Choice Anomaly," *American Economic Review* 88, 933–946.

{% The authors consider a variety of risk attitude elicitation tasks. Their six results all amount to a conclusion popular among psychologists: Everything depends on everything. They only consider expected utility. And as common in experimental economics, they do not cite behavioral economists nor the Nobel-awarded prospect theory. (**Prospect theory not cited**) %}

Friedman, Daniel, Sameh Habib, Duncan James, & Brett WilliamS (2022) "Varieties of Risk Preference Elicitation," *Games and Economic Behavior* 133, 58–76.

{% Cite many cases where people prefer coarse categorical statements of probability over precise numerical ones, although this paper analyzes in detail 888,328 forecasts to conclude that it is normatively better to give numerical probabilities. This in itself is not surprising. %}

Friedman, Jeffrey A., Joshua D. Baker, Barbara A. Mellers, Philip E. Tetlock, & Richard Zeckhauser (2018) "The Value of Precision in Probability Assessment: Evidence from a Large-Scale Geopolitical Forecasting Tournament," *International Studies Quarterly* 62, 410–422. https://doi.org/10.1093/isq/sqx078

{% %}

Friedman, Milton (1935) "Professor Pigou's Method for Measuring Elasticities of Demand from Budgetary Data," *Quarterly Journal of Economics* 49, 151–163.

{% Doesn't care if model is incorrect, as long as it gives the right predictions. A famous reference for this view. %}

Friedman, Milton (1953) "*Methodology of Positive Economics*." University of Chicago Press, Chicago.

{% A reaction to Robertson (1954).

risky utility u = transform of strength of preference v, latter doesn't exist.

P. 406, middle:

"It is not at all clear to me what the outside source of information about marginal utility is,"

P. 406, last para: "a concept used in the interpretation of observable phenomena has no meaning independently of the operations specified for measuring it."

P. 409:

"Science is science and ethics is ethics; it takes both to make a whole man;" %}

Friedman, Milton (1955) "What All Is Utility?," *Economic Journal* 65, 405–409.

{% A classic paper because it is about the first to try to use utility in the expected utility model seriously, to capture nontrivial phenomena beyond risk aversion.

They posit utility function that has convex regions, so that EU can explain the co-existence of gambling and insurance.

Markowitz (1952) discussed that their utility curve makes many wrong empirical predictions. F&S themselves also pointed out such predictions, not yet knowing they are wrong but saying they are things to be tested. See the comments on their pages 282/301 below.

The authors argue that the common thinking has been that marginal riskless utility is meaningful, that it is diminishing, and that the expectation of this utility is to be maximized under risk (EU), which implies universal risk aversion. They argue that this reasoning is incorrect because, first, marginal riskless utility is not meaningful anyhow and, second, if it were, it need not be vNM utility. Therefore, their partly convex vNM utility does not violate the intuition of diminishing riskless marginal utility.

P. 282 says about their conjectured utility function that it has predictions beyond the phenomena considered and then, very appropriately, "Further empirical work should make it possible to determine whether or not these implications conform to reality."

P. 282 seems to write (**coherentism**)

"asserts that individuals behave as if they calculated and compared expected utility and as if they knew the odds ... the validity of this assertion does not depend on whether individuals know the precise odds, much less on whether they say that they calculate and compare expected utilities or think that they do, or whether psychologists can uncover any evidence that they do, but solely on whether it yields sufficiently accurate predictions about the class of decisions with which the hypothesis deals"

P. 301 indicates, correctly, that their curve predicts risk seeking for small gambles at specific levels of wealth. That this does not hold has later been taken as empirical refutation of their utility function. So, F&S themselves very correctly pointed out a critical test of their theory.

P. 283 cites Vickrey who identifies marginal utility with vNM utility in a critical manner.

P. 298 gives nice description of EU as an as-if model.

!not! **risky utility u = strength of preference v (or other riskless cardinal utility, often called value)** because they assume that riskless utility is only ordinal and not cardinal; the famous paper; one of the early papers to state that risk aversion iff u concave, referring to Marshall for it. %}

Friedman, Milton & Leonard J. Savage (1948) "The Utility Analysis of Choices Involving Risk," *Journal of Political Economy* 56, 279–304.

{% A verbose discussion of Baumol's (1951) reaction, and a correction of a mathematical mistake in the EU derivation in their 1948 paper (I think that they only used betweenness and not full-force vNM independence there).

This paper seems to have been the first to formulate the sure-thing principle. About it, p. 468:

"practically unique among maxims for wise action in the face of uncertainty, in the strength of its intuitive appeal. The principle is universally known and recognized; and the Greeks must surely have had a name for it, though current English seems not to." At a young age I was puzzled by this claim, until Peter Fishburn pointed out to me that they wrote this tongue-in-cheek.

P. 473 seems to write:

"The failure of these experiments [i.e. those aimed at making riskless utility cardinally measurable] should be interpreted neither as a consequence of the nonmeasurability of utility in some absolute sense nor as showing that utility is not measurable. . . . It may be that future experiments along the same general lines will be more successful." %}

Friedman, Milton & Leonard J. Savage (1952) "The Expected Utility Hypothesis and the Measurability of Utility," *Journal of Political Economy* 60, 463–474.

{% **utility elicitation**?; **decreasing ARA/increasing RRA**: Seem to criticize, on p. 901, Arrow's conjecture of increasing RRA. Seem to estimate, based upon portfolio holdings of individuals, that the index of RRA is about 2, so, power −1. %}

Friend, Irwin & Marshall E. Blume (1975) "The Demand for Risky Assets," *American Economic Review* 65, 900–922.

{% **anonymity protection** %}
Frigg, Roman (2004) "In What Sense is the Kolmogorov-Sinai Entropy a Measure for Chaotic Behaviour? - Bridging the Gap between Dynamical Systems Theory and Communication Theory," *British Journal for the Philosophy of Science* 55, 411–434.

{% Seem to find competence effect. %}
Frijns, Bart, Esther Koellen, & Thorsten Lehnert (2008) "On the Determinants of Portfolio Choice," *Journal of Economic Behavior and Organization* 66, 373–386. https://doi.org/10.1016/j.jebo.2006.04.004

{% **suspicion under ambiguity**: P. 153 seems to say that people need ambiguity aversion because that's rational in game situations. People transfer a heuristic that is helpful in many natural situations --- to other situations in which their fears are unfounded. Sometimes called the hostile nature hypothesis (Curley, Yates, & Abrams 1986).

Seem to have been first to conjecture that ambiguity avoidance is driven by the salience of missing information. %}
Frisch, Deborah & Jonathan Baron (1988) "Ambiguity and Rationality," *Journal of Behavioral Decision Making* 1, 149–157.

{% P. 47: SEU as an as if model versus SEU as a process model. %}
Frisch, Deborah & Robert T. Clemen (1994) "Beyond Expected Utility: Rethinking Behavioral Decision Research," *Psychological Bulletin* 116, 46–54.

{% **strength-of-preference representation**; May have been first, together with Pareto, to define strength of preference. Used econometric techniques to measure marginal utility, well, elasticity of marginal utility of income. May also have been the first to use an axiomatization for utility. %}
Frisch, Ragnar (1926) "Sur un Problème d'Economie Pure," *Norsk Matematisk Forenings Skrifter Serie 1* 16, 1–40. Translated into English by John S. Chipman,

“On a Problem in Pure Economics.” *In* John S. Chipman, Leonid Hurwicz, Marcel K. Richter, & Hugo F. Sonnenschein (1971, eds.) *Preferences, Utility, and Demand*, Ch. 19, Hartcourt, New York.

{% Obtains cardinal utility by imposing additive decomposability. %}
Frisch, Ragnar (1932) “New Methods of Measuring Marginal Utility,” *Beiträge zur Ökonomischen Theorie* 3 (Tübingen 1932); Henri Schultz, *The Theory and Measurement of Demand*, pp. 111–117.

{% %}
Frisch, Ragnar (1937) “General Choice-Field Theory.” *In Report of Third Annual Research Conference on Economics and Statistics,* Cowles Commision for Research in Economics, 64–69.

{% Law invariance means decision under risk (acts are completely determined by their generated probability distribution over outcomes). They take the representing functional as primitive, as this is common in the theory of risk measures, and derive some results for convexity. %}
Frittel, Marco & Emanuela Rosazza Gianin (2005) “Law Invariance Convex Risk Measures,” *Advances in Mathematical Economics* 7, 33–46.

{% **risky utility u = strength of preference v (or other riskless cardinal utility, often called value)**.: Seems to open with: “In this paper, preferences or utilities refer to levels of subjective satisfaction, distress, or desirability that people associate with a particular health state.” %}
Frohberg, Debra G. & Robert L. Kane (1989) “Methodology for Measuring Health State Preferences,” *Journal of Clininal Epidemiology* 42, 345–354, 459–471, 585–592, 675–685.

{% **Conservation of influence**: Below follows a famous poem. One can recognize decision theory principles. The choice of the less trodden road can be taken as a plea for ambiguity seeking (☺: why not?). The one taken having the better claim but still being essentially equivalent in every respect can be taken as lexicographic preference. The justification of the choice in retrospect (if the last

line can be interpreted this way, which is debatable) can be taken as cognitive dissonance. The last sentence can also be taken as definition of influence (**conservation of influence**), with “all the difference” taken as identifying the agent with his actions. Nice is that “sigh” and “all the difference” can equally well be positive as negative. The title refers to the essential role of counterfactuals in analyzing preferences, decisions, and free will, which distinguishes social sciences from natural sciences.

The Road Not Taken

TWO roads diverged in a yellow wood
And sorry I could not travel both
And be one traveler, long I stood
And looked down one as far as I could
To where it bent in the undergrowth;

Then took the other, as just as fair
And having perhaps the better claim
Because it was grassy and wanted wear
Though as for that the passing there
Had worn them really about the same;

And both that morning equally lay
In leaves no step had trodden black.
Oh, I kept the first for another day!
Yet knowing how way leads on to way
I doubted if I should ever come back.

I shall be telling this with a sigh
Somewhere ages and ages hence:
Two roads diverged in a wood, and I—
I took the one less traveled by
And that has made all the difference. %}

Robert Frost (1920) “The Road Not Taken”

{% The more risk dependence, the higher in the convex ordering. Probably something like second-order risk aversion. Mrl (mean residual life) ordering seems to generalize it. Refer to Dhaene & Goovaerts and others. %}

Frostig, Esther (2006) "On Risk Dependence and Mrl Ordering," *Statistics and Probability Letters* 76, 231–243.

{% %}

Fryback, Dennis G. (1993) "QALYs, HYEs, and the Loss of Innocence," *Medical Decision Making* 13, 271–272.

{% nice survey of QALY history %}

Fryback, Dennis G. (1999) "The QALY Model: Utilities for Cost-Utility Analysis in Health Care." *In* James C. Shanteau, Barbara A. Mellers, & David A. Schum (eds.) *Decision Science and Technology: Reflections on the Contributions of Ward Edwards*, 331–351, Kluwer, Dordrecht.

{% Is function of percentage of body burnt to what degree. Is MAUT on subsets of product sets. %}

Fryback, Dennis G. & Ralph L. Keeney (1983) "Constructing a Complex Judgmental Model: An Index of Trauma Severity," *Management Science* 29, 869–883.

{% **questionnaire versus choice utility** %}

Fryback, Dennis G., William F. Lawrence, Patricia A. Martin, Ronald Klein, & Barbara E.K. Klein (1997) "Predicting Quality of Well-Being Scores from the SF-36," *Medical Decision Making* 17, 1–9.

{% Subjects choose between sure outcomes and two-outcome lotteries. The authors show that risk attitudes in an experiment depend on the stimuli faced before; i.e., there are carryover effects. For instance, one group received lotteries with big variation in outcomes. The other with small variation. The latter group then is more sensitive to changes in outcomes. Or, one group has received lotteries that are getting better and better during the experiment, and for the other group they are getting worse and worse. Then the former are more risk seeking. Such

dependencies have been found in many papers before, for instance in papers by Neil Stewart who developed a good model (decision-by-sampling model) for it, and the authors cite such literature. Just one early reference: Poulton (1968). This issue is central for good implementations of the random incentive system, where one tries to minimize them. The authors propose a model of bounded rationality where efficient coding can explain things. (**calculation costs incorporated**) The utility shape of prospect theory can be "rationalized" this way.

For every irrational bias in decision attitudes, one can imagine an environment with wrong information for the agent so that the bias best neutralizes the wrong information and therefore is best to do. van den Steen (2004 AER) is a good example. Steiner & Stewart (2016 AER) also tried to do this. Question is to what extent the imagined environment is realistic/interesting. I did not study the environment and coding theory of this paper enough to judge on this. %}

Frydman, Cary & Lawrence J. Jin (2022) "Efficient Coding and Risky Choice," *Quarterly Journal of Economics* 137, 161–213. https://doi.org/10.1093/qje/qjab031

{% Izhakian (2024) wrote a reply.

This paper criticizes Izhakian's (2020 JET) mathematical analysis. It claims that his 2nd order probability distribution cannot serve as an index of ambiguity at least not in the way he claims. The paper crticizes Izhakian's Theorem 1 which connects perceived probabilities and Izhakian's index of ambiguity. The authors provide alternative versions of Izhakian's Theorems 1 and 2. They are more critical of Izhakian's Lemma 3 (separating risk and ambiguity attitudes), for which they see no easy fix. The problem seems to be most serious for continuous distributions (§5.2). It would then invalidate later results in the paper, which all depend on Lemma 3. (In my annotations I already indicated that the ambiguity comparisons require same a-neutral probabilities μ.) The authors point out, p. 2 2nd para, that the index may still work in an ad hoc manner and that it has served empirical work. But they claim that it does not have the properties claimed. In particular, it is not independent of risk attitude. §5.3 proposes an alternative measure which, unlike Izhakian's, is invariant under monotonic transformations, although it does not have several other properties.

The conclusion, p. 18, writes on ambiguity in general, and I agree: "Ambiguity research has been mostly restricted to theoretical work for far too long. Finding ways of taking the theory to the data is a timely and important topic." %}

Fu, Ruonan, Bertrand Melenberg, & Nikolaus Schweizer (2023) "Comment on "A Theoretical Foundation of Ambiguity Measurement [J. Econ. Theory 187 (2020) 105001]," *Journal of Economic Theory* 207, 105573. https://doi.org/10.1016/j.jet.2022.105573

{% Has Hahn's embedding theorem, which says that every linearly ordered Abelian group can be represented as a subgrou[p of $\mathbb{R}^{\Omega}$ endowed with the lexicographic ordering, with Ω linearly ordered. %}

Fuchs, László (1963) "*Partially Ordered Algebraic Systems.*" Pergamon Press, Oxford.

{% %}

Fuchs, Victor R. (1974) "*Who Shall Live? Health, Economics, and Social Choice*." Basic Books, New York.

{% %}

Fuchs, Victor R. & Richard J. Zeckhauser (1987) "Valuing Health—A "Priceless" Commodity," *American Economic Review, Papers and Proceedings* 77, 263–268.

{% **Dutch book; ordered vector space**; gezien in boekenkast van Alain Chateauneuf december 1994 %}

Fuchssteiner, Benno & Wolfgang Lusky (1981) "*Convex Cones.*" Mathematical Studies, 82. North-Holland, Amsterdam.

{% %}

Fudenberg, Drew (2006) "Advancing beyond Advances in Behavioral Economics," *Journal of Economic Literature* 44, 694–711.

{% %}

Fudenberg, Drew & Dorothy Hodges (1997) "Manual for Eonometrica Authors, Revised," *Econometrica* 65, 965–975.

{% **quasi-concave so deliberate randomization**: Axiomatize many probabilistic error models for choices over menus. State space can be subjective. %}

Fudenberg, Drew, Ryota Lijima, & Tomasz Strzalecki (2015) "Stochastic Choice and Revealed Perturbed Utility," *Econometrica* 83, 2371–2409.

{% Superstitions two or more steps off the equilibrium path are more likely to survive. %}

Fudenberg, Drew & David K. Levine (2006) "Superstition and Rational Learning," *American Economic Review* 96, 630–651.

{% %}

Fudenberg, Drew & David K. Levine (2006) "A Dual Self Model of Impulse Control," *American Economic Review* 96, 1449–1476.

{% Use the dual model of their 2006 American Economic Review paper, where for decisions within a day the emotional self plays the biggest role, and cognitive load does so too; with the cost function of self-control convex. Increasing stakes and probability of winning reduces the importance of cognitive load and enhances rational choice, and reduction of paradoxes such as Allais'. This model suggests that in the usual Allais paradox the irrational emotional choosing occurs with the small-probability choices and, hence, that the certainty effect plays less of a role as irrationality. In their model, discount rates ranging 1-7% and relative risk aversion (they assume EU) of 2 fit some existing data sets well. They also predict that violations of stationarity will reduce if the intertemporal choices are risky, which has been confirmed by Keren & Roelofsma (1995) and later papers. This can be taken as a violation of generalized stochastic dominance (**restrictiveness of monotonicity/weak separability**).

In the conclusion the authors argue that their model may be better in explaining a wide range of phenomena across different contexts with a limited number of parameters than, for instance, prospect theory. But they, nicely, also mention problems for their theory. %}

Fudenberg, Drew & David K. Levine (2011) "Risk, Delay, and Convex Self-Control Costs," *American Economic Journal: Microeconomics* 3, 34–68.

{% This short note briefly summarizes a longer working paper. They propose what they call simplicity theory, which can be combined with any other risk theory. What it does is add to the other theory a term C(|support(P)|), i.e., a term depending only on the number of outcomes in the support of the lottery P. (If the absolute values of the outcomes of P are very small then readily violations of stochastic dominance follow.) For that other theory they consider expected utility, 1979 original prospect theory, and the new 1992 prospect theory. Remarkable, simplicity theory joint with new prospect theory does best and with original prospect theory it does worst (p. 422 2nd column). Unfortunately, the paper only cites a few papers that find what they call complexity aversion (dislike of large supports; actually a misnomer), and not the more papers that find complexity seeking, which is the prevailing finding. See Wakker (2023 JBEE §6). %}

Fudenberg, Drew & Indira Puri (2022) "Simplicity and Probability Weighting in Choice under Risk," *AEA Papers and Proceedings* 112, 421–425. https://doi.org/10.1257/pandp.20221091

{% Preferences not only over present menus but also for how they affect future menus (**conservation of influence**: this is a bit about future influence). %}

Fudenberg, Drew & Tomasz Strzalecki (2015) "Dynamic Logit with Choice Aversion," *Econometrica* 83, 651–691.

{% %}

Fudenberg, Drew & Jean Tirole (1985) "Preemption and Rent Equalization in the Adoption of New Technology," *Review of Economic Studies* 52, 383–401.

{% **strength-of-preference representation** %}

Fuhrken, Gebhard & Marcel K. Richter (1988) "Algebra and Topology in Cardinal Utility Theory." *In* Wolfgang Eichhorn (ed.) "*Measurement in Economics* (Theory and Applications of Economic Indices)," 239–252, Physica-Verlag, Heidelberg.

{% **cancellation axioms**: Do additive representations like Debreu (1960) but impose all cancellation axioms. This is of course not at all general in a mathematical sense. The nice thing is that it makes continuity purely technical. That is, under additive representation with all cancellation axioms states continuity becomes only technical in the sense of adding no empirical content to the other axioms.

P. 94, on continuity in Debreu (1960): "Thus his Theorem 1 lacks a clear separation of proper and [A]rchimedean axioms." **criticizing the dangerous role of technical axioms such as continuity** %}

Fuhrken, Gebhard & Marcel K. Richter (1991) "Additive Utility," *Economic Theory* 1, 83–105.

{% %}

Fuhrken, Gebhard & Marcel K. Richter (1991) "Polynomial Utility," *Economic Theory* 1, 231–249.

{% %}

Fuhrken, Gebhard & Marcel K. Richter (1987) "Additive Measurement Theory," Department of Economics, University of Minnesota.

{% **tradeoff method**:

Bleichrod, Cillo, & Diecidue (2010) showed a way to quantitatively measure regret theory which, given its intransitivity, is not easy to conceive. This paper extends their technique to multiattribute. It considers the following evaluation, for a state space S, the outcome space an n-fold product space, acts f mapping S to outcomes, and $f_i(s)$ the ith attribute of outcome f(s) $(1 \le i \le n)$:

$$f \succcurlyeq g \iff \int_S \varphi\Big(\sum_{j=1}^{n} \tau_i\big[v_i(f_i(s)) - v_i(g_i(s))\big]\Big)dp(s) \ \ge\ 0$$

Here v_i is the attribute-dependent utility of the ith attribute $f_i(s)$ of outcome f(s), $\tau_i[v_i(f_i(s)) - v_i(g_i(s))]$ is the regret of getting $f_i(s)$ instead of $g_i(s)$, there is an additive and separable summation over the attributes, and then, finally, a sort of EU-type probability-weighted average of φ-transformed regret is taken. The authors axiomatize the model, using preceding axiomatizations of regret-type models by Fishburn, Sugden, and Nakamura. Karl Vind also gave related axiomatizations, but his work is not used. The authors show how the functions

can be measured empirically in a deliberately small experiment only to illustrate. They also consider and axiomatize special properties of the functions. Attribute-dependent regret is captured by τ, and holistic regret by φ. %}

Fujii, Yoichiro, Hajime Murakami, Yutaka Nakamura, & Kazuhisa Takemura (2023) "Multiattribute Regret: Theory and Experimental Study," *Theory and Decision* 95, 623–662. https://doi.org/10.1007/s11238-023-09936-w

{% %}

Füllbrunn, Sascha, Holger A. Rau, & Utz Weitzel (2014) "Does Ambiguity Aversion Survive in Experimental Asset Markets?," *Journal of Economic Behavior and Organization* 107, 810–816.

{% Criticizes relevance of neurostudies for economics, as title indicates. %}

Fumagalli, Roberto (2014) "Neural Findings and Economic Models: Why Brains Have Limited Relevance for Economics," *Philosophy of the Social Sciences* 44, 606–629.

{% **questionnaire versus choice utility**: use the nice term "transfer to utility." From the abstract:

Quality of life mapping methods such as "Transfer to Utility" can be used to translate scores on disease-specific measures to utility values, when traditional utility measurement methods (e.g. standard gamble, time trade-off, preference-based multi-attribute instruments) have not been used. The aim of this study was to generate preliminary ordinary least squares (OLS) regression-based algorithms to transform scores from the Strengths and Difficulties Questionnaires (SDQ), a widely used measure of mental health in children and adolescents, to utility values obtained using the preference-based Child Health Utility (CHU9D) instrument. %}

Furber, Gareth, Leonie Segal, Matthew Leach, & Jane Cocks (2014) "Mapping Scores from the Strengths and Difficulties Questionnaire (SDQ) to Preference-Based Utility Values," *Quality of Life Research* 23, 403–411.

{% %}

Furlong William J., David H. Feeny, George W. Torrance, & Ronald D. Barr (2001) “The Health Utilities Index (HUI) System for Assessing Health-Related Quality of Life in Clinical Studies,” *Annals of Medicine* 33, 375–384.

{% %}

Furnham, Adrian & Michael Argyle (1998) “*The Psychology of Money*.” Routledge, London.

{% **natural-language-ambiguity**: Seem to argue that tolerance of ambiguity, in general natural-language sense, as a unitary model has been operationalized using quantitative assessments, but assessing qualitatively multi-dimensional attitudes toward ambiguity is a more realistic and attractive approach. %}

Furnham, Adrian, & Joseph Marks (2013) “Tolerance of Ambiguity: A Review of the Recent Literature,” *Psychology* 4, 717–728.

{% **natural-language-ambiguity**: Seem to argue that tolerance of ambiguity, in general natural-language sense, as a unitary model has been operationalized using quantitative assessments, but assessing qualitatively multi-dimensional attitudes toward ambiguity is a more realistic and attractive approach. %}

Furnham, Adrian, & Ribchester, Tracy (1995) “Tolerance of Ambiguity: A Review of the Concept, Its Measurement and Applications,” *Current Psychology* 14, 179–199.

{% Relative to Baucells & Shapley (2008) and Dubra, Maccheroni, & Ok (2004), they treat strict preferences differently. %}

Galaabaatar, Tsogbadral & Edi Karni (2012) “Expected Multi-Utility Representations,” *Mathematical Social Sciences* 64, 242–246.

{% **completeness criticisms**

Relax completeness in SEU (in the Anscombe-Aumann framework). They require unanimous agreement over sets of pairs {(P,U)} of subjective probability measures and utility functions. They also characterize special cases where the set is a product set of a probability-measure set and a utility-function set, and then

where one or the other is a singleton.

P. 268 derives ≽ from ≻: f ≽ g if h ≻ f ⇒ h ≻ g.

This def. allows separating indifference from noncomparability. %}

Galaabaatar, Tsogbadral & Edi Karni (2013) "Subjective Expected Utility Theory with Incomplete Preferences," *Econometrica* 81, 255–284.

{% %}

Gabaix, Xavier (2012) "Variable Rare Disasters: An Exactly Solved Framework for Ten Puzzles in Macro-Finance," *Quarterly Journal of Economics* 127, 645–700.

{% Measure loss aversion among 600 car manufacturer customers. Both within- and between subjects. With risk and without (endowment effect, WTP-WTA), and find it higher if no risk. They make the plausible assumption of linear utility with kink at 0. Interestingly, they find high correlation (0.677) between risky and riskless loss aversion. A companion paper is Mrkva, Johnson, Gächter, & Herrmann (2020).

cognitive ability related to risk/ambiguity aversion: loss aversion decreases with education. %}

Gächter, Simon, Eric J. Johnson, & Andreas Herrmann (2022) "Individual-Level Loss Aversion in Riskless and Risky Choices," *Theory and Decision* 92, 599–624. https://doi.org/10.1007/s11238-021-09839-8

{% For ESA conference 2006 subscription, for half the subjects they formulated early registration as a discount, and for the other half late registration as a penalty. Among old subjects they found no difference, but among the young they found more early subscriptions in the penalty treatment. Nice illustration of framing with real field data and experimental economists as subjects! Nice paper. %}

Gächter, Simon, Henrik Orzen, Elke Renner, & Chris Starmer (2009) "Are Experimental Economists Prone to Framing Effects? A Natural Field Experiment," *Journal of Economic Behavior and Organization* 70, 443–446.

{% **questionnaire versus choice utility**: Derive CRRA (logpower) utility from introspective well-being using big surveys. Find that ln utility fits well (power 0,

CRRA index 1). Marginal utility of money decreases with increasing health, contrary to what other studies find. %}

Gandelman, Néstor & Rubén Hernández-Murillo (2013) “What Do Happiness and Health Satisfaction Data Tell Us about Relative Risk Aversion?,” *Journal of Economic Psychology* 39, 301–312.

{% **ordering of subsets**: Definition 3 lists properties for set ordering, useful to avoid manipulation in social choice, that are satisfied under average utility and not under additive utility over subsets. %}

Gärdenfors, Peter (1976) “Manipulation of Social Choice Functions,” *Journal of Economic Theory* 13, 217–228.

{% **second-order probabilities to model ambiguity**: In his §6. §5 has probability intervals. There he proposes maxmin EU w.r.t. probability intervals. %}

Gärdenfors, Peter (1979) “Forecasts, Decisions and Uncertain Probabilities,” *Erkenntnis* 14, 159–181.

{% **second-order probabilities to model ambiguity**; **ambiguity seeking for unlikely**: Not really. P. 363, citing (then unpublished) experiments by Goldsmith & Sahlin: “for probabilities other than fairly low ones, lottery tickets involving more reliable probability estimates tend to be preferred.”

P. 366 2nd para explains that set of priors is more general than assigning probability interval to each event.

P. 371: Paper proposes to take a set of 1st order probability distributions, assign a degree of epistemic reliability to each, take only the set of 1st order probability distributions that exceed a threshold, and then do maxmin EU with respect to this set, displayed in the middle of p. 371. So, it essentially has maxmin EU. The paper is a theoretical discussion. %}

Gärdenfors, Peter & Nils-Eric Sahlin (1982) “Unreliable Probabilities, Risk Taking, and Decision Making,” *Synthese* 53, 361–386.

{% **second-order probabilities to model ambiguity**: P. 244 bottom argues that subjects in Yates & Zukowski (1976), being psychology students who must have had some statistical training, will reduce 2nd order distributions to 1st, so that 2nd order distribution was no good way to implement ambiguity there. §5 p. 247 does consider it with the wave effect, which amounts to overweighting of extreme 2nd order probabilities, meaning violation of RCLA. %}

Gärdenfors, Peter & Nils-Eric Sahlin (1983) "Decision Making with Unreliable Probabilities," *British Journal of Mathematical and Statistical Psychology* 36, 240–251.

{% Maybe in US?; **second-order probabilities to model ambiguity** %}

Gärdenfors, Peter & Nils-Eric Sahlin (1987, eds.) "*Decision, Probability, and Utility; Selected Readings.*" Cambridge University Press, Cambridge.

{% **utility elicitation** %}

Gafni, Amiram (1991) "Measuring the Adverse Effects of Unnecessary Hypertension Drug Therapy: QALYs vs HYE," *Clin. Invest. Med.* 14, 266–270.

{% **utility elicitation** %}

Gafni, Amiram (1991) "Willingness-to-Pay as a Measure of Benefits," *Medical Care* 29, 1246–1252.

{% **utility elicitation** %}

Gafni, Amiram (1989) "The Quality of QALYs (Quality-Adjusted Life-Years): Do QALYs Measure What They at Least Intend to Measure?," *Health Policy* 13, 81–83.

{% **utility elicitation** %}

Gafni, Amiram & Stephen Birch (1991) "Equity Considerations in Utility-Based Measures of Health Outcomes in Economic Appraisals: An Adjustment Algorithm," *Journal of Health Economics* 10, 329–342.

{% **utility elicitation** %}

Gafni, Amiram & Stephen Birch (1997) "QALYs and HYEs; Spotting the Differences," *Journal of Health Economics* 16, 601–608.

{% **utility elicitation** %}

Gafni, Amiram, Stephen Birch, & Abraham Mehrez (1993) “Economics, Health and Health Economics: HYEs versus QALYs,” *Journal of Health Economics* 11, 325–339.

{% %}

Gafni, Amiram & Abraham Mehrez (1993) Reply, *Medical Decision Making* 13, 168–169.

{% **utility elicitation**; Take exponential function as utility function, with exponent sum of Gamble Effect parameter, **time preference** effect, and Quantity Effect; They are not aware that this is all empirically indistinguishable. %}

Gafni, Amiram & George W. Torrance (1984) “Risk Attitude and Time Preference in Health,” *Management Science* 30, 440–451.

{% %}

Gafni, Amiram & Carl J. Zylak (1990) “Ionic versus Nonionic Contrast Media: A Burden or a Bargain?,” *Can Med Assoc J* 143, 475–481.

{% %}

Gafni, Amiram & Carl J. Zylak (1991) Reply (to Kalant, “Ionic versus Nonionic Contrast Media: A Burden or a Bargain?”), *Can. Med. Assoc. J.* 144, 123–124.

{% How agents go wrong in environment with learning if they ignore reference dependence. %}

Gagnon-Bartsch, Tristan & Benjamin Bushong (2022) “Learning with Misattribution of Reference Dependence,” *Journal of Economic Theory* 203, 105473.

{% %}

Gahvari, Firouz (1984) “Incidence and Efficiency Aspects of Differential Taxation of Residential and Industrial Capital in a Growing Economy,” *Journal of Public Economics* 25, 211–234.

{% %}

Gahvari, Firouz (1986) "A Note on Additivity and Diminishing Marginal Utility," *Oxford Economic Papers* 38, 185–186.

{% This paper provides basically the same ideas as Gaifman & Liu (2018; cited). Detailed annotations are given there and, therefore, mostly pertain to this paper as well. This 2015 paper also adopts the 2CA assumption, correctly criticizes Savage for not explicitly defining domain, but itself does not do either, by apparently assuming closedness w.r.t. cut-and-paste for instance, but doing so only implicitly and never saying so explicitly. The authors assume probability μ (their symbol), derived from qualitative probability as done by Gaifman & Liu (2018), available. This paper then sets out to derive the EU representation, but does not really do it. As explained in my annotations on §4 of Gaifman & Liu (2015), they only show how utility can be defined from preference if EU holds, which is the easy first step in proving preference axiomatizations, but they do nothing to prove that the definition is consistent or would really represent preference.

There is yet another problem. The paper is confusing on whether utility is state-dependent or not. Its claim to do Savage suggests state independence. Several parts in their text do so too. Below Eq. 2.13 they write (where P refers to an event from a partition) "where $u(P_i,x_i)$ is the utility of consequence x_i given P_i. As it will be shortly shown, in all cases in which $\mu(P_i) > 0$ this value depends only on the consequence x_i." But they do not prove any of what is promised here. Their footnote 6, to the contrary, explicitly states that they take utility state-dependent. Several formulas such as Eq. 2.13 and 2.16 indeed take utility state-dependent. In the title of §2.3, and other places, they use the term context-dependence, which, per footnote 6, refers to state dependence. However, doesn't Savage's P4 preclude state-dependence in the author's model, as it does in Savage's? It can of course happen that some consequences are never associated with some states, but don't they have the same utility for every state where they appear?

With all these holes and gaps in their analysis still open, the proof suddenly closes and the final sentence before Theorem 2.7 comes out of the blue: "The rather straightforward proof is omitted." In particular, their announcement "As it will be shortly shown, … this value depends only on the consequence x_i" (below Eq. 2.13) has never been

taken up. Whether the functional would imply the axioms is never discussed either. I think P4 is not implied. As for that matter, how is it defined here!?

And yet another question: The authors take two arbitrary constant acts, which they seem to treat as state-independent. Couldn't utility of these two be state-dependent, with the probabilities μ and the whole model depending on which two constant acts were used for this purpose!? Wakker & Zank (1999 MOR) study state-dependent EU functionals. For such a functional one can always fix two arbitrary nonindifferent outcomes, scale their utilities as 0 and 1 for every state, and then use them to identify the probability measure. But this probability measure depends entirely on the two outcomes chosen. For nonsimple acts, one then will also need some absolute continuity to ensure that the whole functional is writable as an integral of the probability measure obtained, which in absence of countable additivity is complicated.

§3 considers extensions to infinitely many outcomes. The authors consider countably many outcomes, and countably infinite summations of terms $\mu[f(s) = x_i]u\big(f^{-1}(x_i), x_i\big)$. They apparently are totally unaware of the complications of finite additivity here. One can't just do countable addition under the absence of countable additivity. The authors assume every event $\mu[f(s) = x_i]$ nonnull. It can well happen that the above sum does converge (even absolutely) but the sum of probabilities $\mu[f(s) = x_i]$ is strictly less than 1, for instance. It then gives violations of monotonicity. %}

Gaifman, Haim & Yang Liu (2015) "Context-Dependent Utilities: A Solution to the Problem of Constant Acts in Savage." *In* Wiebe van der Hoek, Wesley H. Holliday, & Wen-Fang Wang (eds.) *Proceedings of the Fifth International Workshop on Logic, Rationality, and Interaction*, vol. LNCS 9394, 90–101, Springer, Berlin.

{% This paper provides basically the same ideas as Gaifman & Liu (2015; cited).

The authors, correctly, point out that Savage (1954) is vague on what the set of acts in the preference domain is. Fishburn (1970) puts it right by immediately writing "F is the set of all functions of S into X" (§14.1, p. 192), and this is how we should take Savage's theorem. Yet, I disagree with many details in this paper, and also with the main ideas and results. In particular, I think that this paper is also

guilty of not clearly stating its assumed domain.

P. 4208 writes: "Savage insists however that we should not require the subjective probability to be σ-additive." It is only a matter of subjective interpretation of nuance, but I think that Savage rather insists that we should not care, and should not commit one way or the other. He is more saying that it should not matter rather than that we should do one thing or the other. But my interpretation here is open to debate.

The paper in particular criticizes Savage for assuming all constant acts present (implying that every consequence can be assigned to every state). It cites many who criticized Savage for the same reason. I have always been surprised by this. Savage's model involves many unrealistic acts, and the constant ones are just one special case. Well, they are a clearcut case, that is true.

The authors assume only for two nonequivalent consequences that the constant acts are available. This assumption is denoted 2CA on p. 4210. This is enough to do qualitative probability theory and get the subjective probability measure μ as is well known. CA denotes the assumption that every constant act is available in the preference domain.

P. 4209: Proposition 1.1, is claimed to hold under P1-P6 and CA. However, it needs more, such as the presence of sufficiently many simple acts. It seems that the authors throughout implicitly assume that the preference domain is closed under their cut-and-paste operation defined on p. 4211. That would be enough in the presence of CA to generate all simple acts.

P. 4210, footnote 10: The definition of null event is problematic because it uses the concept of preference given an event, which has not yet been defined there. But it could have been, in the presence of Savage's P2. The page argues that we should only consider "feasible" consequences, i.e., consequences that for some acts occur under nonnull events: "It is not difficult to see that the name is justified and that unfeasible consequences, while theoretically possible, are merely a pathological curiosity." However, I disagree. For example, in finance one may want to work with continuous probability distributions where each single consequence always has probability 0.

P. 4210, Proposition 1.2 claims SEU for all simple acts under P1-P6 and 2CA. But surely more is needed. The authors will implicitly use closedness under cut-and-paste: for two acts f and g and an event E, the act that agrees with f on E and with g on E^c is the result of cut-and-paste.

P. 4211 writes: "Savage takes it for granted that the acts are closed under cut-and-paste. Although the stipulation is never stated explicitly, it is obviously a property of A." That is, they criticize Savage, but themselves aloso never state explicitly whether or not they assume it. Their Proposition 1.2, preceding the def. of cut-paste, needs closedness under cut-paste to be correct, but it is not stated.

P. 4212 has a mysterious sentence: "The σ-algebra assumption can lead to even more extreme cases in a different area: the foundation of set theory. We will not go into this here, since this would require too long a detour."

P. 4214 incorrectly claims that Savage's state space should be uncountable; it need not be. First the page, correctly, writes that Savage's sigma-algebra must be uncountable, an immediate consequence of its μ-image being the uncountable[0,1]; μ denotes the subjective probability. However, it then incorrectly claims that the state space should be uncountable. We can take for S the rational numbers in [0,1], have μ([a,b] intersection S) = b-a for all rational a,b, and then take any finitely additive extension to the collection of all subsets. Such an extension cannot be countably additive, but finitely additive is well possible. We also have P6 and convex-rangedness (the authors use the term complete instead of convex-rangedness). For instance, for irrational numbers c,d in [0,1], μ((c,d) intersection S) = d-c. Btw., this countable example is easier than the case the authors present in their Theorem 3.34. Fishburn (1970) also incorrectly claims that Savage's S must be uncountable. Being a Ph.D. student end of the 70s, I sent a letter to Fishburn pointing out his mistake. He kindly replied and thanked me, and got it right in his follow-up writings. Strangely enough, the authors write on p.4216 middle that there exist "countable models that satisfy all the required postulates of Savage", where it is unclear what "model" means. The authors then seem to cite a Theorem 3.3.5 of Savage that, however, does not exist.

Section 3, the main part of the paper, considers qualitative probability theory. It shows that with P6´, which is equivalent to fineness and tightness, the derivation of μ, done for Savage for a σ-algebra, can also be done on an algebra. This was demonstrated before by Wakker (1981, Annals of Statistics). Wakker used fineness and tightness but, as these authors point out on p. 4216 bottom, this is equivalent to their P6´. That convex-rangedness then need not be satisfies is also well known (e.g., P_1 in Example 3 of Wakker 1981). These results also follow from Kopylov (2007 JET).

Section 4, supposedly, derives EU for simple acts. But the analysis does almost nothing of it. The authors show how utility can be defined from preferences if EU holds, using what Abdellaoui & Wakker (2018) call conditional SG equivalents. This is common as the first step in deriving preference axiomatizations, and is the easy step. Next steps are to show that the definitions are consistent, not depending on the particular stimuli chosen (e.g., the two constant acts assumed present), and then that the functional is of the kind claimed and does really represent preference. The authors do nothing beyond the first step, but then simply claim that they are done. Or should it be the vague sentence "The proof is straightforward." at the end of §4.1, p. 4236? P. 4210 end of penultimate para writes: "In Sect. 4, we take up the problem of CA. We argue that, as far as realistic decision theory is concerned, we need to assign utilities only to simple acts. Then we indicate the proof of Proposition 1.2. To a large extent this material has been presented in Gaifman and Liu (2015), hence we contend ourselves with a short sketch." It suggests, contrary to fact, that Gaifman and Liu (2015) would provide the proof. As I explain in my annotations to that paper, it does not do so. %}

Gaifman, Haim & Yang Liu (2018) "A Simpler and More Realistic Subjective Decision Theory," *Synthese* 195, 4204–4241.

{% %}

Gaines, Brian R. (1983) "Precise Past, Fuzzy Future," *International Journal of Man-Machine Studies* 19, 117–134.

{% Math. Reviews 86d:03-023; relates probability theory and fuzzy sets. %}

Gaines, Brian R. (1984) "Fundamentals of Decision: Probabilistic, Possibilistic and other Forms of Uncertainty in Decision Analysis," *Fuzzy Sets and Decision Analysis* 47–65, Stud. Management Sci., 20, North-Holland, Amsterdam.

{% SWF is weighted sum of values of all coalitions in society. These use RDU-transformation with linear utility with transformation function the k-th power and all coalitions with more than k members contributing nothing. %}

Gajdos, Thibault (2002) “Measuring Inequalities without Linearity in Envy: Choquet Integrals for Symmetric Capacities,” *Journal of Economic Theory* 106, 190–200.

{% Preferences between (x,C) and (x´,C´) where x and x´ are acts and C, C´ are sets of priors. C and C´ can be different and are exogenously given. Thus, the data set is very rich. The agent evaluates each (x,C) using the maxmin EU model where the set of priors is a subset of C. C reflects state of information and its subset reflects decision attitude. The paper generalizes some preceding papers on similar models by (subsets of) these authors.

Section 4 has a convenient subfamily of multiple priors: To define the subjective family of priors, we start from an objective set of priors denoted P, which is assumed given as it is assumed throughout this paper. s(P) is its midpoint (center of gravity; Steiner point), and $0 \leq \varepsilon \leq 1$ is a subjective parameter reflecting perceived ambiguity. The subjective family of priors to be used then consists of all convex combinations

$(1-\varepsilon)s(P) + \varepsilon Q$ for any Q from P.

This theory can be called contraction EU. A generalization would consist of allowing s(P) to be different than the midpoint of P.

biseparable utility %}

Gajdos, Thibault, Takashi Hayashi, Jean-Marc Tallon, & Jean-Christophe Vergnaud (2008) “Attitude towards Imprecise Information,” *Journal of Economic Theory* 140, 27–65.

{% Do something like α-maxmin but for social choice. Maintain anonymity and conclude that, therefore, anonymity alone does not distinguish Harsany’s welfarism from Rawls. %}

Gajdos, Thibault & Feriel Kandil (2008) “The Ignorant Observer,” *Social Choice and Welfare* 31, 193–232.

{% Model with welfare and uncertainty, so, twofold aggregation. For example, weighted average of ex post and ex ante optimum. The abstract writes: “Our most general result is that a small number of reasonable assumptions regarding welfare orderings under uncertainty rule out pure ex ante as well as pure ex post evaluations. Any social welfare function that satisfies these axioms should lie strictly between the ex ante and the ex post evaluations of income distributions." However, Point 3 in their Theorem 1 gives the strict inequality only for matrices for which it is already assumed that the ex ante and ex post evaluations are different. They then only show that some other axioms imply that the overall evaluation is strictly between. This is nice but not surprising. For instance, utilitarian expected utility evaluation with power utility satisfies all their assumptions, including homogeneity, and only does not satisfy that ex ante and ex post evaluation are different. %}

Gajdos, Thibault & Eric Maurin (2004) "Unequal Uncertainties and Uncertain Inequalities: An Axiomatic Approach," *Journal of Economic Theory* 116, 93–118.

{% If two sets of beliefs have one Pareto optimal two-period allocation in common, and it is interior solution, then the two sets of PO-optimal allocations must actually coincide, because the first-order conditions imply same marginal rates of substitutions across different states.

multiattribute CEU (Choquet expected utility) %}

Gajdos, Thibault & Jean-Marc Tallon (2002) "Beliefs and Pareto Efficient Sets: A Remark," *Journal of Economic Theory* 106, 467–471.

{% Show that allocations may exist that are both ex ante efficient and ex post envy-free. %}

Gajdos, Thibault & Jean-Marc Tallon (2002) "Fairness under Uncertainty," *Economic Bulletin* 4, 1–7.

{% Imagine DUU with three colors, Red, Black, and Yellow. Consider choices with multiple priors between f when set of priors is F, and g when set of priors is G. F and G refer to DIFFERENT unrelated urns. For each urn, there is a rich set of acts, and in addition there are many urns. In addition, each set of priors has a so-called anchor, being the one to be chosen if only one measure can be chosen. %}

Gajdos, Thibault, Jean-Marc Tallon, & Jean-Christophe Vergnaud (2004) "Decision Making with Imprecise Probabilistic Information," *Journal of Mathematical Economics* 40, 647–681.

{% Belief aggregation in Anscombe-Aumann framework and then nonEU at first stage, much like Schmeidler (1989). They consider a state-dependent version of RDU (rank-dependent utility for uncertainty; is Choquet expected utility = CEU) as axiomatized by Chew & Wakker (1996) for instance, but restricted to acts with only two outcomes (outcome is probability distribution over prizes in Anscombe-Aumann). Show that aggregation, if existing, must be linear, and that nonEU models such as RDU and maxmin EU cannot deliver belief aggregation. %}

Gajdos, Thibault, Jean-Marc Tallon, & Jean-Christophe Vergnaud (2008) "Representation and Aggregation of Preferences under Uncertainty," *Journal of Economic Theory* 141, 68–99.

{% Relative to the JME-2004 paper of the same authors, they drop the anchor. %}

Gajdos, Thibault, Jean-Marc Tallon, & Jean-Christophe Vergnaud (2004) "Coping with Imprecise Information: A Decision Theoretic Approach,"

{% The authors consider expert aggregation, comparing disagreement between precise predictions (one says 1/3, and the other says 2/3) with agreement between vague predictions (both say that it is either 1/3 or 2/3). Motivation is on pp. 420-421: "Therefore, the first step for making policy decisions in complex situations (such as, for instance, climate changes) is to *elicit* experts beliefs."

They introduce a theoretical decision model for it, building on ambiguity models of these authors (Gajdos, Hayashi, Tallon, & Vergnaud 2008 JET). Novelties in modeling are described on p. 431. Agents can choose between options that have different informations: For instance, they can choose between [a with experts saying A and B] or [b with experts saying C and D]. This cannot readily be modeled through Savage's state space, but the authors solve this problem by giving up on any interpretation of the state space, and they write: "state space … It is for us a mere coding device, without any substantial existence." (p. 421). The provide results on more averse to imprecision (Proposition 2, p. 437). Because now info provided by two experts is considered, and this can be different for different acts considered, the model is very general.

If one expert says that the true probability is in A, and the other says in B, then one could consider taking the intersection of A and B!?

However, Axiom A2 presented as-if dominance or Pareto, is not intuitive to me,

and seems like a form of not caring about conflict. For example, assume that P1 = Q1 = Q2 consisting of only one single probability, so that (f,P1), (g,Q1), (g,Q2) actually concern risk. Assume that P2 is different and also contains a singleton, so that (f,P2) is also risk. And assume that all four (f,P1), (f,P2), (g,Q1), (g,Q2) are indifferent. The authors' axiom implies

(f,P1,P2) ~ (g,Q1,Q2).

But this is not plausible because (f,P1,P2) comprises conflict and ambiguity and (g,Q1,Q2) does not. The axiom seems to imply indifference toward conflict and ambiguity. It treats P1 and P2 in a way as separable, not considering how they are related and agree or differ. This goes against the interpretations given. %}

Gajdos, Thibault & Jean-Christophe Vergnaud (2013) "Decisions with Conflicting and Imprecise Information," *Social Choice and Welfare* 41, 427–452.

{% multiattribute CEU (Choquet expected utility) %}

Gajdos, Thibault & John A. Weymark (2004) "Multidimensional Generalized Gini Indices," *Economic Theory* 26, 471–496.

{% This paper doesn't do more than briefly claim, based on th review Gal & Rucker (2018), just that there is no loss aversion and then criticizes the behavioral approach for it. %}

Gal, David (2018) "Why the Most Important Idea in Behavioral Decision-Making Is a Fallacy," *Scientific American* 29, 52–54.
https://doi.org/10.1038/scientificamerican mind1118-52

{% Argue against loss aversion, first, by proposing alternative explanations and, second, by citing some studies that do not find it, primarily their own. On the basis of that, they write long about how wrong it is of science to be so wrong. %}

Gal, David & Derek D. Rucker (2018) "The Loss of Loss aversion:Will It Loom Larger than Its Gain?," *Journal of Consumer Psychology* 28, 497–516.
https://doi.org/10.1002/jcpy.1047

{% Apply Choquet integral in multiattribute optimization. %}

Galand, Lucie, Patrice Perny, & Olivier Spanjaard (2010) "Choquet-Based Optimisation in Multiobjective Shortest Path and Spanning Tree Problems," *European Journal of Operational Research* 204, 303–315.

{% **value of information**: Under unawareness, which is a form of mistaken belief, info can have negative value (also under usual EU). But the agent cannot know this. %}

Galanis, Spyros (2015) "The Value of Information under Unawareness," *Journal of Economic Theory* 157, 384–396.

{% Considers consequentialism and dynamic consistency under ambiguity. Says that one of these must be violated under ambiguity deviations from SEU, apparently taking reversal of events (analog of RCLA) implicitly. Relates dynamic consistency to positive value of info. (**value of information**) %}

Galanis, Spyros (2021) "Dynamic Consistency, Valuable Information and Subjective Beliefs," *Economic Theory* 71, 1467–1497. https://doi.org/10.1007/s00199-021-01351-y

{% **utility elicitation**: Asked for direct assessment of utility of money. Found that x to the power 0.43 fitted well for gains. Seems to find that subjects find it very difficult for losses. %}

Galanter, Eugene (1962) "The Direct Measurement of Utility and Subjective Probability," *American Journal of Psychology* 75, 208–220.

{% Seems simple. %}

Galanter, Eugene (1990) "Utility Functions for Nonmonetary Events," *American Journal of Psychology* 103, 449–470.

{% **utility elicitation**, p. 65: "But all of the data are sketchy, and the field is more populated with theory and derivations of a variety of models than it is with a wealth of empirical information"

P. 75: "The remarkable consistency of the power function as a representation of data that show how people judge events that have a quantitative character is once again supported in these studies."

P. 75 suggests loss aversion using nice words: "On the basis of intuition and

anecdote, one would expect the negative limb of the utility function to decrease more sharply than the positive limb increases."

concave utility for gains, convex utility for losses: Power for gains is 0.45 (Experiment 1, p. 68), for losses it is 0.59 (Experiment 2, p. 70). So, utility is concave for gains and (less) convex for losses.

Cross-modality matching means comparing subjective evaluations of different continua with each other. This paper does it with money and loudness. For example, is the value of this amount of money the same as the loudness of this tone? Power transformations seem to fit the data well. The method can be compared to the VAS that asks to relate lengths of lines to value of money/lifeduration, be it that length of a line is objective.

More pessimistically, it can be argued that this kind of research demonstrates that subjects answer to all questions no matter what the questions are. One may be measuring stable response modes without anything underlying it. I haven't yet made up my mind on the validity of this viewpoint.

Christiane, Veronika & I: cross-modality matching seems to measure numerical sensitivity more than intrinsic value. %}

Galanter, Eugene & Patricia Pliner (1974) "Cross-Modality Matching of Money against Other Continua." *In* Herbert Moskowitz, Bertram Sharf, & Joseph C. Stevens (eds.) *Sensation and Measurement: Papers in Honor of S.S. Stevens*, 65–76, Reidel, Dordrecht.

{% **foundations of probability** %}

Galavotti, Maria Carla (2005) "*Philosophical Introduction to Probability*." University of Chicago Press, Chicago.

{% **foundations of probability** %}

Galavotti, Maria Carla (2014) "Probability Theories and Organization Science: The Nature and Usefulness of Different Ways of Treating Uncertainty," *Journal of Management* 41, 744–760.
http://dx.doi.org/10.1177/0149206314532951

Galaxy NGC 3783.

{% **revealed preference** %}
Gale, David (1960) "A Note on Revealed Preference," *Economica*, N.S. 27, 348–354.

{% **cancellation axioms**: seems to show that solving linear inequalities as relevant to additive conjoint measurement is equivalent to solving an integer optimization problem. %}
Gale, David (1960) "*The Theory of Linear Economic Models.*" McGraw-Hill, New York.

{% Shows existence of policies optimal w.r.t. overtaking criterion in certain context. %}
Gale, David (1967) "An Optimal Development in a Multi-Sector Economy," *Review of Economic Studies* 34, 1–18.

{% Social sensing means you don't ask a subject about herself (say opinion about capital punishment) but how it is with a social circle around her (e.g., "your 10 best friends"). This has several pros, such as better privacy, and is at the basis of Prelec's (2004) truth serum. Cons can be that the social circle can introduce extra variance. This "Perspective" paper mentions many applications and propagates it, sometimes overselling, e.g., the para on pp. 216-217, too much suggesting that social sensing is the solution to all social science biases. %}
Galesic, Mirta, Wändi Bruine de Bruin, Jonas Dalege, Scott L. Feld, Frauke Kreuter, Henrik Olsson, Drazen Prelec, Daniel L. Stein, & Tamara van der Does (2022) "Human Social Sensing is an Untapped Resource for Computational Social Science," *Nature* 595, 214–222.
https://doi.org/10.1038/s41586-021-03649-2

{% This paper generalizes Yaari's (1987) dual theory to multidimensional distributions, using generalized quantile functions, also extending Yaari (1986). %}
Galichon, Alfred & Marc Henry (2012) "Dual Theory of Choice with Multivariate Risks," *Journal of Economic Theory* 147, 1501–1516.

{% Primary/secondary quality distinction:

"I think that tastes, odors, colors, and so on are no more than mere names so far as the object in which we locate them are concerned, and that they reside in consciousness. Hence if the living creature were removed, all these qualities would be wiped away and annihilated."

John Locke discussed it extensively. Leibniz argued that it is gradual. Berkeley argued that only secondary (subjective) we can know for sure. %}

Galilei, Galileo (1623) *The Assayer*.

{% Seems that the character Sagredo says, on the water-diamond paradox:

What greater stupidity can be imagined than that of calling jewels, silver and gold "precious," and earth and soil "base"? People who do this ought to remember that if there were as great a scarcity of soil as jewels or precious metals, there would not be a prince who would not spend a bushel of diamonds and rubies and a cartload of gold just to have enough earth to plant a jasmine in a little pot, or to sow an orange seed and watch it sprout, grow, and produce its handsome leaves, its fragrant flowers and fine fruit. It is scarcity and plenty that make the vulgar take things to be precious or worthless; they call a diamond very beautiful because it is like pure water, and then would not exchange one for ten barrels of water.

This is apparently in Dava Sobel (1999) "*Galileo's Daughter: A Historical Memoir of Science, Faith, and Love.*" Fourth Estate, London, p. 152. %}

Galilei, Galileo (1638) Dialogues.

{% %}

Galizzi, Matteo M. & Daniel Navarro-Martínez (2019) "On the External Validity of Social Preference Games: A Systematic Lab-Field Study," *Management Science* 65, 976–1002.

{% %}

Gallant, A. Ronald, Mohammad R. Jahan-Parvar, & Hening Liu (2019) "Does Smooth Ambiguity Matter for Asset Pricing?," *Review of Financial Studies* 32, 3617–3666.

{% **foundations of probability**: Argues for deterministic interpretation of probability. Discusses to what extent it is epistemic or a "worldly affair." %}
Gallow, J. Dmitri (2021) "A Subjectivist's Guide to Deterministic Chance," *Synthese* 198, 4339–4372. https://doi.org/10.1007/s11229-019-02346-y

{% Use Hofstede's (1991) index of long-term orientation to proxy time preference. Analyze many countries and regions and pre-industrial agro-climatic characteristics. Find that higher return to agricultural investment triggered long-term orientation and impacted technological adoption, education, saving, and smoking. %}
Galor, Oded & Ömer Özak (2016) "The Agricultural Origins of Time Preference," *American Economic Review* 106, 3064–3103.

{% Paper was written in 1907. Crowd should guess weight of an ox. Their average was incredibly close. %}
Galton, F. (1949) "Vox Populi," *Nature* 75, 450–451.

{% %}
Gambetta, Diego (2000) "Can We Trust Trust," *Trust: Making and Breaking Cooperative Relations*, electronic edn., University of Oxford, 213–237.

{% **Christiane, Veronika & I**; no clear results are found. If not only prices but also income are expressed in a low-value unit (high numbers) then sometimes a reversed euro illusion may be expected. This paper finds different effects for cheap than for expensive products. %}
Gamble, Amelie (2006) "Euro Illusion or the Reverse? Effects of Currency and Income on Evaluations of Prices of Consumer Products," *Journal of Economic Psychology* 27, 531–542.

{% **Christiane, Veronika & I** %}
Gamble, Amelie, Tommy Gärling, John P. Charlton, & Rob Ranyard (2002) "Euro Illusion: Psychological insights into Price Evaluations with a Unitary Currency," *European Psychologist* 7, 302–311.

{% **Christiane, Veronika & I** %}

Gamble, Amelie & Tommy Gärling (2003) “Violations of Invariance of Perceived Value of Money,”

{% Good book on proposition-logic, recommended to me by Monika.
Gamut = Johan F.A.K. van Benthem, Jeroen Groenendijk, Dick de Jongh, Martin Stokhof, & Henk Verkuyl %}

Gamut, L.T.F. (1991) *Logic, Language, and Meaning* (Vol. 1. Introduction to Logic, Vol. 2. Intensional Logic and Logical Grammar). The University of Chicago Press, Chicago.

{% Mehrez & Gafni, end 1980s, introduced their so-called healthy years equivalent (HYE) as an alternative to QALYs in health economics. Unfortunately, their papers have many logical errors, and many have criticized it, including Johannesson, Pliskin, & Weinstein (1993, MDM), Loomes (1995, JHE), and myself (Wakker 2008 MDM). This paper is a follow-up, worthy of the traditions, because again it is full of logical errors. The basic new model, Eq, 2 p. 1210, is not well defined because a utility function of (x,x_2) (wiggle above x and arrow above x_2 I do not write here) he lets depend on other things than just (x,x_2), being a distribution $L(u_2(x))$ of x of which it has never been specified formally where it comes from. L should by the rules of logic have been expressed as an argument of the utility function then. But then the theory becomes very different from traditional QALY models that first take utility of outcomes without regarding any distribution and only then look at distribution and see how the utilities are to be aggregated, using a probability-weighted mean as in EU or some other aggregation formula. In particular, it loses the tractability of QALYs where evaluation of outcomes is separated from the aggregation of distribution. It now also is unclear if the utility as the author defines should be maximized using an EU aggregation, or otherwise. The author sometimes (p. 1211 top and also 2nd para) explicitly writes that he is deviating from EU. So, in what theory is this function to be used? There he seems to take his model as just taking certainty equivalents without even EU, so that his model is not much more than continuity and transitivity, leaving almost no predictive power.

Many positive claims about HYE are based on nothing other than that HYE is, here, apparently, taken as nothing other than a certainty equivalent (with health assumed perfect) under general EU. Then little wonder that no empirical violations (other than general EU), but problem that little predictive power (mentioned on p. 1210 4th para but not properly incorporated in the rest of the text). Then little wonder that the particular case of SSUF and HYE coincide whenever the model of SSUF holds (pp. 1209-1210).

P. 1210 makes the mistake criticized in Comment 2.6.5 of my 2010 book (p. 63), of not realizing that the utility unit already comprises risk attitude, and that speculating on risk attitudes w.r.t. util units is double counting.

P. 1211 surprises us with the claim that the risk theory of EU would imply the intertemporal restriction of time consistency. New to me!

The second para seems to present, as a positive feature of the theory, that we don't "need to" elicit its separate parameters. I would put this more negatively: These parameters are not identifiable because the theory is of almost complete generality. P. 1211 end of 2nd-to last para writes that the only assumption is monotonicity in life years in full health. (Let us give the author continuity and weak ordering for free.)

equate risk aversion with concave utility under nonEU: P. 1211 penultimate para then equates risk aversion with concave utility, which only holds true under EU, a theory explicitly abandoned here.

One thing the author and I share is admiration for the appealing idea (SSUF) of Guerrero & Herrero (2005). %}

Gandjour, Afschin (2008) "Incorporating Feelings Related to the Uncertainty about Future Health in Utility Measurement," *Health Economics* 17, 1207–1213.

{% Argues for higher relevance of patient preferences than community preferences in C/E (cost-effectiveness) analyses. Apparently sees a theoretical justification in Harsanyi's 1955 welfare theorem using veil of ignorance. %}

Gandjour, Afschin (2010) "Theoretical Foundation of Patient v. Population Preferences in Calculating QALYs," *Medical Decision Making* 30, E57–E63.

{% %}

Gandjour, Afschin & Amiram Gafni (2010) "The Additive Utility Assumption of the QALY Model Revisited," *Journal of Health Economics* 29, 325–328.

{% **probability elicitation**: experiment to compare different methods of measuring beliefs, incentivized and not. %}

Gangadharan, Lata, Philip J. Grossman, & Nina Xue (2024) "Belief Elicitation under Competing Motivations: Does it Matter how You Ask?," *European Economic Review* 169, 104830.

https://doi.org/10.1016/j.euroecorev.2024.104830

{% **information aversion**: tested in several contexts. %}

Ganguly, Ananda & Joshua Tasoff (2017) "Fantasy and Dread: The Demand for Information and the Consumption Utility of the Future," *Management Science* 63, 4037–4060.

{% Points out that Keeler-Cretin argument for constant discounting of money and health requires fungibility between money and health with constant exchange rate between them. %}

Ganiats, Theodore G. (1994) "Discounting in Cost-Effectiveness Research," *Medical Decision Making* 14, 298–300.

{% Configurality is very similar to rank-dependence; disjunctive is similar to optimism, overweighting of high values; conjunctive is similar to pessimism, overweighting of low values. For judgment of intervention for cases of child abuse, based on aggregation of some pieces of information, laypersons were more disjunctive than experts. %}

Ganzach, Yoah (1994) "Theory and Configurality in Expert and Layperson Judgment," *Journal of Applied Probability* 79, 439–448.

{% P. 170: Normative regressions should be regressive for most bivariate distributions. Representativeness heuristic leads people to give overly extreme answers, so that variation in dependent variable resembles true variation and variation in predictor. These things are moderated by weak regressiveness.

Leniency is like the positivity bias from social research, where under uncertainty people tend to judge overly positive about others (“the benefit of the doubt”). %}

Ganzach, Yoah & David H. Krantz (1991) “The Psychology of Moderate Prediction II. Leniency and Uncertainty,” *Organizational Behavior and Human Decision Processes* 48, 169–192.

{% Intro to the special issue on Liu’s uncertainty theory. %}

Gao, Jinwu, Jin Peng, & Baoding Liu (2013) “Uncertainty Theory with Applications,” *Fuzzy Optimization and Decision Making* 12, 1–2.

{% (**natural sources of ambiguity; ambiguity seeking for unlikely**; **cognitive ability related to likelihood insensitivity (= inverse S)**

The authors measured the ambiguity indexes of Baillon et al. (2018), capturing aversion and insensitivity. They did it online with physicians and the general public. They did it on covid uncertainty, in 2020, when the disease was new and ambiguous. They also do it for financial uncertainties. Physicians have a bit of ambiguity version, but much insensitivity. They are much less insensitive for financial risks than the general public, but similarly for covid, remarkably. Ambiguity neutrality and expected utility are extensively violated, also by the professional physicians. %}

Gao, Yu, Zhenxing Huang, Ning Liu, & Jia Yang (2024) “Are Physicians Rational under Ambiguity?,” *Journal of Risk and Uncertainty* 68, 183–203. https://doi.org/10.1007/s11166-023-09425-z

{% **Prospect theory not cited**: p. 166 qualifies Holt & Laury (2002) as the most influential paper using choice lists to measure risk attitudes, even though Tversky & Kahneman (1992) has been cited almost three times more at this moment of writing (2023).

N = 403 and then N = 400 subjects through Prolific, from general population. The author considers predictive power and comprehension of choice lists (HL), a single choice from six lotteries (EG), and investment (INV). Choice lists and investment do equally well, though hardly better than expected value, and EG worse. They also considered budget choices, but they were too difficult to understand. %}

Garagnani, Michele (2023) "The Predictive Power of Risk Elicitation Tasks," *Journal of Risk and Uncertainty* 67, 165–192. https://doi.org/10.1007/s11166-023-09408-0

{% Let subjects choose from three risky prospects, so that their choice shows their risk tolerance à la Binswanger (1981). Show that people with a higher ratio of the length of their second and fourth finger take more risks. %}

Garbarino, Ellen, Robert Slonim, & Justin Sydnor (2011) "Digit Ratios (2D:4D) as Predictors of Risky Decision Making for Both Sexes," *Journal of Risk and Uncertainty* 42, 1–26.

{% Tradeoffs involving small-probability health hazards are difficult to make for subjects because small probabilities are hard to process as is well known. This paper proposes to translate those tradeoffs into a threshoods of mortality. %}

Garcia-Hernandez, Alberto (2014) "Quality-of-Life—Adjusted Hazard of Death: A Formulation of the Quality-Adjusted Life-Years Model of Use in Benefit- Risk Assessment," *Value in Health* 17, 275–279.

{% Empirical study into centipede games. By varying parameters, they can speculate on reasons for people to deviate from NE (Nash equilibrium). The two main reasons found are failure of common knowledge of rationality and bounded level-k reasonings that can be captured by quantum response equilibrium (QRE). My reason for deviating if I'd play the centipede game is not mentioned: that the basic assumptions of game theory are inconsistent (rationality of players but yet independent moving) and NE is not rational. %}

García-Pola, Bernardo, Nagore Iriberri, & Jaromír Kovářík (2020) "Non-Equilibrium Play in Centipede Games," *Games and Economic Behavior* 120, 391–433.

{% Seems to be: **Decision under stress**; Ch. 9 deals with risks, catastrophes and "protection-motivation theory," comparing external threats and internal coping. %}

Gardner, Gerald T. & Paul C. Stern (1996) "*Environmental Problems and Human Behavior.*" Allyn and Bacon, Boston.

{% Gives an account of the cognitive revolution. %}
Gardner, Howard (1985) "*The Mind's New Science: A History of the Cognitive Revolution*." Basic Books, new York.

{% **three-doors problem** %}
Gardner, Martin (1961) "*Second Scientific American Book of Mathematical Puzzles and Diversions*." Simon and Schuster, New York NY.

{% %}
Gardner, Martin (1973) "Free Will Revisited, with a Mind-Bending Prediction Paradox by William Newcomb," *Scientific American* 229, No. 1 (July), 104–108.

{% 652 readers of Scientific American wrote their choices; 70% would take only one box. %}
Gardner, Martin (1974) "Reflections on Newcomb's Problem: A Prediction and Free-Will Dilemma," *Scientific American* 230, No. 3 (March), 102–109.

{% Discusses the Penney game (Penney 1969). %}
Gardner, Martin (1974) "Mathematical Games," *Scientific American* 230, March 1974, 108–113.

{% This seems to be part of a serious called "Mathematical Games" by Gardner.
P. 120 2nd column gives "juicy" reference to Samuelson who relates Arrow's theorem to democracy. John Conway found a simple formula for calculating the probability that player A wins. This formula is described by Gardner. %}
Gardner, Martin (1974) "On the Paradoxical Situations that Arise from Nontransitive Relations," *Scientific American* 123 no. 4 (Oct.), 120–125.

{% **foundations of statistics** %}
Gardner, Martin J. & David G. Altman (1986) "Confidence Intervals rather than P Values: Estimation rather than Hypothesis Testing," *Br. Med. J. (Clin. Res. ed.)* 292, 746–750.

{% **finite additivity** %}

Gardner, Roy J. (1981) "The Regularity of Borel Measures." *In* Dietrich Kölzow & Dorothy Maharam-Stone (eds.) *Proceedings of Measure Theory*, Oberwolfach, Lecture notes 945, Springer, Berlin.

{% %}

Garey, Michael R. & David S. Johnson (1979) "*Computers and Intractability: A Guide to the Theory of NP-Completeness*." Freeman, San Francisco.

{% **anonymity protection** %}

Garfinkel, Robert, Ram Gopal, & Paulo Goes (2002) "Privacy Protection of Binary Confidential Data against Deterministic, Stochastic, and Insider Threat," *Management Science* 48, 749–764.

{% Use maxmin EU through a "confidence interval" around the estimated expected returns and then ambiguity aversion via minimization over priors. Ambiguity-averse portfolios are more stable over time and deliver a higher out-of sample Sharpe ratio. %}

Garlappi, Lorenzo, Raman Uppal, & Tan Wang (2007) "Portfolio Selection with Parameter and Model Uncertainty: A Multi-Prior Approach," *Review of Financial Studies* 20, 41–81.
https://doi.org/10.1093/rfs/hhl003

{% A 2011 study on this interesting decision problem. %}

Garrouste, Clémentine, Jérôme Le, & Eric Maurin (2011) "The Choice of Detecting Down Syndrome: Does Money Matter?," *Health Economics* 20, 1073–1089.

{% **probability elicitation**; Compares eliciting all j/4 quantiles to another similar procedure and sees which performs best. %}

Garthwaite, Paul H. & James M. Dickey (1985) "Double- and Single-Bisection Methods for Subjective Probability Assessments in a Location-Scale Family, *Journal of Econometrics* 29, 149–163.

{% **survey on belief measurement**. %}

Garthwaite, Paul H., Joseph B. Kadane, & Anthony O'Hagan (2005) "Statistical Methods for Eliciting Probability Distributions," *Journal of the American Statistical Association* 100, 680–701.

{% **real incentives/hypothetical choice, for time preferences**: finds annual discount rate exceeding 26% at purchases of individual refrigerators. %}

Gately, Dermot (1980) "Individual Discount Rates and the Purchase and Utilization of Energy-Using Durables: Comment," *Bell Journal of Economics* 11, 373–374.

{% P. 330: **relative curvature** %}

Gati, Itamar & Amos Tversky (1982) "Representations of Qualitative and Quantitative Dimensions," *Journal of Experimental Psychology: Human Perception and Performance* 8, 325–340.

{% %}

Gattig, Alexander (2002) "Intertemporal Decision Making," Ph.D. dissertation, ICS, Groningen, the Netherlands.

{% Made pictures of RDU on p. 9 %}

Gayant, Jean-Pascal (1991) "Un Diagramme Représentatif de l'Utilité "Anticipée" ," W.P. 9109, June 1991, Center of Mathematics, Economics, and Computer Science, University of Paris I, Paris, France.

{% Made nice pictures of RDU; p. 1056: estimate of w(.5) for 20 subjects, yielding w(.5) = .42 (hurray!); however, the estimation is based on some linearity assumptions

P. 1054 writes (translated from French original):

"the dissociation of the two effects is difficult because they interact jointly without it being possible to isolate one from the other" It then assumes, and will later verify, linear utility to estimate transformation of p = .5. Well, by the **tradeoff method** it is easy!

P. 1056: subjects do not distinguish between close probabilities, which reminds a bit of low sensitivity à la Tversky & I. %}

Gayant, Jean-Pascal (1995) "Généralisation de l'Espérance d'utilité en univers risqué: Représentation en Estimation," *Revue Economique* 46, 1047–1061.

{% **CBDT**; **inverse S; cognitive ability related to likelihood insensitivity (= inverse S)**: Develops a case-based, cognitive, justification for inverse S-shaped probability transformation. Has probability 0.5 undistorted, as Quiggin (1982). It also supports my claim in Wakker (2004, Psychological Review, Figure 2a) that that is plausible for the cognitive component of probability transformation.

uncertainty amplifies risk: Confirms it. The fewer cases in memory and the worse the similarity function, the more inverse S. %}

Gayer, Gabrielle (2010) "Perception of Probabilities in Situations of Risk; A Case Based Approach," *Games and Economic Behavior* 68, 130–143. https://doi.org/10.1016/j.geb.2009.05.002

{% **CBDT**; Consider prices for houses for rent, where speculation will play no role, and for sale, where speculation will play a role. Compare two ways to determine the price of a house: (1) Rule-based. Regress it on a number of properties such as size, distance to shopping center, and so on. (2) Case-based. Derive the price as a similarity-weighted mean of prices of other, similar, houses. Here the properties of houses are similarity-weighted averages of the other prices, where the similarity weight of two houses is derived by transforming a dimension-weighted Euclidean distance between houses when characterized through a vector or properties (I guess the same as above). They don't sum the similarity-weighted prices but average them. They find that for buying prices the rule-based method works best and for renting the case-based, and give arguments for it. %}

Gayer, Gabrielle, Itzhak Gilboa, & Offer Lieberman (2007) "Rule-Based and Case-Based Reasoning in Housing Prices," *B.E. Journal of Theoretical Economics* 7, Iss. 1 Article 10.

{% Seems to give the following example. Patient had left and right hemisphere separated. Right hemisphere was told to wave hand. Left hemisphere observed the waving but did not know why and, as explanation, came up with explanations such as just seeing a friend. Moral of this story may be that our mind, to some extent, does not make decisions but rationalizes them in retrospect. %}

Gazzaniga, Michael S. & Joseph E. LeDoux (1978) "*The Integrated Mind.*" Plenum, New York.

{% **total utility theory**: Nice reference where total utility theory is applied in a rather straightforward manner: Terminal cancer patients with bone metastases receive radiotherapy. What is better, once a dose of 10 Gy, or five times a dose of 4.5 Gy? The two treatments are given to randomized trials, patients or doctors or both report pain scores at several timepoints, treatments are compared according to the pain scores. Other relevant dimensions are costs (11 times 10 Gy is cheaper) and side effects. %}

Gaze, Mark N., Charles G. Kelly, Gillian R. Kerr et al. (1997) "Pain Relief and Quality of Life Following Radiotherapy for Bone Metastases: A Randomised Trial of Two Fractionation Schedules," *Radiotherapy and Oncologie* 45, 109–116.

{% Seems to have introduced psychological game theory. Unfortunately, also this term, taking psychology—a field broader and more diverse than economics—as one concept. It is like psychologists using the term "economic game theory" because games involve money, or "mathematical game theory" because on page 2 they used a formula. %}

Geanakoplos, John, David Pearce, & Ennio Stacchetti (1989) "Psychological Games and Sequential Rationality," *Games and Economic Behavior* 1, 60–79.

{% 12 subjects chose repeatedly (768 times), 24 blocks of each 32 times, between two fifty-fifty gambles yielding a gain or loss of x for x = 5 or x = 25 cents. So, they must choose whether x = 5 or x = 25. They received sum total at end of each block. As William explained to me on August 21, 2002, in an email, the latter happened only if that total was positive. If the total was negative it was not subtracted. 52% of the choices were risk seeking, so, x = 25 instead of x = 5. Given that the incentive system enhances risk seeking, it is not amazing that there was some more risk seeking.

Brain-activities for losses were qualitatively different than for gains. After a preceding loss people became more risk-seeking than after a preceding gain. In the first quarter of blocks, there were 58% risky choices (x = 25), in the last 48%.

Because subjects could also see what their alternative choice would have yielded, they could feel regret. But, regret did not do much. I did not find it mentioned what percentage overall was risk seeking (choose x = 25 cents) or risk averse (choose x = 5 cents). How the real incentives were implemented (did they have to pay really if the lost?) is not explained. %}

Gehring, William J. & Adrian R. Willoughby (2002) “The Medial Frontal Cortex and the Rapid Processing of Monetary Gains and Losses,” *Science* 295, 2279–2282.

{% %}

Geiger, Gebhard (2002) “On the Statistical Foundations of Non-Linear Utility Theory: The Case of Status Quo-Dependent Preferences,” *European Journal of Operational Research* 136, 449–465.

{% Takes a very general model for decision under risk, with weak ordering and a weakened version of stochastic dominance (Axiom 4, p. 119). There is not only the prospects p and q to be chosen from but also another prospect r that is something like your background risk or reference point. So, the choice is between p|r and q|r. It is not clear to me if choosing p means you get p instead of r, or you get p in addition to r. P. 124 suggests something like uncertainty about r being implemented before or after p. Besides weak ordering and weakened stochastic dominance, Axiom 5 is imposed (if preferences given r are the same as without r given, then r must be equivalent to receiving 0). Then a general functional satisfying these requirements is defined. %}

Geiger, Gebhard (2008) “An Axiomatic Account of Status Quo-Dependent Non-Expected Utility: Pragmatic Constraints on Rational Choice under Risk,” *Mathematical Social Sciences* 55, 116–142.

{% Derives a very general model on multiattribute nonEU, with probability-dependent utility. In the proof of Theorem 2, I did not see why the limit of W(x´) could not be strictly less than W(x), in other words, where continuity in outcome comes from. (Axiom 2 is continuity in probabilistic mixing.) %}

Geiger, Gebhard (2012) “Multi-Attribute Non-Expected Utility,” *Annals of Operations Research* 196, 269–292.

{% **foundations of statistics**

P. 973 describes the essence of the paper: "we propose to replace, wherever possible, the words 'objectivity' and 'subjectivity' with broader collections of attributes, namely by transparency, consensus, impartiality and correspondence to observable reality, all related to objectivity, awareness of multiple perspectives and context dependence, related to subjectivity, and investigation of stability, related to both." This sentence lists the seven criteria displayed in Table 1.

A good old discussion on statistics with many (53 it seems) discussants writing after. I read many such discussions in the 1980s. The authors focus on the distinction objective-subjective, which is related to the distinction frequentist-Bayesian. They consider it to be counter-productive. Instead, they put up a useful Table 1 with seven desiderata for statistical analyses.

P. 969: "Researchers often rely on the seeming objectivity of the $p < 0.05$ criterion without realizing that theory behind the p-value is invalidated when analysis is contingent on data (Simmons et al., 2011; Gelman and Loken, 2014)."

P. 970: "Some Bayesians (notably Jaynes (2003) and Berger (2006)) have advocated an objective approach, whereas others (notably de Finetti (1974)) have embraced subjectivity."

P. 972: "science should be guided by principles that at the same time aim at stable and reliable consensus as usually associated with 'objectivity' while remaining open to a variety of perspectives, often associated with 'subjectivity', exchange between which is needed to build a stable and reliable scientific world view."

P. 974: "For example, Bayesian statistics is commonly characterized as 'subjective' by Bayesians and non-Bayesians alike. But, depending on how exactly prior distributions are interpreted and used (see Sections 5.3–5.5), they fulfil or aid some or all of the virtues that were listed above. Priors Beyond Subjective and Objective 975 make the researchers' prior point of view transparent; different approaches of interpreting them provide different rationales for consensus; 'objective Bayesians' (see Section 5.4) try to make them impartial; and if suitably interpreted (see Section 5.5) they can be properly grounded in observations."

P. 976 gives Table 1, reproduced here:

"**Table 1.** Virtues

V1. Transparency

(a) Clear and unambiguous definitions of concepts

(b) Open planning and following agreed protocols

(c) Full communication of reasoning, procedures, spelling out of (potentially unverifiable) assumptions and potential limitations

V2. Consensus

(a) Accounting for relevant knowledge and existing related work

(b) Following generally accepted rules where possible and reasonable

(c) Provision of rationales for consensus and unification

V3. Impartiality

(a) Thorough consideration of relevant and potentially competing theories and points of view

(b) Thorough consideration and if possible removal of potential biases: factors that may jeopardize consensus and the intended interpretation of results

(c) Openness to criticism and exchange

V4. Correspondence to observable reality

(a) Clear connection of concepts and models to observables

(b) Clear conditions for reproduction, testing and falsification

V5. Awareness of multiple perspectives

V6. Awareness of context dependence

(a) Recognition of dependence on specific contexts and aims

(b) Honest acknowledgement of the researcher's position, goals, experiences and subjective point of view

V7. Investigation of stability

(a) Consequences of alternative decisions and assumptions that could have been made in the analysis

(b) Variability and reproducibility of conclusions on new data"

Even if one does not fully agree with such a table and even if one feels more disagreements than agreements, then still, where it takes much work to create such a table, it is very useful.

P. 979: "with the Bayesian fitting algorithm being stuck going through remote regions of parameter space that corresponded to *implausible or unphysical parameter values*." [italics added here]

P. 980: "The point is not that our particular choices of prior distributions are 'correct' (whatever that means) or optimal, or even good, but rather that they are transparent, and in a transparent way connected to knowledge. Subsequent researchers—whether supportive, critical or neutral regarding our methods and substantive findings—should be able to interpret our priors (and, by implication, our posterior inferences) as the result of some systematic process, a process which is sufficiently open that it can be criticized and improved as appropriate." This may be the idea of objective Bayesianism. If we take some standardized (say, noninformative) prior that is transparent (so, everyone knows it), then everyone can back it out and put in their own preferred prior. In other words, then it can serve just as a convenient way to just convey the likehood function.

P. 984: "In doing this, we deviated from classical significance test logic in several ways, by not using a test statistic that was optimal against any specific alternative, by not arguing from a single p-value and by using a null model that relied heavily on the data" They "admit" here that they chose the test after seeing the data.

P. 987, §5.2, discusses works by Mayo et al. who defend frequentist approaches.

P. 989: "Dawid (1982b) discussed calibration (quality of match between predictive probabilities and the frequency of predicted events to happen) of subjectivist Bayesians inferences, and he suggested that badly calibrated Bayesians could do well to adjust their future priors if this is needed to improve calibration, even at the cost of violating coherence."

P. 989 §5.4 is on objective Bayesianism, and on Jaynes who favors he logical view of probability.

P. 990: "Jaynes (2003) admitted that setting up objective priors including all information is an unsolved problem. One may wonder whether his ideal is achievable at all."

P. 990 ff.: The authors seem to favor falsificationist Bayesianism, which seems to combine Bayesian ideas with frequentist interpretations of probability. Oh well.

P. 1004, comment by Bartholomew, criticizes the sufficiency concept:

" 'Sufficiency', for example, is an important concept which is often too limited for situations in which it is used."

P. 1004, comment by Bartholomew, is related to the stopping rule paradox: "In this connection it is readily recognized that all so-called frequentist inferences involve a degree of subjectivity. For example, although the sample size may be treated as fixed, this may not actually be so. The choice may, in fact, have resulted from the resolution of conflict between competing interests, or the data may actually be the outcome of a sequential experiment with ill-defined and often unrecognized stopping rules. Conditioning on the sample size we ignore some information which may be relevant. Such 'objective' inferences may thus easily conceal an unacknowledged subjective input."

P. 1020: comment by Stephen M. Stigler is very critical.

P. 1023: comment by Eric-Jan Wagenmakers at the end uses emotionally-loaded terms to plead for Bayesianism.

P. 1020: comment by Winkler: "The subjective–objective dichotomy in statistics has its roots in the Bayesian–frequentist debate that seemed most heated when Bayesian methods were starting to gain traction in the 1950s–1970s."

P. 1025, the authors' reply cites formalizations of exploratory data analysis. %}

Gelman, Andrew & Christian Hennig (2017) "Beyond Subjective and Objective in Statistics," *Journal of the Royal Statistical Society: Series A (Statistics in Society)* 180, 967–1033.

{% **common knowledge** %}

Geneakoplos, John & Herakles M. Polemarchakis (1982) "We Can't Disagree Forever," *Journal of Economic Theory* 28, 192–200.

{% %}

Genesove, David & Christopher Mayer (2001) "Loss Aversion and Seller Behavior: Evidence from the Housing Market," *Quarterly Journal of Economics* 116, 1233–1260.

{% **revealed preference** %}

Gensemer, Susan H. (1991) "Revealed Preference and Intransitive Indifference," *Journal of Economic Theory* 54, 98–105.

{% **dynamic consistency**: **favors abandoning time consistency, so, favors sophisticated choice**: does so descriptively; **updating under ambiguity with sampling** A follow-up paper, analyzing the same data set, is Georgalos (2021).

This paper uses Hey's bingo blower, with a ball to be drawn with three possible colors but unknown probability, to generate ambiguity. Subjects can allocate money to the three colors by state-contingent exchange rates that can change between different choice situations. They also do so after updating, being informed only about whether one particular color did or did not obtain. For nonEU one has to make problematic assumptions about updating. This paper maintains SEU's consequentialism and gives up dynamic consistency (p. 58; §4), which I think is empirically most plausible here. The data will indeed give many violations of dynamic consistency (p. 58 footnote 12). Georgalos (2021, p. 30 top) confirms that this paper assumes, and does not test, consequentialism. That is tested by Georgalos (2021).

The paper considers α maxmin, Choquet expected utility (CEU), prospect theory through Abdellaoui et al.'s (2011) source method (implemented as in Kothiyal, Spinu, & Wakker 2014 JRU), the Chateauneuf et al. (2007) neo-additive model, and SEU. Given that there are no losses, prospect theory through the source method is in fact a particular specification of CEU. So is the neo-additive model. As an aside, also α maxmin (implemented here as in Hey et al. 2014), in fact is so, as can be seen. I assume that what the authors call CEU means that no parametric assumption is made about W. For utility it takes CRRA throughout.

The paper does not consider the smooth model because the author writes that consequentialism then is problematic. I do not fully understand this. At least the basic smooth model that I know satisfies dynamic consistency and consequentialism, but violates reduction of compound lotteries. My difficulty with the smooth model is that the second-order distribution to be chosen is too general a parameter, of too high dimensionality, and essentially unobservable. The paper also considers various parametric families, and various update rules. For multiple priors it uses the same family of priors as Hey et al. (2014) do.

The paper uses predictive power as criterion. The best performing model is the source method, with Choquet expected utility as close second.

P. 57 last para defends the RIS against the hedging-for-ambiguity argument, mostly arguing that subjects cannot know beforehand the choice situations occurring in the experiment.

P. 58 Eq. 1: note that the author will allow the weights w to depend on the outcomes, e.g., as under rank dependence.

P. 76: **ambiguity seeking for unlikely**: the author finds likelihood insensitivity, but it concerns general uncertainty and not only ambiguity because no risk attitude is taken out. %}

Georgalos, Konstantinos (2019) "An Experimental Test of the Predictive Power of Dynamic Ambiguity Models," *Journal of Risk and Uncertainty* 59, 51–83. https://doi.org/10.1007/s11166-019-09311-7

{% **updating under ambiguity with sampling**

Georgalos (2019, GEB) considered dynamic choices under ambiguity, with updating, assumed consequentialism (I guess), and then tested several models, finding that Abdellaoui's (2011) source method performs best. This paper further analyzes the same data set, but now critically considers consequentialism. It distinguishes between resolute choice, sophisticated choice, and naïve choice. It is close in spirit to the marvelous Cubitt, Starmer, & Sugden (1998) for risk, although the conditions tested are not exact analogs. For instance, the conditions tested here involve repeated choices and this was not so in Cubitt et al. Some more than half of the subjects are not ambiguity neutral. Of them, most are sophisticated, some are naïve and very few are resolute. (**dynamic consistency**: **favors abandoning time consistency, so, favors sophisticated choice**; however, descriptively, with no normative position taken).

One general observation: In the ambiguity literature, researchers usually assume EU for risk, and then ambiguity neutrality is equivalent to SEU and (under some minimal assumptions) can readily be made to satisfy consequentialism, dynamic consistency, sophistication, resoluteness, and everything. However, empirically, people violate EU for risk, and then ambiguity neutrality does not give SEU, and still means that some of the dynamic principles are violated. This paper assumes α maxmin and, therefore, has this problem. For instance, p. 35 ℓ. -3 writes: "The resolute type is dynamically consistent but has ambiguity non-neutral preferences." In reality, a resolute agent can be ambiguity neutral but still violate consequentialism and sophistication, already in her risk preferences.

Finding 3 confirms **inverse S** for ambiguity and **ambiguity seeking for unlikely**. In general, the paper finds as much ambiguity seeking as aversion, once again confirming the fourfold pattern of ambiguity and that ambiguity aversion is not at all as widespread as was once thought.

P. 57 last para defends the RIS against the hedging-for-ambiguity argument.

%}

Georgalos, Konstantinos (2021) "Dynamic Decision Making under Ambiguity: An Experimental Investigation," *Games and Economic Behavior* 127, 28–46.

https://doi.org/10.1016/j.geb.2021.02.002

{% Bouchouicha et al. (2019 JRU), in a big empirical study, tried to estimate loss aversion, but found completely opposite results depending on parametric specifications and specific definition of loss aversion. This paper presents a detailed study, also of collinearity of prospect theory parameters. Wakker (2010 §9.6) noted a problem of a definition of loss aversion with the popular logpower (= CRRA) utility, being that the loss aversion found depends much on the unit of money chosen. He also noted that that problem does not arise if we take the same power of utility for gains and losses. This paper finds that this way, taking logpower utility, works best, giving consistent estimates of loss aversion. %}

Georgalos, Konstantinos (2024) "Gender Effects for Loss Aversion: A Reconsideration," *Journal of Economic Psychology* 105, 102760. https://doi.org/10.1016/j.joep.2024.102760

{% The authors consider an M (Markowitz 1952) model, which is EU but with a reference point and loss aversion and a utility function that is convex for small gains and large losses, and concave elsewhere. The authors use the expo-power family for this purpose. They consider three reference points: the status quo, the maxmin outcome, and, apparently, expected value. The latter is apparently lottery-dependent and not choice-situation dependent, which is hard for me to understand.

For 1/3 of subjects, the Markowitz model fits best, and for 2/3 CPT (92 prospect theory) does. %}

Georgalos, Konstantinos, Ivan Paya, & David Peel (2023) "Higher Order Risk Attitudes: New Model Insights and Heterogeneity of Preferences," *Experimental Economics* 26, 145–192. https://doi.org/10.1007/s10683-022-09784-5

{% They reproduce the WTP-WTA disparity and relate it to all kinds of things such as introspective scales and also loss aversion in risky tasks. They find that loss aversion has much influence (p. 904 last para preceding §3.5). End of section 1 appropriately criticizes Plott & Zeiler (2005). %}

Georgantzís, Nikolaos & Daniel Navarro-Martínez (2010) "Understanding the WTA-WTP Gap: Attitudes, Feelings, Uncertainty and Personality," *Journal of Economic Psychology* 31, 895–907.

{% **risky utility u = strength of preference v (or other riskless cardinal utility, often called value)**: Discusses ordinal-cardinal and vNM's role in that, although not specifically about strength of preferences. Argues that in cardinal view not the vNM independence axiom, but weak ordering and in particular indifference, is the problem. I found the paper confused. Has nice citations of Marx and Aristotle.

P. 515: **conservation of influence**: "For this is in fact what *utility* represents; the common essence of all wants, the unique want into which all wants can be merged." [italics from original]

P. 525 looks silly: "a sure alternative and a risk proposition, being relatively heterogeneous, can in no case be indifferent."

Seem to show that a hexagon-type condition implies additive representation. This had been known in web theory (Blaschke & Bol, 1938) before. %}

Georgescu-Roegen, Nicholas (1954) "Choice, Expectations and Measurability," *Quarterly Journal of Economics* 68, 503–534.

{% %}

Georgescu-Roegen, Nicholas (1969) "The Relation between Binary and Multiple Choices: Some Comments and Further Results," *Econometrica* 37, 728–730.

{% Several continuity conditions (upper/lower, open/closed) that are equivelent under completeness, are no longer so under incompleteness. This paper investigates logical relations, with variations of Schmeidler (1971). %}

Gerasimou, Georgios (2013) "On Continuity of Incomplete Preferences," *Social Choice and Welfare* 41, 157–167.

{% Banerjee (2022) provides a correction, and Gerasimou (2022) provides further comments.

strength-of-preference representation: The common presentation of strengths of preferences is through utility differences U(a)–U(b), with Köbberling

(2006) the most general representation theorem. This paper considers presentations more general than through utility differences, satisfying mostly s(a,b) = –s(b,a) (skew-symmetry in Fishburn's terminolology), and called preference intensity functions. It gives a comprehensive discussion of situations where the concept arises directly or indirectly. It is in fact closely related to measures of similarity (**measure of similarity**), a topic not mentioned. %}

Gerasimou, Georgios (2021) "Simple Preference Intensity Comparisons," *Journal of Economic Theory* 192, 105199.
https://doi.org/10.1016/j.jet.2021.105199

{% %}

Gerasimou, Georgios (2022) "Corrigendum to Gerasimou (2021) and Comment on Banerjee (2022)," *Journal of Economic Theory* 205, 105542.

{% Considers prospects (x,p,t), receiving $x with probability p at timepoint t, and nothing otherwise. It axiomatizes weighted temporal utility (WTU): w(p,t)v(x,t) . w(p,t) reflects psychological distance and v(,t) time-dependent utility. Many interactions are allowed (e.g., time and risk attitude) but, for every fixed timepoint t, money x and probability p are separable. Trading off time and probability is independent of outcome, and trading off time and outcome is independent of outcome; §6 discusses the corresponding elicitations. Many empirical phenomena can be accommodated this way. A dynamic extension with preferences at every timepoint is considered (§5).

The idea that many supposed violations of constant discounting are in fact different, and are due to time-dependence of utility, is important. I may have a special preference for one apple immediately today because I know that I need it today. %}

Gerber, Anke & Kirsten I. M. Rohde (2018) "Weighted Temporal Utility," *Economic Theory* 66, 187–212.
https://doi.org/10.1007/s00199-017-1058-8

{% **information aversion**

When the allies bombed Germany in WWII, they deliberately let information leak to the Germans to let them know (through double spies) that one of the potential targets would not be bombed. %}

Gerchak, Yigal & Frank R. Safayeni (1993) “Perfect Information with Negative Value: An Intriguing War Story and a Possible Explanation,” Dept. of Management Science, University of Waterloo, Waterloo, Ontario, Canada.

{% §1 briefly explains the rational expectations model (i.e., that expectations are a martingale). §2 briefly discusses Keynes’ ideas. %}

Gerrard, Bill (1994) “Beyond Rational Expectations: A Constructive Interpretation of Keynes’s Analysis of Behaviour under Uncertainty,” *Economic Journal* 104, 327–337.

{% The abstract writes, about the novelty of this paper: “utility functions can be compositionally structured: The utility of a combination is a function of its constituents’ utilities and the rules for combining them.” But this is the basic framework of multiattribute theory, consumer preferences over commodity bundles, multicriteria optimization, and what have you. Many concepts are brought in out of the blue, unrelated to others.

Sentences such as “Thus, the subtree kernel is built out of feature conjunctions just like other linear models, but the conjunctions it encodes are dictated by the underlying object structure.” (p. 72) remind me of Sokal (1996, *Social Text*).

What is called “realistic domain,” “naturalistic food rating task,” an so on, is a list of hypothetical food items and ingredients, of which hypothetical ratings are sometimes given to the subjects, where it is next left to subjects to imaginatorily evaluate hypothetical compositions. Subjects are taken from Amazon Mechanical Turk. More uncontrolled, hypothetical, and unrealistic is hard to imagine. The experiment studies what arbitrary combination rules subjects use for hypothetical objects they have no clue about or interest in, just to make $3 to satisfy some experimenters. Small numbers of subjects are sampled, and they are paid little money. %}

Gershman, Sam J., Jonathan Malmaud, & Joshua B. Tenenbaum (2017) “Structured Representations of Utility in Combinatorial Domains,” *Decision* 4, 67–86. https://doi.org/10.1037/dec0000053

{% %}
Gescheider, George A. (1988) "Psycho-Physical Scaling," *American Review of Psychology* 39, 169–200.

{% **bisection > matching**: Chapter 3: The Classical Psychophysical Methods. Discuss direct matching, choice lists, and bisection in psychophysics. Bisection avoids a number of biases. It seems to be called the staircase method. These things were debated already in psychophysics in the 1960s. %}
Gescheider, George A. (1997) "*Psychophysics: The Fundamentals*; 3rd edn." Lawrence Erlbaum Associates.

{% %}
Geweke, John F. (1992) "*Decision Making under Risk and Uncertainty; New Models and Empirical Findings*." Kluwer Academic Publishers, Dordrecht.

{% Seems that probability weighting explains their data on horse race betting well. %}
Gandhi, Amit, and Ricardo Serrano-Padial (2012) "From Aggregate Betting Data to Individual Risk Preferences,"

{% %}
Ghirardato, Paolo (1994) "Agency Theory with Non-Additive Uncertainty," University of California at Berkeley.

{% %}
Ghirardato, Paolo (1997) "On Independence for Non-Additive Measures, with a Fubini Theorem," *Journal of Economic Theory* 73, 261–291.

{% With belief functions, model with subpartition describing all that is observed and acts are correspondences; to them Savage's axioms are applied, leading to a probability distribution over subsets of outcomes, which, in turn, is uniquely related to a belief function over outcomes, being its Möbius inverse. Is similar to Jaffray & I, generalizing it in an appealing manner. %}

Ghirardato, Paolo (2001) “Coping with Ignorance: Unforeseen Contingencies and Non-Additive Uncertainty,” *Economic Theory* 17, 247–276.

{% **updating: discussing conditional probability and/or updating**: Uses **dynamic consistency** and consequentialism to model Savage’s SEU plus Bayesian updating. Not very new (in a lecture Paolo called the result a folk theorem), but done neatly and maybe the nicest paper to demonstrate how dynamic principles imply EU.

The only choice options are static functions from state space to outcomes; i.e., the static analogues of strategies. This automatically implies RCLA. Paolo clearly and explicitly says so two paras above Axiom 1. For each event A, a conditional pref $\succcurlyeq_A$ is given. Can be interpreted as anticipated-conditional, or ex post. Paolo explicitly leaves both open. In this setup, a choice f $\succcurlyeq_A$ g, such as considered in DC (dynamic consistency) (axiom 2) for f and g disagreeing outside of A, is not easily depicted in a conventional decision tree. It is therefore easier to first assume consequentialism (axiom 7). This axiom does not refer to de novo decisions, such not occurring in the model, but says that $\succcurlyeq_A$ ignores the counterfactual part (so that de novo decisions can be meaningfully defined, independently of what counterfactual part is assumed). With that given, Paolo’s DC reduces to the usual DC that [$\succcurlyeq$ if agreement outside of A] agrees with [$_A$ if agreement outside of A]. Paolo’s DC also requires agreement of [$\succcurlyeq$ if agreement outside of A] with [$_A$ if no agreement outside of A] which is a bit hard to interpret. %}

Ghirardato, Paolo (2002) “Revisiting Savage in a Conditional World,” *Economic Theory* 20, 83–92.

{% Two functions are comonotonic iff the Choquet integral of the sum is the sum of the Choquet integrals for every capacity. The authors show an analogous result for multiple priors: Two functions are affine-related (one function being affine transform of the other) if and only if the multiple priors value of the sum is the sum of the multiple priors model for every convex set of probability distributions.

The analogy does not go through for another aspect of comonotonicity: Comonotonic additivity holds iff the representation is a Choquet integral. There is no analogous statement for multiple priors and affine relatedness. %}

Ghirardato, Paolo, Peter Klibanoff, & Massimo Marinacci (1998) “Additivity with Multiple Priors,” *Journal of Mathematical Economics* 30, 405–420.

{% **updating: nonadditive measures** %}

Ghirardato, Paolo & Michel Le Breton (2000) “Choquet Rationalizability,” *Journal of Economic Theory* 90, 277–285.

{% **event/outcome driven ambiguity model: event driven**

The authors refer to unpublished work by Nehring for similar ideas. They consider a representation

$$f \dashrightarrow \alpha(f)\inf_{P\in C}\int_S U(f(s))dP + (1-\alpha(f)) \sup_{P\in C}\int_S U(f(s))dP$$

where f is an act mapping S to outcomes, C is a set of probability measures on S, $\int_S$ is the integral over S, U is utility, and $0 \le \alpha \le 1$. Arrow-Hurwicz is the special case of α constant and C the set of all probability measures.

Without any restriction, this model has little predictive power because of the generality of α depending on f in every possible way, apart from the EU evaluation of risk and the required certainty equivalence. We can always let C be the set of all probability measures, so that inf is the worst outcome of f and sup the best, and with $\alpha(f)$ we can get whatever is the desired midpoint between their utilities. The authors impose the following restriction on C. Let ≥´ be the preference relation. They define as the unambiguous part ≥´* the preferences f ≥´* g whenever $\lambda f + (1-\lambda)c$ ≥´ $\lambda g + (1-\lambda)c$ for all λ from [0,1] and acts c (by taking λ close to 0, they can let the decision take place in the comonotonic set with rank-ordering or whatever circumstances as dictated by c, so, whatever they want it to be). ≥´* is a nice and valuable idea.

As regards the mixing operation on acts, they assume the Anscombe-Aumann structure on S, amounting to a convex space of outcomes with linear utility U and statewise mixing for the acts. So, the unambiguous preferences are those that reflect vNM independence and behave according to EU. ≥´* is like an EU preference, only it is not complete. Then they use the appealing representation by Castagnoli, Maccheroni, & Marinacci (2003), and others, that f ≥´* g if and only if there is unanimous agreement that $\int_S U(f(s))dP \ge \int_S U(g(s))dP$ for all P from a set C. They take the set C above to be this set. This makes the representation operational, although I would not call it observable because it still is an existence result not fundamentally different from the existence result of for instance Gilboa & Schmeidler (1989).

The sup of expected utilities above turns out to correspond to the lowest sure outcome x^* that has $x^* \geq'^* f$, and the inf of expected utilities above corresponds to the highest sure outcome x_* that has $x_* \leq'^* f$. So, the value of f is between x^* and x_*, and $\alpha(f)$ is derived from this. The set C turns out to be the smallest set that could be used.

$\alpha(f)$ is constant (independent of f) if and only if x^* and x_* completely determine the preference value of f (Proposition 19). This gives the famous α maxmin model, which the paper is mostly cited for. This result would have been appealing and the main result of this paper because for tractability reasons it is desirable that α not be very general. However, Eichberger, Grant, Kelsey, & Koshevoy (2011, JET) later showed that it is not correct. For finite state spaces the α maxmin model can only exist, under the axioms of this paper, if $\alpha = 1$ or $\alpha = 0$, that is, when it is maxmin or maxmax as known before.

The authors interpret $\geq'^*$ as unambiguous preferences, C as reflecting the state of belief and of ambiguity of the agent, and $\alpha(f)$ as reflecting attitude towards ambiguity. It means that for the special case of maxmin EU they take the whole set of priors as reflecting belief, and not decision attitude. For example, if there is DUR with known probabilities, the agent does RDU with convex probability transformation w, so that we have CEU (Choquet expected utility) with convex nonadditive measure $w(P(.))$, then this model can be written as maxmin EU (the priors are the CORE of $w(P(.))$), and then the authors consider this to reflect ambiguous beliefs.

The authors discuss the point just raised. First, p. 137 next-to-last para discusses that absence of and neutrality towards ambiguity cannot be distinguished in their approach, and that they equate SEU with unambiguous. P. 138 then mentions the big problem that what they call ambiguity also comprises the part of risk attitude that deviates from expected utility (see above example of RDU with convex w). Amarante (2009, §3.1) criticizes the interpretation.

The authors emphasize that they do not want to use objective probabilities as given, based on non-preference info, because they do not want to use such info. (p. 138 ℓ. 12-13). Problem is that the Anscombe-Aumann framework uses (such?) probabilities. The authors defend (p. 138 3rd para) by saying that such probabilities, and the corresponding mixing operation, can be obtained subjectively, justifying it by referring to Ghirardato, Maccheroni, Marinacci, & Siniscalchi (2003, *Econometrica*). Big problem is that such subjective probabilities are not directly observable, but must be derived from preferences. There is a rule of the game in preference axiomatizations that one does not use such inputs in axioms, just the same as one does not use utilities in preference axioms. %}

Ghirardato, Paolo, Fabio Maccheroni, & Massimo Marinacci (2004) "Differentiating Ambiguity and Ambiguity Attitude," *Journal of Economic Theory* 118, 133–173. https://doi.org/10.1016/j.jet.2003.12.004

{% I first describe what the theorem in the paper, Theorem 1, does mathematically. Then I describe the interpretation that the authors give to it, which I think is incorrect. It also obscures the mathematical result of Theorem 1. Clearer statements of some results may be in Sokolov (2011) (I did not check out exactly now).

Theorem 1 is as follows. S is a state space, finite or infinite. Acts map S to an interval $K \subset \mathbb{R}$ and have finite range. (The authors interpret these real numbers as utility units; see below. But this interpretation does not play any role for the maths. All of their maths is only about those "utilites" and in no way involves where those utilities may come from or what they are.) I prefer for now to call these real numbers outcomes. One can endow S with an algebra and restrict to measurable acts. Outcomes α are identified with constant acts. $\succcurlyeq$ is a preference relation over acts. It is a nontrivial weak order that is monotonic (in the weak sense: $f \geq g$ statewise $\Rightarrow$ $f \succcurlyeq g$). We assume a certainty equivalent I(f) for each f.

I is *constant affine* if $I\big(\lambda f + (1-\lambda)\alpha\big) = \lambda I(f) + (1-\lambda)\alpha$ for all acts f, $0 \leq \lambda \leq 1$, and $\alpha \in K$. For $K = \mathbb{R}$ it is equivalent to *constant linearity*: $I(\lambda f + \mu) = \lambda I(f) + \mu$ for all $\mu \in \mathbb{R}$ and $\lambda \geq 0$. It readily follows that for a two-element S this is equivalent to I being a rank-dependent (=biseparable) functional with linear utility, and in general it implies biseparable utility with linear utility.

In my terminology, *constant absolute risk aversion* (called homotheticity in more general contexts beyond uncertainty) holds if $I(f+\alpha) = I(f) + \alpha$ for all acts f and real α such that all involved are acts (outcomes in K), and *constant relative risk aversion* (more generally called homogeneity (of degree 1)) holds if $I(\lambda f) = \lambda I(f)$ for all acts f and $\lambda \geq 0$ such that all involved are acts.

In Theorem 1, Statement (i) is readily seen to be equivalent to constant relative and constant abolute risk aversion. Theorem 1 then says that it is equivalent to I being constant affine (Statement ii) and it is also equivalent to Statement (iii): certainty independence $\left(f \succcurlyeq g \iff \lambda f + (1-\lambda)\alpha \succcurlyeq \lambda g + (1-\lambda)\alpha \text{ for all } 0 < \lambda < 1\right)$. These things imply that I is biseparable with linear utility and, for two elements in S, it characterizes biseparable utility (= rank-dependent utility) with linear utility. (This special case I have known since my youth because Chew Soo Hong told me. But I don’t know any place other than here where it is written in the literature.) If S had three or more nonnull elements then we have biseparable utility with linear utility but with the extra restriction that I is constant affine for all acts.

The authors state Statements (i) and (ii) in a more complex manner by letting transformations v intervene, but this is readily seen to be equivalent to my above statements by referring back to certainty equivalents.

I next turn to the interpretations that the authors give to the result. As written above, they interpret elements of K as units of a utility function u. They further assume that u results from a representation where it is an interval scale, i.e., it is unique up to scale and location. (This interpretation already complicates the readers’ understanding, because they have to understand that this whole framework underlying u in fact does not play any role in the mathematical meaning of Theorem 1. Sokolov (2011) may be clearer.) But u is now used for some further purpose, through I. The typical case is the Anscombe-Aumann (AA) framework, where u results from representing risky choices (between probability distributions over what will now be called prizes) through the expected utility formula, and is next used in I to capture ambiguity attitudes. The authors have this AA framework in mind, where they interpret I as capturing beliefs, although they express proper reservations about this interpretation. Next comes the mistake in interpretation.

The authors assume, erroneously, that functional I should "respect" the interval scale property of u, implying that I should be compatible with affine transformations of outcomes = u-values, i.e., satisfy constant absolute and relative risk aversion in my above terminology, or, equivalently, certainty independence. However, there is nothing in the world why this should be so. An example to clarify: Assume that the agent does expected value maximization for risk. Thus, changing the unit of money from cents to dollars (multiplying all prizes by 100) does not matter for the risk attitude. Then this multiplication may still very well affect the ambiguity attitude. For gains, the agent may be ambiguity neutral as long as all prizes are below $1000, but become ambiguity averse if prizes exceed $1000. For instance, in the KMM smooth ambiguity model, with u the identity function, φ (the second-stage function transforming u due to ambiguity) may be linear up to 1000, but become concave above. Put differently, for ambiguity attitudes we know exactly what the prizes are and may use more info about prizes than what risk attitude they generate. (If the authors defend by saying that I depending on utilities means that the info about the underlying prizes is lost: this is a completely unrealistic assumption in any application. One knows the underlying prizes more than their utilities.) Put yet differently, whether a function is an interval scale, is not an absolute property of that function, but depends on what we want to do with that function. Scale type is a "meta-property," depending on our wishes. Thus, u may be an interval scale when representing risky choice, but not when giving ambiguity attitudes.

The authors could argue that they want I to reflect belief and, if it is different for prizes below $1000 than above, then I is not just belief. However, more formalization then remains to be done, to explain more how beliefs are or are not supposed to depend on prizes, events, and so on. The authors can go circular and say that this is how they define beliefs, but then the result is circular and trivial. I have the same basic objection against Nash (1950). See my annotations there. %}

Ghirardato, Paolo, Fabio Maccheroni, & Massimo Marinacci (2005) "Certainty Independence and the Separation of Utility and Beliefs," *Journal of Economic Theory* 120, 129–136.

{% Decision under uncertainty. Assume that a Choquet expected utility representation exists for all binary acts. CE denotes certainty equivalent. Then, under appropriate rank-ordering,

CE(CE(x,y),CE(v,w)) ~ CE(CE(x,v),CE(y,w)) follows from substitution; this is bisymmetry. They define a midpoint operation x*z = y, assigning midpoint y to x and z, by CE(CE(x,x),CE(z,z)) ~ CE(CE(x,y),CE(y,z)), for x > y > z. Substitution shows that y is the midpoint of x and z in utility units. By repeated procedures we can, thus, get (where mixing is always in utility units) x/4 + 3z/4, 3x/4 + z/4, etc., so, ax + (1-a)z for a dense subset of a's in [0,1] (all dyadic a's). By limit taking, or approximately, we can get it for all a in [0,1]. Note that eliciting all these mixtures amounts to the same as eliciting the utility function itself.

The authors argue that now the mixing operation is observable, behavioral as they call it, and that it can be used as a primitive in axioms. They subsequently reformulate preference axioms in the literature in this manner for extraneous mixing à la Anscombe-Aumann (1963).

derived concepts in pref. axioms: A difficulty is that the mixture operation becomes observable only after a long elicitation procedure. Preference axiomatizations in terms of this are in fact very complex axioms, not easily testable. For instance, f ~ g $\Rightarrow$ f/3 + 2h/3 ~ g/3 + 2h/3, mixture independence for mixture weight 1/3, can never be verified exactly, because weight 1/3 can never be obtained exactly; it can only be verified approximately or in the limit. When Hübner & Suck (1993) similarly used a preference condition in terms of observables that involves infinitely many preferences, they explicitly mentioned this as a weak point on p 638.

The axioms could have been stated directly in terms of utility as well as in terms of the mixing operation, because utility can be elicited as easily, in fact through the same observations, as the mixture operation. (Sugden, *Journal of Economic Theory* 1993, similarly demonstrated how utility can be elicited and then used it as a primitive in axioms. I would not call that behavioral for the same reasons.) I consider this approach derived measurement. While their axiomatizations are logically true, they do not have the behavioral status and appeal of preference axiomatizations that can be stated directly in terms of a small number of preferences. The results of this paper are logical equivalences between two statements in theoretical terms. The authors could have avoided these problems for Choquet expected utility by imposing their axioms only for .5/.5 mixtures, which given continuity will imply the whole axiom. They have such, more appealing, results in the 2003 extended version of this paper.

Besides Choquet expected utility, the authors also characterize maxmin EU, and Bewley's (1982, 2002) model under the special assumption that there is an event E for which subjective expected utility holds, implying that all probability measures in the set of priors assign the same probability to E. This rules out, for instance, probabilistic risk attitudes with RDU with the probability weighting strictly convex.

Köbberling & Wakker (2003 *Mathematics of Operations Research*) use a tradeoff consistency axiom and show in their §7 that the axiom is weaker than the bisymmetry axiom used in this paper, so that most theorems in this paper are immediate corollaries of the K&W theorms. Unfortunately, this paper does not cite K&W.

P. 1897 writes negatively about the Anscombe-Aumann (AA) framework: "In the AA setting, payoffs are lotteries contingent on the output of a randomizing device, or 'roulette wheel.' Postulating the existence of such a device, characterized by objective probabilities, is generally considered unappealing and philosophically debatable (cf. the references cited in Section 4)." The authors are critical of using objective probabilities here. %}

Ghirardato, Paolo, Fabio Maccheroni, Massimo Marinacci, & Marciano Siniscalchi (2003) "A Subjective Spin on Roulette Wheels," *Econometrica* 71, 1897–1908.

{% **criticizing the dangerous role of technical axioms such as continuity**: Krantz et al. (1971 §9.1), and other works, explain that "technical" axioms such as continuity are dangerous because they add implications to intuitive axioms, and we don't know exactly what those are. The authors refer to Krantz et al. for this point, and illustrate it by other examples, regarding the technical assumption of solvability (range convexity as they call it) of a capacity.

The main point is that under CEU/RDU and convex-rangedness, the existence of one symmetric event such as implied by complement-symmetry preference axioms for that event (betting on or betting against the event gives same likelihood ordering) and convexity as implied by what is often interpreted as ambiguity aversion, together imply additivity and SEU. It is like a continuous strictly increasing function w from [0,1] to [0,1] with w(0) = 0 and w(1) = 1, if it is convex and if there is a p with w(p) + w(1–p) = 1 (implying that not both w(p) and w(1–p) can be below the diagonal), then w must be linear. The authors argue, on p. 609 end of §3, that the existence of such an event (or such a p) is a weak assumption, and then put the blame on convex-rangedness. %}

Ghirardato, Paolo & Massimo Marinacci (2001) "Range Convexity and Ambiguity Averse Preferences," *Economic Theory* 17, 599–617.

{% **event/outcome driven ambiguity model: event driven**

That preferences satisfying CEU (Choquet expected utility) on binary (two-valued) acts can be useful and interesting has been observed before (Miyamoto & Wakker 1996 OR; Luce 2000 Ch. 3; Miyamoto 1988 for risk), as it has been that such acts suffice to identify utility and the capacity. But no one used this insight as clearly and thoroughly as this paper does. The results obtained apply to all theories that agree with CEU on binary acts, such as maxmin EU, Gul's disappointment aversion theory, prospect theory only for gains or only for losses, and α-Hurwicz.

In most places the paper interprets the capacity (= weighting function), nicely, as willingness to bet. Sometimes, however, it interprets the capacity as belief (claiming a separation of tastes and beliefs), which is questionable. They point this out in §5.2, p. 879.

Like Epstein, the authors do not want to use objective given probabilities. Then it is hard, or impossible, to separate out the risk attitude component from the capacity (and take what remains as ambiguity component). However, this does not justify the assumption of the authors that there be no risk attitude in the capacity, and that the capacity consists merely of ambiguity attitude. In the terminology that the authors use, probabilistic risk attitude ends up in the wrong place. It should be part of risk attitude, not of ambiguity attitude as it now is. In the authors' terminology, "risk attitude" refers merely to utility. By not wanting to use objective probabilities for the study of ambiguity, the authors have the same basic problem as Epstein (1999). I discuss the case in my annotations to Epstein (1999).

biseparable utility: Emphasized much and a central topic in this paper. They use the term biseparable for it. They impose the Chew & Karni (1994) CEU axioms on binary acts only, giving the CEU representation only there. Show that results on utility, such as u_2 being concave transform of u_1 iff certainty equivalents for u_2 smaller than for u_1, can be derived in their model as well; i.e., if SEU on a comonotonic subset for two states of nature. However, they make the nonbehavioral assumption of equal capacity for the two agents (they suggest they have an axiom for that but don't give it). For real outcomes, they adapt preference for diversification and quasi-convexity characterizations of concave utility to their model.

binary prospects identify U and W;

§5.1, on probabilistic beliefs for binary acts: this is also in Pfanzagl (1959).

%}

Ghirardato, Paolo & Massimo Marinacci (2001) "Risk, Ambiguity, and the Separation of Utility and Beliefs," *Mathematics of Operations Research* 26, 864–890. https://doi.org/10.1287/moor.26.4.864.10002

{% **tradeoff method**: use it on p. 264 and elsewhere to characterize identity of two utility functions in their cardinal symmetry.

I think that a better title of this paper would have been:

"A Separation of Utility and Uncertainty Attitude."

They consider CEU (Choquet expected utility) (or, similarly, maxmin EU) for two-outcome gambles. Interpret utility U as "cardinal" risk attitude, and capacity as ambiguity attitude. A problem is that all of risk attitude outside expected utility, such as Allais paradox, probabilistic risk attitude (probability transformation in RDU), thus ends up in ambiguity attitude and not in risk attitude. The authors signal and discuss this problem on p. 257, 274-275, and several times in the Discussion section. They don't want to use given probabilities (usually described broadly as "extraneous device"), which is why they don't isolate probabilistic risk attitude from ambiguity attitude. They provide arguments against probabilistic sophistication as ambiguity-neutrality in the Discussion section, arguments that I agree with. (But my solution is different: I recommend using ("extraneously-")given probabilities as ambiguity neutrality.) By not wanting to use objective probabilities for the study of ambiguity, the authors have the same basic problem as Epstein (1999). I discuss the case in my annotations to Epstein (1999).

Sometimes (p. 256 ℓ. 7) they interpret the capacity as belief. Mostly they, nicely, interpret it as willingness to bet.

P. 257 ℓ. 12-14 is misleading because Savage did not consider ambiguity as a normatively compelling argument against expected utility.

derived concepts in pref. axioms: p. 265 discusses a preference condition that would require the whole elicitation of a continuum of a utility scale: "This extension requires the exact measurement of the two preferences' canonical utility indices, and is thus "less behavioral" than the one we just anticipated." P. 276 states it as: "Nonetheless, this ranking requires the full elicitation of the DM's canonical utility indices, and thus is operationally more complex than that in Definition 7." Exactly these criticisms apply to the endogenous mixture operation used as behavioral in Ghirardato, Maccheroni, Marinacci, & Siniscalchi (2003, Econometrica).

They use the Yaari-definition of higher certainty equivalents. Call a second agent more uncertainty averse than a first if the second always has lower certainty equivalents. Under identical utilities (implied by their cardinal symmetry) they then call the first more ambiguity averse. It implies, and under CEU is equivalent to, the capacity of the second being dominated by the first. They define SEU as ambiguity neutral and define ambiguity aversion in an absolute sense as *existence* of SEU with same utility that is less ambiguity averse. The latter holds iff the capacity is pointwise dominated by an additive probability, in other words, has a nonempty CORE. This is an axiomatization in the sense of necessary and sufficient, a logical equivalence between two statements about theoretical concepts. It is not a decision-axiomatization because both conditions are not stated in terms of directly observable choices: The *existence* of the less ambiguity averse SEU is not directly observable (**derived concepts in pref. axioms**). The authors signal this problem on p. 256, saying that their definition of ambiguity neutrality is behavioral but computationally demanding. Their definition of ambiguity aversion had been proposed before by Montesano & Giovannoni (1996 Def. 1 p. 136). The authors do not sufficiently credit this priority, and only write on p. 258: "Montesano and Giovannoni [21] notice a connection between absolute ambiguity aversion in the CEU model and nonemptiness of the core, but they base themselves purely on intuitive considerations on Ellsberg's example."

It is troublesome that they can handle ambiguity attitudes, ambiguity neutrality etc., only if there is either ambiguity seeking or ambiguity aversion, and not for more general attitudes towards ambiguity. For insensitive symmetric weighting functions, for instance, their definitions do not detect the ambiguity present. (**Ambiguity = amb.av = source.pref, ignoring insensitivity**) %}

Ghirardato, Paolo & Massimo Marinacci (2002) “Ambiguity Made Precise: A Comparative Foundation,” *Journal of Economic Theory* 102, 251–289. https://doi.org/10.1006/jeth.2001.2815

{% **biseparable utility violated**: they consider a direct generalization.

The authors use a generalization of the endogenous utility-midpoint operation of GMMS (Ghirardato, Paolo, Fabio Maccheroni, Massimo Marinacci, & Marciano Siniscalchi 2003, *Econometrica*). They generalize it by not assuming biseparable utility to hold throughout, but only for one event E and the E-dependent binary acts, or for some events. This they call local biseparability. One such event E suffices to define a utility midpoint operation. Then they proceed as GMMS, first defining subjective mixtures for weights different than ½ by repeatedly taking midpoints and then taking limits. Note that this can involve infinitely many repetitions, for instance for weight 1/3. And as in GMMS, they can then define the Anscombe-Aumann framework endogenously. Because they do not assume biseparable utility, as did GMMS, but only local biseparability, then can handle more models. They don’t need the, for nonEU debatable, monotonicity axiom of Anscombe-Aumann, or the certainty independence axiom, because there are no exogenous mixtures.

One drawback that the authors share with GMMS is that their utility midpoint operation is complex, and hard to implement empirically because it involves many certainty equivalents. Using Wakker & Deneffe’s (1996) tradeoff technique, two indifferences $\alpha_E\sigma \sim \beta_E\tau$ and $\beta_E\sigma \sim \gamma_E\tau$ ($\alpha \preccurlyeq \beta \preccurlyeq \gamma \preccurlyeq \tau \preccurlyeq \sigma$) more easily give an endogenous utility midpoint, as pointed out by Köberling & Wakker (2003). Another drawback that the authors share with GMMS is that their general mixture operation is very complex empirically, and may even require infinitely many observations. Such a concept should not be used in a preference axiom. It in fact amounts to just measuring the utility function, and using it in axioms is like using utility in axioms. %}

Ghirardato, Paolo & Daniele Pennesi (2020) “A General Theory of Subjective Mixtures,” *Journal of Economic Theory* 188, 105056.

{% Consider general multiple prior models, explicitly NOT assuming uncertainty aversion or certainty independence. Use the Anscombe-Aumann setup. They do not explicitly refer to it, but it is because they assume a convex set X of outcomes, preferences over which are represented by an affine function u (their term Bernoullian refers to this being like EU).

Show that sets of priors, as from the pretty unambiguous subpreference of Ghirardato, Maccheroni, & Marinacci (2004), are obtained as union of Clarke differentials. The latter are a kind of multidimensional analog of derivatives, but can also be used if a functional is not differentiable. Thus, they relate priors to local optimizations. Although it can be called an operationalization of sets of multiple priors, unions of Clark differentials and local linear approximations of preferences are too complex to be used for empirical calibration. This paper is an analog for uncertainty of what Machina (1982) did for risk. %}

Ghirardato, Paolo & Marciano Siniscalchi (2012) “Ambiguity in the Small and in the Large,” *Econometrica* 80, 2827–2847.

{% Refinements of Billot, Chateauneuf, Gilboa, & Tallon (2000) and its generalizations by Rigotti, Shannon, & Strzalecki (2008) that show how to do withot assuming convex preferences. %}

Ghirardato, Paolo & Marciano Siniscalchi (2018) “Risk Sharing in the Small and in the Large,” *Journal of Economic Theory* 175, 730–765.

{% Solvability for preference relations, weaker than continuity, is closely related to the intermediate value property of functions. This paper elaborates on that. %}

Ghosh, Aniruddha, M. Ali Khan, & Metin Uyanik (2022) “The Intermediate Value Theorem and Decision-Making in Psychology and Economics: An Expositional Consolidation,” *Games* 13, 51.
https://doi.org/10.3390/g13040051

{% This paper brings useful results on continuity and solvability for preference foundations in decision theory. These are technical axioms needed to construct representing functionals. Continuity axioms are by far most used, especially by economists. Solvability axioms have been used primarily by mathematical psychologists, but deserve more attention because they have several advantages. This paper serves this purpose. It follows up on some other papers that the authors wrote on this topic and provides several additions. They give complete accounts of logical relations.

P. 191 writes, nicely: "With Luce and Tukey's 1964 axiomatization and its culmination in the 1971 treatise Foundations of Measurement (Krantz et al., 1971), the solvability axiom was concretized in mathematical psychology." Luce & Tukey (1964) provided, indeed, the major step forward, but I only cite Krantz et al. (1971) because this was the perfectioning. %}

Ghosh, Aniruddha, M. Ali Khan, & Metin Uyanık (2023) "Continuity Postulates and Solvability Axioms in Economic Theory and in Mathematical Psychology: A Consolidation of the Theory of Individual Choice," *Theory and Decision* 94, 189–210.
https://doi.org/10.1007/s11238-022-09890-z

{% **questionnaire for measuring risk aversion**: use it and give references in mid p. 87;

uncertainty amplifies risk: find that. They use subjective general questionnaires to assess risk aversion and ambiguity aversion of people. Also use a Kachelmeier (1993) list of risky choices to assess risk attitude (which, unfortunately, gave risk neutrality for all 39 subjects so that it was not sufficiently discriminating). Then let N = 39 students decide on how many inspections to carry out in a supposed manufacturing plant where, subjects, however, received real performance-contingent payments. For high risk and high ambiguity they find aversion, for low risk no aversion and for low ambiguity also no aversion. (p. 86 when in the five hypotheses H1-H5 they write "explain" they mean that aversion is exhibited). %}

Ghosh, Dipankar & Manash R. Ray (1997) "Risk, Ambiguity and Decision Choice: Some Additional Evidence," *Decision Sciences* 28, 81–104.

{% Provide many results on risk aversion in RDU, and cite many papers. The authors consider weak risk aversion, and a composition of the risk premium into a probability weighting premium (if utility were linear), taking the remainder as utility premium (note: the latter depends on probability weighting). Hilton (1988) considers a similar separation. They give many necessary and sufficient conditions, for instance for weak risk aversion. However, the conditions are not preference conditions but they involve theoretical constructs (u and w), so that the axiomatizations are not preference axiomatizations. Thus, a preference axiomatization of weak risk aversion remains as the main open mathematical question in RDU.

Warning: Unfortunately, the authors do not the top-down integration as nowadays (1990-2023) convention, but bottom-up. Also unfortunate: they use the inefficient term RDEU. %}

Ghossoub, Mario & Xue Dong He (2021) "Comparative Risk Aversion in RDEU with Applications to Optimal Underwriting of Securities Issuance," *Insurance, Mathematics and Economics* 101, 6–22.
https://doi.org/10.1016/j.insmatheco.2020.06.007

{% CEs (certainty equivalents) are used to define comparative ambiguity attitudes in a general convex preference model for ambiguity. %}

Giammarino, Flavia & Pauline Barrieu (2013) "Indifference Pricing with Uncertainty Averse Preferences," *Journal of Mathematical Economics* 49, 22–27.

{% The paper considers belief functions via the Möbius inverse, as in Dempster's random messages. It provides a detailed comparison beween a model by Jaffray & Wakker (JW) and one by Giang & Shenoy (GS). The latter considers only (partially) consonant belief functions (Def. 6 p. 42) their Möbius inverse lives on disjoint groups that are all telescopically nested, which means nested (for each pair one is a subset of the other) and in this sense is less general. But JW deal only with Dempster-type setups where the mixture weights used in Möbius inverse are exogenously given objective probabilities ("disambiguate the foci of belief;" p. 50) and in that sense are less general. The paper considers a sequential consistency condition as in Sarin & Wakker (1998) that is violated by JW but satisfied by GS. %}

Giang, Phan H. (2012) "Decision with Dempster–Shafer Belief Functions: Decision under Ignorance and Sequential Consistency," *International Journal of Approximate Reasoning* 53, 38–53.

{% Presents a model similar to Jaffray (1989 ORL), but does not know or cite Jaffray.
Assumes that risk with known probabilities is one extreme, complete ignorance is another (here he does cite Cohen & Jaffray 1980), and (§3) considers also cases in between where, unlike most of the modern ambiguity Anscombe-Aumann frameworks, the roulette precedes horses, which I think is better (Wakker 2010 §10.7.3). Uses Arrow-Hurwicz to model complete ignorance, where only minimal and maximal possible outcomes matter. Uses an Anscombe-Aumann multi-stage setup, and relaxes the collapse-event assumption. It does hold within one source (my term) but not between. So, in Anscombe-Aumann, roulette before horse is different than horse before roulette. Derives comparative results as being more tolerant for ignorance from Yaari-type certainty equivalent comparisons. Discusses Ellsberg, maxmin EU, and belief functions. Does not discuss modern (2015) ambiguity models although as an aside it cites the smooth KMM (2005) paper. %}

Giang, Phan H. (2015) "Decision Making under Uncertainty Comprising Complete Ignorance and Probability," *International Journal of Approximate Reasoning* 62, 27–45.

{% **completeness criticisms**: this paper has the nice idea of incomplete preferences (called necessary) that are next extended using preference conditions. (**extending preference relations using conditions**) %}

Giarlotta, Alfio & Salvatore Greco (2013) "Necessary and Possible Preference Structures," *Journal of Mathematical Economics* 49, 163–182. https://doi.org/10.1016/j.jmateco.2013.01.001

{% %}

Gibbard, Alan & William L. Harper (1987) "Counterfactuals and Two Kinds of Expected Utility." *In* Peter Gärdenfors & Nils-Eric Sahlin (eds.) *Decision, Probability, and Utility*, 341–376, Cambridge University Press, Cambridge.

{% %}
Gibbons, Robert (1992) "*A Primer in Game Theory*." Prentice-Hall, London.

{% **decision under stress** %}
Giesen, Carin, Arne Maas, & Marco Vriens (1989) "Stress among Farm Women: A Structural Approach," *Behavioral Medicine* 15, 53–62.

{% Suggest that VAS is better than TTO, PE, or WTP (**PE doesn't do well**). (If I remember well, they call it SG.) However, there are many many problems in the methodology and goodness-scores.
(differentiation/inconsistency) used in this study. %}
Giesler, Brian R. et al. (1999) "Assessing the Performance of Utility Techniques in the Absence of a Gold Standard," *Medical Care* 37, 580–588.

{% Pp. 260-261, Examples 1 and 2, show that the author does not understand probability other than frequentist, leading to silly viewpoints on statistical inference in a single case. %}
Gigerenzer, Gerd (1991) "From Tools to Theories: A Heuristic of Discovery in Cognitive Psychology," *Psychological Review* 98, 254–267.

{% Origins and limits of overconfidence; **probability communication**: relative frequencies work better. %}
Gigerenzer, Gerd (1996) "Why do Frequency Formats Improve Bayesian Reasoning? Cognitive Algorithms Work on Information, which Needs Representation," *Behavioral and Brain Sciences* 19, 23.
https://doi.org/10.1017/S0140525X00041248

{% **probability communication**: relative frequencies work better. %}
Gigerenzer, Gerd (1996) "The Psychology of Good Judgment: Frequency Formats and Simple Algorithms" *Medical Decision Making* 16, 273–280.
https://doi.org/10.1177/0272989X9601600312

{% Pp. 26-27 seem to write: [there are three major interpretations of probability] "Of the three interpretations of probability, the subjective interpretation is the most liberal about

expressing uncertainties as quantitative probabilities."

(Then anecdote about surgeon doing first ever heart-transplantation. The wife of the patient asks to the surgeon:

"What chance do you give him?" The surgeon answers:

"An 80 percent chance.")

"[the surgeon's] "80 percent" reflected a degree of belief, or subjective probability. In the subjective view, uncertainties can always be transformed into risks, even in novel situations, as long as they satisfy the laws of probability - such as that probabilities of an exhaustive and [mutually] exclusive set alternatives such as survival and death add up to 1. Thus [the surgeon's statement that the patient] had an 80 percent chance of survival is meaningful provided that the surgeon also held that there was a 20 percent chance of his patient not surviving." %}

Gigerenzer, Gerd (2002) "*Reckoning with Risk: Learning to Live with Uncertainty*." Penguin Books, London.

{% %}

Gigerenzer, Gerd (2008) "*Rationality for Mortals: Risk and Rules of Thumb*." Oxford University Press, New York.

{% The nice writing style of Gigerenzer with inspiring metaphors showing deep understandings. But it is also selling lemons. That this is ecologically rather than logically based (p. 651 1st column 2nd para) sounds nice and clever at first but does not survive serious thinking. Is ecological the trivial point of finding environments where heuristics survive?

"Simon's insight that the minds of living systems should be understood relative to the environment in which they evolved, rather than to the tenets of classical rationality" (p. 651 1st column ℓ. −13) is mixing unrelated concepts.

"They did not report such a test. We shall." (p. 651 2ne column 1st sentence) is bombastic.

Heuristics as studied here are interesting, but serve different purposes than quantitative theories such as prospect theory and expected utility. The authors' continued search for competitions between these is unfounded.

P. 654 2nd column $\ell\ell$. 7-10: that German and US students can worse compare sizes of cities in their own country than in the other is surprising, but the authors document it also by citing other studies. %}

Gigerenzer, Gerd & Daniel G. Goldstein (1996) "Reasoning the Fast and Frugal Way: Models of Bounded Rationality," *Psychological Review* 103, 650–669.

{% %}
Gigerenzer, Gerd, Ullrich Hoffrage, & Heinz Kleinbölting (1991) "Probabilistic Mental Models: A Brunswikian Theory of Confidence," *Psychological Review* 98, 506–528.

{% A.o., discusses and references is-ought distinction. %}
Gigerenzer, Gerd & Thomas Sturm (2012) "How (Far) Can Rationality Be Naturalized?," *Synthese* 187, 243–268.

{% **foundations of probability**: history %}
Gigerenzer, Gerd, Zeno Swijting, Theodore M. Porter, Lorraine J. Daston, & John Beatty (1990) "*The Empire of Chance: How Probability Changed Science and Everyday Life*." Cambridge University Press, Cambridge.

{% Do Ellsberg paradox where, however, subjects are allowed to sample from the urns, which, obviously, leads to preference for the ambiguous urn if favorable to one color. Model this by assuming that subjects do some sort of classical-statistics hypothesis testing. %}
Gigliotti, Gary & Barry Sopher (1996) "The Testing Principle: Inductive Reasoning and the Ellsberg Paradox," *Thinking and Reasoning* 2, 33–49.

{% **real incentives/hypothetical choice, for time preferences**: seems to be **decreasing/increasing impatience**: find counter-evidence against the commonly assumed decreasing impatience and/or present effect. %}
Gigliotti, Gary & Barry Sopher (2004) "Analysis of Intertemporal Choice: A New Framework and Experimental Results," *Theory and Decision* 55, 209–233.

{% This paper contains the nice observation that under RDU (= CEU (Choquet expected utility)) the decomposition W = f(P) with f strictly increasing amounts to exactly the same in a mathematical sense as imposing the qualitative probability axioms (having a P that orders events the same as W). So, probabilistic sophistication comes here from only qualitative probability and does not need the stronger conditions that Machina & Schmeidler (1992) had to impose for general probabilistic sophistication. The paper does try to formulate axioms, but, as Gilboa (1986, personal communication) pointed out there is something missing. Convex-rangedness of W does imply solvability of the more-likely-than relation, but not the Archimedeanity that is needed to get P. In other words, although W is quantitative and satisfies some sort of Archimedeanity in its ordinal class, it does not satisfy the additive Archimedeanity that is needed to give P. It does not exclude infinitely many equally likely disjoint nonnull events in terms of P. %}

Gilboa, Itzhak (1985) "Subjective Distortions of Probabilities and Non-Additive Probabilities," Working paper 18–85, Foerder Institute for Economic Research, Tel-Aviv University, Ramat Aviv, Israel.

{% %}

Gilboa, Itzhak (1986) "Non-Additive Probability Measures and Their Applications in Expected Utility Theory," Ph.D. dissertation, Dept. of Economics, University of Amsterdam.

{% P. 69 l. -6: in "f-convex" the author immediately uses the clever definition of betweenness for a preference interval that I at young age never found until I learned it from Fishburn's works.

P3*: gives pointwise monotonicity for simple acts.

P7*: A should be nonempty. Lemma 4.3.3: take B_j in Lemmea 4.3.2 as ~ {s: (j−1)/n ≤ u(f(s)) ≤ j/n}. Then $\overline{u} - \underline{u} \le \frac{1}{n}$. In proof of Theorem 4.3.4, on last page (p. 88): (i) is by P6*. In (ii), "in which case" is by P7*.

biseparable utility %}

Gilboa, Itzhak (1987) "Expected Utility with Purely Subjective Non-Additive Probabilities," *Journal of Mathematical Economics* 16, 65–88. https://doi.org/10.1016/0304-4068(87)90022-X

{% %}

Gilboa, Itzhak (1988) “The Complexity of Computing Best-Response Automata in Repeated Games,” *Journal of Economic Theory* 45, 342–352.

{% **EU+a*sup+b*inf** %}
Gilboa, Itzhak (1988) “A Combination of Expected Utility Theory and Maxmin Decision Criteria,” *Journal of Mathematical Psychology* 32, 405–420.

{% Games with incomplete knowledge, **common knowledge** %}
Gilboa, Itzhak (1988) “Information and Meta Information.” *In* Moshe Y. Vardi (ed.) *Proceedings of the Second Conference on Theoretical Aspects of Reasoning about Knowledge*, 227–243, Morgan-Kaufmann, Los Altos, CA.

{% %}
Gilboa, Itzhak (1989) “Duality in Non-Additive Expected Utility Theory,” *Annals of Operations Research* 19, 405–414.

{% %}
Gilboa, Itzhak (1989) “Additivizations of NonAdditive Measures,” *Mathematics of Operations Research* 14, 1–17.

{% **preferring streams of increasing income**; **intertemporal separability criticized**: p. 1155, bottom states that separability is more convincing for uncertainty than for other contexts. %}
Gilboa, Itzhak (1989) “Expectation and Variation in Multi-Period Decisions,” *Econometrica* 57, 1153–1169.

{% %}
Gilboa, Itzhak (1990) “A Necessary but Insufficient Condition for the Stochastic Binary Choice Problem,” *Journal of Mathematical Psychology* 34, 371–393.

{% %}
Gilboa, Itzhak (1990) “Philosophical Applications of Kolmogorov’s Complexity Measure.”

{% %}

Gilboa, Itzhak (1993) "Hempel, Good, and Bayes."

{% **free will/determinism** %}

Gilboa, Itzhak (1994) "Can Free Choice Be Known?". *In* Cristina Bicchieri, Richard C. Jeffrey, and Brian F. Skyrms (eds.) *The Logic of Strategy*, Oxford University Press, 163–174.

{% **foundations of statistics** %}

Gilboa, Itzhak (1994) "Teaching Statistics: A Letter to Colleagues."

{% %}

Gilboa, Itzhak (1995) Book Review of: Steven J. Brams (1994) "Theory of Moves." Cambridge University Press, New York; *Games and Economic Behavior* 10, 368–372.

{% **dynamic consistency** %}

Gilboa, Itzhak (1997) "A Comment on the Absent Minded Driver Paradox," *Games and Economic Behavior* 20, 25–30.

{% %}

Gilboa, Itzhak (1998) "Counter-Counterfactuals," *Games and Economic Behavior* 24, 175–180.

{% %}

Gilboa, Itzhak (2004, ed.) "*Uncertainty in Economic Theory: Essays in Honor of David Schmeidler's 65th Birthday*." Routledge, London.

{% On Goodman's paradox. Takes properties as functions of time (which is the novelty of Goodman) but then defines underlying constants such as "green at all times" and argues that green is easier to state in terms of such constants than grue. That green-at-all-times is a better constant than grue-at-all-times is, I guess, determined by evolution. Similarly one could, I guess, let evolution decide directly at the level of functions that green is a better function than grue. %}

Gilboa, Itzhak (2007) “Green is Simpler than Grue.”

{% **free will/determinism** %}
Gilboa, Itzhak (2007) “Free Will: A Rational Illusion.”

{% **criticisms of Savage’s basic mode**: in several places.

Text on decision under uncertainty based on what Gilboa teaches. The text pays much attention to methodological issues, based on Gilboa’s philosophical background, and is more oriented towards the probability-uncertainty part than towards the utility part.

Part I. Ch. 2 **free will/determinism**. §2.6: “The distinction between the acts, over which the decision maker has control, and states, over which she hasn’t, is one of the pillars of rational choice.” **foundations of probability**
Chs 3-5 (§5.3 on classical vs. Bayesian statistics).

Part II. §6 on **one-dimensional utility**, using this as the initial model to introduce terms such as normative. The author lets terms such as normative-descriptive and framing refer not only to agents, but also in a meta-sense for theorists developing theories. §6.4 introduces cardinal utility through **just noticeable difference**s and semi-orders.

Ch. 7 (where the author indicates that its location is somewhat ad hoc) argues that to some extent theories need not be so correct but need only be good tools (conceptual frameworks) for us researchers to find good conclusions. Ch. 8 has vNM EU preference axiomatization, with §8.3 sketching three ways of proof, Ch. 9 de Finetti’s SEV theorem with preference axiomatization, and Ch. 10 has Savage’s SEU theorem. Ch. 11 discusses the definition of states of nature. Ch. 12 discusses Savage’s axioms critically, with §12.3 discussing P1 (completeness) and P2 (sure-thing principle) jointly. For the author problems of completeness (P1) lead to multiple priors and then to violation of P2. Ch. 13 distinguishes between weak and strong rationality, with a big role for objectivity. (**ambiguity attitude taken to be rational**)

natural sources of ambiguity: §3.3.3: “David Schmeidler often says, ‘Real life is not about balls and urns’. Indeed, important decision involve war and peace, recessions and booms, diseases and cures. In these examples there are no symmetries and no natural priors, and the principle of indifference cannot lead us very far.”

(strong means you can convince others). Ch. 14 has Anscombe-Aumann. Ch. 15 brings CEU (Choquet expected utility), Ch. 16 has a digression on prospect theory in the new 1992 version, however doing it only for given probabilities and not giving the complete definition. Ch. 17 discusses CEU versus multiple priors. Part IV briefly brings the case-based model, presenting it as a model with cognitive inputs and not just **revealed preference**. %}

Gilboa, Itzhak (2009) "*Theory of Decision under Uncertainty*." Econometric Society Monograph Series, Cambridge University Press, Cambridge.

{% P. 3: Gilboa defines rationality as follows, as it had been done in preceding papers by him and Schmeidler:

"a mode of behaviour is rational for a given decision maker if, when confronted with the analysis of her behaviour, the decision maker does not wish to change it."

It is an interesting concept, worth studying and discussing. But it is absolutely not how I would define rationality. A heroine addict may not wish to change preferences, but I still call it irrational. In general, rationality has a natural-language meaning that is very important for decision theory. And that, I think, cannot be formalized, or expressed in mathematical terms. Many things can't be captured by mathematics, contrary to the thinking of some mathematicians subject to the ubiquity fallacy. Given the importance in our field of the natural-language word rational, I have always objected to any formalization of the concept, and here I do again. I guess that Giboa's condition is necessary for being rational because a rational agent will, I guess, be consciously aware of things, and therefore will not want to change, so that in that sense not-wanting-to-change is necessary for rationality. But it surely is not sufficient. Gilboa's concept becomes subjective, and an empirical concept. (My, vague, meaning of rationality does not.) Fellner (1961 p. 680) nicely stated my point: "But the question still remains whether leaving him alone is not like leaving an otherwise rational person alone who consistently prefers three dollars to *quatre dollars* [French for "four dollars"]. This latter person needs to be supplied with a dictionary rather than to be assured of our respect for his preference scales. He is making a mistake."

Gilboa then argues that we can "preach" rationality conditions. If we think that transitivity is necessary for rationality, which I do, then we can try to convince others that they should satisfy it. If we succeed then we are happy, but if not and an agent prefers to violate rationality, then for that agent transitivity is not rational in Gilboa's terminology.

P. 4 writes: "What are the merits of this definition then? We are equipped with the phenomenally elegant classical decision theory and faced with the outpour of experimental evidence à la Kahneman and Tversky, showing that each and every axiom fails in carefully designed laboratory experiments.4 What should we do in face of these violations? One approach is to incorporate them into our descriptive theories, to make the latter more accurate. This is, to a large extent, the road taken by behavioral economics. Another approach is to go out and preach our classical theories, that is, to use them as normative ones. For example, if we teach more probability calculus in high school, future generations might make less mistakes in probability judgments. In other words, we can either bring the theory closer to reality (making the theory a better descriptive one) or bring reality closer to the theory (preaching the theory as a normative one). Which should we choose?" The answer is easy, and already given in the cited text: for descriptive work we bring the theory closer to reality and for prescriptive theory the other way around.

P. 5: "The final judge of rationality is the decision maker herself." %}

Gilboa, Itzhak (2010) "Questions in Decision Theory," *Annual Review of Economics* 2, 1–19.
https://doi.org/10.1146/annurev.economics.102308.124332

{% P. 1: **common knowledge** references, agreeing to disagree, question of state of world resolving all uncertainty. %}

Gilboa, Itzhak (2011) "Why the Empty Shells Were not Fired: A Semi-Bibliographical Note," *Episteme* 8, 301–308.

{% P. 5 seems to write: "We consider a decision normatively appealing (to the decision maker) if the decision maker (still) makes this choice after thorough reflection." Strictly speaking, this text does not define normative, but only normatively appealing to the agent. %}

Gilboa, Itzhak (2012) "*Rational Choice*." MIT Press, Cambridge MA.

{% %}

Gilboa, Itzhak & Avraham Beja (1990) "Values for Two-stage Games: Another View of the Shapley Axioms," *International Journal of Game Theory* 19, 17–31.

{% %}

Gilboa, Itzhak, Ehud Kalai & Eitan Zemel (1990) "On the Order of Eliminating Dominated Strategies," *O.R. Letters* 9, 85–89.

{% %}

Gilboa, Itzhak, Ehud Kalai, & Eitan Zemel (1993) "The Complexity of Eliminating Dominated Strategies," *Mathematics of Operations Research* 18, 553–565.

{% %}

Gilboa, Itzhak & Robert Lapson (1995) "Aggregation of Semiorders: Intransitive Indifference Makes a Difference," *Economic Theory* 5, 109–126.

{% **value of information** ; seem to study when value of information can be because of future (unmodeled?) decisions to be taken. %}

Gilboa, Itzhak & Ehud Lehrer (1991) "The Value of Information - - An Axiomatic Approach," *Journal of Mathematical Economics* 20, 443–459.

{% %}

Gilboa, Itzhak & Ehud Lehrer (1991) "Global Games," *International Journal of Game Theory* 20, 129–147.

{% **CBDT**: Take objective probabilities as similarity-weighted average observed relative frequencies. Propose to estimate the similarity function from data. The result is related to Gilboa & Schmeidler (2003 Methods of Operations Research). %}

Gilboa, Itzhak, Offer Lieberman, & David Schmeidler (2010) "On the Definition of Objective Probabilities by Empirical Similarity," *Synthese* 172, 79–95.

{% **CBDT**;

This paper relates case-based decision theory to statistical techniques, in particular kernel methods. Thus the decision-theory axioms of CBDT, in particular the combination axiom, can be related to statistics. Model: To estimate y_t of a subject with variables $(x_t^1,\ldots,x_t^d)$, we observe n subjects with values y_i related to $(x_i^1,\ldots,x_i^d)$, i = 1, …, n. The paper does not use regression estimates, but normalized similarity-weighted averages of the y_i based on the similarities of the x vectors. %}

Gilboa, Itzhak, Offer Lieberman & David Schmeidler (2011) "A Similarity-Based Approach to Prediction," *Journal of Econometrics* 162, 124–131.

{% **ambiguity attitude taken to be rational**: Consider two preference relations as primitives. The first is objectively rational in the sense of being justifiable to others. The second is subjectively rational in the sense of not being justifiably wrong. The first is incomplete, and the second extends the first (imposed by their axiom with the vague name consistency on p. 761) into a complete relation (we also have to choose if no decisive objective arguments). A similar idea is in Greco, Mousseau, & Slowinski (2010).

The authors use the Anscombe-Aumann framework. The authors impose preference conditions, mainly the usual vNM independence in the Anscombe-Aumann setting, for the objective preference relation. They argue that the usual argument for vNM independence is convincing for objective rationality. For incomplete preference relations this leads to a multiple prior Bewley (1986, 2002) incomplete model with preference f > g iff EU-unanimous (EU(f) > EU(g) under all probability measures in the set of priors).

To axiomatize the subjective relation, the authors impose a very ambiguity averse axiom (caution, p. 761): If f is constant (assigning the same outcome to each state of nature, where outcome can be sure prize but also probability distribution over prizes with risk involved; at any rate no ambiguity involved) and g is not constant, and g is not objectively preferred to f, then already f is subjectively preferred to g. So, subjective preference is in favor of certainty (in sense of no ambiguity but maybe still risk) as much as at all possible given the objective preference relation. Then ambiguous acts are evaluated as negatively as can be; i.e., it is maxmin EU w.r.t. the same set of priors as used in Bewley model. So, caution then characterizes maxmin.

The authors argue that it is natural that subjective preference violates Anscombe-Aumann independence because of hedging. I disagree with this in the sense that I disagree with the very Anscombe-Aumann framework to model ambiguity. I think that independence with respect to prior probabilistic mixing is just as convincing here as it is for objective acts. Independence with only posterior mixing, as commonly taken in the Anscombe-Aumann framework nowadays (1990-2023), is not convincing for the reasons given by the authors. The equating of prior and posterior mixing (reversal of order), while acceptable under Anscombe-Aumann with EU, is not convincing under nonEU and ambiguity, and this is the reason that the Anscombe-Aumann framework, so popular in the modern literature, is not suited for analyzing ambiguity. I prefer Jaffray's justification of independence for prior mixing also under ambiguity but against posterior mixing. (So, referring to p. 760 last sentence of §2.2, a DM can reason in terms of the mixture operation but does not want to.) Once Anscombe-Aumann accepted, then "soit" (let it be as it is) as the French would say. A limitation of the analysis is also that it is still completely hooked up with only one ambiguity attitude: Aversion aversion aversion. The reference to Rubinstein (1988) in the concluding para of the main text (p. 764) is irrelevant (we can call everything a "relation" as much as the similarity relation; it is not a preference relation).

The idea of an incomplete primitive relation to start with and then extensions to completeness is natural. The objective/subjective distinction is nice too, although the criteria for objective and even more for subjective rationality is too permissive and more restrictions are conceivable. For example, could the symmetry argument in the middle of p. 757 not be given an objective status, even if ambiguity? Nice is also that two popular conservative approaches to multiple priors, the Bewley (1986, 2002) unanimity and maxmin, are brought together. So, this is a pretty paper. I do not like Anscombe-Aumann for ambiguity and the focusing on only aversion for ambiguity, but, soit. %}

Gilboa, Itzhak, Fabio Maccheroni, Massimo Marinacci, & David Schmeidler (2010) "Objective and Subjective Rationality in a Multiple Prior Model," *Econometrica* 78, 755–770.

{% <u>I checked the long file out on the term belief but found no clear interpretations stated in this survey.</u>

survey on nonEU: a good reference for surveying axiomatic approaches based on the Anscombe-Aumann framework. §5 is on updating under ambiguity (**updating under ambiguity**).

They affirmatively cite a text by Arrow who, I think erroneously, suggested that (monotone) continuity is a harmless assumption. (**criticizing the dangerous role of technical axioms such as continuity**) %}

Gilboa, Itzhak & Massimo Marinacci (2013) "Ambiguity and the Bayesian Paradigm." *In* Daron Acemoglu, Manuel Arellano, & Eddie Dekel (eds.) *Advances in Economics and Econometrics: Theory and Applications, Tenth World Congress of the Econometric Society* Vol. 1 Ch. 7, 179–242. Cambridge University Press, Cambridge UK.

Reprinted as:

Gilboa, Itzhak & Massimo Marinacci (2016) "Ambiguity and the Bayesian Paradigm." *In* Horacio Arló-Costa, Vincent F. Hendricks, & Johan F.A.K. van Benthem (eds.), *Readings in Formal Epistemology*, 385–439. Springer, Berlin.

{% Abstract: "A mode of behavior is rational for a decision maker if she feels comfortable with it once it has been analyzed and explained to her." It is the defintion of rationality in many papers by Gilboa, and is an interesting concept, but I think it should not be called rationality. The paper presents a new preference model and its axiomatization that can be seen independent of whatever interpretation of rationality one has.

The model is decision under risk and expected utility (EU) with one modification: the outcome set X is partitioned into X_1 and X_2. X_1 is extra aversive. Further, $b > 0$ is a constant. There is extra appreciation, b, if the probability of receiving nothing from X_1 is 0. Thus, for a lottery L over X, the value is $EU(L) + b$ if $L(X_1) = 0$ and it is EU(L) if $L(X_1) > 0$. It is sort of Archimedean non-Archimedeanity. The authors also consider the cases where there are more than two categories of outcomes. %}

Gilboa, Itzhak, Stefania Minardi, & Fan Wang (2024) "Rationality and Zero Risk," *Journal of the European Economic Association* 22, 1–33. https://doi.org/10.1093/jeea/jvad071

{% The authors discuss the use of preference axiomatizations of individual choice under uncertainty/risk for descriptive applications in economics. (1) Axioms are more useful for normative applications than for descriptive; (2) are more used to defend a model than to criticize it; (3) are more used in a meta-science manner (to convince other researchers, "rhetorically" where this word is not meant to have negative nuances) than concretely.

The authors paraphrase Tolstoy's saying on happy families, replacing happy by rational, and some other things: "All rational people are rational in the same way, but all irrational ones are irrational in their own way." %}

Gilboa, Itzhak, Andrew Postlewaite, Larry Samuelson, & David Schmeidler (2019) "What Are Axiomatizations Good For?," *Theory and Decision* 86, 339–359. https://doi.org/10.1007/s11238-018-09685-1

{% **ambiguity attitude taken to be rational**: A didactical discussion of expected utility and preference axioms. The authors argue that the sure-thing principle is not convincing and that, hence, multiple priors is better (p. 184 2nd para is very explicit on this point). They also argue against completeness (**completeness criticisms**) but derive no model from it; multiple priors satisfies completeness. They argue that if it is not clear what the state space should be, then case-based decision theory is better. They also argue that case-based decision theory offers insights into how people choose probabilities.

SEU = risk: P. 173 suggests that if Savage's model of decision under uncertainty holds, then this is "reduced to problems of decision under risk." I prefer to let decision under risk refer only to the case of objective probabilities.

P. 174 4th paragraph assumes that objective probabilities are automatically informationally preferable to cases of unknown probabilities. P. 176 middle likewise assumes that a known 60% probability will be preferred to an unknown 60% probability.

P. 177: they cite Drèze (1961) for his work on state dependence; not for his preceding work on maxmin EU.

Pp. 179-180 argues that completeness is unconvincing because we often have no clear preference. (**completeness criticisms**)

P. 181 suggests that choices of utility are entirely subjective and never irrational (as soon as some basic requirements), but choices of subjective probabilities can more easily be irrational. (**paternalism/Humean-view-of-preference**). It is true that for probabilities there is some more a criterion of truth when objective probabilities exist, which has more exact truth status than linear utility for moderate amounts. But this difference is not essential for most situations where subjective probabilities exist.

P. 185 2nd para nicely states that problem of finding appropriate probabilities has simply been replaced in case-based decision theory by the problem of finding appropriate similarity weights, but continues to argue that the introduction of similarity is nevertheless a meaningful step and that sometimes there can be objective bases for similarity weights (but that also can be for probabilities) and give an example of Gilboa, Lieberman, & Schmeidler (2006) where similarity weights have been obtained through optimal fits with historical data.

The paper ends in its last para with bringing up statistics, where sets of probabilities are considered. There is a difference with multiple priors though, being that in multiple priors the sets of probabilities concern the outcome relevant events, whereas in statistics they only concerns signals (this is what observed statistics are). In statistics the outcome-relevant events concern the unknown statistical parameters, but over these no (sets of) probability distributions are imposed. %}

Gilboa, Itzhak, Andrew W. Postlewaite, & David Schmeidler (2008) "Probability and Uncertainty in Economic Modeling," *Journal of Economic Perspectives* 22, 173–188.

{% **ambiguity attitude taken to be rational**

The authors argue against Bayesian expected utility. I, Bayesian, of course disagree. P. 285 writes: "Choosing one probability number in the interval [0,1] would be akin to pretending that we know something that we don't." a criticism often leveled against expected utility. I disagree. A subjective probability is not an expression of knowledge about some fact in the world, unlike objective probability, but it is only language to express an attitude, a decision. If the authors prefer a multiple prior model to capture their attitude, they have to use language to express their attitude, which will involve utility and a set of priors. They then are not claiming to have some magical info, but only express their attitude. If they are allowed to "exactly" specify a set of probabilities why isn't a Bayesian allowed to "exactly" specify a probability? Same story for utility. How can they pretend to "exactly" know utility?

P. 286 writes: "The Bayesian approach is lacking because it is not rich enough to describe one's degree of confidence in one's assessments." I, again, disagree. One's confidence in one's assessment shows up, in Bayesiansm, where it should, and that is in updating. If you throw a biased coin and observe a heads-up, how much this changes your belief in a next heads-up depends on your degree of confidence in your prior belief, including the nr. of observations that your prior belief is based upon.

P.287 Footnote 2 cites Carnap (1952), Lindley (1965), Levi (1980), and Jeffrey (2004) as people agreeing that expected utility is imperfect. I am sure that this is incorrect for Lindley, strongly convinced it is incorrect for Carnap, am sure it is correct for Levi, and don't know about Jeffrey.

P. 287 writes: "Moreover, many believe that there is no mathematical result in the entire corpus of the social sciences that compares to Savage's theorem in terms of elegance and generality, as well as conceptual and mathematical depth." I belong to those many believing it.

P. 289 writes: "But the quest for a single set of rules that will universally define *the* rational choice is misguided." [italics from original] This is a misleading version of Bayesianism. Bayesianism claims that expected utility is necessary for rationality, not sufficient. It therefore does not "define" rationality. The authors later, when writing their own opinions, do properly point out that consistency conditions are not enough for rationality. P. 290 writes: "Savage's axioms are consistency principles ... In isolation, these principles do not put any constraints on one's beliefs. Hence, they are insufficient for a definition of rationality. A definition of rationality that does not impose additional constraints on beliefs beyond Savage's consistency principles would be … " And later, p. 292: "Internal coherence of beliefs is important, but so is external coherence"

P. 289: "When dealing with the definition of morality or of rationality, we take a normative point of view, rather than a descriptive one: we attempt to model the behaviour that people would like to exhibit, rather than the behaviour they actually do exhibit." I disagree with this definition, also written in other papers by the authors. Rational need not be what people want themselves.

P. 291: "We may also feel that all equally poor people should be entitled to the same level of support." I do not understand this example. We may not be able to support all equally poor people simply because of practical constraints, and I see no relevance for the discussion of rational axioms there. %}

Gilboa, Itzhak, Andrew Postlewaite, & David Schmeidler (2009) "Is It always Rational to Satisfy Savage's Axioms?," *Economics and Philosophy* 25, 285–296. https://doi.org/10.1017/S0266267109990241

{% **paternalism/Humean-view-of-preference**: the paper claims that economics has this view, but the paper argues against it.

ambiguity attitude taken to be rational

The abstract claims that economics reduces rationality to (Bayesian) consistency. I think that Bayesian consistency is necessary but surely not sufficient for rationality. Although some economists claim sufficiency, I don't expect that to be any, given that (I think) it is very dumb. The authors argue that the latter is too permissive and that beliefs, for instance, can be irrational, which I agree with. They also argue that Bayesian consistency is also too restrictive because deviations from Bayesianism can be rational, where I disagree.

P. 17 penultimate para claims (as in first tenet on p. 14) that all relevant info, also regarding the choice of subjective probability, should be captured by the (grand) state space. Such a view is also found in papers by Aumann, and in the circular definitions of types of players by Harsanyi. I disagree. Thoughts about the state space, such as about what the right subjective probabilities are, should be at a higher level and should not be captured in the state space (grand or not), to avoid circular definitions. The set describing ALL information will face the Russel paradox, like the set containing all sets (variation: set that contains all sets that do not contain themselves).

P. 18 3rd para writes that Gilboa & Schmeidler (1989), and Schmeidler (1989), were not meant to be descriptive: "While the non-additive Choquet expected utility model and the maxmin expected utility model can be used to resolve Ellsberg's paradox (1961), they were not motivated by the need to describe observed behavior, but rather by the a-priori argument that the Bayesian approach is too restrictive to satisfactorily represent the information one has."
%}

Gilboa, Itzhak, Andrew Postlewaite, & David Schmeidler (2012) "Rationality of Belief or: Why Savage's Axioms are Neither Necessary nor Sufficient for Rationality," *Synthese* 187, 11–31.

{% Argue that economics is more case-based, and psychology is more rule-based. Economists live with models of which they know that they are "wrong" (I would not say wrong, but only approximative of the truth). The authors argue that every theorem, data set, or whatever, in economics is just an extra argument for or against some hypothesis, adding according to its similarity weight.

Section 3.1 suggests that economic papers can be rejected if the proofs of theorems are not intuitive, but I think that the nature of mathematical proofs in appendices is usually ignored. Axioms/conditions should be intuitive, that is true. Section 3.2 claims that axioms are not useful in testing theories ("Moreover, when statistical errors are taken into account, one may argue that it is better to test the theory directly, rather than to separately test several conditions that are jointly equivalent to the theory.") But in many cases it is easier to test axioms and it is not clear how to test a theory directly. %}

Gilboa, Itzhak, Andrew Postlewaite, Larry Samuelson, & David Schmeidler (2014) "Economic Models as Analogies," *Economic Journal* 124, F513–F533.

{% %}

Gilboa, Itzhak & Dov Samet (1989) "Bounded versus Unbounded Rationality: The Tyranny of the Weak," *Games and Economic Behavior* 1, 213–221.

{% **Harsanyi's aggregation**: There are well-known impossibility results on aggregating individual SEU maximizers into a social SEU maximizer, with violations of Pareto (PO) unavoidable (Mongin 1995). The authors argue that PO is not reasonable if subjects have different subjective probabilities, and impose it only if they have the same subjective probabilities. Then the group SEU is a weighted average of the individual SEUs (so, group-subjective probability is weighted average of individual subjective probabilities, with group utility weighted average of individual utilities. The proof then is like Harsanyi (1955). %}

Gilboa, Itzhak, Dov Samet, & David Schmeidler (2004) "Utilitarian Aggregation of Beliefs and Tastes," *Journal of Political Economy* 112, 932–938.

{% Assuming no bounded rationality limitations, the paper shows that agents who only learn from objective info, ignoring subjective considerations, are doomed to ineffective learning. Their model involves Turing machines. %}

Gilboa, Itzhak & Larry Samuelson (2012) "Subjectivity in Inductive Inference," *Theoretical Economics* 7, 183–215.

{% The intro opens with a catchy text on drawing the line between trading and betting, which is a lead through the paper. Preceding results required, for Pareto-improving trade, that there must exist a common probabilistic belief supporting it. This paper extends to ambiguity: There must be a common ambiguous belief. It does so for maxmin EU. Raising the research question how this goes with other ambiguity models. %}

Gilboa, Itzhak & Larry Samuelson (2022) "No-Betting Pareto under Ambiguity," *Theory and Decision* 92, 625–645.
https://doi.org/10.1007/s11238-021-09817-0

{% The paper considers separating hyperplane theorems, leading to maxmin functionals in Theorem 1 (assuming payment in utility units, i.e., linear utility). It relates it to the fundamental no-arbitrage theorem in finance. It gives careful didactical explanations on how to use such results in normative settings. The paper pleas for ambiguity aversion. %}

Gilboa, Itzhak & Larry Samuelson (2022) "What Were You Thinking? Decision Theory as Coherence Test," *Theoretical Economics* 17, 507–519.
https://doi.org/10.3982/TE4707

{% If Alice prefers bananas to apples and Bob prefers apples to bananas, then (Alice: 2 bananas, Bob: 2 apples) is Pareto optimal. Nothing wrong with it if we make the assumption, common in economics, that de gustibus non est disputandem, which is commonly taken to mean that any utility function is acceptable (the authors write this more or less on p. 1406). However, now assume that Ann thinks P(E) = 1 and Bill thinks that P(not-E) = 1. Then (Ann: 2 if E & nil otherwise, Bill: 2 if not-E & nil otherwise) is Pareto optimal. But now it is due to different beliefs and we feel that then one must be wrong. Therefore, the authors define the Pareto condition as an allocation being so not only by every person's beliefs but also there must exist at least one common belief such that it is optimal for every agent. In the other case, the Pareto condition can only live by at least one wrong belief, which makes it less convincing.

A deep underlying idea of this paper is that uncertainty/probability is different than outcomes in the sense that there can be one true probability and that it is an error to have a different belief.

conservation of influence: p. 1415 defines (f,g) as swapping g for f.

Theorems 1 and 2 derive results from the theorem of the alternative. %}

Gilboa, Itzhak, Larry Samuelson, & David Schmeidler (2014) "No-Betting Pareto Dominance," *Econometrica* 82, 1405–1442.

{% %}

Gilboa, Itzhak & David Schmeidler (1988) "Information Dependent Games: Can Common Sense Be Common Knowledge?," *Economics Letters* 27, 215–221.

{% **ambiguity attitude taken to be rational**

biseparable utility;

event/outcome driven ambiguity model: event driven

Remarkably, Drèze (1987 Ch. 2) derived essentially the same theorem as this paper does, axiomatizing maxmax EU (G&S do maxmin), using essentially the same axioms, but interpreting it not as ambiguity but as moral hazard. %}

Gilboa, Itzhak & David Schmeidler (1989) "Maxmin Expected Utility with a Non-Unique Prior," *Journal of Mathematical Economics* 18, 141–153.

{% **dynamic consistency**: **favors abandoning time consistency, so, favors sophisticated choice**: seems so; **updating under ambiguity**

Consider a general axiomatic approach to updating. They use the term "Bayesian updating" for update rules where one act is fixed outside of E and the choice of this same act is then used for all updatings in all decision situations; the act is not explicitly related to a prior optimization procedure. %}

Gilboa, Itzhak & David Schmeidler (1993) "Updating Ambiguous Beliefs," *Journal of Economic Theory* 59, 33–49.

{% %}

Gilboa, Itzhak & David Schmeidler (1994) "Infinite Histories and Steady Orbits in Repeated Games," *Games and Economic Behavior* 6, 370–399.

{% Contains adaptation of Radon-Nikodym to nonadditive measures in §7, by going through Möbius inverse. %}

Gilboa, Itzhak & David Schmeidler (1994) "Additive Representations of Non-Additive Measures and the Choquet Integral," *Annals of Operations Research* 52, 43–65.

Mathematics of Operations Research

{% %}

Gilboa, Itzhak & David Schmeidler (1995) "Canonical Representation of Set Functions," *Mathematics of Operations Research* 20, 197–212.

{% **CBDT** %}

Gilboa, Itzhak & David Schmeidler (1995) "Case-Based Decision Theory," *Quarterly Journal of Economics* 110, 605–639.

{% **CBDT** %}

Gilboa, Itzhak & David Schmeidler (1996) "Case-Based Optimization," *Games and Economic Behavior* 15, 1–26.

{% **CBDT** %}

Gilboa, Itzhak, David Schmeidler (1996) "Case-Based Knowledge and Intuition," *IEEE Transactions on Systems, Man and Cybernetics*, Part A.

{% Uses **CBDT** %}

Gilboa, Itzhak & David Schmeidler (1997) "Cumulative Utility Consumer Theory," *International Economic Review* 38, 737–761.

{% **CBDT** %}

Gilboa, Itzhak & David Schmeidler (1997) "Act Similarity in Case-Based Decision Theory," *Economic Theory* 9, 47–61.

{% **measure of similarity**; **CBDT**

Actual problem p, to be chosen from set D of acts. Preferences over acts depend on memory M. D is fixed, and M is variable. M is set of cases. Cases are triples (p,a,r), with p problem faced in the past, a the act chosen in problem p, and r the outcome resulting.

Pp. 16-17: behaviorist is strict revealed preference.

behavioral, in the terminology of these authors, is based on revealed preference but that use cognitive metaphors.

cognitive: allow for cognitive (which includes emotional in their terminology as they explain) empirical inputs.

P. 19 ℓ. 3: rationality definition requires cognitive inputs.

P. 27: good decision theory should tell a convincing story about the cognitive processes. (**coherentism**)

Pp. 31-32: CBDT if cannot specify all the states.

P. 35 §4.2: with problems, acts, results, similarity weights are taken to depend only on problems.

P. 35: similarity is the main engine of CBDT

P. 36: similarity weights are nonnegative.

Pp. 34-39, §4.2: each case occurs only once.

P. 38: sum is taken only over past circumstances involving the same act as now considered. (Amounts to taking similarity weights 0 for different past acts.)

P. 40: because sum of similarity weights is not constant, level of utility (where it is 0) is important. Also p. 43.

P. 41: 0 utility level serves as kind of aspiration level. If act has utility below, then a completely new and unknown act is preferred. But if act has positive utility, then no completely new and unknown act is chosen anymore.

P. 44: CBDT and EU are complementary.

P. 45: CBDT if structural uncertainty, where we do not know what the state space is.

P. 47: CBDT can incorporate hypothetical cases, such as Jane knowing she would have run into road construction and delay had she taken route B.

P. 51: circumstance-similarity

Pp. 52-53: case-similarity

Pp. 55 ff.: repetitions approach, where each case (p,a,r) can occur any finite number of times in M. Then techniques similar to Wakker (1986, Theory and Decision) can be used to axiomatize a cardinal representation. Ch. 3, pp. 62-, gives it. P. 66 Axiom A2 (combination) is the additivity axiom.

P. 74 discusses average approach (denoted V) where similarity weights are normalized, and which is appropriate if we observe many repeated independent cases. The page gives the Simpson paradox. For a long time I did not understand the argument the authors give for average versus sum, but now I think I do. If infinitely repeated choices, the act with highest average is best. For one single choice now, the info it gives for all future choices is infinitely more important than the preference value it yields for this one time. So, one is only out for finding the best average in repeated choice, and only for the info-part. In one-time choice one may prefer a first act with a somewhat lower positive average but more info, because a second act with higher positive average one may have less info about so, it is plausible that its real utility will be lower than its average up to now.

P. 75 explains that the additive combination axiom A2 (p. 66) is reasonable only if the memories considered are complete, and have no implicit background memory that in fact makes them nondisjoint. The latter is the case in statistics where two disjoint sets of observations give no rejection of H_0, but their combination does. Violations are further discussed on pp. 174-181.

Pp. 93-95 that CBDT is less hypothetical than EU.

Pp. 133, 148 ff. on zero level of utility.

Pp. 158 ff. on sum versus average. %}

Gilboa, Itzhak & David Schmeidler (2001) "*A Theory of Case-Based Decisions.*" Cambridge University Press, Cambridge.

{% **coherentism**: Argue that nonbehavioral, "cognitive," inputs are desirable. Evaluate consumption streams $(x_1,\ldots,x_n)$, with n variable, through:

There exist real numbers $w_1,w_2,\ldots$ and s_{it} $(1 \leq i < t)$ s.t.

$\Sigma_{1\leq t\leq T}\big(w_t(x_t^T - a_t(x^T))\big)$

with $a_t(x^T) = \Sigma_{1\leq i\leq t-1} s_{it} x_i^T$

evaluates the consumption stream $(x_1^T, \ldots, x_T^T)$.

G&S relate the different coordinates to "facts" and not to timepoints. The fixed ordering of the facts would fit well with timepoints also. One can interpret $a_t(x^T)$ as aspiration level at timepoint t.

For each fixed n the representing function is a linear form, and the authors give the classical additivity preference axioms to justify this form for each fixed n. Then they add existence of a neutral outcome x_{n+1} (depending on $x_1 \cdots x_n$) to make the n+1 tuple indifferent to the n-tuple, probably to fix the location constant of each representation. They give many interpretations of the form regarding aspiration, self-deception, social influence (x_2 can describe the income of your neighbor), etc. %}

Gilboa, Itzhak & David Schmeidler (2001) "A Cognitive Model of Individual Well-Being," *Social Choice and Welfare* 18, 269–288.

{% **CBDT** The cognitive foundation is how past cases in memory, using the techniques of case-based decision theory. It leads to probability judgments. The result is related to Gilboa & Schmeidler (2003 Econometrica). %}

Gilboa, Itzhak & David Schmeidler (2002) "Cognitive Foundations of Probability," *Mathematics of Operations Research* 27, 65–81.

{% Assume a particular game matrix given. Then assume that for player 1 all (or many) probability distributions over strategy choices of opponent are conceivable, and take all rankings of player 1's strategies given all those probability distributions as input. Provide representation theorem for this, using CBDT techniques (with varying probability distributions instead of varying frequencies of cases in memory). The paper is somewhat like Aumann & Drèze (2008). Kadane & Larkey (1982, 1983) and ensuing discussions also discuss the issue. (**game theory can/cannot be viewed as decision under uncertainty**) %}

Gilboa, Itzhak & David Schmeidler (2003) "A Derivation of Expected Utility Maximization in the Context of a Game," *Games and Economic Behavior* 44, 184–194.

{% **CBDT**; For each choice object x, $\sum_{c \in M} v(x,c)n(c)$ is its value, with n(c) the number of times case c appears in memory, and v(x,c) the support of case c for object x. So, for every x it is an x-dependent repetitions approach (Wakker 1986) evaluation. It is so in the CBDT dual theory (requiring diversity) for each choice object. The result is related to Gilboa & Schmeidler (2003 Methods of Operations Research). %}

Gilboa, Itzhak & David Schmeidler (2003) "Inductive Inference: An Axiomatic Approach," *Econometrica* 71, 1–26.

{% %}

Gilboa, Itzhak & David Schmeidler (2004) "Subjective Distributions," *Theory and Decision* 56, 345–357.

{% Theory selection based on finite data sets is axiomatized. Generalizes the Akaike criterion. %}

Gilboa, Itzhak & David Schmeidler (2010) "Simplicity and Likelihood: An Axiomatic Approach," *Journal of Economic Theory* 145, 1757–1775.

{% **CBDT; tradeoff method** used for theoretical purpose. %}

Gilboa, Itzhak, David Schmeidler, & Peter P. Wakker (2002) "Utility in Case-Based Decision Theory," *Journal of Economic Theory* 105, 483–502.

https://doi.org/10.1006/jeth.2001.2858

Direct link to paper

Link to comments

(Link does not work for some computers. Then can:

go to Papers and comments; go to paper 02.2 there; see comments there.)

{% **conservation of influence**: There is a special status for a status quo option. The agent primarily distinguishes between sticking with the status quo or deviating, and only secondarily with how to deviate. Case-based reasoning and maximum likelihood are used to decide whether or not to deviate from the status. The very fact that something is status quo provides info that it probably is good, corresponding with a theory saying that it is better than all alternatives. New info/theories must come to overrule it. %}

Gilboa, Itzhak & Fan Wang (2019) "Rational Status Quo," *Journal of Economic Theory* 181, 289–308.

{% **foundations of quantum mechanics** %}

Giles, Robin (1970) "Foundations for Quantum Mechanics," *Journal of Mathematical Physics* 11, 2139–2160.

{% **foundations of probability** (?) %}

Giles, Robin (1988) "The Concept of Grade of Membership," *Fuzzy Sets and Systems* 25, 297–323.

{% Assume disappointment aversion, modeled as loss aversion, in game situations. It is essential that reference points are endogenous. Subjects take expected gain as reference point, and they instantaneously adapt it to their own, and their opponent's, moves. This is what their experiments find. Expectations may be salient when in competition. %}
Gill, David & Victoria Prowse (2012) "A Structural Analysis of Disappointment Aversion in a Real Effort Competition," *American Economic Review* 102, 469–503.

{% **three-doors problem**; Contains many nice references on the topic, and nicely discusses the role of the host's strategy in case he has to choose from two doors not containing the prize. But the paper starts very unfortunately in the abstract by giving (citing) a description where an essential piece of information is missing: that the host should always open a door with no prize. %}
Gill, Richard D. (2011) "The Monty Hall Problem is not a Probability Puzzle," *Statistica Neerlandica* 65, 58–71.

{% An overview of regressions where the independent variables also have errors. %}
Gillard, Jonathan (2010) " An Overview of Linear Structural Models in Errors in Variables Regression," *REVSTAT - Statistical Journal* 8, 57–80.

{% The paper introduces a method ("ORIV") for handling error in measurement that, apparently, is new. It is something like doing a measurement twice and then using each as an instrumental variable for the other. A specialist in econometrics explained the basic idea of this paper to me as follows: "The way I think about this method intuitively is that you look at the correlation between X (psychological concept of interest) and Z (IV, other way of measuring the same psychological concept). Let's say this is 0.5, then it must be the case that there is 50% measurement error since Z and X should measure the same concept (i.e. the correlation should be 1 in theory). What you then do is assuming that there must also be 50% measurement error in the relationship between Z and Y (the outcome). So, effectively you multiply the coefficient of Z on Y by 2 to account for the fact that X and Z are also only 50% correlated." My worry here is that by getting much noise in Z, you can

boast your correlations much.

When the authors reanalyze existing data, and replicate experiments (with N=786 subjects), they invariably find way higher correlations than was done before. For instance, they find high correlations between different measurements of risk aversion. And they do so with Halevy (2007) on violation of RCLA and ambiguity aversion and find an almost perfect correlation. An "uncorrected" correlation of 0.65 is increased into 0.85 using their correction (p. 1857). This is potentially very interesting, shedding new light on many phenomena, and the paper received much interest.

I did not come to understand the authors' method (colleagues told me that p. 1850 is clear), but I feel doubts because I think that violation of RCLA and ambiguity aversion are just different things. Even exact replications of subjective attitude variables half an hour apart have low correlations usually. Could it have to do with joint variances all being maximally ascribed to what gives correlations? Often, econometric techniques take errors of different actions within one individual as independent, an assumption that I dislike. (Clustering helps.)

Two econometrics specialists told me that the orthogonality assumption on p. 1831 ℓ. 14 is very restrictive.

The paper often writes as if most past papers did not reckon with measurement error at all, suggesting that this paper is among the first. For instance, p. 1828 top: "In contrast, we find that many commonly used measures of risk attitudes are highly correlated once measurement error is taken into account." Or p. 1833: "It emphasizes, as we do, the ubiquity of measurement error, and the paucity of concern about it." Or p. 1844: "However, none of the studies on which this conclusion is based account for measurement error." This is misleading. EVERY statistical test and reported p-value is based on an underlying assumption of measurement error, including every t-test and Wilcoxon test etc. The authors probably have in mind only the sophisticated measurement error models with quite precise quantitative assumptions and parametric assumptions about them that are commonly used by econometricians, and they ignore everything else. Sometimes econometricians are narrow on such things. For instance, they often take t-tests just as special case of regressions, not knowing that t-tests need milder assumptions than regular regressions.

suspicion under ambiguity: I did not find a control against suspicion mentioned on pp. 1835-1836.

random incentive system: apparently they paid for all choices (p. 1838 top), which I regret.

p. 1844: Allocations of assets (called "projects") seem to better measure risk attitudes than choice lists. My gut feeling suggests that it is opposite. P. 1845 end of 1st para suggests that in the projects no risk seeking is possible, which makes me worry about it. %}

Gillen, Ben, Erik Snowberg, & Leeat Yariv (2019) "Experimenting with Measurement Error: Techniques with Applications to the Caltech Cohort Study," *Journal of Political Economy* 127, 1826–1863.

{% Playing with probabilities and odds. %}

Gillies, Donald (1990) "The Turing-Good Weight of Evidence Function and Popper's Measure of the Severity of a Test," *British Journal for the Philosophy of Science* 41, 143–146.

{% **foundations of probability** %}

Gillies, Donald (2000) "*Philosophical Theories of Probability*." Routledge, London.

{% %}

Gilovich, Thomas & Victoria Husted Medvec (1995) "The Experience of Regret: What, when and why?," *Psychological Review* 102, 379–395.

{% %}

Giné, Xavier, Jessica Goldberg, Dan Silverman, & Dean Yang (2018) "Revising Commitments: Field Evidence on the Adjustment of Prior Choices," *Economic Journal* 128, 159–188.

{% Motivated Bayesian is a broad term to designate the following concept: a person, when gathering info, will be biased in believing more in info that supports morality of the person. So, it is a form of self-deception, similar to the confirmatory bias (cited by the authors) and, in psychology, rationalization and cognitive dissonance. Bayesian here does not refer to expected utility or even much to updating, but is just the general point that people process info properly in a general informal sense. Motivated is not general motivation but the very particular motivation of self-deception to think to be more moral than is real. One challenge for studying this is that self-deception is a subtle concept, not easy to induce or find. One has to induce a sort of split-personality of on the one hand knowing but on the other not. An even challenge is to empirically isolate self-deception from other factors, in particular deception of others. I read a few experiments reviewed in the paper, but disappointedly came to think that none handles these two challenges.

P. 192 last para: Subjects had to allocate a nice (incentivized) and nonnice (nonincentivized) job, one to themselves and the other to a partner. They could just do it, or flip a coin to decide. They described what they did to the experimenter. But it was unverifiable what they had done, e.g. if they had flipped a coin at all, and if they had, what the result had been. Of the subjects who said they had had a coin flip decide, 90% ended up taking the nice job themselves, as much as the noncoin flippers. The authors interpret this finding as self-deception and motivated Bayesianism. But I take it as the opposite: The subjects only want to deceive the experimenter and possibly the partner, and not themselves. Those who claim to have tossed a coin but lie, add immorality by not only taking the nice thing themselves but by also lying. And they know so, and do and cannot deceive themselves. I have the same problem with the experiment on p. 193 bottom (Figures 1 & 2).

Pp. 199-200: Some subjects are told that endurance to stand cold water predicts longevity of life duration. Others are told the opposite. (Entails deception but so, be it.) The former endure more. Alternative explanation: Subjects are seduced to misperceive the causal relation, and in the second group reason: if I do a big effort then I get punished by living shorter. So, I don't do a big effort.

P. 200 2nd para: a winner does not critically investigate own performance. Alternative explanation: because no need, as things are going well anyhow. A loser has to search for changes.

The paper opens with "A growing body of evidence," with "growing literature" in its concluding sentence, opens many sentences with "importantly," repeats its main hypothesis prior to any discussion, mentions "important" implications for economics and policy (p. 191 end of intro), and ends the conclusion with it being desirable to have more future investigations. %}

Gino, Francesca, Michael I. Norton, & Roberto A. Weber (2016) "Motivated Bayesians: Feeling Moral While Acting Egoistically," *Journal of Economic Perspectives* 30, 189–212.

{% Nice study on illusion of control. Show that this may just be regression to the mean. Only thing is that people do not exactly know their control. They overestimate it in situations of low control (usually studied in the literature), but underestimate it in situations of high control (shown in this paper). %}

Gino, Francesca, Zachariah Sharek, & Don A. Moore (2011) "Keeping the Illusion of Control under Control: Ceilings, Floors, and Imperfect Calibration," *Organizational Behavior and Human Decision Processes* 114, 104–114.

{% **loss aversion: erroneously thinking it is reflection**: p. 25 erroneously writes that the difference between risk aversion for gains and risk seeking for losses is due to loss aversion. %}

Gintis, Herbert (2009) "*The Bounds of Reason; Game Theory and the Unification of the Behavioral Sciences*." Princeton University Press, Princeton NJ.

{% Seem to show, in an intercultural study, that the ambiguity aversion typically found with students does not generalize to general populations in the European union. But stimuli seem to be problematic for the purpose of finding ambiguity aversion. %}

Giordani, Paolo E., Karl H. Schlag, & Sanne Zwart (2010) "Decision Makers Facing Uncertainty: Theory versus Evidence," *Journal of Economic Psychology* 31, 659–675.

{% Found different neural localizations for regret and disappointment. %}

Giorgetta, Cinzia, Alessandro Grecucci, Nicolao Bonini, Giorgio Coricelli, Gianpaolo Demarchi, Christoph Braun, & Alan G. Sanfey (2013) "Waves of Regret: A MEG Study of Emotion and Decision-Making," *Neuropsychologia* 51, 38–51.

{% Considers a variation of the smooth model, or recursive utility. In the second stage there is not a nonlinear utility transformation, but, instead, there is a nonadditive measure. (**event/outcome driven ambiguity model: event driven**) §1.1

discusses the smooth model, including Epstein's (2010) criticism. The paper follows papers by Gajdos et al. in having sets of information variable as inputs of decisions. A person may have to choose between f given info set I1 or g given info set I2. It considers general functionals and does not commit to pessimism or optimism or so. %}

Giraud, Raphael (2014) "Second order Beliefs Models of Choice under Imprecise Risk: Nonadditive Second Order Beliefs versus Nonlinear Second Order Utility," *Theoretical Economics* 9, 779–816.

{% Introduce and axiomatize basically the Bewley (1986, 2002) famous model, preceding him! %}

Giron, Francisco J. & Sixto Rios (1980) "Quasi-Bayesian Behaviour: A More Realistic Approach to Decision Making?," *Trabajos de Estadstica y de Investigacin Operativa* 31, 17–38.

{% Characterize incomplete preferences through unanimity over multiple priors in Anscombe-Aumann setting. Extend earlier results by Bewley (1986, 2002) and several after by allowing for more unboundedness of utility and more technical flexibility. Many references on this model. %}

Girotti, Bruno & Silvano Holzer (2006) "Representation of Subjective Preferences under Ambiguity," *Journal of Mathematical Psychology* 49, 372–382.

{% **PT, applications**; **survey on nonEU**

Surveys 37 applications of prospect theory in health, mainly in preventive and screening behaviors, promotion of healthy habits, and COVID-related decision making. %}

Gisbert-Pérez, Júlia, Manuel Martí-Vilar, & Francisco González-Sala (2022) "Prospect Theory: A Bibliometric and Systematic Review in the Categories of Psychology in Web of Science," *Healthcare (Basel)* 10, 2098. https://doi.org/10.3390/healthcare10102098

{% Argues against paternalism, saying that the modern behavioral deviations from rationality can be more reason to be AGAINST paternalism. Does not assume that the paternalistic government is almighty and has the right view, but that it can err as well, and sometimes more likely than citizens. %}

Glaeser, Edward (2006) "Paternalism and Psychology," *University of Chicago Law Review* 73, 133–156.

{% %}

Glaeser, Edward L., David I. Laibson, Jose A. Scheinkman, & Christine L. Soutter (2000) "Measuring Trust," *Quarterly Journal of Economics* 115, 811–846.

{% N = 12, so, not many subjects. Incentives: Subjects got a showup fee, but 6 choices were implemented for real, generating an income effect. Nonzero outcomes were either $1 or $2.

Subjects do decisions under risk from description, with probabilities given, and from sampling, where they observe iid repetitions of a random event and have to guess frequencies (**updating under ambiguity with sampling**). The latter is similar to Wu, Delgado, & Maloney (2009) with a big difference though: Now subjects cannot influence the random event, unlike Wu et al. where it is a skill task. The latter study found the opposite of inverse S (**inverse S**; maybe due to disliking small probability of succeeding in task), but this study finds regular inverse S also for the sampling task. Utility was mostly concave, as is usual for gains.

The lotteries considered had only one nonzero outcome, implying that the joint power of utility and probability weighting is unidentifiable. It is identified here in the sense that the authors used the T&K'92 weighting function, which kind of imposes a scaling convention on probability weighting. The authors are apparently unaware of this problem. Note that while power does affect risk aversion, it need not affect the degree of inverse S.

uncertainty amplifies risk: They find this because probability weighting is more pronounced inverse S under sampling (which has some ambiguity) than under given probabilities. %}

Glaser, Craig R., Julia Trommershäuser, Pascal Mamassian & Laurence T. Maloney (2012) "Comparison of the Distortion of Probability Information in Decision under Risk and an Equivalent Visual Task," *Psychological Science* 23, 419–426.

{% **(very) small probabilities** %}

Glasserman, Paul, Philip Heidelberger, Perwez Shahabuddin, & Tim Zajic (1999) "Multilevel Splitting for Estimating Rare Event Probabilities," *Operations Research* 47, 585–600.

{% That classical economic assumptions have been modified, not eliminated, by behavioral economists. %}

Gleaser, Edward L. (2004) "Psychology and the Market," *American Economic Review* 94, 408–413.

{% **producing random numbers**: If animals must play in situations where their opponent tries to predict their choices, then they produce random behavior. Author seems to suggest that the animals have some kind of pseudo-random number generator. Seems to claim to have found the parts in brains corresponding with probability weighting and utility maximization. %}

Glimcher, Paul W. (2003) "*Decisions, Uncertainty, and the Brain: The Science of Neuroeconomics*." MIT Press, Cambridge MA.

{% **coherentism**: Seem to write, optimistically:

"The available data suggest that the neural architecture actually does compute a desirability for each available course of action. This is real physical computation, accomplished by neurons, that derives and encodes a real variable" (p. 220). %}

Glimcher, Paul W., Michael C. Dorris & Hannah M. Bayer (2005) "Physiological Utility Theory and the Neuroeconomics of Choice," *Games and Economic Behaviour* 52, 213–256.

{% In this paper the authors show great enthusiasm for their field of research. They argue that psychology, economics, and neuroscience should converge to one field, neuroeconomics (which is the authors' field), and that this new field will better answer all questions in economics, psychology, neuroscience, and so on, than anything existing before (**ubiquity fallacy**). Abstract: "Economics, psychology, and neuroscience are converging today into a single, unified discipline with the ultimate aim of providing a single, general theory of human behavior … by revealing the neurobiological mechanisms by which decisions are made."

P. 448, 2nd column, last para: "once this reconstruction of decision science is *completed*, many of the most puzzling aspects …that economic theory, psychological analysis, or neurobiological deconstruction have failed to explain, will become formally and mechanically explainable." [italics added]

P. 448, 3rd column, last para:
"We believe that this [not considering subjective preferences] has been a critical flaw in neurobiological studies."

P. 449, 2nd column, below figure: "Platt and Glimcher found that some parietal neurons did indeed encode the value and …"

The authors express the same enthusiasm in many other places and were rewarded for these repeated expressions with a science publication. %}

Glimcher, Paul W. & Aldo Rustichini (2004) "Neuroeconomics: The Consilience of Brain and Decision," *Science* 306, 15 Oct., 447–452.

{% Test the priority heuristic of Brandstätter, Gigerenzer, & Hertwig (2006). Find that prospect theory does way better. Their abstract concludes, very negatively on the priority heuristic: "The findings indicate that earlier results supporting the PH might have been caused by the selection of decision tasks that were not diagnostic for the PH as compared to PT." %}

Glöckner, Andreas & Tilmann Betsch (2008) "Do People Make Decisions under Risk Based on Ignorance? An Empirical Test of the Priority Heuristic against Cumulative Prospect Theory," *Organizational Behavior and Human Decision Processes* 107, 75–95.

{% Do decision from experience, and don't find the DFD-DFE gap, but the opposite: more inverse S for DFE rather than less. (**DFE-DFD gap but no reversal**) %}

Glöckner, Andreas, Benjamin E. Hilbig, & Felix Henninger (2016) "The Reversed Description-Experience Gap: Disentangling Sources of Presentation Format Effects in Risky Choice," *Journal of Experimental Psychology: General* 145, 486–508.

{% Real incentives: **random incentive system** (p. 26 penultimate para) & **losses from prior endowment mechanism** (p. 26 1st para)

reflection at individual level for risk: Have data but do not report it.

They test all kinds of versions of PT (they write CPT) to risky choices of subjects, to see which and how many parameters work best. Measure subjects' choices twice, one week apart, with different stimuli, to test stability and predictive power. Take wide variety of gain-, loss-, and mixed prospects. P. 27 describes limitations that they imposed on parameters.

Introduction is on pros and cons of free parameters, explaining well but only didactical because standard; maybe because of journal.

They use power utility when estimating loss aversion. Wakker (2010 §9.6) describes analytical problems for it, unless the same power for gains and for losses. The latter is exactly what the authors do here.

Pp. 23-24 cites studies on stability of risk attitudes over time, pointing out that instability of preference may be caused by instability of some parameters while stability of some others.

Use two indexes of fit. One is percentage of choices predicted right. Other is loglikelihood distance.

concave utility for gains, convex utility for losses: They only consider models where utility for losses is the reflection of that for gains, with the same power (p. 25 1st column penultimate para, also for EU (p. 25 Eq. 8), and with power between 0 and 1 (p. 27 last para).

P. 27 bottom has nice optimization method for data fitting.

Pp. 28-29: In general, increasing the number of parameters of PT led to a better fit which is obvious, although not much better. The increases did not lead to better or worse predictions (latter could very well happen if overfitting). So, the data are not very informative on predictive performance. Some modifications: 2-parameter probability weighting did not improve 1-parameter (2-parameter utility was not considered); EU and EV can be considered to be special cases of PT, with restrictions on parameters, but their fits and predictions were seriously worse (the authors did not incorporate loss aversion in EU although one could argue for it given fixed reference point). EV did better than Gigerenzer's heuristics (p. 29 end of §3). Individual parameters are better than group medians (could have been the other way around if overfitting), but they were better than the T&K'92 parameters (p. 29). Loss aversion ranged between 1.05 and 1.99, quite smaller than the 2.25 of T&K'92, and loss aversion was most volatile.

As regards stability, they found clear and significant correlations between

choices separated by a week, but not very strong.

loss aversion: erroneously thinking it is reflection: p. 30 middle of 2nd para: "prediction, differences between gains and losses seem to be sufficiently represented by having a loss aversion parameter" %}

Glöckner, Andreas & Thorsten Pachur (2012) "Cognitive Models of Risky Choice: Parameter Stability and Predictive Accuracy of Prospect Theory," *Cognition* 123, 21–32.
https://doi.org/10.1016/j.cognition.2011.12.002

{% **coalescing**: the authors fit probability weighting with coalesced and noncoalesced presentations of lotteries. The former finds more nonlinearity. %}

Glöckner, Andreas, Baiba Renerte, & Ulrich Schmidt (2020) "Violations of Coalescing in Parametric Utility Measurement," *Theory and Decision* 89, 471–501.
https://doi.org/10.1007/s11238-020-09761-5

{% **conservation of influence**: her poem "Nostos" in this book has, as last lines: "We look at the world once, in childhood. The rest is memory." %}

Glück, Louise (1996) "*Meadowlands*." HarperCollins, Amsterdam.

{% **foundations of probability**: argues that in deterministic world, objective nonepistemic probabilities can still exist. %}

Glynn, Luke (2010) "Deterministic Chance," *British Journal for the Philosophy of Science* 61, 51–80.

{% Topic; see title. %}

Glynn, Luke (2011) "A Probabilistic Analysis of Causation," *British Journal for the Philosophy of Science* 62, 343–392.

{% Seems to show that subjects like to answer truthfully, and not lie, also if no incentive. %}

Gneezy, Uri (2005) "Deception: The Role of Consequences," *American Economic Review* 95, 384–394.

{% Test Allais paradox in rural area in Nairobi. They find that increasing stakes does not reduce Allais paradox. %}

Gneezy, Uri, Yoram Halevy, Brian Hall, Theo Offerman, & Jeroen van de Ven (2024) "How Real is Hypothetical? A High-Stakes Test of the Allais Paradox," working paper.

{% Assume EU for risk and use a choice list to estimate the power of a log-power (CRRA) utility function. Then use this in two-color Ellsberg urns where the outcome of the known color is matched (using choice list) to get indifference. Then use an αmin(U) + $(1-\alpha)$max(U) representation to estimate an α to index ambiguity aversion. They call the representation α maxmin (using the complete set of all priors) but it is the more general biseparable utility which can be many things, such as RDU or PT, just as well. %}

Gneezy, Uri, Alex Imas, & John A. List (2015) "Estimating Individual Ambiguity Aversion: A Simple Approach," working paper.

{% Examples of what the title says. The term "uncertainty effect" is too broad, giving a signal about the paper. Then, as it has to do with economics, why not call it the "economic effect"? %}

Gneezy, Uri, John A. List, & George Wu (2006) "The Uncertainty Effect: When a Risky Prospect Is Valued Less than Its Worst Possible Outcome," *Quarterly Journal of Economics* 121, 1283–1309.
https://doi.org/10.1093/qje/121.4.1283

{% **crowding-out**: Discuss/review this phenomenon for many contexts. The concluding para summarizes the contribution well:

"Our message is that when economists discuss incentives, they should broaden their focus. A considerable and growing body of evidence suggests that the effects of incentives depend on how they are designed, the form in which they are given (especially monetary or nonmonetary), how they interact with intrinsic motivations and social motivations, and what happens after they are withdrawn. Incentives do matter, but in various and sometimes unexpected ways." %}

Gneezy, Uri, Stephan Meier, & Pedro Rey-Biel (2011) "When and why Incentives (Don't) Work to Modify Behavior," *Journal of Economic Perspectives* 25 191–210.

{% **PT, applications**, loss aversion, equity premium puzzle
Vary on and confirm Benartzi & Thaler (1995).
gender differences in risk attitudes: women more risk averse than men. %}
Gneezy, Uri & Jan Potters (1997) "An Experiment on Risk Taking and Evaluation Periods," *Quarterly Journal of Economics* 112, 631–645.

{% **crowding-out**: show that pupils collecting donations for charity perform worse when receiving a small payment than when receiving no payment at all (perform OK again when receiving considerable payment), and similar findings. %}
Gneezy, Uri, & Aldo Rustichini (2000) "Pay Enough or Don't Pay at All," *Quarterly Journal of Economics* 115, 791–810.

{% **crowding-out**: letting parents pay who are late to collect their children from a day-care center increases, not decreases, parents' coming late. %}
Gneezy, Uri, & Aldo Rustichini (2000) "A Fine is a Price," *Journal of Legal Studies* 29, 1–17.

{% **proper scoring rules**: in intro mention as fields of application of proper scoring rules: weather and climate prediction, computational finance (Duffie & Pan 1997), and macroeconomic forecasting (Garratt, Lee, Pesaran, and Shin 2003; Granger 2006).
This paper analyzes proper scoring rules on general event spaces.
Theorem 1 relates proper scoring rules to convex functions. %}
Gneiting, Tilmann & Adrian E. Raftery (2007) "Strictly Proper Scoring Rules, Prediction, and Estimation," *Journal of the American Statistical Association* 102, 359–378.

{% %}
Goddard, Stephen T. (1983) "Ranking Tournaments and Group Decisionmaking," *Management Science* 29, 1384–1392.

{% **common knowledge**? Footnote 48 (cited by Feferman, 1989):
"true reason higher types can be continued into the transfinite." %}

Gödel, Kurt (1931) "Über Formel Unentscheidbare Sätze der *Principia Mathematica* und Verwandter Systeme I," *Monatsh.Math.Phys.* 38, 173–198. Reproduced with English translation in Kurt Gödel (1986; Solomon Feferman et al., eds.) *Collected Works, Volume I, Publications 1929-1936*, Oxford, New York; 144–195.

{% %}

Gödel, Kurt (1986; Solomon Feferman et al., eds.) *Collected Works, Volume I, Publications 1929-1936*, Oxford, New York.

{% Rudy's blog (Rudy Rucker), August 1, 2012, reporting conversations with Kurt Gödel, ascribes the following words to Gödel: "The illusion of the passage of time arises from the confusing of the given with the real. Passage of time arises because we think of occupying different realities. In fact, we occupy only different givens. There is only one reality."

(**free will/determinism)**

Rephrasing in my own words: "free will makes us believe that there are more realities, but in reality there is only one reality." ☺

Appeared in the magazine Science 82 in April 1982, and in Rudy's 1982 book "Infinity and the Mind." %}

Gödel, Kurt

{% %}

Goel, Prem K. & Arnold Zellner (1986, eds.) "B*ayesian Inference and Decision Techniques*, Essays in Honor of Bruno de Finetti," Studies in Bayesian Econometrics and Statistics Vol. 6. North-Holland, Amsterdam.

{% **HYE** %}

Goel, Vivek, Raisa B. Deber, Allan S. Detsky (1990) "Nonionic Contrast Media: A Bargain for Some, a Burden for Many," *Can. Med. Assoc. J.* 143, 480–481.

{% In several experiments show deviations from Nash equilibria that are bigger the lower the costs.

ambiguity seeking for unlikely: seems that they find that unlikely events are overweighted, where the unlikely events concerns strategy choices of others. %}

Goeree, Jacob K. & Charles A. Holt (2001) "Ten Little Treasures of Game Theory and Ten Intuitive Contradictions," *American Economic Review* 91, 1402–1422.

{% Quantal Response Equilibrium (QRE) is explained in my annotations to McKelvey & Palfrey (1995).

It is a highly desirable step forward in game theory that not just expected value, but more general risk attitude models, are used for evaluations of strategies given others' choice probabilities. For the future of prospect theory etc., it is necessary to find applications in other domains such as here in game theory.

The precise working of the models, and the precise estimations of individual risk evaluations from the findings from game theory, are still complex. The only observable from behavior is the choice probabilities. To what extent these can be ascribed to individual evaluation, expected utility, prospect theory, or whatever the considered theory is, or some transformation of such an evaluation, and to what extent they can be ascribed to the noise parameters and other aspects of the strategic situation, depends on the models and parametric families chosen by the experimenters. That the choice probabilities depend on probabilities/utilities only through the EU or prospect theory of a prospect, so that this functional form is separable, is already a heavy assumption. As another example, in the middle of p. 255, the authors write that overbidding by some players will enhance overbidding by the others, in other words, overbidding is a self-reinforcing effect. However, in the analysis of this paper stronger overbidding leads to higher estimates of individual risk aversion. Thus, estimates of individual risk attitudes are affected by strategic aspects of the game. One observable (choice probability) is used to estimate two or more parameters.

Another difference between these games and usual individual decision theories is that these theories consider decisions that are repeated many times, with repeated payoffs, income effects, etc. We must assume that in each repeated game, a strong isolation effect takes place, where the players forget about all other games. In spite of these difficulties, this is a highly intriguing attempt to apply individual risk theories in other domains.

When they do expected utility with power utility as index of risk aversion, they estimate the coefficient of RRA as 0.52 (so, power 0.48), which is similar to other findings in the literature. (**PT falsified**) When they do rank-dependent utility with linear utility, and Prelec's two-parameter family, they find convex and not **inverse S** weighting functions. This puts the ball in the court of the inverse S advocates. To maintain their hypothesis, they have to find other explanations for the strategic behavior of subjects than put forward in this paper. %}

Goeree, Jacob K., Charles A. Holt, & Thomas R. Palfrey (2002) "Quantal Response Equilibrium and Overbidding in Private-Value Auctions," *Journal of Economic Theory* 104, 247–272.

{% **PT falsified**: Find S-shaped rather than **inverse S** shaped probability weighting. P. 105 2nd para reports evidence against the procedure of paying in probabilities.

For the risk aversion assessment in the games as in §4, there is only one nonzero outcome, and then the problem is that a common power of utility and probability weighting is unidentifiable without further assumptions. The lottery-choice data in §5 have more variation in outcomes and there the problem does not arise.

The paper assumes that Nash equilibrium is what should/will happen under EU and no probabilistic choice. Many people, including me, do not find this a plausible assumption. %}

Goeree, Jacob K., Charles A. Holt, & Thomas R. Palfrey (2003) "Risk Averse Behavior in Generalized Matching Pennies Games," *Games and Economic Behavior* 45, 97–113.

{% **Nash equilibrium discussion**: much literature on its empirical failure. %}

Goeree, Jacob K. & Philippos Louis (2021) "M Equilibrium: A Theory of Beliefs and Choices in Games," *American Economic Review* 1112, 4002–4045. https://doi.org/10.1257/aer.20201683

{% Part of letter cited by Mandelkow (1968 p. 254): "I am inclined to offer Mr. Vieweg from Berlin an epic poem, Hermann and Dorothea … Concerning the royalty we will proceed as follows: I will hand over to Mr. Counsel Böttiger a sealed note which contains my demand, and I wait for what Mr. Vieweg will suggest to offer for my work. If his offer is lower than my demand, then I take my note back, unopened, and the negotiation is broken. If, however, his offer is higher, then I will not ask for more than what is written in the note to be opened by Mr. Böttiger." %}

Goethe, Johann W. (1797).

{% **QALY overestimated when ill**: P. 100, first give references to works suggesting that people's values for generic health states are remarkably consistent. However, the bottom gives four references to papers finding that people in an impaired health state value it more positively than others.

intertemporal separability criticized: p. 100 (quality of life depends on past and future health) %}

Gold, Marthe R., Joanna E. Siegel, Louise B. Russell, & Milton C. Weinstein (1996) "*Cost-Effectiveness in Health and Medicine*." Oxford University Press, New York.

Gold, Marthe R., Peter Franks, & Pennifer Erickson (1992) "Assessing the Health of the Nation: The Predictive Validity of a Preference-Based Instrument and Self-Rated Health," *Medical Care* 34, 163–177.

{% Consider the trolley problem, where you can save five lives by sacrificing one other life. When judging morality of others' decisions, people are more permissive in doing the sacrifice than when deciding by themselves. %}

Gold, Natalie, Briony D. Pulford, & Andrew M. Colman (2015) "Do as I Say, Don't Do as I Do: Differences in Moral Judgments Do not Translate into Differences in Decisions in Real-Life Trolley Problems," *Journal of Economic Psychology* 47, 50–61.
http://dx.doi.org/10.1016/j.joep.2015.01.001

{% In letter to Euler he proposed (roughly) the conjecture that every even number > 2 can be written as the sum of two prime numbers. It has been 4×10^{18} numbers in July 2019. %}

Goldbach, Christian (1742)

{% **intuitive versus analytical decisions**
seems to argue that some simple averaging formula have higher clinical validity than clinical expert judgments. %}

Goldberg, Lew R. (1968) "Simple Models or Simple Processes? Some Research on Clinical Judgments," *American Psychologist* 23, 483–496. http://dx.doi.org/10.1037/h0026206

{% Mathematical Review 48 (1974), No. 2, # 2919. %}
Goldberg, Vladislav V. (1973) "n+1- Webs of Multidimensional Surfaces," *Soviet Math. Dokl.* 14, No. 3, 795–799.

{% Mathematical Review 52 (1976), No. 5, # 11763. %}
Goldberg, Vladislav V. (1973) "Isocline n+1 -Webs of Multidimensional Surfaces," *Soviet Math. Dokl.* 15, No. 5, 1437–1441.

{% %}
Goldman, Alvin I. (2006) "*Simulating Minds: The Philosophy, Psychology, and Neuroscience of Mindreading*." Oxford University Press, New York.

{% **dynamic consistency** %}
Goldman, Steven M. (1979) "Intertemporally Inconsistent Preferences and the Rate of Consumption," *Econometrica* 47, 621–626.

{% **dynamic consistency** %}
Goldman, Steven M. (1980) "Consistent Plans," *Review of Economic Studies* 47, 533–538.

{% I guess it was hypothetical choice (not explicitly stated as far as I saw but it usually concerned future events); the paper only gives verbal reports of results; a detailed report of the experiment was planned but never completed.

ambiguity seeking for unlikely;

For ambiguous events, subjects are asked to give subjective probability judgments, but then also 2nd order probability judgments (**second-order probabilities to model ambiguity**). So, the latter are subjective, and introspective.

Their theory (hypothesis) H1: either ambiguity aversion or ambiguity seeking.

Their theory (hypothesis H2): likelihood insensitivity.

inverse S: Study A (N = 20) considers gain prospects and loss prospects but not mixed. For gains 8 subjects are ambiguity averse throughout, 7 are a(mbiguity-generated) insensitive (then inflection points between 0.05 and 0.45; p. 465 top), and 5 unclassified. For losses 7 are ambiguity seeking, 9 are a-insensitive (then inflection points between 0.05 and 0.65; p. 465 top), and 4 unclassified.

ambiguity seeking for losses: study A supports it.

reflection at individual level for ambiguity: no info is given on it; i.e., how gain-patterns go together with loss patterns.

P. 464, 3rd (last) para, nicely indicates that H2 (likelihood insensitivity) is unaffected by reflection (taking dual weighting function under modern RDU).

Studies B and C (each N = 20) consider mixed prospects have no unambiguous options, to avoid contrast effects (à la Fox & Tversky 1995), but relate ambiguous prospects (with second-order subjective probabilities) probably to their 1st order expectations. Study B and C have in total 10 subjects ambiguity averse, 1 ambiguity seeking, 17 a-insensitive.

Throughout, verbal reports of subjects nicely support a-insensitivity.

More details on the experiments seem to be available in papers "Do Second-Order Probabilities Affect Decisions?" and "Second-Order Probabilities and Risk in Decision Making," but those papers have never been completed. %}

Goldsmith, Robert W. & Nils-Eric Sahlin (1983) "The Role of Second-Order Probabilities in Decision Making." *In* Patrick C. Humphreys, Ola Svenson, & Anna Vari (eds.) *Analysing and Aiding Decision Processes*, 455–467, North-Holland, Amsterdam.

{% ISBN 0262071789 %}

Goldschmidt, Tijs (1996) "*Darwin's Dreampond: Drama on Lake Victoria*." MIT Press, Cambridge, MA.

{% **R.C. Jeffrey model**: the value of a prospect is the sum of its instrumental value, determined by its outcomes, and its intrinsic value, determined by its probabilities. %}

Goldschmidt, Zeev & Ittay Nissan-Rozen (2021) "The Intrinsic Value of Risky Prospects," *Synthese* 198, 7553–7575.

https://doi.org/10.1007/s11229-020-02532-3

{% **probability elicitation**: This paper provides a very good method. Incentivization works well if it is for guessing a true existing underlying objective probability distribution. If there is no clear such, and it is to measure purely subjective probabilities, then it is not very easy to incentive/score it. Could impose a scoring rule, e.g. the logarithmic one which is convenient for three or more events.

Five sets of 100 balls, numbered 1-10, were created, with different beta distributions of 1,…,10. Subjects could see the result of a 100-fold sample with replacement, quickly within one minute presented to them one by one. Then they had to predict the distribution of a next sample of size 100 with replacement. That is, their subjective probabilities were measured. Two different methods were used: (1) the more common one of asking some statistics such as quantiles and means. (2) A method where 10 bins were given to subjects, clearly on a computer screen, and they had to distribute 100 markers over the 10 bins to reflect the right distribution (the histogram method). §1.1 reviews the literature, citing four or so surveys, and also discussing preceding implementations of the histogram method. It also cites decision from experience (DFE). There haven't been comparative studies yet it seems, and this paper is the first.

The histogram method performed superior to the other methods, with fewer biases and no overconfidence, and greater general accuracy. This is in a way unsurprising because the visual histogram is more natural and clear. An additional advantage is that subjects are then thinking in terms of frequencies rather than probabilities. P. 11 writes: "To get accurate estimates about various statistics of a subjective probability distribution, our findings suggest it may be better to elicit the entire distribution graphically and compute arbitrary statistics, rather than asking about the statistics directly."

There were no real incentives but it was flat payment (p. 4 §2, beginning). Real incentives can easily be implemented here by paying some distance function to the true distribution (as with expectations of proper scoring rules).

The method only clearly works if there is a clearly defined underlying frequency-based true probability distribution. For natural events with no known probabilities it will be harder to implement. How to pay then if no reference to a true distribution? Some scoring rule I guess. Ambiguity theories complicate life

here. One other problem can then be what partition one then takes (with the 10 numbered balls the basic partition was obvious). Studies by Craig Fox suggest that a bias toward uniform distribution will result. %}

Goldstein, Daniel G. & David Rothschild (2014) "Lay Understanding of Probability Distributions," *Judgment and Decision Making* 9, 1–14. https://doi.org/10.1017/S1930297500004940

{% **PT, applications**: Seems to show that prospect theory is applied in many fields. Is more popular press %}

Goldstein, Evan R. (2011) "The Anatomy of Influence," *Chronicle of Higher Education* 58, B6–B10.

{% **updating: discussing conditional probability and/or updating**: "We prove that the result EX = E(E(X|Y)) is true, for bounded X, when the usual concept of conditional expectation or prevision is replaced by an alternative definition reflecting an individual's actual beliefs concerning X after observing Y." %}

Goldstein, Michael (1983) "The Prevision of a Prevision," *Journal of the American Statistical Association* 78, 817–819.

{% A deep author. **dynamic consistency**; **updating: discussing conditional probability and/or updating** Suppose you'll observe E (or not E) in two days from now. P(H|E) is conditional probability of H given E today. You think that tomorrow P(H|E) need not be the same as today. (Ramsey 1931 also wrote on this.) But, Goldstein argues, the expectation of your tomorrow-P(H|E) should be today's P(H|E). He calls this requirement temporal coherence. Lindley, discussing the paper, argues that P(H|E) tomorrow will differ because of further info received and that that further info should then be expressed by writing an additional conditioning event.

P. 233: "Subject to the conditions of coherence you have complete freedom of choice in evaluating previsions."

P. 232 2nd para: there is not only the info that E happens, but also the "meta-info" that that info was received, which distorts conditioning.

P.242 cites Good (1977) for arguments as to why we should explicitly consider changes in previsions arising from pure thought. %}

Goldstein, Michael (1985) "Temporal Coherence" (with discussion). *In* Jose M. Bernardo, Morris H. DeGroot, Dennis V. Lindley, & Adrian F.M. Smith (eds.) *Bayesian Statistics 2: Proceedings of the Second Valencia International Meeting*, 231–248, North-Holland, Amsterdam.

{% **foundations of statistics**: Deep author.

updating: discussing conditional probability and/or updating

P. 134: "Like any other careful definition of conditioning, this definition is not concerned with how you should act after determining the truth of H, but with your choice now, before H is revealed, of a particular called-off penalty."

P. 134 (**completeness criticisms**): … "Bayes methodology is locked into the requirement of specification of full probability distributions …" p. 136/137 and also 152/153: the method proposed by Goldstein should allow for conditioning without requiring a full specification of probabilities. %}

Goldstein, Michael (1988) "Adjusting Belief Structures," *Journal of the Royal Statistical Society, Ser. B,* 50, 133–154.

{% %}

Goldstein, Michael A. & Kenneth A. Kavajecz (2000) "Eighths, Sixteenths, and Market Depth: Changes in Tick Size and Liquidity Provision on the NYSE," *Journal of Financial Economics* 56, 125–149.

{% Seems to examine the weakenings of triple cancellation à la Vind. Got this reference from Bouyssou & Prilot (2002, JMP). %}

Goldstein, William M. (1991) "Decomposable Threshold Models," *Journal of Mathematical Psychology* 35, 64–79.

{% P. 251: **utility elicitation**, some words on that. Eq. (1), p. 240, is **biseparable utility. E**qs. 22-24 already give the two-parameter extension of Karmarkar that is often ascribed to Lattimore et al. (1992).

P. 240 Eq. 1: **biseparable utility**!

Analysis on pp. 242-243 makes strange assumptions about the f and g function. So does p. 25 2nd column.

Experiment 3 shows violation of monotonicity resulting from neglect of zero-

outcome that was studied extensively in several papers by Birnbaum; it's actually dual to Birnbaum's finding; i.e., replacing a zero outcome by a negative outcome increases the valuation of the lottery. Birnbaum explained to me by email that that may be caused because subjects take a different range of outcomes to refer to. G & E ascribe the idea to Slovic (1984, personal communication). Slovic found it but did not publish.

The family if Eqs. 22-24 is the most popular one today (Oct. 2020) together with Prelec's (1998) CI family. However, the family here is a bit better than Prelec's. In his CI family, the two parameters are not very well separated. The α parameter, supposed to capture insensitivity, also somewhat affects elevation. This can be seen from Wakker (2010 Figure 7.2.2). For the figures with $\beta = 1$, the fourth (outer right) figure with $\alpha = 0.35$ has the curve on average lower than the second figure with $\alpha = 1$ (EU). So, with β fixed, lowering α led to some decrease of elevation. In this regard the Goldstein-Einhorn (1987) family is better (Wakker 2010 Figure 7.2.3). %}

Goldstein, William M. & Hillel J. Einhorn (1987) "Expression Theory and the Preference Reversal Phenomena," *Psychological Review* 94, 236–254.

{% **measure of similarity** %}

Goldstone, Robert L. (1994) "Similarity, Interactive Activation, and Mapping," *Journal of Experimental Psychology. Learning, Memory, and Cognition* 20, 3–28.

{% Say that long-shot effect (overbet on outsiders, underbet on favorites) can be reconciled with risk aversion because love for skewness drives it. Unfortunately, I did not find a definition of risk aversion. Apparently, the authors identify risk aversion with a negative weight of variance in the regression. %}

Golec, Joseph & Maurry Tamarkin (1998) "Bettors Love Skewness, Not Risk, at the Horse Track," *Journal of Political Economy* 106, 205–225.

{% %}

Gollier, Christian (1997) "A Note on Portfolio Dominance," *Review of Economic Studies* 64, 147–150.

{% Economists often use representative agent with average income. If, in reality, there is inequality of income, will average of risk aversion be bigger or smaller than risk aversion of average? Under linear risk tolerance (HARA family including exponential, power) it's the same, under concave absolute risk tolerance the risk aversion is bigger, under convex it is smaller. Some numerical suggestions give a doubling of the equity premium.

decreasing ARA/increasing RRA: P. 182 and §4 criticize increasing-RRA by mentioning empirical economic findings contradicting it. P. 187 says that the relative share of stocks in total wealth increases with the latter. P. 58 seems to also doubt it.

I am not sure here what the role of consumption of basic is, if that should first be subtracted.) %}

Gollier, Christian (2001) "Wealth Inequality and Asset Pricing," *Review of Economic Studies* 68, 181–203.

{% Book assumes expected utility throughout, and studies how uncertainty affects welfare and equilibria. Analogy with **time preference**s is pointed out. There are 26 chapters, each centered around some theoretical finding from the literature, many results on background risks etc. Exercises at the end of the chapters.

§11.2.3 gives a sufficient condition for young people to be more risk averse

. Pp. 11-12, §1.4.2, treats my dynamic discussion of the Allais paradox. HARA utilities play a central role. Ch. 5 is on the equity premium puzzle, which is presented as a central problem for the field. Proposition 11 on p. 83 in §6.1 gives the appealing diffidence theorem of Gollier & Kimball, the application of the separating hyperplane theorem.

Ch. 19 is on the Samuelson-Merton result for saving-portfolio.

source-dependent utility: Ch. 20 gives an elementary treatment of the Kreps & Porteus (1978) model.

§21.4.2, p. 317, gives the Arrow-Lind theorem.

Ch. 23 is nice, on the nontrivial derivation of the representative agents's characteristics from the characteristics of the individual agents. The average behavior need not result from the average of the individual risk parameters. Sometimes, the absolute risk tolerance of the representative agent equals the average absolute risk tolerance of the individual agents, but such a result does not hold for prudence.

Ch. 24 is on the **value of information**, Blackwell theorem etc.

The concluding sentence is: "Far from that I believe that this book calls for another round of theoretical and empirical research."

Epilogue, p 424ff., argues that it is remarkable that there are so few studies into risk aversion (he means utility curvature).

Gollier, Christian (2001) "*The Economics of Risk and Time.*" MIT Press, Cambridge MA.

{% Discounting: P. 150 explains why saving money yields profits: because we expect that future consumption will be better than past consumption. Paper shows that uncertainty about growth rate, plus prudence, reduces the optimal discount factor.

P. 163: French Commissariat au Plan recommends to use 8% discounting, most developed countries do between 5% and 8%. Author suggests 5% for periods between 50 and 100 years, and 1.5% for over 200 years. %}

Gollier, Christian (2002) "Discounting an Uncertain Future," *Journal of Public Economics* 85, 149–166.

{% When growth is almost surely nonnegative, the yield curve is decreasing if and only if RRA is decreasing with wealth. %}

Gollier, Christian (2003) "Time Horizon and the Discount Rate," *Journal of Economic Theory* 107, 463–473.

{% Net present value can give phenomena on increasing/decreasing discounting that are different than net future value. Paradox is resolved by having risk aversion and reckoning with consumption stream. %}

Gollier, Christian (2010) "Expected Net Present Value, Expected Net Future Value, and the Ramsey Rule," *Journal of Environmental Economics and Management* 59, 142–148.

{% Two-good multiperiod model with substitutability between goods and uncertainty, and then what optimal discounting is. Can be really different for the different

groups. The author, based on data, proposed 3.2% as discount rate for consumption and 1.2% for biodiversity. %}

Gollier, Christian (2010) "Ecological Discounting," *Journal of Economic Theory* 145, 830–859.

{% Application of ambiguity theory;

Uses the smooth ambiguity model to investigate the effect of increase in ambiguity aversion on the standard portfolio problem of dividing money to be invested over a safe and an ambiguous asset. Increasing ambiguity aversion is by making the 2nd order utility transformation φ more concave while keeping 1st order utility u, and keeping first- and second-order probabilities fixed. In general, increased ambiguity aversion need not always reduce investment in the portfolio. It does so mostly, e.g. if utilities are power/exponential for normal distributions, or if the set of priors can be ranked according to maximum-likelihood ordering. %}

Gollier, Christian (2011) "Portfolio Choices and Asset Prices: The Comparative Statics of Ambiguity Aversion," *Review of Economic Studies* 78, 1329–1344.

{% When choosing between several prospects, the maximum outcome possible is given a special role, and regret is taken with respect to it. Aversion to risk of regret then leads to risk seeking for small-probability gains (increasing the highest outcome enhances regret elsewhere) and can on restricted domains be related to optimistic probability weighting (maybe more than inverse S weighting) in RDU. %}

Gollier, Christian (2015) "Aversion to Risk of Regret and Preference for Positively Skewed Risks," working paper.

{% General recursive methods to generate high degrees risk. %}

Gollier, Christian (2021) "A General Theory of Risk Apportionment," *Journal of Economic Theory* 192, 105189.

{% %}

Gollier, Christian & Mark J. Machina (1995, eds.) "*Non-Expected Utility and Risk Management.*" Kluwer Academic Publishers, Dordrecht.

{% **decreasing/increasing impatience**: if all individuals have constant discounting but are heterogeneous, then the representative agent will have decreasing impatience, if decreasing absolute risk aversion holds for all. %}

Gollier, Christian & Richard J. Zeckhauser (2005) "Aggregation of Heterogeneous Time Preferences," *Journal of Political Economy* 113, 878–896.

{% This paper uses the information gap theory, introduced by two of the authors (Golman & Loewenstein 2018), to shed new light on ambiguity attitudes. Intrinsic value of information gaps can indeed lead to source preference and other ambiguity attitudes. The authors take ambiguity in a narrow sense, i.e., they assume that it is always multistage probabilities with reduction of compound lotteries violated. %}

Golman, Russell, Nikolos Gurney, & George F. Loewenstein (2021) "Information Gaps for Risk and Ambiguity," *Psychological Review* 128, 86–103.

{% **information aversion**: The paper considers intrinsic value of information. It extensively reviews cases and literature of this phenomenon, and its many implications. %}

Golman, Russell & George F. Loewenstein (2017) "Information Avoidance," *Journal of Economic Literature* 55, 96–135.

{% **information aversion**: The paper presents a psychological theory for it. An information gap is when a person becomes aware of missing relevant information and develops ideas and emotions about it. Information is not only instrumental in getting better outcomes but also has intrinsic utility.

A question can have countably many possible answers, one being correct and the others not. It is much like Savage's state space. A subject faces n questions. $(a_1,\ldots,a_n,x)$ denotes a situation where the answers are $a_1,\ldots,a_n$, and a prize x results. A cognitive state is a probability distribution over such n+1 tuples. The subject is assumed to maximize EU over cognitive states. The authors then formulate seven conditions that imply a particular shape of utility $U(a_1,\ldots,a_n,x)$, a

sort of weighted average attribute-utility, with also attention weights for the questions coming in.

An *information gap* means that an agent does not know the correct answer for sure, and feels that lack. Thinking about an information gap has intrinsic utility. Some are nice and others are not. Subjects can face several questions at the same time.

The authors also consider compound questions, which are like Savagean multistage acts.

In general, thinking about very nice questions brings positive utility. But the authors also discuss the ostrich effect.

A section on p. 157 discusses ambiguity attitudes, which, according to the theory of this paper, may be driven by information gaps. The authors have a separate paper on risk and ambiguity (Golman, Russell, & Gurney (2016), and this section summarizes only. See my annotations there. %}

Golman, Russell & George F. Loewenstein (2018) “Information Gaps: A Theory of Preferences Regarding the Presence and Absence of Information,” *Decision* 5, 143–164.

{% Belief consonance) people dislike situations where they have different views than others, and try to avoid those. %}

Golman, Russell, George F. Loewenstein, Karl Ove Moene, & Luca Zarri (2016) “The Preference for Belief Consonance,” *Journal of Economic Perspectives* 30, 165–188.

{% Test and confirm their theory. Demand for information depends on importance, salience, and valence, also if not decision-relevant. %}

Golman, Russell, George Loewenstein, Andras Molnar, & Silvia Saccardo (2022) “The Demand for, and Avoidance of, Information,” *Management Science* 68, 6454–6476.
https://doi.org/10.1287/mnsc.2021.4244

{% **CBDT;** They consider choices between stocks using case-based decision theory. Take CBDT as to be used if we do decision under uncertainty but don’t know the states, similarly as Gilboa & Schmeidler often take it (e.g., p. 731, beginning of

Conclusion). They pay much attention to the choice of an aspiration level. Given that similarity weights need not always sum to the same, the choice of utility level 0 is crucial. This is what the aspiration level serves for. It can be compared to the reference point of prospect theory.

In Eq. 8 they, more or less ad hoc, choose a parametric family of similarity functions, and use this to fit data.

Pp. 730-1, correctly, points out that if with case-based reasoning one could make profit in the stock-exchange market, then the market would be predictable and arbitrage would be possible. Rest of p. 731 has far-reaching conjectures on CBDT thus improving market efficiency. %}

Golosnoy, Vasyl & Yarema Okhrin (2008) "General Uncertainty in Portfolio Selection: A Case-Based Decision Approach," *Journal of Economic Behavior and Organization* 67, 718–734.

{% Asked one time preference question to 13-year olds in longitudinal Swedish data set. Find negative relationship between discounting and school performance, health, labour supply, and income. Males and high-ability children gain more from being future oriented. Measured cognitive spatial ability. %}

Golsteyn, Bart H.H., Hans Grönqvist, & Lena Lindahl (2014) "Adolescent Time Preferences Predict Lifetime Outcomes," *Economic Journal* 124, F739–F761.

{% This paper is the introduction to an impressive special issue on how psychologists and economists can learn from each others' measurements of subjective decision attitudes or personality traits.

P. 2 middle is strange on defining versions of validity differently than I think they should be. For instance, different questions measuring into the same underlying construct is convergence validity and not construct validity, and so on.

Pp. 2-3 point out that test-retest reliability, and predictive tests are more common psychometric requirements for personality traits in psychology than for subjective decision attitudes in economics. Then it continues that economists may have fewer anchoring biases because their outcomes (e.g. monetary reward) are more objectively defined.

§3 is on stability of decision attitudes. Economists may sometimes be too easy going in assuming such stability. The third para, that psychologists define stability in a rank-order sense and not in a cardinal or absolute way, was strange to read for me. Then several studies into stability are cited.

To have clearcut language, the authors often omit nuances. Much so. Thus, they often just state plainly that economists assume that preferences are stable over time. In some other places they may add nuances. In general, as they point out, economists can learn from the advanced knowledge of psychologist on classical test theory, for instance, with factor analysis, test-retest reliability, and so on, and psychologists from economists' ways to get less ambiguous measures. %}

Golsteyn, Bart H.H. & Hannah Schildberg-Hörisch (2017) "Challenges in Research on Preferences and Personality Traits: Measurement, Stability, and Inference," *Journal of Economic Psychology* 60, 1–6. https://doi.org/10.1016/j.joep.2017.03.001

{% Propose a new discount function for discrete time, and argue through examples that it has reasonable implications. It is a common generalization of constant discounting and quasi-hyperbolic discounting, and can accommodate increasing impatience. Central is the exponential discounting bias, that people even if wanting to do exponential discounting numerically underestimate how fast this decreases over time. %}

Gomes, Orlando, Alexandra Ferreira-Lopes, & Tiago Neves Sequeira (2014) "Exponential Discounting Bias," *Journal of Economics* 113, 31–57.

{% Ch. 11 presents MadMax, a program for eliciting additive utilities. %}

Gonzales, Christophe (1996) "Utilités Additives: Existence et Construction," Ph.D. dissertation, spécialité Informatique, Université de Paris 6, France.

{% %}

Gonzales, Christophe (1996) "Additive Utilities when Some Components Are Solvable and Others Are Not," *Journal of Mathematical Psychology* 40, 141–151.

{% %}

Gonzales, Christophe (1997) "Additive Utilities without Solvability on All Components." *In* Andranik Tangian & Josef Gruber (eds.) *Lecture Notes in Economics and Mathematical Systems* 453, 64–90, Springer, Berlin.

{% **cancellation axioms**; derives relations between cancellation axioms. %}

Gonzales, Christophe (2000) "Two Factor Additive Conjoint Measurement with One Solvable Component," *Journal of Mathematical Psychology* 44, 285–309.

{% The results of Gonzales (1996, JMP), which were derived under unrestricted solvability, are generalized here to the case of restricted solvability. %}

Gonzales, Christophe (2003) "Additive Utilities without Restricted Solvability on All Components," *Journal of Mathematical Psychology* 47, 47–65.

{% %}

Gonzales, Christophe & Jean-Yves Jaffray (1998) "Imprecise Sampling and Direct Decision Making," *Annals of Operations Research* 80, 207–235.

{% %}

González-Vallejo, Claudia C. (2002) "Making Tradeoffs: A New Probabilistic and Context-Sensitive Model of Choice Behavior," *Psychological Review* 109, 137–155.

{% %}

González-Vallejo, Claudia C., Alberto Bonazzi, & Andrea J. Shapiro (1996) "Effects of Vague Probabilities and of Vague Payoffs on Preferences: A Model Comparison Analysis," *Journal of Mathematical Psychology* 40, 130–140.

{% %}

González-Vallejo, Claudia C., Ido Erev, & Thomas S. Wallsten (1994) "Do Decision Quality and Preference Order Depend on whether Probabilities are Verbal or Numerical?," *American Journal of Psychology* 107, 157–172. https://doi.org/10.2307/1423035

{% **PT falsified**; find deviating kinds of reflection effects and different parameters when fitting. Main point of this work: propensity to show risk aversion/seeking depend on actual lottery pairs and person's proclivity.

Experiment 1 considered hypothetical choice, Experiment 2 real prizes (possibly given to charity). Stimuli were formulated as investments in the stock market (with selling short also).

risk averse for gains, risk seeking for losses: is found. Further, there is more risk aversion for gains than risk seeking for losses:

- See Fig. 1: Above 0.5 on y-axis risk seeking is found. Highest 80% risk seeking for losses, lowest 5% risk seeking (so, 95% risk aversion) for gains. For most gamble pairs in Appendix C (all with d ≠ 0.5) risk aversion is more pronounced than risk seeking.

- Table 2 on p. 948: More risk aversion for gains than risk seeking for losses, because always the loss- and gain percentage sum to less than 100%, so that for gains we are closer to zero (total risk aversion) than for losses we are to 100% (total risk seeking). Average 57% risk seeking for losses, 100–35 = 65% risk aversion for gains.

reflection at individual level for risk: no clear pattern, depending much on particular prospects

- Personal communication (email of Claudia of April 7 '04): in total, 87% of subjects have risk aversion for gains, 63% have risk seeking for losses. %}

González-Vallejo, Claudia C., Aaron A. Reid, & Joel Schiltz (2003) "Context Effects: The Proportional Difference Model and the Reflection of Preference," *Journal of Experimental Psychology: Learning, Memory, and Cognition* 29, 942–953.

{% %}

González-Vallejo, Claudia C. & Thomas S. Wallsten (1992) "Effects of Probability Mode on Preference Reversal," *Journal of Experimental Psychology: Learning, Memory, and Cognition* 18, 855–864.

{% **losses give more/less noise**: Show that people have more difficulties choosing between losses than between gains. fMRI gives that sure choices for gains require

less effort than risky choices, but for losses both kinds of choices require the same effort. %}

Gonzalez, Cleotilde, Jason Dana, Hideya Koshino, & Marcel A. Just (2005) "The Framing Effect and Risky Decisions: Examining Cognitive Functions with fMRI," *Journal of Economic Psychology* 26, 1–20.

{% There have been many papers on decision from experience, but when it comes to quantitative modeling and prediction there have only been some ad hoc parametric fittings in choice competitions organized by Erev and others. This paper probably presents the first psychologically founded theory to do so. It is the instance-based learning theory of Gonzalez et al. It predicts, and data confirm, that DFE with repeated payments and DFE with prior sampling and only one payment give the same learning and risk taking decisions, but with sampling there is double more choice switching suggesting there is more exploration there which is natural. %}

Gonzalez, Cleotilde & Varun Dutt (2011) "Instance-Based Learning: Integrating Sampling and Repeated Decisions from Experience," *Psychological Review* 118, 523–551.

{% %}

Gonzalez, Cleotilde, Lelyn D. Saner, & Laurie Z. Eisenberg (2012) "Learning to Stand in the Other's Shoes: A Computer Video Game Experience of the Israeli–Palestinian Conflict," *Social Science Computer Review* 31, 236–243. https://doi.org/10.1177/0894439312453979

{% **inverse S**; published as Gonzalez & Wu (1999, Cognitive Psychology) %}

Gonzalez, Richard (1993) "New Experiments on the Probability Weighting Function," presented at the annual meeting of the Society for Mathematical Psychology, Norman, OK.

{% I often cite this paper because it has a very good discussion of likelihood insensitivity as discriminatory power (**cognitive ability related to likelihood insensitivity (= inverse S))**

PT: data on probability weighting; **inverse S:** Does nonparametric fitting of

PT for 10 subjects, using choice-derived certainty equivalents for 2-outcome lotteries. Finds inverse S for all 10 subjects! They do not explain how they sampled the 10 subjects, but it seems that they took 10 well behaved subjects from a larger pool. Their purpose is to illustrate that their method can give nice measurements at the individual level, and not to do statistics with a representative sample.

P. 133 warns that prospect with only one nonzero outcome do not identify a joint power of utility and probability weighting.

Pp. 136-139, and else, discuss insensitivity, nicely using the expression diminishing sensitivity also for probability weighting w, although they use the cavexity concept that I think is not very good to capture it.

P. 140: "Because the weighting function is constrained at the end points (w(0) 5 0 and w(1) 5 1), an independent separation of curvature and elevation is not possible due to the "pinching" that occurs at the end points."

P. 142 discusses pros and cons of parametric fitting.

Real incentives: **random incentive system**

They tested the lower- and upper SA conditions of Tversky & Wakker (1995) and found them well confirmed.

P. 157 seems to report that there are substantial interactions between the PT parameters on parametric interaction.

The authors claim, in the appendix, an axiomatization of the Goldstein & Einhorn (1987, Eqs. 22-24) weighting family (also ascribed to Lattimore et al. 1992), but this is not correct. P. 163 ℓ. 1 has the problem that they did not get it for all x,y, but only for x=y. A corrected axiomatization is in Nascimento & Tat Ng (2022 JMP). In my annotations there I give detailed explanations of the math. %}

Gonzalez, Richard & George Wu (1999) "On the Shape of the Probability Weighting Function," *Cognitive Psychology* 38, 129–166. https://doi.org/10.1006/cogp.1998.0710

{% **biseparable utility**; **binary prospects identify U and W**

I use the term CPT (1992 cumulative as the authors do and most others, although I prefer the term PT. The paper and I here focus on gains.

SPT instead of OPT: What the authors call OPT is not really 1979 OPT (original prospect theory), but it neither is separable prospect theory. Instead, they do a mix. For two-outcome prospects they do real OPT, which deviates from separable prospect theory (if both outcomes are nonzero, because then it is rank dependence). But for three-outcome prospects they do separable prospect theory, which deviates from real OPT (if all outcomes are nonzero because real OPT does not want the outcome closest to 0 to be weighted; see Wakker 2023). They point this out in footnote 2. I will use the term OPT henceforth as the authors do.

They use two-outcome prospects, where CPT and OPT agree, and which suffice to measure/identify probability weighting. Then they see which better predicts for three-outcome prospects. CPT does bit better although a close call. CPT underestimates, and OPT overestimates, certainty equivalents. The concluding para of the paper favors CPT. I want to add a strong further argument supporting CPT: OPT has been targeted towards two or three outcomes, but goes nowhere for more outcomes, grossly overestimatng their values. Hence, this paper tests the two theories in the domain most favorable to OPT, the only domain where OPT has any chance at all. %}

Gonzalez, Richard & George Wu (2022) "Composition Rules in Original and Cumulative Prospect Theory," *Theory and Decision* 92, 647–675. https://doi.org/10.1007/s11238-022-09873-0

{% Field experiment with 670 small and medium-sized enterprises (SMEs) and their 33,000 employees. Measured risk preference, time preference, and trust. There is only a nonsystematic, short-term effect of previous phishing emails on clicking behavior. Individuals with greater patience, trust, and risk seeking were more likely to click on phishing links but also more likely to benefit from phishing drills. %}

Gonzalez-Jimenez, David, Francesco Capozza, Thomas Dirkmaat, Evelien van de Veer, Amber van Druten, & Aurélien Baillon (2025) "Falling and Failing (to Learn): Evidence from a Nation-Wide Cybersecurity Field Experiment with SMEs," *Journal of Economic Behavior and Organization* 230, 106868. https://doi.org/10.1016/j.jebo.2024.106868

{% The basic idea of this paper is to exploit probability weighting for incentives. If agents overweigh small probabilities, as is the common empirical finding, then giving them a small-probability reward gives a particular degree of incentivization at the lowest expected-value cost. The paper uses rank-dependent utility to derive the point theoretically, and demonstrates that it works in an experiment. In this experiment, the paper uses Abdellaoui's (2000) method to measure probability weighting and utility (**tradeoff method**). P. 613 discusses multistage updating, a delicate issue under nonexpected utility, and the paper assumes reduction of compound lotteries, citing the relevant Machina (1989). Pp. 614-615 give Yaari's definitions of between-subject within-source comparisons of pessimism and insensitivity. The paper finds almost linear utility, as is common when correcting for probability weighting. It finds stronger insensivity and weaker pessimism than in mnay other studies.

P. 639 Result 4: As the author points out, it is likelihood insensitivity that drives the main result. %}

Gonzalez-Jimenez, Victor (2024) "Incentive Contracts when Agents Distort Probabilities," *Quantitative Economics* 15, 697–653. https://doi.org/10.3982/QE2275

{% **probability intervals**; Introduced the α-maxmin model but only for statistical info. %}

Good, Isidore J. (1950) "*Probability and the Weighing of Evidence*." Hafners, New York.

{% Discusses, a.o., Wald's maxmin EU. Calls all kinds of things rational. P. 112 middle, nicely, puts forward that logarithmic payment gives proper scoring rule! %}

Good, Isidore J. (1952) "Rational Decisions," *Journal of the Royal Statistical Society Series B* 14, 107–114.

{% %}

Good, Isidore J. (1962) "Subjective Probability as the Measure of a Non-Measurable Set." *In* Henry E. Kyburg Jr. & Howard E. Smokler (1964, eds.) *Studies in Subjective Probability*, Wiley, New York. (2nd edn. 1980, Krieger, New York.)

{% Seems to have introduced the term "Johnstone's sufficientness postulate." %}
Good, Isidore J. (1965) "*The Estimation of Probabilities: An Essay on Modern Bayesian Methods.*" Massachusetts Institute of Technology Press, Cambridge, MA.

{% **value of information**; Shows that under EU info can never have negative info. This was also noted already in Savage (1954) (?); and even by unpublished Ramsey (see Sahlin, 1990) %}
Good, Isidore J. (1967) "On the Principle of Total Evidence," *British Journal for the Philosophy of Science* 17, 319–321.

{% **dynamic consistency**; **updating: discussing conditional probability and/or updating**
Seems to argue that we should explicitly consider changes in previsions arising from pure thought. %}
Good, Isidore J. (1977) "Dynamic Probability, Computer Chess and the Measurement of Knowledge." *In* Edward W. Elcock & Donald Michie (eds.) *Machine Intelligence* 8, 139–150, Ellis Harwood and Wiley, London and New York.

{% %}
Good, Isidore J. (1983) "*Good Thinking.*" University of Minnesota Press, Minneapolis, MN.

{% **foundations of statistics** %}
Good, Isidore J. (1988) "The Interface between Statistics and Philosophy of Science," *Statistical Science* 3, 386–412.

{% **foundations of statistics**; §1.3 has a few remarks on the use of the likelihood ratio test. %}
Good, Isidore J. (1992) "The Bayes/Non-Bayes Compromise: A Brief Review," *Journal of the American Statistical Association* 87, 597–606.

{% **real incentives/hypothetical choice**: used real nontrivial payments. %}

Goodman, Barbara, Mark Saltzman, Ward Edwards, & David H. Krantz (1979) "Prediction of Bids for Two-Outcome Gambles in a Casino Setting," *Organizational Behavior and Human Performance* 24, 382–399.

{% **updating: discussing conditional probability and/or updating** %}

Goodman, Irwin R. & Hung T. Nguyen (1991) "Foundations for an Algebraic Theory of Conditioning," *Fuzzy Sets and Systems* 42, 103–117.

{% %}

Goodman, Irwin R. & Hung T. Nguyen, & Gerald S. Rogers (1991) "On the Scoring Approach to Admissibility of Uncertainty Measures in Expert Systems," *Journal of Mathematical Analysis and Applications* 159, 550–594.

{% People have special preferences to bet on particular random numbers more than others. Not (only) for illusion of control but also because of pleasure of how numbers fit into scheme etc. %}

Goodman, Joseph K. & Julie R. Irwin (2006) "Special Random Numbers: Beyond the Illusion of Control," *Organizational Behavior and Human Decision Processes* 99, 161–174.

{% Seems to write, on p. 54: "A rule is amended if it yields an inference we are unwilling to accept; an inference is rejected if it violates a rule we are unwilling to amend. The process of justification is the delicate one of making mutual adjustments between rules and accepted inferences; and in the agreement achieved lies the only justification needed for either." This citation resembles a bit the interaction between decisions derived from a decision analysis and direct intuitive decisions. %}

Goodman, Nelson (1965) "*Fact, Fiction and Forecast.*" Bobbs-Merrill: New York.

{% **foundations of statistics**: The author, properly I think, cricitizes another paper that, blinded by the follies of hypothesis testing, does the wrong thing of saying meta-analyses should reduce the impact of studies that stopped before the originally planned stopping. %}

Goodman, Steven N. (2008) "Systematic Reviews Are not Biased by Results from Trials Stopped Early for Benefit," *Journal of Clinical Epidemiology* 61, 95–96.

{% **foundations of statistics**: Criticizes p-values and hypothesis testing, following up on the recent ASA statement. This author has deep understanding, understanding Fisher and Neymann-Pearson well. P. 1180 points out that p-value has interpretation as frequentist probability, to which I add that that is probably why the statistical world erred in taking it as criterion. Nice text on p. 1181 3rd column end of 2nd para on no author ever (being able to) argue for p-value chosen. Nice references, e.g. p. 1181 3rd column on different significance levels in different fields. %}

Goodman, Steven N. (2016) "Aligning Statistical and Scientific Reasoning," *Science* 352 (6290), 1180–1181. https://doi.org/10.1126/science.aaf5406

{% Beginning, pp. 6-10 ("Een Belangrijk Misverstand: '*De Ziekte van Alzheimer is één Ziekte*' ") nicely shows how the disease of Alzheimer is not one existing disease, but a product of the sociology of medical research. Rest, as usual for inaugural lectures, pleas for more attention and money for own research, and less for any other. %}

Gool, Wim A. (2001) "Dementie en Misverstand," inaugural lecture, Medical Dept., University of Amsterdam, the Netherlands.

{% If a risk measure for RDU is additive w.r.t. independent risks, then w must be linear (EU) and E exponential. %}

Goovaerts, Marc J., Rob Kaas, & Roger J.A. Laeven (2010) "A Note on Additive Risk Measures in Rank-Dependent Utility," *Insurance: Mathematics and Economics* 47, 187–189.

{% Risk measures and decision models, such as maxmin EU, are very similar in a mathematical sense. Conceptually, they are not meant to be the same. Risk measures are supposed to measure only the downside of risk, and to be only one ingredient in decision making. This paper nicely explains this point and discusses all kinds of concepts from the two perspectives. %}

Goovaerts, Marc J., Rob Kaas, & Roger J.A. Laeven (2010) "Decision Principles Derived from Risk Measures," *Insurance: Mathematics and Economics* 47, 294–302.

{% %}

Gorbatsjov, Michael. "I have hundred economic consultants at my disposal, and I am sure that one of them is right; if I only knew which one" Citation translated from Dutch, as given in the "Volkskrant" of August 27, 1992.

{% %}

Gordon, Jean & Edward H. Shortliffe (1985) "A Method for Managing Evidential Reasoning in a Hierarchical Hypothesis Space," *Artificial Intelligence* 26, 323–357.

{% Gorman 1968 in Econometrica is less general. Murphy (1981) (RESTUD) showed that Gorman's assumption of arcconnectedness can be weaked to connectedness. %}

Gorman, William M. (1968) "The Structure of Utility Functions," *Review of Economic Studies* 35, 367–390.

{% Blackorby, Charles, Russell Davidson, & David Donaldson (1977) refer to this paper as the first to show that quasi-concave additively decomposable function has only one nonconcave additive value function; already Stigler (1950) had that in footnote 82, saying that Slutsky already had it. %}

Gorman, William M. (1970) "Concavity of Additive Utility Functions." London School of Economics (Lecture Notes).

{% %}

Gorman, William M. (1971) "Apologia for a Lemma," *Review of Economic Studies* 38, 114.
https://doi.org/10.2307/2296627

{% %}

Gorman, William M. (1971) "Clontarf Revisited," *Review of Economic Studies* 38, 116.
https://doi.org/10.2307/2296629

{% %}
Gorman, William M. (1976) "Tricks with Utility Functions." *In* Michael J. Artis & A. Robert Nobay (eds.) *Essays in Economic Analysis*, 211–243, Cambridge University Press, Cambridge.

{% Shows that the representation of Dubra, Maccheroni, & Ok (2004) can be rewritten in a nice way, closer to Aumann's (1962) setup. %}
Gorno, Leandro (2017) "A Strict Expected Multi-Utility Theorem," *Journal of Mathematical Economics* 71, 92–95.

{% Classical preference model cannot explain findings. Reference dependence with loss aversion and diminishing sensitivity can. %}
Götte, Lorenz, David Huffman, & Ernst Fehr (2004) "Loss Aversion and Labor Supply," *Journal of the European Economic Association* 2, 216–228.

{% **probability communication**: Present probabilities in different ways, one of them frequencies, other percentages, or experiences. Percentages attenuated common-ratio but augmented common-consequence. They do not consider salience of common outcome. %}
Gottlieb, Daniel A., Talia Weiss, & Gretchen B. Chapman (2007) "The Format in Which Uncertainty Information Is Presented Affects Decision Biases," *Psychological Science* 18, 240–246.

{% %}
Gourieroux, Christian & Alain Monfort (1995) "*Statistics and Econometrics Models*." Cambridge University Press, Cambridge.

{% **utility families parametric** %}
Gourieroux, Christian & Alain Monfort (2004) "Infrequent Extreme Risks," *Geneva Papers on Risk and Insurance Theory* 29, 5–22.

{% **marginal utility is diminishing**: According to Larrick (1993) one of the first to suggest that under certainty. Seems to take utility as cardinal, suggesting that money could be a convenient unit. Gossen's second law: in optimum, marginal utility per $ of each good is the same. %}

Gossen, Hermann Heinrich (1854) "*Entwickelung der Gesetze des Menschlichen Verkehrs, und der daraus Fliessenden Regeln für Menschliches Handeln.*" Druck und Verlag von Friedrich Vieweg und Sohn, 1854, Braunschweig. New edn. (1889): Verlag von R.L. Prager, Berlin. Translated into English by Rudolph C. Blitz (1983) "*The Laws of Human Relations and the Rules of Human Action Derived therefrom,*" MIT Press, Cambridge MA.

{% **foundations of quantum mechanics** %}

Goswami, Amit (1990) "Consciousness in Quantum Physics and the Mind-Body Problem," *Journal of Mind and Behavior* 11, 75–96.

{% **foundations of statistics**; review and propose post-data inferences based on frequentist criteria. Suggest that both Bayesians and frequentists can do pre- and post-data inference. That the latter is the more relevant difference, not Bayesian or nonBayesian. Suggest that procedures should satisfy both the Bayesian and the frequentist criteria. %}

Goutis, Constantinos & George Casella (1995) "Frequentist Post-Data Inference," *International Statistical Review* 63, 325–344.

{% %}

Gower, Barry (1991) "Hume on Probability," *British Journal for the Philosophy of Science* 42, 1–19.

{% Didactical survey of Sugeno integral and Choquet integral %}

Grabisch, Michel (1996) "The Application of Fuzzy Integrals in Multicriteria Decision Making," *European Journal of Operational Research* 89, 445–456.

{% %}

Grabisch, Michel (2000) “The Interaction and Möbius Representations of Fuzzy Measures on Finite Spaces, *k*-Additive Measures: A Survey.” *In* Michel Grabisch, Toshiaki Murofushi & Michio Sugeno (eds.) *Fuzzy Measures and Integrals: Theory and Applications*, 70–93, Physica-Verlag, Berlin.

{% A theory that could, as the author writes, be called ordinal cumulative prospect theory.

Outcome set is $\{x_{-k}, ..., x_{-1}, x_0, x_1, x_k\}$. Is ordinal but, x_{-j} is $-x_j$, so, distances to x_0 can be compared. Then defines symmetric Sugeno integral also for negative values, so, the analogue of the Šipoš (Sipos) integral. Essential step is definition of symmetric maximum, assigning to {a,b} the one farthest from zero, but zero if they are equally far from zero and of opposite sign.

He also suggests an asymmetric extension which kind of normalizes, mapping minimal outcome to zero and maximal to one. %}

Grabisch, Michel (2003) “The Symmetric Sugeno Integral,” *Fuzzy Sets and Systems* 139, 473–490.

{% A kind of follow-up on Denneberg (1994). %}

Grabisch, Michel (2016) “*Set Functions, Games and Capacities in Decision Making*.” Springer, Berlin.

{% Paper considers the measurement of weighting functions for uncertainty. It explains how software developed by the authors and made publically available can be used to best fit data. It does not formulate the context as uncertainty, but as general aggregation, as multiattribute utility. Uncertainty is an important special case though. Then each attribute refers to a state of nature and $(x_1,\ldots,x_n)$ is a prospect yielding x_j if state j obtains. In general multiattribute utility, to define a ranking of the attributes, they must be commensurable, so that values at different attributes can be compared (p. 767). They assume utility identified. P. 771: They take indifference if the functional-difference is closer to 0 than some threshold δ_C. §4 considers all kinds of distance measures to be minimized, usually in utility units. §5 illustrates an application of choosing between students based on their grades.

Several approaches in the paper consider data not only of the kind of choices and indifferences between n-tuples, but also data such as “the weight of attributes 1,2,3 should be at least 0.3.” P. 778 bottom explains that their LP, minimum variance, and minimum distance approaches work when data are only preferences between n-tuples, as mostly considered in decision theory. %}

Grabisch, Michel, Ivan Kojadinovic, & Patrick Meyer (2008) “A Review of Methods for Capacity Identification in Choquet Integral Based Multi-Attribute Utility Theory; Applications of the Kappalab R Package,” *European Journal of Operational Research* 186, 766–785.

{% Use term multicriteria decision making for the general problem of aggregation, so that decision under uncertainty is a special case.

nonadditive measures are too general: Sections 2.7 and 7

§2.7 presents several special cases of the Choquet integral meant to make it more tractable than the (overly) general general case. %}

Grabisch, Michel & Christophe Labreuche (2008) “A Decade of Application of the Choquet and Sugeno Integrals in Multi-Criteria Decision Aid,” *4OR* 6, 1–44.

{% %}

Grabisch, Michel, Jean-Luc Marichal, Radko Mesiar, & Endre Pap (2009) “*Aggregation Functions: Encyclopedia of Mathematics and Its Applications* 127,” Cambridge University Press, Cambridge, UK.

{% A (first part of a) survey of many generalized mean-type aggregator functions and their characterizations in terms of functional equations. These can generate preference representation theorems by interpreting these functionals as certainty equivalents.

Definition 20 is multisymmetry.

Remark 7 references early studies of the symmetric Choquet integral. %}

Grabisch, Michel, Jean-Luc Marichal, Radko Mesiar, & Endre Pap (2011) “Aggregation Functions: Means,” *Information Sciences* 181, 1–22.

{% The second part of their survey, showing primarily how to define and get many aggregator functions and discussing conorms. %}

Grabisch, Michel, Jean-Luc Marichal, Radko Mesiar, & Endre Pap (2011) “Aggregation Functions: Construction Methods, Conjunctive, Disjunctive and Mixed Classes,” *Information Sciences* 181, 23–43.

{% Study several equivalent ways of describing nonadditive set functions, Möbius inverses but also several different ways. %}
Grabisch, Michel, Jean-Luc Marichal, & Marc Roubens (2000) “Equivalent Representations of Set Functions,” *Mathematics of Operations Research* 25, 157–178.

{% A function is called k-additive if its Möbius-inverse assigns value 0 to all sets of more than k elements. So, there are no interactions involving more than k elements. For each game, a k can be established such that the generalized CORE, containing dominating k-additive functions, is nonempty. A trivial result is k = N with N the total number of elements. But k < N can often be. %}
Grabisch, Michel & Pedro Miranda (2008) “On the Vertices of the *k*-Additive Core,” *Discrete Mathematics* 308, 5204–5217.
https://doi.org/10.1016/j.disc.2007.09.042

{% The authors consider optimization w.r.t. two components as in Mongin (2020), Mongin & Pivato (2015), and Li, Rohde, & Wakker (2023), where both components concern uncertainty. So, the state space S is a product set of two state spaces, S = S1 x S2, and acts can be written as matrices. The authors consider what Li, Rohde, & Wakker (2023) called monotonicity following Mongin’s (2020) interpretation that this is a kind of stochastic or informational independence. They show that these seemingly weak monotonicity conditions imply expected utility over S with a product measure, similarly as the other references. However, a deviation is that the authors do it for Savage’s (1954) rich atomless state spaces (where they take countable additivity using Affow’s 1970 monotone continuity aixom) whereas the cited references do it for rich outcome sets. They also give an extension to Choquet expected utility, with comonotonic versions of the axioms. %}

Grabisch, Michel, Benjamin Monet, & Vassili Vergopoulos (2023) "Subjective Expected Utility through Stochastic Independence," *Economic Theory* 76, 723–757.
https://doi.org/10.1007/s00199-022-01476-8

{% %}
Grabisch, Michel, Toshiaki Murofushi & Michio Sugeno (2000, eds.) "*Fuzzy Measures and Integrals: Theory and Applications*." Physica-Verlag, Berlin.

{% **state space derived endogeously**: Shows that for every complete transitive monotone preference on a finite set, always a Savage-type state space can be constructed with SEU maximization. One, trivial, way to do this is take a singleton state space S = {s_1} and then the outcome set is the above finite set. %}
Grabiszewski, Konrad (2016) "On the Rejectability of the Subjective Expected Utility Theory," *B.E. Journal of Theoretical Economics* 16, 437–454.
https://doi.org/10.1515/bejte-2015-0074

{% %}
Gradshteyn, Israil S. & Iosof M. Ryzhik (1993, eds.) "*Table of Integrals, Series, and Products*." Academic Press, New York. (Translated into English by Alan Jeffrey.)

{% Hahn-decomposition theorem can be formulated as: For all measures v, u, there exists a set A such that v is absolutely continuous with respect to u on A, and u is with respect to v on A^c. This condition is generalized in some sense to capacities. §5 defines conditional expectation for capacity v w.r.t. sigma sub-algebra S: For every regular function f there exists S-measurable g s.t. $\int_B fdv = \int_B gdv$ for all B in S. Under some richness (at least four disjoint nonnull sets or something similar) v has a conditional expectation for every sub-sigma algebra if and only if v is a measure. %}
Graf, Siegfried (1980) "A Radon-Nikodym Theorem for Capacities," *Journal für die Reine und Angewandte Mathematik* 320, 192–214.

{% I read this interesting paper, probably given to me by Stef Tijs when I was a Ph.D. student in the early 1980s, before I started to write this annotated bibliography, made handwritten annotations, and "refound" them 06Nov2016. Many of "my" opinions are written in this paper.

P. 33 argues that game theory should specify the info that players have, for otherwise it is just individual choice.

P. 36 last para: **conservation of influence** (essentially redefining choice as influence), as I pointed out around 1983. %}

Grafstein, Robert (1983) "The Social Scientific Interpretation of Game Theory," *Erkenntnis* 20, 27–47.

{% **foundations of statistics**: the paper cites Evans et al. (1986). %}

Gandenberger, Greg (2015) "A New Proof of the Likelihood Principle," *British Journal for the Philosophy of Science* 66, 475–503.
https://doi.org/10.1093/bjps/axt039

{% **free will/determinism** %}

Grandjean, Vincent (2021) "How Is the Asymmetry between the Open Future and the Fixed Past to Be Characterized?," *Synthese* 198, 1863–1886.
https://doi.org/10.1007/s11229-019-02164-2

{% %}

Granger, Clive W.J. & Mark J. Machina (2006) "Structural Attribution of Observed Volatility Clustering," *Journal of Econometrics* 135, 15–29.

{% The provide analytical expressions for optima under prospect theory. %}

Grant, Andrew, David Johnstone, & Oh Kang Kwon (2021) "A Cumulative Prospect Theory Explanation of Gamblers Cashing-out," *Journal of Mathematical Psychology* 102, 102534.

{% %}

Grant, Simon (1995) "Subjective Probability without Eventwise Montonicity: Or: How Machina's Mom May also Be Probabilistically Sophisticated," *Econometrica* 63, 159–189.

{% %}

Grant, Simon & Atsushi Kajii (1998) “AUSI Expected Utility: An Anticipated Utility Theory of Relative Disappointment Aversion,” *Journal of Economic Behaviour and Organization* 37, 277–290.

{% **game theory for nonexpected utility** %}

Grant, Simon & Atsushi Kajii (1995) “A Cardinal Characterization of the Rubinstein-Safra-Thomson Axiomatic Bargaining Theory,” *Econometrica* 63, 1241–1249.

{% “ADI” axiom is indifference-monotonicity. %}

Grant, Simon, Atsushi Kajii, & Ben Polak (1992) “Many Good Choice Axioms: When Can Many be Treated As One?,” *Journal of Economic Theory* 56, 313–337.

{% %}

Grant, Simon, Atsushi Kajii, & Ben Polak (1992) “Many Good Risks: An Interpretation of Multivariate Risk and Risk Aversion without the Independence Axiom,” *Journal of Economic Theory* 56, 338–351.

{% **information aversion**;

Basic paper that starts their work on intrinsic preference for information.

dynamic consistency: favors abandoning RCLA when time is physical.

This can be caused by an intrinsic **value of information**, even if no better decisions can be made with it. Derive logical relations between preference or dispreference for information and quasi-convexity/concavity of prior/posterior preferences. Use term recursivity for what Luce calls consequence monotonicity, what Segal calls compound independence, what is similar to what was called substitution, etc. %}

Grant, Simon, Atsushi Kajii, & Ben Polak (1998) “Intrinsic Preference for Information,” *Journal of Economic Theory* 83, 233–259.

{% **dynamic consistency**; **information aversion**; assume that timing of resolution of uncertainty matters (is crucial for their SAIL = Single-Act-Information-Loving).

Have results on betweenness and RDU very similar to what Sarin & Wakker (1998, *Journal of Risk and Uncertainty* 17) get with sequential consistency, implying EU in one stage but not the other. We are not aware of logical relations between the results. %}

Grant, Simon, Atsushi Kajii, & Ben Polak (2000) "Temporal Resolution of Uncertainty and Recursive Non-Expected Utility Models," *Econometrica* 68, 425–434.

{% Seem to consider the following decomposability condition: [$f_R g \succ g$ and $g_R f \succ f$] $\Rightarrow$ $f \succ g$. The authors seem to show that betweenness (for risk) implies this condition. %}

Grant, Simon, Atsushi Kajii, & Ben Polak (2000) "Decomposable Choice under Uncertainty," *Journal of Economic Theory* 92, 167–197. https://doi.org/10.1006/jeth.2000.2644

{% **dynamic consistency**; **value of information**; **DC = stationarity**: end of §4 before appendix. %}

Grant, Simon, Atsushi Kajii, & Ben Polak (2000) "Preference for Information and Dynamic Consistency," *Theory and Decision* 48, 263–286.

{% **source-dependent utility**; **game theory for nonexpected utility** & **dynamic consistency**: Dixit & Skeath (1999) suggested that with high stakes more risk averse strategies in a two-outcome game is more plausible, but EU says the heigth of stakes shouldn't matter. This paper shows that giving up **RCLA** and using recursive utility, and not other aspects of nonEU, can resolve the paradox. The authors are in fact using (as they properly reference) the Kreps & Porteus (1978) model. %}

Grant, Simon, Atsushi Kajii, & Ben Polak (2001) " "Third Down with a Yard to Go": Recursive Expected Utility and the Dixit-Skeath Conundrum," *Economics Letters* 73, 275–286.

{% **Harsanyi's aggregation; source-dependent utility**: This paper characterizes the Kreps & Porteus (1978) model, well-known nowadays (2005-2023) for its use in the KMM smooth ambiguity model, and also analyzed by Grant, Kajii, & Polak (2001). However, it does so not for the Anscombe-Aumann model, but for the more general Harsanyi (1955) model, but the latter in an extended sense. De Meyer & Mongin (1995) showed that Harsanyi (19550 is more general than Anscombe-Aumann (1963). To wit, Harsanyi has a set of outcomes X, with generic element x. Can write x as $(x_1,\ldots,x_n)$ with x_j denoting what x means for individual j. If $y = (y_1,\ldots,y_n)$ has $y_j \sim_j x_j$ then we identify x_j and y_j. That way, Harsanyi's X becomes an arbitrary subset of a product set $X_1 \times \cdots \times X_n$. A Harsanyi probability distribution over X thus becomes an Anscombe-Aumann probability distribution over $X_1 \times \cdots \times X_n$. In this way Anscombe & Aumann (1963) becomes a corollary of Harsanyi (1955).

Whereas Harsanyi, implicitly, has 1/n probabilities over being individual i, in which case different subjective (endogenous) weights for different individuals can be interpreted as different welfare weights rather than probabilities, this paper adds an extra structure, making it different (not more or less general than Harsanyi): It additionally assumes probability distributions over the set I of individuals. Thus, the choice set is a product set $\Delta(I) \times \Delta(X)$, where Δ designates set of probability distributions. On p. 1953, beginning of §6, the authors write that Harsanyi worked with $\Delta(I \times X)$, deviating some from the $\Delta(X)$ that I assumed above. I took weights over I in Harsanyi as endogenous and not exogenous. Harsanyi does not write very explicitly about domain, and one can view it in different ways. %}

Grant, Simon, Atsushi Kajii, Ben Polak, & Zvi Safra (2010) "Generalized Utilitarianism and Harsanyi's Impartial Oberver Theorem," *Econometrica* 78, 1939–1971.

{% **Harsanyi's aggregation**: Generalize Harsanyi by using only subset of lotteries, involving less imagination of the social planners, by considering only lotteries over the identities the observer may assume independent of the social alternative. %}

Grant, Simon, Atsushi Kajii, Ben Polak, & Zvi Safra (2012) "Generalized Representation Theorem for Harsanyi's ('Impartial') Observer," *Social Choice and Welfare* 39, 833–846.

{% For the same preference domain as in their Econometrica (2010) model, they provide a representation with a dual treatment of the stages (intersecting with the Econometrica paper only in EU), dealing with Fleurbaey's objection to Harsanyi, getting inequality aversion ex post. %}

Grant, Simon, Atsushi Kajii, Ben Polak, & Zvi Safra (2012) "Equally-Distributed Equivalent Utility, Ex Post Egalitarianism and Utilitarianism," *Journal of Economic Theory* 147, 1545–1571.

{% %}

Grant, Simon & Edi Karni (2004) "A Theory of Quantifiable Beliefs," *Journal of Mathematical Economics* 40, 515–546.

{% %}

Grant, Simon & Edi Karni (2005) "Why Does It Matter that Beliefs and Valuations Be Correctly Represented?," *International Economic Review* 46, 917–934.

{% Application of ambiguity theory;

Intro nicely relates ambiguity of decision theory to linguistic ambiguity. %}

Grant, Simon, Jeffrey J. Kline, & John Quiggin (2014) "A Matter of Interpretation: Ambiguous Contracts and Liquidated Damages," *Games and Economic Behavior* 85, 180–187.

{% This paper considers robustness of experiments w.r.t. small probabilistic perturbations. For example, an agent exhibiting the typical Allais paradox might in fact maximize EU, be almost indifferent between the options provided, but slightly misperceive the probabilities. A theory is developed of experiments robust against this (being in topological interiors), and many paradoxes are discussed using this criterion. %}

Grant, Simon, Jeffrey J. Kline, Idione Meneghel, John Quiggin, Rabee Tourky (2016) "A Theory of Robust Experiments for Choice under Uncertainty," *Journal of Economic Theory* 165, 124–151.

{% Find mathematical mistakes in Gul & Pesendorfer (2014 Econometrica). The interval utility u(x,y) can be state-dependent and the set of ideal events does not need to be a sigma-algebra, given GP's axioms. Also, μ need not be countably additive. The auhors propose corrected axioms. %}

Grant, Simon, Shuo L. Liu, & Jingni Yang (2024) "A Comment on: Expected Uncertain Utility," *Econometrica* 92, 247–256.

{% **game theory can/cannot be viewed as decision under uncertainty**: the paper models game theory as Savagean decision under uncertainty.

The authors consider general games. They define states of nature that describe all uncertainties, being not only moves by nature but also all moves of players. For a player an information event is one that she can observe and condition strategy choice on. The authors emphatically assume NO randomization device, which I like. This is the main novelty relative to some preceding general modelings of game theory with ambiguity (discussed on p. 669). They only assume general preferences of players over outcomes, which can be state-dependent (Axiom A1 on p. 648). In fact, they only assume preferences over own strategies when the strategy choices of all others are fixed (sounds normal-form like). This fits with the idea that players choose their strategies independently and cannot influence each other, but not with the idea that in a meta-sense players can still influence each other ("if I come to conclude that x is optimal for me then player 2 will come to conclude that y is optimal for him"). Without further info, it also does not (yet) allow for comparisons of different equilibria. Outcomes can be general combinations of strategies.

A difficulty is that the revealed preference approach to observe preferences over own strategies given strategy choices of all others does not work well in games. It involves problematic thought experimennts as in Aumann & Drèze (2008): "imagine that I can only choose between x and y, but my opponents continue to think that I can choose from all my strategies." The authors write that they will not discuss this issue.

The authors derive the existence of an equilibrium (Theorem 1, p. 656), which requires richness, more or less a continuum of states. They assume such Savage-type richness of nonatomicity. As they emphasize, their model does not use randomization and does not need expected utility in any sense and can allow for general ambiguity attitudes (p. 642 end of 1st para). The absence of randomization and absence of commitment to expected utility for risk add to the generality of their approach. They do assume many conditionings on events that are observable to a player and there assume something like Savage's sure-thing principle, or backward induction (p. 650 ℓ. 1). So, it is not a universal sure-thing principle, but still it is a restriction.

It is useful to have a general framework for game theory without commitment to randomization and expected utility, allowing for ambiguity all over the place, and this is the first paper to do so. There is a price to pay of complex richness, general complexity of model, and still a sure-thing principle at some places.

P. 643, end of 2nd para: "It allows us, as well as behooves us, to model equilibrium behavior without the usual technical paraphernalia of convexity or monotonicity of strategies and preferences, and the related praxis that seems to have arisen more from considerations of analytical tractability rather than motivated by, for example, behavioral properties of the underlying preferences." %}

Grant, Simon, Idione Meneghel, & Rabee Tourky (2016) "Savage Games," *Theoretical Economics* 11, 641–682.

{% They consider sequential observations and then ambiguity with learning. New states may come in as with Karni & Vierø (2013). %}

Grant, Simon, Idione Meneghel, Rabee Tourky (2022) "Learning under Unawareness," *Economic Theory* 74, 447–475. https://doi.org/10.1007/s00199-021-01408-y

{% Nice generalization of Machina & Schmeidler (1992) by using P4 and a weaker analog of Savage's P2. %}

Grant, Simon, Hatice Özsoy & Ben Polak (2008) "Probabilistic Sophistication and Stochastic Monotonicity in the Savage Framework," *Mathematical Social Sciences* 55, 371–380.

{% They weaken a central axiom in Machina & Schmeidler's (1995) probabilistic sophistication model in the Anscombe-Aumann setup to stochastic monotonicity (independence when one of the prospects is degenerate). %}

Grant, Simon & Ben Polak (2006) "Bayesian Beliefs with Stochastic Monotonicity: An Extension of Machina and Schmeidler," *Journal of Economic Theory* 130, 264–282.

{% Propose a generalization of mean-variance where the combination of mean and variance is linear. The main contribution: It goes for uncertainty/ambiguity rather than for risk. Assume Anscombe-Aumann. The mean is mean Anscombe-Aumann-EU. Instead of variance they take a generalized dispersion measure, satisfying conditions specified below. The measure of dispersion is the subjective EU an agent would be willing to give up to achieve constant EU over the state space. A generalization relaxing constant absolute uncertainty aversion will be in Chambers, Grant, Polak, & Quiggin (2014 JET).

A probability measure π on the state space S is derived subjectively à la Savage (or Anscombe-Aumann). The model is very general and encompasses Siniscalchi's (2009) vector utility, variational, multiplier, and many other models. The authors share with variational a sort of constant absolute uncertainty aversion. They point out that absolute uncertainty aversion need not always be constant, but they just focus on this case. They axiomatize it in general, given a few inequalities specified below. P. 1363 penultimate para (& p. 1367 5th para): In the models assumed to be special cases, they incorporate Choquet expected utility, apparently implicitly assuming Anscombe-Aumann.

P. 1365: the general form is

$$V(f) = E_{\pi}(U \circ f) - \rho(U \circ f))$$

where $E_{\pi}(U \circ f)$ denotes the subjective Anscombe-Aumann EU, and ρ captures dispersion about $E_{\pi}(U \circ f)$, and $\rho(0) = 0$ for acts with constant k-utility level at every state.

P. 1366 lists axioms. A4 is unrestricted solvability and implies unbounded utility. A5 is constant absolute uncertainty aversion:

$$\alpha f + (1-\alpha)x \succcurlyeq \alpha z + (1-\alpha)x \Rightarrow \alpha f + (1-\alpha)y \succcurlyeq \alpha z + (1-\alpha)y$$

for constant acts x and y, and also constant act z. The latter is immaterial, and could have been any act g, as the authors point out p. 1366 bottom. Hence, the axiom is equivalent to weak certainty independence.

P. 1367 para −4 (also p. 1364 2nd para): without further assumptions, the model is too general to, for instance, have π identifiable. Theorem 1 is called too general to be very useful. (P. 1372 3rd para: in general, any π is possible and π is completely unidentifiable.)

They next consider properties called desirable such as uncertainty aversion (A6 p. 1368: convexity, or A6*: preference for complete hedges, or A7 (p. 1368): certainty betweenness, or A.8 (p. 1368): Siniscalchi's complementary independence, and positivity of ρ, properties that rule out likelihood insensitivity (inverse S) and, hence, will not work well empirically. Theorem 2 (p. 1368) gives the equivalent properties of ρ.

P. 1373: π is identifiable if local smoothness. Problem is that this is a mathematical nontestable condition. P. 1374 5th para: Siniscalchi's symmetry makes π identifiable.

P. 1375 considers (2nd order) probabilistic sophistication. 2nd order because we have not only π on S but also the Anscombe-Aumann objective probabilities. %}

Grant, Simon & Ben Polak (2013) "Mean-Dispersion Preferences and Constant Absolute Uncertainty Aversion," *Journal of Economic Theory* 148, 1361–1398.

{% %}

Grant, Simon & John Quiggin (1997) "Strategic Trade Policy under Uncertainty: Sufficient Conditions for the Optimality of ad Valorem, Specific and Quadratic Trade Taxes," *International Economic Review* 38, 187–204.

{% On social security investments. Equity premium puzzle. Do only EU, where their novelty is to introduce a government that can commit agents to payments. %}

Grant, Simon & John Quiggin (2002) "The Risk Premium for Equity: Implications for the Proposed Diversification of the Social Security Fund," *American Economic Review* 92, 1104–1115.

{% %}

Grant, Simon & John Quiggin (2005) "Increasing Uncertainty: A Definition," *Mathematical Social Sciences* 49, 117–141.

{% Generalize Gul & Pesendorfer's (2014; GP14) Expected Uncertain Utility Theory by having probabilistic sophistication rather than expected utility for the ideal events. Call their theory Generalized Uncertainty utility (GUU). Another deviation that I think is good is that they do not commit to the ideal events being endogenous, but allow them to be exogenous, and commit to neither. In these annotations, I criticize GP14 for claiming to accommodate the Allais paradox but not really doing so. This paper escapes from that and can really accommodate the Allais paradox.

event/outcome driven ambiguity model: outcome driven: like GP14, almost entirely outcome driven.

They share with G&P the central role of diffuse events, which I think is highly problematic. A big problem is that the exchangeability of diffuse events (Gul & Pesendorfer Axiom 3) leads to violations of dominance. The Grant, Rich, & Stecher (2022 p. 10) were forced by a referee (not me) to discuss this issue. I disagree with their defensive text. Their point that this violation of monotonicity comes from geometric reasoning and not from measure-theory reasoning is completely irrelevant to me. So, I agree much with their referee. Another problem is that diffuse events are often unobservable and even nonconstructive (Brouwer; see Birkhoff 1967 Theorem 13 and Cohen 2008). Roughly, it means that no explicit formula can describe them. And, further, the extreme total-absence-of-info α-maxmin type behavior towards diffuse events, violating some forms of dominance (p. 10), is not close to any empirical or normative behavior. For example, a diffuse event D can be a joint union of two disjoint diffuse events D1 and D2, all three nonnull, and all gambling-equivalent. The authors defend by calling this argument "geometric" and then saying that they do measure theory and not geometry, but I disagree with this defense. Anyway, this is essential in GP14 and cannot be avoided when generalizing GP14.

P. 2 cites papers that have NonEU jointly for risk and uncertainty, and writes as aim that any risk attitude can be combined with any ambiguity attitude. This has been achieved before in Choquet expected utility and its generalization of (cumulative) prospect theory, for instance in my 2010 book, which, as most of my papers, argues that one better avoid committing to EU for risk (and the

Anscombe-Aumann framework). Tversky & Kahneman (1992) is one of many papers in this stream. This stream is not cited here; oh well. %}

Grant, Simon, Patricia Rich, & Jack Stecher (2022) "Bayes and Hurwicz without Bernoulli," *Journal of EconomicTheory* 199 105027.
https://doi.org/10.1016/j.jet.2020.105027

{% %}

Grant, Simon, Berend Roorda, & Jingni Yang (2021) "Coherent Rich Beliefs, Decomposable Splits, and Dynamically Consistent Choice," Discussion paper, Australian National University, Canberra.

{% This paper generalizes Gul & Pesendorfer's (2014) expected uncertainty model by not requiring expected utility for unambiguous events but allowing Grant, Kajii, & Polak's (2000 JET) decomposabability model there. It is more general than beteweenness.

There is given a collection of balanced outcome sets, comprising ambiguity about what the outcome is. (**ambiguous outcomes vs. ambiguous probabilities**; **event/outcome driven ambiguity model: outcome driven**) In Savagean framework, agent assigns to each act the minimal map from states to balanced outcome-sets that contains the act. Certainty equivalent is such that, taking that as "balancing value," gives EBUU value 0. It is a special case of implicit utility, satisfying betweenness.

Atttitude to nonambiguous acts (where balanced sets are singletons) gives risk attitude, and what comes to it is ambiguity attitude. Decomposable events E satisfy Grant, Kajii, & Polak's (2000 JET) decomposabability for all acts f,g: [$f_E g \succ g$ and $g_E f \succ f$] $\Rightarrow$ $f \succ g$. An act is decomposable if it is measurable w.r.t. the decomposable events. Decomposable events are taken as unambiguous. The authors define diffuse acts similarly as Gul & Pesendorfer (2014, 2015). Those acts are maximally ambiguous and imply extreme behavior.

The authors conclude by pointing out that they have introduced an ambiguity model thataccommodates betweenness for risky decisions. I add here that Chew & Sagi (2008) is another ambiguity model doing so. I have always taken as the "real" definition of betweenness, also covering uncertainty/ambiguity, that expected utility holds within every indifference class. The authors do not consider this concept and I conjecture that their model does not satisfy it, whereas Chew & Sagi's model does. %}

Grant, Simon, Berend Roorda, & Jingni Yang (2024) "Expected Balanced Uncertain Utility," *Theoretical Economics* 20, 1–25.
https://doi.org/10.3982/TE5404

{% About Babyloniers and so on. %}

Grauer, Hans (1990) "Die Unendlichkeit in der Mathematik," *Mathematische Semesterberichte* 37, 153–156.

{% **principle of complete ignorance**: & **ordering of subsets**: This paper considers rankings of finite subsets of some "motherset," that is a connected topological space so that it is infinite and even a continuum. They consider all finite sets of size n, for each natural n, so, all finite subsets. They interpret sets as choice objects, let me say prospects, as resulting from decision making under complete ignorance. You know that you get one element from the finite set, but you know nothing more. In a preceding paper they axiomatized maximization of average utility. For what they axiomatize in this paper, first note that sets can be reinterpreted as probability distributions assigning the same probability 1/n to each of the n elements of an n-element set. This way the domain becomes all simple equal probability distributions with the restriction that each outcome can appear only once. Thus we, for instance, do NOT get all simple rational-probability distributions. Anyway, here they characterize a generalization of rank-dependent utility (RDU), where for every fixed n all n-outcome sets are evaluated by an RDU functional, but the weights for different n are completely unrelated. The end of the paper gives some restrictions. In this, they use the **tradeoff method**. This case has the popular α maxmin models, taking a convex combination of minimal and maximal utility, as a special case, and average utility as another. %}

Gravel, Nicolas & Thierry Marchant (2022) "Rank Dependent Weighted Average Utility: Models for Decision Making under Ignorance or Objective Ambiguity," working paper.

{% %}

Gravel, Nicholas, Thierry Marchant, & Arunava Sen (2011) "Comparing Societies with Different Numbers of Individuals on the Basis of their Average Advantage." *In* Marc Fleurbaey, Maurice Salles & John A. Weymark (2010) *Social Ethics and Normative Economics*, 261–277, Springer, Berlin.

{% They consider orderings of finite subsets of a set, and characterize average utility maximization: $\{x_1,\ldots,x_n\}$ --> $(U(x_1) + \ldots + U(x_n))/n$, where n is variable. Note the braces and not brackets around the n objects! These are sets and not arrays. So, each element can appear only once. In this sense it is different than generalized quasilinear means. %}

Gravel, Nicolas, Thierry Marchant, & Arunava Sen (2012) "Uniform Expected Utility Criteria for Decision Making under Ignorance or Objective Ambiguity," *Journal of Mathematical Psychology* 56, 297–315.

{% Use their model of sets of outcomes to describe situations of ambiguity. Derive a version of R.C. Jeffrey's model (**R.C. Jeffrey model**). %}

Gravel, Nicolas, Thierry Marchant, & Arunava Sen (2018) "Conditional Expected Utility Criteria for Decision Making under Ignorance or Objective Ambiguity," *Journal of Mathematical Economics* 78, 79–95.

{% Conditions under which, for the aggregation of individual utilities, welfarism must be its special case of utilitarianism, under unanimity. Welfarism was defined by Sen (1977) and sounds much like Fishburn's marginal independence. %}

Gravel, Nicolas & Patrick Moyes (2013) "Utilitarianism or Welfarism: Does It Make a Difference?," *Social Choice and Welfare* 40, 529–551.

{% **information aversion**: poem of 1742; ends with:

"where ignorance is bliss, 'Tis folly to be wise" %}

Gray, Thomas (1742) "Ode on a Distant Prospect of Eton College,"

{% Nice early (1960!) application of decision analysis to drilling oil. First part is descriptive, considerations made with actual decisions, and second part is prescriptive, doing an actual decision analysis. He assessed utility functions using the PE method (hypothetical) of many oil prospectors. One person, William Beard of the Beard Oil Company, had a utility function that could very well be approximated by ln(y + 150,000) on the domain [−150,000, 800,000].

A simplified didactical version is in Winkler (1972, Example 5.10). Seems he measured the risky utility function of the owner of an oil exploration company twice, three months between, finding greater risk aversion the second time but with reasons of changed circumstances to justify the change. %}

Grayson, C. Jackson Jr. (1979) "*Decisions under Uncertainty: Drilling Decisions by Oil and Gas Operators*." Arno Press, New York; first version 1960, Harvard Business School.

{% Do0wnloadable here:
http://www.numdam.org/item/RSMUP_1982__66__21_0.pdf
Seems to already have derived Schmeidler's 1986 representation theorem for Choquet integral functionals, according to Denneberg (1994). An earlier and more general result was given by Anger (1977). %}

Greco, Gabriele (1982) "Sulla Rappresentazione di Funzionali Mediante Integrali," *Rend. Sem. Mat. Univ. Padova* 66, 21–42.

{% They propose a generalization of the Choquet integral that can be interpreted as having **state-dependent utility** or as having outcome-dependent weighting function. They cite Green & Jullien (1988) and Segal (1989) for a similar functional for decision under risk. They do not know Chew & Wakker (1996) who, more generally, consider such functionals also for a state space and who consider connected topological spaces (in their appendix) generalizing the reals, and allow for nonlinear, continuous, utility functions. This paper concerns the special case of the Chew & Wakker (1989) functional for the reals and with utility the identity.

This paper takes the functional as primitive when axiomatizing its form, whereas Chew & Wakker (1996) did it with the represented preference relation as

primitive. Chew & Wakker also point out that 1992-prospect theory is a special case, but, unlike this paper (§9), do not note that the Sugeno integral is also a special case.

P. 15 ℓ. –3 correctly points out that the functional in itself is too general to be very useful. They also analyze the Möbius transform (§8.1), and bipolar generalizations.

I next show briefly how the characterization provided in this paper in Theorem 1 is related to Theorem B1 of Chew & Wakker (1993). Their main characterizing condition, cardinal tail independence (p. 9) implies ordinal independence of Chew & Wakker (Remark A1). The other axioms in Theorem B1 of Chew & Wakker (1993) are implied readily, mainly by the assumed existence of the functional. Thus, this Theorem B1 implies the existence of the functional of Chew & Wakker, and all that remains to be proved is that their utility function is the identity, which follows from cardinal tail independence. %}

Greco, Salvatore, Benedetto Matarazzo, & Silvio Giove (2011) "The Choquet Integral with Respect to a Level Dependent Capacity," *Fuzzy Sets and Systems* 175, 1–35.

{% Into 2nd page or so, about the Sugeno integral: "It appears, however, that this operator has some unpleasant limitations: the most important is the so called co-commensurability; i.e., the evaluation with respect to each considered criterion should be defined on the same scale." %}

Greco, Salvatore, Benedetto Matarazzo, & Roman Slowinski (2001) "Conjoint Measurement and Rough Set Approach for Multicriteria Sorting Problems in Presence of Ordinal Criteria." *In* Alberto Colorni, Massimo Paruccini, Bernard Roy (eds.) A-MCD-A *Aide Multicritère à la Décision* (Multiple Criteria Decision Aiding) EUR Report, 117–144, Joint Research Centre, The European Commission, Ispra.

{% %}

Greco, Salvatore, Benedetto Matarazzo, & Roman Slowinski (2008) "Case-Based Reasoning Using Gradual Rules Induced from Dominance-Based Rough Approximations." *In* Guoyin Wang, Tianrui Li, Jerzy W. Grzymala-Busse, et al. (eds.) *Rough Sets and Knowledge Technology. Lecture Notes in Computer Science*, 268–275, Springer, Heidelberg, Germany.

{% Bipolar is the mathematical way of saying sign dependence. %}
Greco, Salvatore, Radko Mesiar, & Fabio Rindone (2016) “Generalized Bipolar Product and Sum,” *Fuzzy Optimization and Decision Making* 15, 21–31.

{% Distinguish between necessary preferences, that are felt with certainty, and possible preferences. Sets of additive value functions represent it. Similar to Gilboa, Maccheroni, Marinacci, & Schmeidler (2010). %}
Greco, Salvatore, Vincent Mousseau, & Roman Slowinski (2010) “Multiple Criteria Sorting with a Set of Additive Value Functions,” *European Journal of Operational Research* 207, 1455–1470.

{% %}
Greco, Salvatore, Vincent Mousseau, & Roman Slowinski (2009) “The Possible and the Necessary for Multiple Criteria Group Decision,”

{% Generalizes PT by dropping gain-loss separability. So, no additive decomposability between gains and losses. %}
Greco, Salvatore & Fabio Rindone 2014) “The Bipolar Choquet Integral Representation,” *Theory and Decision* 77, 1–29.

{% %}
Green, Donald P., Daniel Kahneman, & Howard C. Kunreuther (1994) “How the Method and Scope of Public Funding Affects Willingness to Pay for Public Goods,” *Public Opinion Quarterly* 58, 48–67.

{% **criticisms of Savage’s basic framework**: Argue that of the three concepts states, consequences, acts, it is not self-evident that the former two are given first and that then the third is a mapping from the first to the second. Do a kind of state-dependent version of Anscombe-Aumann; argue in favor of EU. %}
Green, Edward J. & Kent Osband (1991) “A Revealed Preference Theory for Expected Utility,” *Review of Economic Studies* 58, 677–696.

{% %}

Green, H.A. John (1961) "Direct Additivity and Consumers' Behaviour," *Oxford Economic Papers* 13, 132–136.

{% **dynamic consistency** %}
Green, Jerry R. (1987) "Making Book against Oneself," The Independence Axiom, and Nonlinear Utility Theory," *Quarterly Journal of Economics* 102, 785–796.

{% %}
Green, Jerry R. & Bruno Jullien (1988) "Ordinal Independence in Non-Linear Utility Theory," *Journal of Risk and Uncertainty* 1, 355–387. ("Erratum," 1989, 2, 119.)

{% %}
Green, Jerry R., Lawrence J. Lau, & Herakles M. Polemarchakis (1978) "A Theory on the Identification of the von Neumann-Morgenstern Utility Function from Asset Demands," *Economics Letters* 1, 217–220.

{% A "Birmingham screwdriver" seems to be an expression alreay used before 1860, indicating a hammer but with the interpretation of the habit of using the one tool for all purposes. (**ubiquity fallacy**) %}
Green, Jonathon (1998) "*Dictionary of Slang*." Cassell, Weidenfeld & Nicholson, London.

{% Seems that they use hypothetical choices; no assumptions needed about utility functions (even though they might not have realized this) they do use the assumption of linear utility in arguing that the intercept changes as the amounts change, while keeping the ratio of amounts constant. It is not the ratio of amounts that they should hold constant, but the ratio of utilities.

Median data reject exponential and hyperbolic discounting; there is decreasing impatience but not hyperbolic discounting. %}
Green, Leonard, Nathanael Fristoe, & Joel Myerson (1994) "Temporal Discounting and Preference Reversals in Choice between Delayed Outcomes," *Psychonomic Bulletin and Review* 1, 383–389.

{% No new experiment; seems that they don't fit data at the individual level, only at group level. %}

Green, Leonard, Joel Myerson (1993) "Alternative Frameworks for the Analysis of Self-Control," *Behavior and Philosophy* 21, 37–47.

{% Survey of intertemporal choice together with risky choice. They consider only one nonzero outcome and mostly take linear utility. Then risk attitude is entirely driven by probability weighting, which the authors also call discounting. They consider exponential functions exp(-bx), hyperbolic functions A/(1+kx), and what they call hyperbola-like $A/(a+kx)^s$. In intertemporal context they take time t for x, and in risky choice they take odds ratio p/(1-p) for x (then the hyperbola-like family is the same as the one used by Goldstein & Einhorn (1987). Why odds ratio would be the analog for time is not clear to me, even if it does cover the same range. So, different behavior of utility for one than for the other (a finding presented in several places) is not clear to interpret, the more so as transaction costs work differently for one than for the other. The authors find that both for intertemporal choice and for risky choice the hyperbola perform better than exponential, and the extra parameter s improves the fit. From no more than this usefulness of extra parameter s for time as for risk the authors again and again derive the far-fetched conclusion that the mechanisms for time are the same as for risk, making this the main message of their paper.

They say they find support for inverse S but this is little surprise if only functions are fit that are inverse S.

P. 774 claims that hyperbola-like functions fit well at individual level for ALL individuals. P. 774: When they find that the extra parameter s is worthwhile both for children and for elderly people (**relation age-risk attitude**) this is what they conclude: "These findings demonstrate that the hyperbola-like discounting function (Equation 3) is extremely general in that it describes temporal discounting in individuals from childhood to old age." Variation in payoff (p. 781, top of 2nd column) amounts to tests of constant relative risk aversion.

loss aversion: erroneously thinking it is reflection: p. 768 3rd para thinks that loss aversion generates different predictions for losses than for gains, not realizing that loss aversion is only about exchanges between gains and losses.

real incentives/hypothetical choice, for time preferences: they have several references on it on p. 775. %}

Green, Leonard, & Joel Myerson (2004) "A Discounting Framework for Choice with Delayed and Probabilistic Rewards," *Psychological Bulletin* 130, 769–792. https://doi.org/10.1037/0033-2909.130.5.769

{% Seems that they use Mazur discounting and linear utility;

Choice task between delayed reward (with fixed amount) and immediate reward. Immediate reward was adjusted to find indifference point. Delays between 3 months and 20 years. Delayed rewards between $100 and $100,000.;

Hypothetical questions. Larger amounts are discounted less than smaller amounts. This could be explained by convex utility (and not by concave). Hyperbolic discounting fits data better than exponential, which could also be explained by convex utility (possibly also by concave utility).

Authors give an overview of explanations for the fact that discounting varies with reward size: overview of magnitude effect.

Data of 4 of the 24 subjects plotted at the individual level. %}

Green, Leonard, Joel Myerson, & Edward McFadden (1997) "Rate of Temporal Discounting Decreases with Amount of Reward," *Memory and Cognition* 25, 715–723.

{% Seems that they use exponential, Mazur, and general hyperbolic discounting; hypothetical questions; assume linear utility; fit data at individual level; fix delayed amount, 8 delays per subject and find immediate amount; claim that for children in 2 out of 12 cases exponential and hyperbolic discounting could not fit the data (R^2 less than (???) or equal to 0), for young adults also 2 out of 12, for older adults 2 out of 32; Fig 1, 2, and 3 may show some concave parts of the discount functions. %}

Green, Leonard, Joel Myerson, & Pawel Ostaszewski (1999) "Discounting of Delayed Rewards across the Life Span: Age Differences in Individual Discounting Functions," *Behavioural Processes* 46, 89–96.

{% %}

Green, Paul E. (1963) "Risk Attitudes and Chemical Investment Decisions," *Chemical Engineering Progress* 59, 35–40.

{% r**eal incentives/hypothetical choice, for time preferences**: seems to be on it %}

Green, Ryan M. & Steven R. Lawyer (2014) "Steeper Delay and Probability Discounting of Potentially Real versus Hypothetical Cigarettes (but not Money) among Smokers," *Behavioural Processes* 108, 50–56. https://doi.org/10.1016/j.beproc.2014.09.008

{% %}

Green, Paul E. & V. Srinivasan (1978) "Conjoint Analysis in Consumer Research: Issues and Outlook," *Journal of Consumer Research* 5, 103–123.

{% %}

Greenberg, Leslie S. (1986) "Change Process Research," *Journal of Consulting and Clinical Psychology* 54, 4–9.

{% %}

Greenberg, Leslie S. & William M. Pinsof (1986) "*The Psychotherapeutic Process: A Research Handbook*." New York: Guilford Press.

{% The authors seem to think that all violations of EU are due to misunderstanding utility.

risky utility u = strength of preference v (or other riskless cardinal utility, often called value); Subjects did direct quantitative judgments of utility. Next they did welfare evaluations, and risky decisions (sure vs. two-outcome gamble) where outcomes were money and where outcomes were their own utility assessments. For utility outcomes, risk aversion remained though less pronounced than for monetary outcomes. For welfare, similar aversion to equity. The result is plausible if risky utility = direct assessment and there is extra risk aversion because of nonEU, say probability transformation. However, the authors never consider the possibility that the subjects may deviate from EU (and additively-separable utilitarianism). Instead, they argue that all deviations are caused by misunderstandings of the concept of utility.

P. 245 4th para, about subjects facing outcomes in terms of their own direct assessments of utility, and nicely and appropriately suggesting that the subjects just treat these as monetary outcomes:

"In making such esoteric judgments, do they take the pains necessary to exclude whatever momentarily inappropriate intuitions they have developed over a lifetime of reasoning about the goods of everyday life?"

P. 246 first half gives informal version of the aggregation argument. %}

Greene, Joshua & Jonathan Baron (2001) "Intuitions about Declining Marginal Utility," *Journal of Behavioral Decision Making* 14, 243–255.

{% **survey on nonEU**: Well on EU that is. Gives nice survey of empirical risk studies up to that point, especially regarding relations with demographic variables.

questionnaire for measuring risk aversion: Uses it. No significant correlation between risk attitude measurements and general insurance questions. Maybe because former are for mixed prospects, and latter for losses. %}

Greene, Mark R. (1963) "Attitudes toward Risk and a Theory of Insurance Consumption," *Journal of Insurance* 30, 165–182.

{% **foundations of statistics**: Discusses p-values. The paper does not bring new insights but does an exceptionally thorough job. Especially impressive is that it has 100 or so references on the topic. I kept track of such references all my life and the keyword "Foundations of Statistics" gives about 120 references at this moment of writing (01Nov2016).

The paper many times repeats that p-values and the like are only valid if all assumptions made are valid, which I do not find very informative. Only point to note is that p-value is probability conditional on H_0 being true.

P. 338 2nd column 1st para: "Many problems arise however because this statistical model often incorporates unrealistic or at best unjustified assumptions. This is true even for so-called "non-parametric" methods, which (like other methods) depend on assumptions of random sampling or randomization."

P. 338 2nd column 2nd para points out a problem of classical methods that is avoided under the likelihood principle: "There is also a serious problem of defining the scope of a model, in that it should allow not only for a good representation of the observed data but also of hypothetical alternative data that might have been observed."

P. 338 2nd column 2nd para "many decisions surrounding analysis choices have been made after the data were collected—as is invariably the case [33]."

P. 339 1st column 3rd para "In conventional statistical methods, however, "probability" refers not to hypotheses, but to quantities that are hypothetical frequencies of data patterns under an assumed statistical model. These methods are thus called frequentist methods, and the hypothetical frequencies they predict are called "frequency probabilities." "

P. 343 the 16th common misinterpretation of P value comparisons and predictions:

"16. When the same hypothesis is tested in two different populations and the resulting P values are on opposite sides of 0.05, the results are conflicting.

No!" So, if one test rejects a null hypothesis H_0, and another does not, then this is not inconsistent because accepting H_0 does not mean much.

P. 343 the 17th common misinterpretation of P value comparisons and predictions: "17. When the same hypothesis is tested in two different populations and the same P values are obtained, the results are in agreement. No! Again, tests are sensitive to many differences between populations that are irrelevant to whether their results are in agreement. Two different studies may even exhibit identical P values for testing the same hypothesis yet also exhibit clearly different observed associations. For example, suppose randomized experiment A observed a mean difference between treatment groups of 3.00 with standard error 1.00, while B observed a mean difference of 12.00 with standard error 4.00. Then the standard normal test would produce P = 0.003 in both; yet the test of the hypothesis of no difference in effect across studies gives P = 0.03, reflecting the large difference (12.00 - 3.00 = 9.00) between the mean differences."

P. 347 penultimate para sings the usual song of statistical analyses. %}

Greenland, Sander, Stephen J. Senn, Kenneth J. Rothman, John B. Carlin, Charles Poole, Steven N. Goodman, & Douglas G. Altman (2016) "Statistical Tests, P Values, Confidence Intervals, and Power: A Guide to Misinterpretations," *European Journal of Epidemiology* 31, 337–350. https://doi.org/10.1007/s10654-016-0149-3

{% Pp. 36-37: "The term "uncertainty" is meant here to encompass both "Knightian uncertainty," in which the probability distribution of outcomes is unknown, and "risk," in which uncertainty of outcomes is delimited by a known probability distribution. In practice, one is never quite sure what type of uncertainty one is dealing with in real time, and it may be best to think of a continuum ranging from well-defined risks to the truly unknown."

P. 37: "In essence, the risk-management approach to monetary policymaking is an application of Bayesian decision-making."

P. 37: "Given our inevitably incomplete knowledge about key structural aspects of an ever-changing economy and the sometimes asymmetric costs or benefits of particular outcomes, a central bank needs to consider not only the most likely future path for the economy, but also the distribution of possible outcomes about that path. The decision-makers then need to reach a judgment about the probabilities, costs, and benefits of the various possible outcomes under alternative choices for policy."

P. 37: "The product of a low-probability event and a potentially severe outcome was judged a more serious threat to economic performance than the higher inflation that might ensue in a more probable scenario."

P. 38 suggests ambiguity aversion: "When confronted with uncertainty, especially Knightian uncertainty, humans beings invariably attempt to disengage from medium- to long-term commitments in favor of safety and liquidity."

P. 38: "In pursuing a risk-management approach to policy, we must confront the fact that only a limited number of risks can be quantified with any confidence."

{P. 38: "…how … the economy might respond to a monetary policy initiative may need to be drawn from evidence about past behavior during a period only roughly comparable to the current situation."

P. 39, that subjective info cannot be ignored: "Yet, there is information in those bits and pieces. For example, while we have been unable to readily construct a variable that captures the apparent increased degree of flexibility in the United States or the global economy, there has been too much circumstantial evidence of this critically important trend to ignore its existence."

P. 39: "Thus, both econometric and qualitative models need to be continually tested."

P. 40: "In fact, uncertainty characterized virtually every meeting, and as the transcripts show, our ability to anticipate was limited." %}

Greenspan, Alan (2004) "Innovations and Issues in Monetary Policy: The Last Fifteen Years," *American Economic Review, Papers and Proceedings* 94, 33–40.

{% **foundations of statistics**; shows many biases in research results that result from statistical hypothesis testing. Superficial reading suggests it is a nice paper. %}

Greenwald, Antony G. (1975) "Consequences of Prejudice against the Null Hypothesis," *Psychological Bulletin* 82, 1–20.

{% Points out that within-subjects has more power. Gives a balanced account of pros and cons of within - and between-subject designs. %}

Greenwald, Antony G. (1976) "Within-Subjects Designs: To Use or not to Use?," *Psychological Bulletin* 83, 314–320.

{% %}
Greenwood, John D. (1990) "Kant's Third Antimony: Agency and Causal Explanation," *International Philosophical Quarterly* 30, 43–57.

{% P. 227, middle, on the parameter of exponential utility (denoted α): "Few studies attempt to estimate α though."
Using comments by Frans van Winden of March 16, 2005:
On Table 4: Dividing the implied average coefficients of relative risk aversion, mentioned below the table, by the estimates of absolute risk aversion (alpha-hat in Table 4), I get an estimate of mean consumption that is (roughly) between 1.3 (167/130) and 2 (209/104). Is this 1300 and 2000 *dollar*, respectively? If so, is it then correct to say that the alpha-hat is between 0.08 (104/1300) and 0.05 (104/2000) *in dollars* (and somewhat higher if we use 130 instead of 104 as estimate of alpha-hat)? %}
Gregory, Allen W., Jean-François Lamarche, & Gregor W. Smith (2002) "Information-Theoretic Estimation of Preference Parameters: Macroeconomic Applications and Simulation Evidence," *Journal of Econometrics* 107, 213–233.

{% Cited by Schkade on SPUDM '97: Preference elicitation should be architectural rather than archaeology. It seems that they wrote on p. 179: "not as archaeologists, carefully uncovering what is there, but as architects, working to build a defensible expression of value. %}
Gregory, Robin, Sarah Lichtenstein, & Paul Slovic (1993) "Valuing Environmental Resources: A Constructive Approach," *Journal of Risk and Uncertainty* 7, 177–197.
https://doi.org/10.1007/BF01065813

{% **natural-language-ambiguity**: Seem to investigate tolerance of ambiguity (in general natural-language sense) only from negative perspective regarding threat, discomfort, and anxiety, and not regarding positive aspects such as curiosity and attraction toward ambiguous situations. %}

Grenier, Sebastien, Anne-Marie Barrette., & Robert Ladouceur (2005) "Intolerance of Uncertainty and Intolerance of Ambiguity: Similarities and Differences," *Personality and Individual Differences* 39, 593–600.

{% %}
Greiner, Ben (2004) "The Online Recruitment System ORSEE - A Guide for the Organization of Experiments in Economics." *In* Kurt Kremer & Volker Macho (eds.) Forschung und Wissenschaftliches Rechnen 2003, 79–93, GWDG Bericht 63 (Research and scientific computation 2003. GWDG report 63), Göttingen: Gesellschaft für Wissenschaftliche Datenverarbeitung.

{% Assume that E is an outcome-relevant event, and s a signal. For odds, under Bayesianism,

$P(E|s)/P(E^cs) = P(s|E)/P(s|E^c) \times P(E)/P(E^c)$.

This paper considers a generalization,

$P(E|s)/P(E^cs) = \alpha + \left(P(s|E)/P(s|E^c)\right)^\beta \times \left(P(E)/P(E^c)\right)^\gamma$

Bayesianism has $\alpha = 0$, $\beta = 1$, $\gamma = 1$. If $\beta=2$, it is as if the signal is received twice (independently, having unaltered odds). Assume $\alpha=0$ and the signal uninformative $\left(P(s|E)/P(s|E^c) = 1\right)$. Then still for $\gamma \neq 1$ the person changes probability, making it more extreme if $\gamma>1$ and more towards 0.5 if $\gamma<1$. %}
Grether, David M. (1980) "Bayes Rule as a Descriptive Model: The Representativeness Heuristic," *Quarterly Journal of Economics* 95, 537–557.
https://doi.org/10.2307/1885092

{% **real incentives/hypothetical choice**: they seem to have tested it and seem to have found systematic quantitative differences, but same qualitative effects

random incentive system: seems to be one of the first studies to use it. %}
Grether, David M. & Charles R. Plott (1979) "Economic Theory of Choice and the Preference Reversal Phenomenon," *American Economic Review* 69, 623–638.

{% reply to Pommerehne, Schneider, & Zweifel %}
Grether, David M. & Charles R. Plott (1979) "Economic Theory of Choice and the Preference Reversal Phenomenon: Reply," *American Economic Review* 72, 575.

{% **cognitive ability related to risk/ambiguity aversion**
Examine big data set on people's introspective estimates of their own survival probabilities. See how these are transforms of objective probabilities, for which the authors obtain estimates. Inverse S fits the data well. Likelihood insensitivity correlates well with direct measurements of cognitive ability, supporting its cognitive interpretation. (**cognitive ability related to likelihood insensitivity (= inverse S)**). %}

Grevenbrock, Nils, Max Groneck, Alexander Ludwig, & Alexander Zimper (2021) "Cognition, Optimism, and the Formation of Age-Dependent Survival Beliefs," *International Economic Review* 62, 887–918.
https://doi.org/10.1111/iere.12497

{% %}

Grieco, Daniela & Robin M. Hogarth (2009) "Overconfidence in Absolute and Relative Performance," *Journal of Economic Psychology* 30, 756–771.

{% **updating: testing Bayes' formula**: Descriptively examine Bayesian updating. Distinguish between strength of evidence, which is what probability it would generate if there were no other evidence (or if its "weight" were infinite), and weight of evidence which is how much this evidence will weigh relative to other (say, prior) evidence. For example, if we make a number of observations strength is the observed relative frequency, and the number of observations is the weight. The authors conjecture that subjects are not sufficiently sensitive to the weight dimension, and treat weights as all the same, "average," which means underestimating large weights and overestimating small weights. Verify it in a number of experiments. It explains patterns of both over- and under-confidence found in the literature. %}

Griffin, Dale & Amos Tversky (1992) "The Weighing of Evidence and the Determinants of Confidence," *Cognitive Psychology* 24, 411–435.

{% They compared betting odds of people with frequency of winning. The former is interpreted as derived from decision weights, the latter as objective probability. For example, for horses with betting odds derived from decision weight .10 the frequency of winning is smaller, say .08, suggesting that objective probability .08 is transformed into decision weight .10.

inverse S: Racetrack betting finds nonlinear probability inverse S weights. These data from a different domain do corroborate Preston & Baratta (1948) with intersection of diagonal around .18. Main drawback of horse racing data is that the population is more risk seeking than average people are.

P. 290 argues that people perceive probabilities nonlinearly. %}

Griffith, Richard M. (1949) "Odds Adjustments by American Horse Race Bettors," *American Journal of Psychology* 62, 290–294.

{% Seems **inverse S.**; not in Holland %}

Griffith, Richard M. (1961) "A Footnote on Horse Race Betting," *Transactions Kentucky Academic Science* 22, 78–81.

{% Asks subjects (two population samples of each ±10,000) hypothetical choices between (now: $1000) vs. (in 2 years: $1500) and (in 5 years: $1000) vs. (in 7 years: $1500), as tests of patience and one test of stationarity. Relates it to smoking. Present-biased people do not smoke more, but have harder times quitting. %}

Grignon, Michel (2009) "An Empirical Investigation of Heterogeneity in Time Preferences and Smoking Behaviors," *Journal of Socio-Economics* 38, 739–751.

{% %}

Grigoriev, Pavel G. & Johannes Leitner (2006) "Dilatation Monotone and Comonotonic Additive Risk Measures Represented as Choquet Integrals, *Statistics and Decisions* 24, 27–44.

{% First editions of the book were in 1812 (Vol. 1) and 1814 (Vol. 2). The 7th was final. They died after.

conservation of influence: "Hans im Glück" %}

Grimm, Jakob L.K. & Wilhelm K. Grimm (1857) "*Kinder- und Hausmärche.*" (7th edn.)

{% People must choose between risky allocations over themselves and others, so that risk attitudes and fairness both play a roe. %}

Grimm, Stefan, Martin G. Kocher, Michal Krawczyk, & Fabrice Le Lec (2021) "Sharing or Gambling? On Risk Attitudes in Social Contexts," *Experimental Economics* 24, 1075–1104. https://doi.org/10.1007/s10683-020-09690-8

{% **PT, applications** in finance. On disposition effect: people hold on to losing stocks and sell gaining stocks. %}

Grinblatt, Mark & Bing Han (2005) "Prospect Theory, Mental Accounting and Momentum," *Journal of Financial Economics* 78, 311–339.

{% **foundations of quantum mechanics** %}

Grinbaum, Alexei (2007) "Reconstruction of Quantum Theory," *British Journal for the Philosophy of Science* 58, 387–408.

{% **SPT instead of OPT**: Eq. 13 %}

Grishina, Nina, Comac A. Lucas & Paresh Date (2017) "Prospect Theory–Based Portfolio Optimization: An Empirical Study and Analysis Using Intelligent Algorithms," *Quantitative Finance* 17, 353–367. https://doi.org/10.1080/14697688.2016.1149611

{% Gives mixture-like axiom to characterize proportionality of additive value function. %}

Grodal, Birgit (1978) "Some Further Results on Integral Representation of Utility Functions," Institute of Economics, University of Copenhagen, Copenhagen. Appeared in rewritten form in Ch. 12 of Karl Vind (2003) "*Independence, Additivity, Uncertainty*." *With contributions by B. Grodal*. Springer, Berlin.

{% **revealed preference** %}

Grodal, Birgit & Werner Hildenbrand (1989) "The Weak Axiom of Revealed Preference in a Productive Economy," *Review of Economic Studies* 56, 635–639.

{% **state-dependent utility** %}

Grodal, Birgit & Jean-François Mertens (1976) "Integral Representations of Utility Functions," Institute of Economics, University of Copenhagen. CORE DP6823. Appeared in rewritten form as Ch. 11 by Birgit Grodal in Karl Vind (2003) "*Independence, Additivity, Uncertainty*." *With contributions by B. Grodal.* Springer, Berlin.

{% %}

Groes, Ebbe, Hans-Jörgen Jacobsen, Birgitte Sloth, & Torben Tranaes, (1995) "Testing the Intransitivity Explanation of the Allais Paradox," *Theory and Decision* 47, 229–245.

{% %}

Groes, Ebbe, Hans-Jörgen Jacobsen, Birgitte Sloth, & Torben Tranaes (1998) "Nash Equilibrium with Lower Probabilities," *Theory and Decision* 44, 37–66.

{% %}

Groes, Ebbe, Hans-Jörgen Jacobsen, Birgitte Sloth, & Torben Tranaes (1998) "Axiomatic Characterization of the Choquet Integral," *Economic Theory* 12, 441–448.

{% Examine cheating of subjects for gains and losses. Is more with losses, consistent with loss aversion (more utility saved for the same sacrifice of morality). %}

Grolleau, Gilles, Martin G. Kocher, & Angela Sutan (2016) "Cheating and Loss Aversion: Do People Cheat More to Avoid a Loss?," *Management Science* 62, 3428–3438.

https://doi.org/10.1287/mnsc.2015.2313

{% %}

Gronchi, Giorgio & Elia Strambini (2017) "Quantum Cognition and Bell's Inequality: A Model for Probabilistic Judgment Bias," *Journal of Mathematical Psychology* 78, 65–75.

{% %}

Groot Koerkamp, Bas, M. G. Myriam Hunink, Theo Stijnen, James K. Hammitt, Karen M. Kuntz, & Milton C. Weinstein (2007) "Limitations of Acceptability Curves for Presenting Uncertainty in Cost-Effectiveness Analysis," *Medical Decision Making* 27, 101–111.

{% %}
Grossi, Davide & Gabriella Pigozzi (2014) "*Judgment Aggregation: A Primer.*" Morgan & Claypool, San Rafael, CA, USA.

{% **CBDT**; do one numerical specification of CBDT, and compare it to one other predictive model invented by the authors themselves (a MAX heuristic). They find that CBDT better predicts choices if current info is available, but that their model invented by themselves does better otherwise. A difficulty is how to, when implementing a second memory, make the info of the memory first implemented disappear. The authors do so by telling subjects that for the second memory they should take the info of the first memory as irrelevant. %}
Grosskopf, Brit, Rajiv Sarin, & Elizabeth Watson (2015) "An Experiment on Case-Based Decision Making," *Theory and Decision* 79, 639–666.

{% %}
Grossman, Michael (1972) "On the Concept of Health Capital and the Demand for Health," *Journal of Political Economy* 80, 223–255.

{% **intertemporal separability criticized**; seems to question additivity of disjoint time periods. %}
Grossman, Michael (1982) "The Demand for Health after a Decade," *Journal of Health Economics* 1, 1–3.

{% This paper shows that subjects have a preference for skewness (always taken to be positive skewness), citing preceding literature finding this too. The paper only considers gains. It presents choices between prospects that have the same expected value and variance (taken as riskiness), but differ in skewnes. If subjects positively evaluate skewness, they are of course willing to take some extra risk so as to get extra skewness, as this paper shows empirically. Importantly, §4.5, p.

213, shows that preference for skewness is indistinguishable from the overweighting of small probabilities. Thus, preference for skewness amounts to the same as inverse S probability weighting. Prudence amounts to the same. Unfortunately, the authors only cite 1979 prospect theory for it, and not the many more recent papers showing it. The keywords "**inverse S**" and "**risk seeking for small-probability gains**" in this annotated biblioography give many papers on it. %}

Grossman, Philip J. & Catherine C. Eckel (2015) "Loving the Long Shot: Risk Taking with Skewed Lotteries," *Journal of Risk and Uncertainty* 51, 195–217.

{% **updating under ambiguity** %}

Grove, Adam J. & Joseph Y. Halpern (1998) "Updating Sets of Probabilities." *In* David Poole et al. (eds.) *Proceedings of the Fourteenth Conference on Uncertainty in AI*, 173–182, Morgan Kaufmann, Madison, WI.

{% **intuitive versus analytical decisions**; Mechanical Prediction means based on quantitative (statistical, computer, etc.) analyses, and clinical means direct intuitive judgments by specialists (unfortunate term, originated from medical domain and now has become generally accepted). This meta-analysis finds that in most cases the mechanical predictions did better.

I agree that mechanical does better than commonly thought, and deserves more attention. The work done in decision theory can be considered to be one big attempt at promoting quantitative analyses. Still, mechanical will not be preferable in most cases.

Concerning a different but more interesting question, when can mechanical analysis contribute something at all to other such as clinical analyses, I guess that it can in 1 out of 10,000 cases. 1 out of 10,000 is so much that it is worth dedicating one's life to. So, how come about the finding of this meta-analysis? I think that it was subject to a selection bias. Published studies concern those rare and interesting cases where mechanical can do something. The obvious point that mecanical mostly doesn't work is too trivial to be published. %}

Grove, William M., David H. Zald, Boyd S. Lebow, Beth E. Snitz, & Chad Nelson (2000) "Clinical versus Mechanical Prediction: A Meta-Anaysis," *Psychological Assessment* 12, 19–30.

{% %}
Groves, Robert M., Robert B. Cialdini, & Mick P. Couper (1992) "Understanding the Decision to Participate in a Survey," *Public Opinion Quarterly* 56, 475–495.

{% Mechanism for public goods avoiding free riding. The payment scheme is quadratic in a way reminiscent of the quadratic proper scoring rule. %}
Groves, Theodore & John O. Ledyard (1977) "Optimal Allocation of Public Goods: A Solution to the "Free Rider" Problem," *Econometrica* 4, 783–809.

{% %}
Gruber, Jonathan & Botond Köszegi (2001) "Is Addiction "Rational"? Theory and Evidence," *Quarterly Journal of Economics* 116, 1261–1303.

{% Argues against libertarian paternalism, that it is manipulative, deliberately circumventing people's own deliberations, deliberately not making clear to people what they do, and that it will certainly not work if people see through it. I disagree with all these views. %}
Grüne-Yanoff, Till (2012) "Old Wine in New Casks: Libertarian Paternalism still Violates Liberal Principles," *Social Choice and Welfare* 38, 635–645.

{% %}
Grünwald, Peter D. (2016) "Contextuality of Misspecification and Data-Dependent Losses," *Statistical Science* 31, 495–498.
https://doi.org/10.1214/16-STS561

{% Seems to show relations between proper scoring rules and convex functions. A person in proper scoring rule is as if minimizing a convex function over convex set of probability measures. %}
Grünwald, Peter D. & A. Philip Dawid (2004) "Game Theory, Maximum Entropy, Minimum Discrepancy and Robust Bayesian Decision Theory," *Annals of Statistics* 17, 1367–1433.

{% **three-doors problem** ; **updating: discussing conditional probability and/or updating**: Many papers have discussed the issue that conditioning on an observed event can only be done under a ceteris paribus assumption, entailing that the observation does not carry other information, and does not affect anything conditional upon the event. This paper provides mathematical conditions and formulas stating when exactly Bayes formula for conditioning holds and when not, referring to some other recent papers, and many statistical papers, on similar issues. The mathematics by itself is not particularly hard, but is illuminating by bringing in the right concepts. The three-doors problem provides a good illustration of when a naïve version of Bayes formula need not hold. No one will, after reading this paper, ever again fall victim to forgetting the ceteris paribus condition of Bayes' formula. The precise mathematical statements work better than vague philosophical discussions.

Nice concept: The *naïve* [state] space contains only the states that determine the consequences resulting from acts. There are also observations, which do not directly affect consequences of acts, but only indirectly through their influence/information about the naïve state space. To condition upon information often more than just the naïve state space is required. We also need to know the probabilities of the "sophisticated" state space, which describes both the naïve states and (part of) the observations; i.e., what Shafer called the protocol. In the three-doors problem, you also need to know what the jailor does when he has a choice which of the other two prisoners to indicate, before you can calculate posterior probabilities. The sophisticated space should also describe those things. %}

Grünwald, Peter D. & Joseph Y. Halpern (2002) "Updating Probabilities." *In* Adnam Darwiche & Nir Friedman (eds.) *Uncertainty in Artificial Intelligence, Proceedings of the Eighteenth Conference*, 187–196, Morgan Kaufmann, San Francisco, CA.

{% %}

Guala, Francesco (2000) "The Logic of Normative Falsification: Rationality and Experiments in Decision Theory," *Journal of Economic Methodology* 7, 59–93.

{% Methodological discussion of debates about preference reversals and BDM (Becker-DeGroot-Marschak) mechanism. %}

Guala, Francesco (2000) "Artefacts in Experimental Economics: Preference Reversals and the Becker-DeGroot-Marschak Mechanism," *Economics and Philosophy* 16, 47–75.

{% **equity-versus-efficiency**: seems to be on it. %}

Guala, Francesco & Antonio Filippin 2017) "The Effect of Group Identity on Distributive Choice: Social Preference or Heuristic?," *Economic Journal*, 127, 1047–1068.

{% benedenstaande achterkant voorblad artikel Gudder geschreven

I spent several hours (spread out over years, starting from Gudder's paper) on finding out if not the axiom M5, cancellation, was implied by the others, M1–M4 and M6. It almost is, but not completely. I did observe a possible weakening of M5 in the presence of the other axioms. It can be derived (took me some hours) from Axioms M1–M4 and M6 that [ApC = BpC for some 0 < p < 1] implies [ApC = BpC for all 0 < p < 1]. So, then only for p = 1 we may have inequality. Hence, Axiom M5 may be weakened to: if ApC = BpC for all 0 < p < 1, then A=B. Examples violating this condition, but satisfying M1–M4 and M6, can be constructed.

An open question to me is if in the axioms, in the presence of the full force of M5, the "three-dimensional" associativity can be weakened to the "two-dimensional" associativity as has been used by von Neumann & Morgenstern and others. %}

Gudder, Stanley P. (1977) "Convexity and Mixtures," *SIAM Review* 19, 221–240.

{% **foundations of quantum mechanics**; notion of probability in quantumtheory; compares quantum-probability theory with Kolmogorov-probability theory. %}

Gudder, Stanley P. (1979) "*Stochastic Methods in Quantum Mechanics.*" North-Holland, Amsterdam.

{% %}

Gudder, Stanley P. & Frank Schroeck (1980) "Generalized Convexity," *SIAM Journal on Mathematical Analysis* 11, 984–1001.

{% **CBDT**: Analyzes optimality results when the similarity function is concave in a Euclidean distance measure. Some anomalies of nonexistence can be resolved by allowing convexities in the similarity function. %}

Guerdjikova, Ani (2008) "Case-Based Learning with Different Similarity Functions," *Games and Economic Behavior* 63, 107–132.

{% Application of ambiguity theory;

Analyse market populated with EU maximizers and smooth ambiguity maximizers, who will survive in the long run under all kinds of assumptions and who will affect market prices. %}

Guerdjikova, Ani & Emanuela Sciuba (2015) "Survival with Ambiguity," *Journal of Economic Theory* 155, 50–94.

{% Social planner trades off **preference for flexibility** against ambiguity aversion of individuals in a society; axioms are given. %}

Guerdjikova, Ani & Alexander Zimper (2008) "Flexibility of Choice versus Reduction of Ambiguity," *Social Choice and Welfare* 30, 507–526.

{% A theoretical paper on auctions with EU, showing that in general the utility function is not identifiable, but it is under some exclusion restrictions. %}

Guerre, Emmanuel, Isabelle Perrigne, & Quang Vuong (2009) "Nonparametric Identification of Risk Aversion in First-Price Auctions under Exclusion Restrictions," *Econometrica* 77, 1193–1227.

{% Multiattribute utility à la Keeney & Raiffa, with attributes referring to timepoints. A nice weakening of utility independence, referring only to preceding timepoints, leading to semiseparable utility.

Appealing case of Keeney & Raiffa's (1976) utility independence: Attributes 1,…,n refer to timepoints. Each timeset {j,…,n} is utility independent from past consumption iff a “semi-separable” utility $U(x_1,\ldots,x_n) = SUM_{j=1}^{n}(u_j(x_j)\Pi_{i=1}^{j-1} c_i(x_i))$. %}

Guerrero, Ana M. & Carmen Herrero (2005) “A Semi-Separable Utility Function for Health Profiles,” *Journal of Health Economics* 24, 33–54. https://doi.org/10.1016/j.jhealeco.2004.03.004

{% Defines more risk averse in the smooth ambiguity model, applying the Yaari technique to the vNM utility function. Say it becomes more risk aversion by a concave utility transformation h, replacing u by h(u). Then the smooth ambiguity aversion function φ has to be replaced by $\varphi(h^{-1})$. So, risk and ambiguity attitude are not well separated. %}

Guetlein, Marie-Charlotte (2016) “Comparative Risk Aversion in the Presence of Ambiguity,” *American Economic Journal: Microeconomics* 8, 51–63.

{% Happiness depends on income but also on reference level. Reference level has negative effect on utility in Western Europe, but positive in Eastern Europe, probably in being predictor for future utility. %}

Guglielmo Maria Caporale, Yannis Georgellis, Nicholas Tsitsianis & Ya Ping Yin (2009) “Income and Happiness across Europe: Do Reference Values Matter?,” *Journal of Economic Psychology* 30, 42–51.

{% %}

Gui, Qingyun & Yi C. Huang (2022) “A Consequence of Complementary Symmetry,” *Journal of Mathematical Psychology* 110, 102714. https://doi.org/10.1016/j.jmp.2022.102714

{% **(very) small probabilities**; **anonymity protection** %}

Guiasu, Radu Cornel & Silviu Guiasu (2010) “New Measures for Comparing the Species Diversity Found in Two or More Habitats,” *International Journal of Uncertainty, Fuzziness & Knowledge-Based Systems* 18, 691–720.

{% Application of ambiguity theory;

Survey of the use of ambiguity models in finance. %}

Guidolin, Massimo & Francesca Rinaldi (2013) "Ambiguity in Asset Pricing and Portfolio Choice: A Review of the Literature," *Theory and Decision* 74, 183–217.

{% **CBDT** %}

Guilfoos, Todd & Andreas Duus Pape (2016) "Predicting Human Cooperation in the Prisoner's Dilemma Using Case-Based Decision Theory," *Theory and Decision* 80, 1–32.

{% **linear utility for small stakes**: This is how they justify, in §2, why they use a hypothetical question with a large amount. In this, they correctly specify that they assume expected utility.

decreasing ARA/increasing RRA: this is what they find.

Use household survey data of 8,135 subjects of 1995 Bank of Italy Survey of Household Income and Wealth (SHIW). Risk attitude is measured through the following question, presented "unprepared":

"We would like to ask you a hypothetical question that you should answer as if the situation were a real one. You are offered the opportunity of acquiring a security permitting you, with the same probability, either to gain 10 million lire or to lose all the capital invested. What is the most that you would be prepared to pay for this security?" Here 10 million lire is about $5000. I am afraid that the question leaves many ambiguities. The authors have in mind that it designate a 50-50 prospect. Problem 1. However, one thing unclear is whether not also other outcomes might occur. In practice that will always be the case, so that it is very likely that subjects will assume that there could be other outcomes.

Problem 2. A second difficulty is the vagueness in "with the same probability."

In practice, people never have probabilities given for securities, so, the subjects won't know what probability is being referred to, and will have a hard time picking up that these probabilities are the same.

Problem 3. A third difficulty is that the subjects don't know what guarantee they have that their money will be treated in a fair way. If you invest in stocks you may lose all money, but you will read in the paper that that was the "fair" outcome that the bank had to offer you. If you just give money to a stranger under the terms that maybe the stranger will not return the money, and you don't know the rules of the game, you just will not do it because you don't trust the stranger.

The data, indeed, are bad. Of the 8,135, more than half, 4,677 subjects, were either not willing to pay any positive amount for the security. 3,091 wanted to pay only 0 for it, and 1,586 said they did not know. Only 3,458 were willing to pay a positive amount. The authors argue that it is due to the “complexity” of the question and that it is good to get rid of those who don’t understand, but I think that the security is way more unfavorable than the authors take it. It is also unfortunate that the subjects dropped are not randomly misunderstanding, but comprise the most risk averse and ambiguity averse among the subjects.

Despite the above problems, the data set is so very nice that it is still interesting to analyze the relation between the answers given and demographic variables etc., among the 3,458 that did want to pay a positive amount.

In this group, the young take less risk than the old. (**relation age-risk attitude**) %}

Guiso, Luigi & Monica Paiella (2008) “Risk Aversion, Wealth and Background Risk,” *Journal of the European Economic Association* 6, 1109–1150. https://doi.org/10.1162/JEEA.2008.6.6.1109

{% %}

Guiso, Luigi, Paola Sapienza, & Luigi Zingales (2008) “Trusting the Stock Market,” *Journal of Finance* 63, 2557–2600.

{% %}

Gul, Faruk (1987) “Noncooperative Collusion in Durable Goods Oligopoly,” *Rand Journal of Economics* 18, 248–254.

{% %}

Gul, Faruk (1989) “Bargaining Foundations of Shapley Value,” *Econometrica* 57, 81–95.

{% Idea of the model: To prepare, first consider traditional EU for $(p_1{:}x_1,\ldots,p_n{:}x_n)$, with $x_1 \geq \cdots \geq x_n$. Then CE (certainty equivalent) satisfies, with $x_k \geq CE \geq x_{k+1}$,

$$SUM_{i\leq k}p_i\big(U(x_i)–U(CE)\big) = SUM_{j>k}p_j\big(U(CE)–U(x_j)\big).$$

This paper considers a generalization of EU where there exists a $\beta > -1$ such that the CE satisfies

$\mathrm{SUM}_{i \le k} p_i(U(x_i) - U(CE)) = (1+\beta)\mathrm{SUM}_{j>k} p_j(U(CE) - U(x_j))$ (*)

That is, the disappointing outcomes (worse than the lottery, so, than its CE) are reweighted by a factor $1+\beta$. $\beta > 0$ is in the spirit of loss aversion. In his equation on top of p. 673, the weights are $\alpha/(1+(1-\alpha)\beta)$ and $(1+\beta)(1-\alpha)/(1+(1-\alpha)\beta)$, so, the bad outcomes are indeed overweighted by $(1+\beta)$ relative to the good outcomes, confirming my Eq. (*). Eq. (*) is easiest to understand and analyze the model, I think.

P. 670 above Def. 1 for once and for all imposes that big sure money amounts are preferred to small ones, which will imply that utility is strictly increasing. Stochastic dominance can readily be inferred from Eq. (*) above, where by transitivity it suffices to consider only improvements that do not cross the u(CE) level: If one outcome is increased then, both if $\mathrm{SUM}_{i \le k} p_i(U(x_i) - U(CE))$ was increased and if $\mathrm{SUM}_{j>k} p_j(U(CE) - U(x_j))$ was decreased, to maintain the equality, the CE value has to increase too. Thus, we get classical weak stochastic dominance (increasing any monetary outcome weakly improves the prospect).

biseparable utility: p. 677 points out that for two-outcome lotteries this theory is a special case of rank-dependent utility, with probability weighting function (I write p for probability where Gul writes α)

$p \to p/(1 + (1-p)\beta)$.

If the probability of the worst outcome is $1-p$, then its weight is $(1-p)(1+\beta)/(1 + (1-p)\beta)$. In other words, we at first leave the good-outcome probability p unaffected but give the bad-outcome probability $1-p$ and extra weight factor $1+\beta$. Then we normalize. This means that the Wakker & Deneffe (1996) **tradeoff method** also measures utility for Gul's disappointment aversion theory. Pity I did not know this before Sept. '98, so could not mention it in the 96-paper. Disappointment aversion is a betweenness model, having linear indifference sets and EU within each indifference set, and satisfying quasi-convexity and quasi-concavity w.r.t. probability mixing. (It is not a special case or Chew's (1983) weighted utility.) I guess that Gul did not know these models when inventing his theory, but with his creativity just automatically invented the best and nicest model that can be. %}

Gul, Faruk (1991) "A Theory of Disappointment Aversion," *Econometrica* 59, 667–686.

{% Gives a mixture-like axiom (Assumption 2, nowadays (1995-2023) called act-independence) to characterize proportionality of additive value functions. Faruk told me how the paper came about: He had to teach Savage (1954) to students, but thought it was too difficult and that he wants something simper. His way of getting vNM-type mixure independence in the uncertainty model is very appealing, to the extent that I find it brilliant. %}

Gul, Faruk (1992) "Savage's Theorem with a Finite Number of States," *Journal of Economic Theory* 57, 99–110. ("Erratum," 1993, *Journal of Economic Theory* 61, 184.)

{% %}

Gul, Faruk (1996) "Rationality and Coherent Theories of Strategic Behavior," *Journal of Economic Theory* 70, 1–31.

{% Aumann (1987, Econometrica) introduced correlated equilibria but based it on an, I think, unsound application of Savage's (1954) model. For instance, Aumann had states of the world describe acts and probabilities which cannot be because probabilities and acts can be defined only if first already states of the world have been defined, in Savage's model. In this paper, Gul also criticizes Aumann's model. A reply by Aumann follows. %}

Gul, Faruk (1998) "A Comment on Aumann's Bayesian View," *Econometrica* 66, 923–927.

{% %}

Gul, Faruk (1999) "Efficiency and Immediate Agreement: A Reply to Hart and Levy," *Econometrica* 67, 913–917.

{% %}

Gul, Faruk (2001) "Unobservable Investment and the Hold-Up Problem," *Econometrica* 69, 343–376.

{% Faruk listed “at least 5 ways to deal with the problem” [of time inconsistency] and listed the following five, where I added texts between square brackets.
Strotz (forever game yourself) [sophisticated]
Rabin-O’Donogue (forever disappoint yourself) [naive]
Machina (don’t backward induct; bygones are not bygones) [resolute]
Epstein-Schneider (only use the clock at 9pm and 9am) [only in particular informational situations satisfy particular conditions]
Kreps-Porteus (1978) (the two problems are intrinsically different) [give up RCLA] %}
Gul, Faruk (2019) “Evaluating Ambiguous Random Variables and Updating by Proxy (with Wolfang Pesendorfer); lecture presented at D-TEA 2019 conference.

{% %}
Gul, Faruk & Dilip Abreu (2000) “The English Auction with Differentiated Bargaining and Reputation, *Econometrica* 68, 85–117.

{% %}
Gul, Faruk, Salvador Barbera, & Ennio Stacchetti (1993) “Generalized Median Voting Schemes and Committees,” *Journal of Economic Theory* 61, 262–289.

{% %}
Gul, Faruk, Avinash Dixit & Gene Grossman (2000) “A Theory of Political Compromise,” *Journal of Political Economy* 108, 531–567.

{% **dynamic consistency**; all conditions concern sets of optimal probability distributions in a choice situation and, thus, within equivalence classes, which is equivalent to betweenness. %}
Gul, Faruk & Outi Lantto (1990) “Betweenness Satisfying Preferences and Dynamic Choice,” *Journal of Economic Theory* 52, 162–177.

{% If agents can choose their time of decision, these points seem to be clustered together, because they can anticipate about each others’ information in some sense. %}

Gul, Faruk & Russell Lundholm (1995) "Endogenous Timing and the Clustering of Agent's Decisions," *Journal of Political Economy* 103, 1039–1066.

{% **value of information**
An evolving lottery means a probability distribution at each timepoint. A random evolving lottery is a probability distribution over those. This is like the original Anscombe-Aumann framework, which had lotteries both before and after the hore race. One thing studied is the preference fcor nonintrumental info. %}

Gul, Faruk, Paulo Natenzon, & Wolfgang Pesendorfer (2021) "Random Evolving Lotteries and Intrinsic Preference for Information," *Econometrica* 89, 2225–2259.
https://doi.org/10.3982/ECTA16190

{% %}

Gul, Faruk & David G. Pearce (1996) "Forward Induction and Public Randomization," *Journal of Economic Theory* 70, 43–64.

{% **dynamic consistency**: Seem to argue against the multiple-agent view of dynamic decisions. Dynamically consistent agents may prefer that some ex ante inferior options are deleted. %}

Gul, Faruk & Wolfgang Pesendorfer (2001) "Temptation and Self-Control," *Econometrica* 69, 1403–1435.

{% %}

Gul, Faruk & Wolfgang Pesendorfer (2004) "Self-Control and the Theory of Consumption," *Econometrica* 72, 119–158.

{% **dynamic consistency**: In dynamic decisions, planned choice usually plays a big role. But we cannot observe plans. This paper does not have plans in the formal model. At timepoint 1 we choose between decision problems at timepoint 2. To this they apply principles of revealed preference, and signals of lack of self-control in case of strict preference for subsets, etc. %}

Gul, Faruk & Wolfgang Pesendorfer (2005) "The Revealed Preference Theory of Changing Tastes," *Review of Economic Studies* 72, 429–448.

{% A preference axiomatization of random expected utility for random choice: A probability distribution over vNM utilities leads to random choice. Preference axioms: Mixture continuity, monotonicity (adding prospect to choice set of feasible prospects does not increase probability of choosing another prospect) and independence. %}

Gul, Faruk & Wolfgang Pesendorfer (2006) "Random Expected Utility," *Econometrica* 74, 121–146.

{% **dynamic consistency**: compulsive consumption: if deviating from prior-commitment consumption. Addiction: If consumption leads to more compulsive consumption. They do dynamic model with cycles of addiction and voluntary commitment to prohibition. %}

Gul, Faruk & Wolfgang Pesendorfer (2007) "Harmful Addiction," *Review of Economic Studies* 74, 147–172.

{% This paper, which received a lot of attention, is typically an ivory tower paper by economists who never did applied work. The reasoning of the authors is simple: for everything they argue that that could also be done using only revealed preference and, in fact, could be done better using only revealed preference. (**ubiquity fallacy**)

Endnote 3 explains why the authors avoid the term behavioral economics. They focus on the issue of using choiceless inputs in economics, departing from the revealed preference paradigm. However, they then unfortunately mostly focus on one small subset of choiceless inputs: Neuro-economics inputs, and often seem to take the latter as fully capturing the former. (P. 9 middle calls "psychology and economics," their term for behavioral economics, a pedecessor of neuroeconomics!?). This is because they react much to a Camerer, Loewenstein, & Prelec (2005) paper that greatly overstates the role and potential of neuro-economics.

They take a very strict and I think overly dogmatic revealed-preference viewpoint. (The famous Becker & Murphy 1977 is another example of a paper with such overly dogmatic viewpoints.) Again and again they argue that economics can ignore choiceless inputs, because, as they argue, those are defined to be outside of economics. But it cannot be denied that sometimes choiceless inputs can better predict consumer choices or, say, patient preferences, than choice-based inputs. The authors never take issue with this point, leaving me puzzled. The real reason why the ordinalists in the 1930s chose to go this way is that it gives unambiguous clear definitions, as a pro, with the con of losing inputs and info. The tradeoff between this pro and con cannot be judged on methodological arguments, or in an ivory tower. It came from over half a century of experience, showing that the con of losing inputs and info is too big. Such arguments are not found in this paper. To understand such points, it is better to have worked in a hospital for a year (one can never explain doctors that they should ignore info they read from the faces of patients, also for economic decisions on which money to spend on which treatment …) than to have proved theorems in an ivory tower. ☺

Typical is p. 2 3rd para, on subjective states and hedonic utility being legitimate topics of study. "This may be true …" So, about the whole field of psychology, they don't say that it is legitimate, but only that it may be legitimate. %}

Gul, Faruk & Wolfgang Pesendorfer (2008) "The Case for Mindless Economics." *In* Andrew Caplin & Andrew Schotter (eds.) *Foundations of Positive and Normative Economics*, 3–39, Oxford University Press, New York.

{% %}

Gul, Faruk & Wolfgang Pesendorfer (2009) "Partisan Politics and Aggregation Failure with Ignorant Voters," *Journal of Economic Theory* 144, 146–174.

{% Grant, Liu, & Yang (2023) criticize this paper for mathematical mistakes. For instance, the interval utility u(x,y) can be state-dependent. Also, μ need not be countably additive.

ABBREVIATIONS:

GP: Gul & Pesendorfer

GP14: Gul & Pesendorfer (2014), being this Econometrica paper

GP15: Gul & Pesendorfer (2015), being the JET paper

In short, both papers have deep maths, but their requirement that all ideal events and their probabilities be measured, needed to define inner and outer measures, and their requirement that diffuse events exist that involve unrealistic extreme decision attitudes (violating monotonicity; see Grant, Rich, & Stecher 2022 p. 10), make it impossible to use these theories in applications.

GP14: This paper is close to Jaffray (1989) (see below), only cited on p. 20. Would have been more appropriate to cite Jaffray in the intro. Thus, on p. 13 end of first para the authors claim a subjective foundation of Dempster-Shafer belief functions, not crediting priority of Jaffray.

SUMMARY PART 1. This paper (GP14) considers a Savage framework with acts mapping state space Ω to outcome space $X = [\ell,m] \subset \mathbb{R}$. The paper considers all maps from Ω to X, and imposes no measure-theory restrictions here. (Non-measurable sets will be crucially used.) A sub-σ-algebra of events (called *ideal*), and acts measurable w.r.t. them, satisfy all of Savage's axioms and has SEU, with utility v and subjective probability measure μ. It is atomless and countably additive, so that it has the full richness of the continuum with ample space for nonconstructive concepts, and those will be heavily used through diffuse events for instance. Anyway, GP do not want to commit to taking the ideal events being risky with known probabilities. (GP15 p. 469 calls them least uncertain.) These events are characterized by satisfying the sure-thing principle, thus allowing for conditioning, also for their complement. All such events are ideal. (In general, the collection of events with SEU maximization need not be intersection-closed. In this respect this paper is restricted, but it is OK that one doesn't always maximize generality.)

For all non-ideal events, the inner and outer measure are taken w.r.t. μ. For each act f, a tightest ideal lower bound $[f]_1$ and a tightest ideal upper bound $[f]_2$ exist with the pair $([f]_1,[f]_2)$ called the *envelope*.

GP14 P. 5 Theorem 1 gives the representation of their e*xpected uncertain theory* (*EUT*)

$$\int u([f]_1,[f]_2)d\mu$$

where the bivariate u is *interval utility*: $u(x,y) = \alpha_{x,y}v(x) + (1-\alpha_{x,y})v(y)$ with $0 \le \alpha_{x,y} \le 1$ (always $x \le y$) and $\alpha_{x,y}$ depends on x and y but, as appears from notation, does not depend on f or on events otherwise. u is continuous and monotonic and μ is countably additive (with sigma-algebra complete). GP interpret μ as uncertainty perception and ($\alpha_{x,y}$,v) as uncertainty attitude. GP15 p. 470 interprets v as "risk attitude for ideal events," but the authors use the term risk very differently than I do (I discuss this point at GP15).

As for axioms, the usual weak ordering and monotonicity in outcomes (Savage's P3) are imposed, and pointwise convergence continuity, giving countable additivity of μ and also continuity of u. For ideal events we also have Savage's P2 (sure-thing principle), P4 (more likely than) and P6 (tight and fine), giving SEU there. For nonideal events, complete absence of info à la Jaffray (1989) and others is imposed through Axiom 3 (called interchangeability of diffuse events by GP15), with weak monotonicity and the symmetry that necessitates violation of strong monotonicity (betting on D_1 is equally good as on $D_3 \cup D_4$ but then also as good as on $D_1 \cup D_2$). It implies that only the infimum and supremum outcomes matter there, leading to the interval utility. Diffuse events are maximally nonideal, with inner measure 0 and outer measure 1, nonnested with every nonnull ideal event. Axiom 3, the only nonEU axiom, is only imposed on diffuse events, implying it for all nonideal events through the other axioms.

SUMMARY PART 2. Then the paper gives several comparative results in §3 (pp. 8 ff) and later. I find the following text on p. 8 misleading. The authors claim that EUU achieves separation between attitude and perception, but in reality their result only compares attitude *assuming the same perception*. The authors suggest that they can handle different perceptions but this is just by equating them across agents, which involves not-directly-observable theoretical constructs. It is like me claiming that I can compare agents with different utility functions of outcomes by simply replacing outcomes by their utility values. Here is the text:

"Lemma 3, below, shows how the EUU model achieves separation between uncertainty perception and attitude. Consider two EUU agents with identical priors. How these agents rank acts depends only on their uncertainty attitudes (i.e., interval utilities). When the two agents have different priors μ, μ-bar, we can still isolate the uncertainty attitude by *controlling for the uncertainty they perceive* ($\lambda_\mu = \lambda_{\mu bar}$). Lemma 3 establishes that two agents have the same uncertainty attitude if and only if one's interval utility is a positive affine transformation of the other's interval utility." [italics added]

They provide the following results:

(1) Agent 2 is *more cautious than* agent 1 if, for the same interval lottery

(probability distribution over outcome intervals) the former has lower certainty equivalents than the latter, which holds iff v_2 is more concave than v_1 and each uncertain interval [x,y] has a lower certainty equivalent for agent 2 than for agent 1. (Theorem 2, p. 9) This condition suggests to allow for different μ's, but I disagree (see above).
(2) Agent 1 is *more uncertainty averse* than agent 2 if she compares interval lotteries less favorably to noninterval (μ) lotteries. It is equivalent to being more cautious but having the same v (up to level and unit). (Corollary 1, p. 10)
(3) There is also a comparison of one event being more uncertain than another, which happens iff its probability interval is a superset of the other's. (Theorem 3 p. 10) Corollary 2 in §4 relates it to a greater gap between belief and plausibility of Dempster-Shafer belief functions.

Theorem 5 (p. 14) considers α independent of x and y and shows that the EUU model then becomes a special case of CEU/RDU and α maxmin. Then it is tractable. But it is the topic of GP15, called HEU, and, more there.

§5, p. 14, turns to Ellsberg, so, source dependence (they only consider source preference). It considers urns with finitely many balls and several possible compositions (so, several possible relative frequencies—my term). An event is experimentally unambiguous if it has the same relative frequency for each composition. Here is the only interpretation of ambiguity in GP14. It gives a lambda system, but not a sigma algebra of experimentally unambiguous events, and they can be different from ideal events. A *finite source* is a collection of experimentally unambiguous events if any pair of them with the same relative frequency is exchangeable. So, it is like a finite exchangeable partition. It is a special case of "local" probabilistic sophistication. P. 17, 2nd displayed eq., states that the relative frequency then is the betting preference, but I think that that should be a possibly nonlinear transformation (depending on the source) of that relative frequency. The paper then defines as Ellsberg experiment a source preference for the experimentally unambiguous events over corresponding other events. P. 21 (Conclusion) and throughout say that ideal events are perfectly quantifiable and diffuse events are completely unquantifiable.
==================================

EVALUATION

GP14, and especially its followup GP15, model ambiguity (they mostly write about uncertainty, which is more correct but less fashionable) similarly to the source method, which I most like to work with. In this sense it is the model in the literature by others than my friends/co-authors that is closest to my interests and opinions. For instance, it also puts source dependence (introduced by Tversky but discovered independently by Ergin & Gul 2009) central, and does not focus on uncertainty aversion but explicitly allows for insensitivity. (GP15 p. 467 2nd para lists these views, and on p. 473 uses the expression "uncertainty loving at poor odds" to capture insensitivity).

On many details I have different interpretations (see later). The violation of monotonicity, mentioned below GP14 Axiom 3, is a very serious problem. I think it should have been discussed more rather than almost being put under the cover. Further, the use of nonconstructive mathematical tools such as the continuum hypothesis used to show the existence of many diffuse events (e.g., needed in Lemma 1 on p. 5), used in the only nonEU Axiom 3, is very unsatisfactory for an empirical theory (but can be fixed—see below). Especially for someone like me coming from the Holland, the country of Brouwer. The assumed preference conditions for nonideal (e.g., diffuse) events are also too extreme and unrealistic both empirically and normatively (in a way similar to α maxmin (p. 7), but more extremely). They, for instance, rule out expected utility maximization, which is necessarily violated in this model. (They have countable additivity and atomlessness of μ on the ideal events, which means that the ideal events cannot comprise all events (Banach & Kuratowski 1929; Ulam 1930).) As regards this deviation from EU, it is also impossible to have it gradually. Lemma 2, that every lottery over outcome intervals is present in the domain, also crucially depends on the assumed continuum hypothesis, unfortunately.

Another difference is that my papers are explicitly descriptive and seek much to link with data. GP14 are not explicit on it, but, as mostly in theoretical papers on ambiguity, do not try much to link to data, only Ellsberg and a Machina paradox. Yet, GP do better than almost any other theoretical paper in this regard in GP15 p. 467 2nd para, where they well seek to accommodate the main empirical findings. Jaffray in his related model clearly wanted to be normative, but few will follow his extreme aversion to using subjective inputs to model uncertainty (only utility of outcomes can be subjective for him).

The axioms of Theorem 1 (on the general theory) are admirably efficient, staying close to Savage's with the variations easy to understand. The handling of nonideal events through sups and infs is rigid but in return tractable. The rigidity concerns that we don't use any likelihood info other than what can be captured through the additive (even in SEU) probability μ. The whole work transpires great creativity.

Unfortunately, the comparative axioms involve theoretical constructs such as μ and are not directly observable from preferences. Thus, GP give mathematical theorems that can serve in derived-measurement analyses where one can use utility and so on as inputs, but they cannot qualify as good (preference-foundation) decision-theory results. Papers co-authored by Gul often have this problem.

=================================

ABSENCE OF MEASURE THEORY, AND NONCONSTRUCTIVE INPUTS (E.G. FOR DIFFUSE EVENTS)

It is common in probability theory to impose measure-theory structure, with (sigma)-algebras of events and measurability restrictions, because, without those, weird events and random variables (acts) exist. For instance, it is impossible to have a countably additive atomless probability measure on a power set (Banach & Kuratowski 1929; Ulam 1930).

Savage (1954) did not impose measure-theory restrictions, but did so only for didactical reasons, as he explained on pp. 40-43, §3.4. Everything in his analysis remains unaltered if he had imposed measure theory, and then the probability measure could have been countably additive.

With GP things are less good. They do not impose measure theory either, but for their analysis as written it is crucial that they do not have it. Axiom 3, the only nonEU axiom, is imposed only on diffuse events. To prove that diffuse events exist, GP use the absence of measure theory and the aforementioned "weird" events. They need the mathematically controversial continuum hypothesis for it. (Shown in Lemma 1, p. 5, with footnote 5 mentioning the continuum hypothesis.) I find it unsatisfactory to use such nonconstructive mathematical technicalities to suggest empirical implications. For example, GP assume the agent to bet on events that no mathematician knows how to construct, that some mathematicians think do not exist, and that other mathematicians can prove to exist only if they assume the controversial continuum hypothesis.

Axiom 3: complete absence of info

P. 3 $\ell\ell$. −9/−6 tries to defend, but this text (reproduced next) does not make any sense to me: "Note that Savage's theory allows for a similar possibility for infinite collections of sets. Diffuse sets are limiting events that play a similar role in EUU theory as arbitrarily unlikely events do in Savage's theory. They allow us to calibrate the uncertainty of events." I do not know what "arbitrarily unlikely" events would be in Savage's model. Null events won't do. There is no event for Savage that has the status "arbitrarily unlikely" similarly as any one diffuse event has the status of arbitrarily unmeasurable. Sequences of events decreasing to null are something different. I also do not understand "possibility for infinite collections of sets," or why these events could be used to calibrate the uncertainty of events. Maybe GP refer to finite additivity of P in Savage, where countable partitions of S consisting of only null events can exist, but this is something different. It seems that GP want to suggest that diffuse events are no more artificial than events used in Savage's model, but there is no analogy here. Their axiom 3, and the violation of strict dominance mentioned in the lines below, is unsatisfactory both normatively and descriptively. Grant, Rich, & Stecher (2022 p. 10) were forced by a referee (not me) to discuss this issue. I disagree with their defensive text, and agree much with their referee.

I conjecture that the non-measurability problem is not crucial, and does not affect the essence of the theory. That it could have been avoided by imposing measure theory, and imposing Axiom 3 on nonideal events in a modified manner and also for nondiffuse events. The existence of all warranted diffuse events can be imposed as an extra axiom. For instance, the state space could have been taken as a product space where the first-stage events satisfy the Savage axioms and the second-stage events (that occur conditional on the first-stage events) are diffuse, as I learned from Jaffray. It is a kind of Aumann-Anscombe model, where conditioning on the first-stage events is plausible because they are ideal. The violation of monotonicity then remains as a serious problem.

==================================

FURTHER COMMENTS

The set of ideal events, where we have EU maximization, is taken endogenously given, with an event ideal iff it satisfies the sure-thing principle. This makes the axioms referring to them less observable, referring to endogenous objects as inputs. But, because the ideal events are readily identified through the sure-thing principle, this is not very bad and is acceptable. Irrespective of observability, for studying ambiguity I prefer to assume unambiguity exogenously given rather than endogenously, and, then, if one wants to assume EU somewhere (for empirical purposes this is better not done at all), then do it on the exogenously unambiguous events. The ideal events are the ones with minimal, not at all, vagueness, so, they are the ones maximal regarding sensitivity.

The set of ideal events is intersection-closed, leading to them being a sigma-algebra, because of Gorman's (1968) theorem.

GP claim that they can accommodate not only Ellsberg but also Allais, and put this central. But I disagree (see below). GP14 cite the 2013 working paper version of GP15 for elaboration and I will discuss the point more at GP15.

event/outcome driven ambiguity model: almost entirely outcome driven, through the bivariate function u with parameter $\sigma^{x,y}$. GP15 let $\sigma^{x,y}$ be independent of the outcomes x and y, taking out all outcome dependence, and then only a bit of event-dependent utility remains, although not much and their model is close to expected utility.

§3, p. 8 ff. gives comparative results, all of the Yaari type where either all the components not compared have to be assumed identical by mere assumption (ideal would be by directly observable preference condition), or these theoretical constructs are used as inputs in the axioms, which is what GP usually do, and which is undesirable in decision-theory theorems.

P. 10 first definition: Gul often violates the rule of the game of axiomatizations of only using preference conditions, but uses theoretical constructs such as utility in his conditions. Here again. Theorem 3 is of course mathematically correct but it is not a preference axiomatization.

§5 (p. 14 ff.) discusses the separation of uncertainty perception (μ) and attitude (u), mentioned before on p. 2.

P. 17 uses the term and concept of source introduced by Tversky, imposing probabilistic sophistication as with the uniform sources of Wakker (2008 New Palgrave) and Abdellaoui et al. (2011). However, they only cite Epstein & Zhang (2001) here. I disagree with this reference because Epstein equated probabilistic sophistication with unambiguity (criticized by Wakker 2008) and did not have the general concept of source (similarly as Ellsberg 1961 had a special case but not the general concept). This general concept was introduced by Tversky in the early 1990s, with Heath & Tversky (1991) and Tversky & Kahneman (1992) already mentioning the concept and Tversky & Fox (1995) and Tversky & Wakker (1995) developing it.

P. 17 last displayed Eq. shows that here the authors are completely focused on ambiguity aversion, as most researchers in the field, defining only that as Ellsberg paradox. No more consideration of ambiguity seeking or insensitivity, which becomes relevant if |a| and |b| there are small.

===============================

DETAILED DISCUSSION OF OVERLAP WITH JAFFRAY (1989)

The remainder of my annotations for GP14 compares with Jaffray (1989 *Operations Research Letters*). This paper is an intriguing variation of Jaffray's model of decision under uncertainty. A detailed explanation of Jaffray's ideas is in Wakker (2011, Theory and Decision). In short, Jaffray adopted a philosophy of complete absence of information, applying to events that I, following GP, call diffuse here. Consider a partition of the state space S into diffuse events $\{D_1, \ldots, D_n\}$. Such D_j's are exchangeable (interchanging outcomes of two does not affect preference). But even no statement of D_1 being less likely (in gambling on sense) than $D_2 \cup \cdots \cup D_n$, or, for that matter, than $D_1 \cup \cdots \cup D_{n-1}$, is accepted. Thus, with 100_D0 meaning that 100 results under event D and nothing otherwise, the problematic indifference

$$100_{D_1}0 \sim 100_{D_1 \cup \cdots \cup D_{n-1}}0$$

follows (Wakker 2011 Figure 4.1). (Cohen & Jaffray (1980) take another route by giving up completeness, but we maintain completeness here.) This violation of strong monotonicity is the price to pay for avoiding any subjective commitment about uncertainty. GP treat their diffuse events the same way, mainly through Axiom 3. Under weak monotonicity, it follows that an act conditional on the above uncertain partition is completely characterized by its inf. outcome and its sup. outcome.

Continuing on Jaffray's model, he also assumes unambiguous events (similar to the ideal events of GP except that Jaffray's events are objective and exogenous) that have objective probabilities. He allows for conditioning on unambiguous events (Wakker 2011 p. 18 ℓ. 1). Jaffray's model considers acts conditioned on unambiguous events $E_1,\ldots,E_n$ that have probabilities $p_1,\ldots,p_n$, resulting in a probability distribution $(p_1:(m_1,M_1),\ldots, p_n:(m_n,M_n))$ and utility $p_1U(m_1,M_1) + \cdots + p_nU(m_n,M_n)$. Jaffray gave a preference foundation based on an independence axiom imposed on what amounts to probabilistic mixtures of the above kinds of general acts.

GP generalize Jaffray's model by not assuming the objective probabilities $p_1,\ldots,p_n$ of unambiguous (ideal) events given beforehand, but deriving the probabilities p_j subjectively from the Savage axioms. They specify this relation with Jaffray's model on p. 20: "Hence, EUU theory and Jaffray's model stand roughly in the same relationship as Savage's theory and von Neumann-Morgenstern theory."

The job of GP14's generalization of Jaffray is less trivial than may seem from the above. Several problems to be solved are solved cleverly, leading to tractable modeling. Thus, the separation between ideal and nonideal events is obtained endogenously, through the sure-thing principle (allowing conditioning) in their definition of ideal. Mostly by imposing pointwise continuity (Axiom 6, p. 4; they don't use this term) they ensure at the same time that the probability measure will be countably additive, and that an algebra of ideal events can be extended to a sigma-algebra (and that u is continuous). And, the sigma algebra need not be all subsets, avoiding the problems demonstrated by Banach & Kuratowski (1929) and Ulam (1930). GP need not commit to a product structure of ideal/diffuse or these being given a priori, because the ideal/diffuse separation follows naturally from the axioms. I expect that Jaffray would have been delighted to see this work. For one, it revives his ideas, in a refined version. What deviates from his views is that Jaffray really only wanted objective probabilities, and not any subjectivity in beliefs such as with the subjective Savage probabilities of GP. %}

Gul, Faruk & Wolfgang Pesendorfer (2014) "Expected Uncertain Utility Theory," *Econometrica* 82, 1–39.
https://doi.org/10.3982/ECTA9188

{% ABBREVIATIONS:

GP: Gul & Pesendorfer

GP14: Gul & Pesendorfer (2014), being the Econometrica paper

GP15: Gul & Pesendorfer (2015), being this JET paper

==================================

SUMMARY

This paper follows up on GP14. In my annotations there, Summary Part 1 was written also for this GP15 paper and I assume it read henceforth. Several other issues discussed for GP14 also pertain to GP15, but will not be repeated here. One is: that their model violates dominance, through their Axiom 3 of interchangeability of diffuse events (even if one is a superset of the other).

event/outcome driven ambiguity model: event driven: Relative to GP14, this GP15 paper reinforces axiom 4, Savage's (1954) more likely than axiom P4, from the ideal events to all events. This axiom is the dividing line between event-based ambiguity theories and utility-based or more general ambiguity theories. GP14 was mostly utility based but, by adding full-force P4 here, it becomes utility/outcome independent so only event-dependent or, one might even argue, everything-independent, being constant (for a given agent). Now that $\alpha_{x,y}$ becomes independent of x and y, the generality of the model is greatly and conveniently reduced making it tractable. In fact, given SEU on the ideal events (see below), all deviations from SEU are captured by only one number, α. This achieves an incredibly high level of parsimony and efficiency, reminiscent of Gul's (1992) disappointment aversion model (also one number α only to deviate from expected utility), mathematically brilliant. But at the same time it is too rigid to connect with empirical reality and this model will never work in applications, neither empirically nor normatively. It is an ivory-tower theory. Bleichrodt, Grant, & Yang (2023) claim to have measured this theory empirically, but this is not correct. See my annotations there.

The authors assume a source (sub-sigma algebra satisfying local probabilistic sophistication) of ideal events, that are least uncertain. For these they assume SEU, axiomatized à la Savage but with pointwise monotonicity, so, countable additivity, which makes it more convenient and efficient. The also assume completeness of the subjective probability measure μ (all subsets of null sets are contained). In their overall model, an event is ideal if and only if it, and its complement, satisfy the sure-thing principle. It is very natural, and in agreement with most papers in ambiguity theory today (2022), to assume that the ideal events are what I call risky, meaning they have exogenously determined objective probabilities. GP emphasize that they do NOT assume so and that they can be different. I think that there is little interest in this generalization because usually SEU is violated the least for risky events.

GP assume further sources beyond the ideal events, being groups of events with local probabilistic sophistication. There, GP take the inner and outer measure. The event's weight then is an α/1−α convex mixture of the inner and outer measure, and RDU holds for that source. Here α depends on the agent but not on the events or acts, and is an index of pessimism or ambiguity aversion or "universal" source-independent source dispreference. The resulting basic model of *Hurwicz expected utility* (*HEU*) is

$$W(f) = \alpha \overset{min}{\pi\in\Pi_\mu}\int v\circ f d\pi + (1-\alpha) \overset{max}{\pi\in\Pi_\mu}\int v\circ f d\pi\ . \qquad (*)$$

It is a special case of α maxmin. It is also a special case of CEU/RDU, being where the nonadditive weighting function is a convex combination of an inner and outer measure derived from a countably additive and complete μ on a sub-sigma-algebra. GP show that the weighting functions resulting this way are always a power series with positive weights that sum to 1. They show, remarkably (but extremely weird!), that for every power series there exists a source with that power serious as weighting function. Here, they heavily use the axiom of choice (i.e., continuum hypothesis), implying that there exist all kinds of the most weird nonmeasurable subsets of a continuum. These things are nonconstructive objects, meaning, roughly, that we have no formulas or even words to describe them, making them, in my words, very nonimplementable and empirically irrelevant. The power series if taken in full generality involve infinitely many parameters which is not so nice, and the parameters have no clear interpretation which is also not so nice. In fact, it is all determined, given EU on the ideal events, by one parameter that is only one number: α. It is extremely weird that for every source attitude (weighting function), no matter how weird, there exists a source of events for which the agent has this attitude.

Given μ, inner and outer measures are uniquely determined and in this sense do not add extra parameters, so, in this sense, do not reduce tractability. But they may be hard to calculate and in this sense they do reduce tractability.

The model is a special case of Jaffray & Philippe (1997), who considered CEU/RDU with weighting functions that are convex combinations of convex weighting functions and their duals. This paper is the special case where an additive μ with SEU is available and the convex weighting function comes from extensions/inner measure of that additive μ.

Because nonadditive event-weighting functions of CEU/RDU (and also CPT/PT) are too general, Abdellaoui et al. (2011) introduced the source method, in which the weighting function is a transformation of an additive probability in subcollections of events called uniform sources. The weighting functions are called source functions by Abdellaoui et al. (2011). (GP use the term source utility for the whole preference functional defined relative to the source.) A source function depends on the source, accommodating Ellsberg. GP here go the same way, using the term source instead of uniform source, and also putting such sources and their transformation functions central. So, they are the special case of the source method where the source function is a convex combination of an inner and outer measure, $\alpha\gamma + (1-\alpha)\gamma'$ (γ' is the dual of γ). γ is convex (mentioned on p. 476 two lines below Proposition 6). Thus, within a source GP15 have an RDU representation with as weighting function an $\alpha/1-\alpha$ mixture of a convex weighting function and its dual. (Stated again in Proposition 6.)

§4 starts comparative results that, as with GP14, use theoretical constructs as inputs. Thus, while mathematically true, they cannot be considered preference axiomatizations, which limits their usefulness in decision theory. Typical is for instance that they define risk aversion as aversion to mean-preserving spreads, but those concern the *subjective* probabilities.

P. 472 Proposition 3 gives more uncertainty aversion of one agent over another iff bigger α, related to more favorably comparing bets on ideal events to bets on other events. As stated on p. 470 in the middle, just once in the flow of the text and not displayed, they assume the same μ for throughout. Although they do not say it very explicitly, this is assumed to be the same μ for all agents.

P. 472 Proposition 4 gives more uncertainty of one source over another iff the source function (I prefer this term for the probability weighting function to the vague term source of GP) pointwise dominates (which I would take as source preference). It involves a quasi-preference-condition, called source preference by GP, that for two events from the two sources with the same a-neutral probability (again, my term), always the one from the preferred source is preferred for betting on, next related to being “more uncertain.” Proposition 5 will show that a more uncertain source can be preferred at low likelihoods, à la insensitivity, if for the uncertainty aversion α we heve $\alpha < 1$.

P. 475 §5 continues on sources. Here the general HEU model, which is CEU/RDU for uncertainty, becomes like Quiggin’s RDU with a source-dependent probability transformation that I already referred to above as source function (my term). Proposition 6 states it explicitly, where the source function now is an $\alpha/1-\alpha$ convex combination of a convex function γ and its dual. Proposition 7 states that bigger aversion to mean-preserving spreads iff v more concave and α bigger. For this, it assumes the same γ. Mean-preserving spreads involve subjective probabilities here and, hence, are also not directly observable, again, reducing the interest of this result.

The top of p. 471 shows that insensitivity can be accommodated.

Proposition 8 shows that the functional is concave in source-function units iff $\alpha = 1$ and v is concave.

==================================

COMMENT ON USE OF TERM RISK

GP take the term risk attitude in an uncommon manner. μ and the implied π and so on are uncertainty perception, which could have potentially been source- and not person dependent (as assumed in many other papers) were it not that they are subjective. (α,v) is uncertainty attitude, apparently person-dependent but source-independent. But now risk attitude is to capture it all (p. 468 3rd para), and also μ. Whereas for me uncertainty is the encompassing term capturing risk and ambiguity, for GP risk is the encompassing term. Risk attitude is taken source dependent (in conclusion called context-dependent). There is a discussion of this in the para on pp. 467-468:

“Allais-style experiments confront subjects with lotteries; that is, acts that depend on a roulette wheel, on the draws of a card from a deck, or on some other objective randomization device. …

In a subjective model such as ours, *the randomization devices in Allais-style experiments are a source like any other*; randomization devices *need not yield the least uncertain or most preferred source* nor do *all randomization devices necessarily yield the same source*. Indeed, Heath and Tversky (1991) provide experimental evidence showing that agents may not favor sources based on randomization devices. … In addition, the experimental literature has found that measured risk attitudes vary with the experimental technique used to measure those attitudes. Thus, subjects differentiate among seemingly objective sources." [italics added here]

I have a different opinion on the first italicized text because, in practice, randomization devices, exogenously determined, ARE a special source. I make a big distinction between subjective probabilities and objective ones (they are limiting cases of subjective ones). Objective probabilities are usually, surely by me, taken as ambiguity-neutrality calibration point.

I have a different opinion on the relevance of the second italicized part. Most researchers can think of only one thing as regards ambiguity, and that is ambiguity aversion. They often equate ambiguity with ambiguity aversion. GP are broader in several places, understanding that there is systematic **ambiguity seeking** and insensitivity (my term) in an absolute sense. But they don't yet come to a full comparative treatment of it. Given that GP take α, reflecting ambiguity/uncertainty aversion, source independent, they will not be very open to source-dependent ambiguity aversion.

As for the third italicized part, this is true, although the Dave et al. (2010) reference given by GP is not relevant here (they are indeed about different elicitation methods but that is irrelevant here), the keyword "violation of risk/objective probability = one source" in this bibliography gives references showing it. However, this dependence is too weak to incorporate, and for tractability reasons I favor taking risk as one source, and assume one risk attitude (following Tversky's preference here) (modulo utility for different kinds of outcomes). Risks with unusual emotions (e.g., due to complexity) give deviations but are to be taken as exceptions. Risk is less rich than ambiguity. One further point: ambiguity = uncertainty - risk, but this can no more be defined well if risk is not one thing.

Speaking of source-dependent risk attitude may work easiest when first presenting to uninitiated audiences. But this terminology cannot survive. Not so much risk attitudes, but rather ambiguity attitudes, are a rich domain and are source dependent. Kilka & Weber (2001) used the same unfortunate terminology of source-dependent risk attitude. It is so confusing that I usually avoid citing K&W, even though it otherwise has many great ideas. Chew, Li, Chark, & Zhong (2008) used the same unfortunate terminology.

==================================

COMMENT ON ACCOMMODATING ALLAIS OR NOT

GP15, and also GP14, claim that they can accommodate not only Ellsberg but also Allais, and put this central, but I disagree with the Allais claim for two reasons listed below. Like most other papers on ambiguity, GP do assume EU, only, not necessarily for objective probabilities but for what they call ideal events, which in their analysis can be “less uncertain” than objective probabilities.

(1) For the ideal events, GP cannot accommodate the Allais paradox. Thus, if the Allais paradox is taken as a general certainty effect for all events (this is how I prefer to take it; it speaks to uncertainty as much as to risk), then GP cannot accommodate it.

(2) The generalization that ideal events need not be risky (in my terminology) events but can be different, is of very little interest, both normatively and descriptively. If they are different, objective known probabilities would be more uncertain than some subjective probabilities, which is very implausible. Also, the common finding is that EU is more violated for unknown probabilities than for known (see the keyword **uncertainty amplifies risk**). Fox & Tversky (1995) and Tversky & Fox (1995) found source preference for football/basketball events over risky events among football/basketball fans, but this is not the most relevant component here. Ideal events are optimal regarding sensitivit/perception, and Fox & Tversky (1995) and Tversky & Fox (1995) find *higher sensitivity*, so better understanding, for the risky events than for the football/basketball events.

At the background here is that GP seem to dislike using exogenous concepts such as objective probabilities, which they share with Epstein (1999) but not with me.

p. 466 1st para writes that GP accommodates Ellsberg, Allais, and source preference. As for general aim, this is another aim that GP share with the source method and CPT/PT, making the approaches close. My 2010 book writes on p. 2, penultimate para: “At this moment of writing, 30 years after its invention, prospect theory is still the only theory that can deliver the full spectrum of what is required for decision under uncertainty, with a natural integration of risk and ambiguity." In many places in my book and papers, and in many applications of the source method, it is emphasized that there is no commitment to EU for risk (or unambiguous events). Wakker (2010 §11.6) discusses the different roles that the Allais and Ellsberg paradox have in uncertainty. I by the way disagree that GP15 can accommodate the Allais paradox. For their ideal events they need full EU.

==================================

FURTHER COMMENTS

biseparable utility: satisfied.

event/outcome driven ambiguity model: event driven: Relative to GP14, the parameter α is independent of outcomes here in GP15, so that the theory is no more outcome driven. It is in fact close to expected utility, with only a bit of event dependence.

The authors use the outdated and inefficient terms rank-dependent EXPECTED utility and RDEU instead of RDU.

P. 466's functional formula (Eq. * in my annotations above): I do not understand how it is defined if f is not measurable with respect to π. Given that this paper does not impose measurability (Borel or Lebesgue or anything), so, considers all subsets of Ω and all f (and that is even crucial for its results), that no sigma-additive π can be defined on all subsets of Ω (Banach & Kuratowski (1929) and Ulam 1930), this will surely happen.

Note that, with expected utility available on a Savage-type rich domain as is the case here, RDU can easily be axiomatized, for completely general outcomes, by cumulative dominance (Sarin & Wakker 1992).

P. 466 Footnote 7: only if two FIXED prizes!

P. 466-467 para is confusing to me, because it seems to have in mind a group of agents rather than one. Their 2020 paper may clarify.

The paper defines sources as countably additive probabilities on complete sigma-algebras where "local" probabilistic sophistication holds, which the source method calls uniform source. One difference is that GP take sources entirely endogenous, whereas the source method takes a source as exogenous (like commodity), and only uniformity is endogenous.

Given that α and v are assumed source-independent, source-dependent utility is related to the source functions of the source method.

P. 468 last 4 lines discuss the source method: "Abdellaoui et al. (2011) study source specific lottery preferences and estimate source-specific RDEU utility functions. Our model exhibits related source utilities and, in addition, *provides a utility function for arbitrary multi-source acts*." [italics added here]

The italicized claim, suggesting difference with Abdellaoui et al. (2011), is not correct. GP have the general HEU theory that compares all acts. This justifies their italicized claim. In some subcases they have (uniform) sources, with a convenient special structure. Entirely the same way, Abdellaoui et al. (2011) **have the general CPT/PT that compares all acts.** In some subcases they have (uniform) sources, with a convenient special structure. Because of the bold sentence, Abdellaoui et al. (2011) as much satisfy the aforementioned italicized claim of GP. GP missed that Abdellaoui et al. (2011) is a special case of CPT/PT, or of RDU/CEU if one prefers. GP repeat this omission in footnote 22 p. 477.

P. 467 2nd para lists major empirical findings and, to my joy, and unlike most theoretical papers, seeks to link with them. P. 473 will use the expression "uncertainty loving at poor odds" to capture insensitivity.

P. 468 just above §1.1: It is strange that risk attitude is context/source dependent but uncertainty attitude is not.

P. 469: "A prior is a countably additive, complete, and non-atomic probability measure on some σ-algebra of subsets of Ω."

P. 469: "The σ-algebra $\mathcal{E}_\mu$ consists of the events the decision maker perceives to be least uncertain."

P. 470 middle, in the flow of the text, states an assumption crucial for all results to follow: "For the remainder of this paper, we fix μ, the agent's uncertainty perception, and let $W=(\alpha, v)$ denote an HEU." As stated before, I regret that the authors use the theoretical construct μ in this assumption and, hence, in all following results.

P. 471 ℓ. 5 gives a sort of preference condition excluded by probabilistic sophistication within a source, i.e., excluded by uniformity of the source. Unfortunately, contrary to what I automatically thought it must be until August 2018, it is not excluding source preference within a source, which exclusion would lead to Wakker's (2008) uniform sources. Instead, it involves two different preference relations, a maximally pessimistic ($\alpha = 1$) and a maximally optimistic ($\alpha = 0$) one, and gives a condition involving these two different hypothetical agents, which cannot serve as a good observable preference condition.

P. 471: Unfortunately, the authors use the term power series in an unconventional manner. Usually, it means a polynomial where the coefficients can be any real number. But the authors do it only for coefficients from [0,1] summing to 1, meaning convex combinations (of powers). There is a Weierstrass theorem saying that each continuous function on a compact interval (e.g., [0,1]!) can be written as a power series (in the traditional meaning), in which case the claim of the authors would be vacuously true and uninformative, if traditional terminology. The weights adding to 1 follows from normalization $\gamma(1) = 1$. Nonnegativity of the weights implies convexity of γ. Unfortunately, the authors do not discuss if their power series is more restrictive than general convexity, so, if their condition is vacuous or not. Well, it is not vacuous, and is more restrictive than convexity. For example, $1.1 \times t^2 - 0.1 \times t^3$ is strictly increasing and convex and continuous, but is no power series in the authors' sense. I do not find power-series a convenient family. First, it has infinitely many parameters (if not restricted to be derived from μ by only the parameter α.) Second, the parameters have no clear interpretation—at least, no such is given. This result is a mathematical fact but I do not see empirical interest.

P. 472 Proposition 2: Every γ (prior) is a power series. And, every power series occurs for some prior on some sigma-algebra. This does not illustrate attitudinal richness for the agents, because here the model in fact is extremely parsimonious and nonrich where, given EU and μ on the ideal events, only one number α determines the whole nonEU attitude. Instead, it illustrates the mathematical richness of nonmeasurable (nonconstructive!) events. The idea that every attitude would appear for every agent is weird I think. So, for every agent every situation of ambiguity perception would exist!? This is hard to imagine if ambiguity perception is subjective. Mathematically, it follows from the authors not having imposed measure theory restrictions, so that weird and nonconstructive things exist. This needs the continuum hypothesis, making it nonconstructive and empirically unsatisfactory.

P. 472: for the comparative results that follow in §4 and further, the restriction of same μ, stated before (p. 470), is restrictive (and is formulated using theoretical constructs).

P. 472 Proposition 4 gives more uncertainty of one source over another iff the source function (I prefer this term for the probability weighting function to the vague term source of GP) pointwise dominates. So, this is what I would take as source preference (implicitly assuming same insensitivity). GP have a quasi-preference-condition, (informally?) called source preference by them, that for two events from the two sources with the same a-neutral probability (again, my term), always the one from the preferred source is preferred for betting on. Here the requirement of same a-neutral probability involves a theoretical construct. They use this as input in a definition of “more uncertain” that is a bit complex and at any rate not easily observable, involving existence and for all quantifiers over different HEU models, so, not one agent.

[Absence of real comprehension of insensitivity] Proposition 4 shows that they equate more uncertainty with what I would call source preference. It shows that here they only think of ambiguity aversion and not of ambiguity seeking, and that they ignore insensitivity here. Although the authors show awareness of insensitivity in several places and play lipservice to it, they did not really digest the concept. They mostly think only one-dimensional, aversion/seeking. Thus, they define as ideal (unambiguous) events simply those events that have maximal source preference. So, the only thing about ambiguity is that it brings extra aversion. Of the one dimension aversion/seeking, they yet lose half, being ambiguity seeking.

P. 473 last para: as a nostalgic typo, the authors here still twice use the term issue, which Ergin & Gul (2009) used instead of source.

P. 476 Proposition 7 can be derived from Chew, Karni, & Safra (1987). More aversion to mean-preserving spreads iff utility v is more concave and probability weighting is more convex. Given that the authors have fixed the theoretical construct γ there, more convex probability weighting is equivalent to α being bigger.

Bleichrodt, Grant, & Yang (2022) claim to have empirically measured HEU. However, as I explain in my annotations there, HEU is totally and completely unobservable. As brilliant as HEU is mathematically, so ivory tower and disconnected it is from reality. %}

Gul, Faruk & Wolfgang Pesendorfer (2015) "Hurwicz Expected Utility and Subjective Sources," *Journal of Economic Theory* 159, 465–488. https://doi.org/10.1016/j.jet.2015.05.007

{% **Ambiguity = amb.av = source.pref, ignoring insensitivity**

SHORT SUMMARY: They have a sub-sigma algebra $\mathcal{E}$ of unambiguous events endowed with an additive probability measure μ, $(\mu,\mathcal{E})$. Then they have (ν,Σ), where Σ is the overall sigma algebra. ν is a belief function capturing ambiguity. All of this is belief/info, objectively given, and independent of the agent. It is the same for all agents. The agents take for each ambiguous events an inner measure with added δ times the belief function ν. Here $0 < \delta < 1$ is a subjective discount measure. The small δ, the more ambiguity aversion. This is attitude, not belief, subjective, and agent-dependent stimuli-independent.

The rest of these annotations provide more detailed comments.

DETAILED COMMENTS.

Unfortunately, the authors do not number definitions, making it harder for others to cite them.

P. 4 specifies that they have single-stage, and not two-stage as in Anscombe-Aumann.

Unambiguous events are often taken as risky events (e.g. by me although not necessarily by these authors), which has an objective status. Objective means something like all clever people agreeing on it. This paper does seek to get objectivity in, and to formalize this, similarly as Gilboa et al. (2010 ECMA) did. There is a group of decision makers (DMs). For events A,B, $A \succcurlyeq_j B$ means the usual thing: Agent j prefers betting on A to betting on B. We write $A \succcurlyeq B$ if all DMs agree. Then this preference is objective and taken as unambiguous. It is, obviously, incomplete. It is called qualitative uncertainty assessment (QUA). It is meant to work for all ambiguity attitudes, which are all assumed present in the population. (Given that they take ambiguity of info objectively available, we can just calculate what preferences result from ambiguity attitudes and, accordingly, assuming that available is not restrictive.) For any individual j and any ambiguous event, whether $A \succcurlyeq_j B$ depends on the agent's ambiguity attitude.

The ambiguous info is assumed to be objectively available. The quantitative model of this info/belief, a capacity π on the events that will be a Dempster-Shafer belief function, is as follows. There is, first, a *risk measure* $(\mu,\mathcal{E})$. Here $\mathcal{E}$ is a subsigma-algebra of unabiguous events, and μ is an atomless probability measure (countably additive). For these, $\pi = \mu$. Second, there is an *ambiguity measure* (ν,Σ). Here Σ is the overall sigma-algebra (of which E was a sub-sigma-algebra). And ν is a probability measure, but not on the state space assigning probabilities to elements of Σ, but on Σ assigning probabilities to subsets of Σ. It is the Möbius inverse of the belief function ν. Because of ambiguity, ν is sort of discounted by a factor $0 < \delta < 1$, and only $\eta = \delta\nu$ is used. So, $\eta(\Omega) = \delta$. Note that this is a purely pessimistic ambiguity attitude. They satisfy some regularity (p. 5 bottom point (ii)). Then

$$\pi(A) = \max_{E \subset A, E \in \mathcal{E}}\big(\mu(E) + \eta(A \backslash E)\big)$$

Roughly, not precisely, they first take the largest unambiguous subset E, and its μ measure, and of the rest take the ν measure. (This would hold if μ and ν in a way were orthogonal, as in the example below.) This is close to taking inner measure. π is indeed a belief function.

Their Example 1:

EXAMPLE 1: $\Omega = [0,1] \times [0,1]$. First coordinate is unambiguous with $\mu = \lambda$ (Lebesgue measure), second coordinate has $\nu = \lambda$. If δ were 1 we'd have the product measure, but it is different and $\delta = 0.5$. Take

$A = [0,1/3) \times [0,1] \cup [1/3,2/3] \times [0,3/4]$.

$\pi(A) = \mu\big([0,1/3) \times [0,1]\big) + \eta\big([1/3,2/3] \times [0,3/4]\big) = 1/3 + 0.5 \times 1/3 \times 3/4 = 1/3 + 1/8$.

We can sandwich any ambiguous event A by an interval $[E^1, E^2]$ with E^1 and E^2 unambiguous and closets with $E^1 \preccurlyeq A \preccurlyeq E^2$, called a tight window. It gives a probability interval $[\pi(A), \overline{\pi}(B)]$ with the upper and lower probability, as usual for belief functions. They take this as a measure of ambiguity.

π represents $\succcurlyeq$, the unambiguous ordering of events, with $A \succcurlyeq B$ iff $\pi(A) \geq \pi(B)$

and $\overline{\pi}(A) \geq \overline{\pi}(B)$. Next the authors give a preference axiomatization for π. To this effect, they first consider only two fixed outcomes, i.e., only a qualitative ordering of events. To get probabilistic sophistication on the unambiguous events, they use an unambiguity axiom as in Epstein & Zhang (2001), which calls E unambiguous if, kind of, E^c is separable w.r.t. more-likely-than. (Their double expected utility model of §5.1 gives complete separability so that an Aumann-Anscombe model results, with first lottery events and then horse events.) Wakker (2008) mentions drawbacks of this condition. For instance, in any Anscombe-Aumannn framework with exactly two horses, both ambiguous, this definition, in the corresponding one-stage state space, implies that the two horses are unambiguous, and this is undesirable. Further, it does not work well for general (betweenness-type) ambiguity, but only for Savage-P4-type ambiguity, as the online appendix of Wakker (2008) shows. As for structural richness, they use Savage-type, efficiently so that it also incorporates the ambiguous events.

They use matching probabilities, which they call risk equivalent, one for each probability interval, specifying the ambiguity attitude of an agent. They assume that this is the same for all events with the same probability interval through their range dependence axiom (p. 9).

Proposition 3 separates ambiguity perception, captured by the probability intervals and being objective, and ambiguity attitude, captured by the matching probabilities. For every individual agent, the ambiguity preferences uniquely determine ambiguity perception and $\succcurlyeq$.

P. 15 1st sentence of §5 incorrectly writes that Machina & Schmeidler (1992) introduced probabilistic sophistication. This concept had been standardly known long before. See, for instance, Cohen, Jaffray, & Said (1987, p. 1).

The authors give a weak and strong version of more ambiguity averse than. The weak one has systematic more dispreference for ambiguous relative to unambiguous. The strong one is more restrictive (more incomplete) and has systematic more preference for more ambiguous versus less ambiguous (the latter tighter upper and lower probabilities). They have a quantitative representation for it, capturing more overweighting of the bad probability, but it uses derivatives which is not very tractable. It is extended to general acts in §5.2.

They extend the qualitative ordering theory to general decision theories for many-outcome acts in three ways. In the first, they assume EU for risk. The second is a generalization of (special versions of!) Choquet expected utility with a clear separation of QUA (belief), risk attitude, and ambiguity attitude. The third is most general. The authors suggest almost complete generality there, but I do not agree with that. Their Epstein-Zhang definition of unambiguous does not work for betweenness-type ambiguity (Wakker 2008 online appendix) but only for Savage-P4-type ambiguity.

Pp. 18-19, end of paper, argue that common definitions of ambiguity in the literature require EU for risk and can be conflated by deviations from EU under risk. This paper brings separations for those also if nonEU for risk. However, they have EU-type for the least uncertain events, the ideal events, which in practice almost always have to incorporate the risky events. Being closer to ambiguity neutrality for some ambiguous events than for risky events is implausible. %}

Gul, Faruk & Wolfgang Pesendorfer (2020) "Calibrated Uncertainty," *Journal of Economic Theory* 188, 105016.

{% **updating: nonadditive measures**: The authors start from a static CEU model of decision under uncertainty model with Dempster-Shafer belief functions. That is, these are extremely pessimistic. And, they are a special case of maxmin EU. Then they consider updating. Whereas much literature is sloppy in implicitly assume backward induction for instance, the authors carefully discuss this point and make clear that and how they assume backward induction with dynamic consistency and consequentialism, but violating independence of order of resolution of uncertainty (like RCLA for risk), that is, the law of iterated expectation. After updating, the model is no more CEU/RDU. But it still is maxmin EU, beccause the updating is like the Epstein-Schneider (2003) rectangular updating, called the reduced family by Sarin & Wakker (1998, JRU), although it is more general (p. 4 §1.1).

P. 2 Figure 1 has the nice Raiffa-type problem where hedging against ambiguity or not just depends on the order of resolution of updating/conditioning.

Their Theorem 3 is a reverse to Sarin & Wakker (1998 Theorem 2): a maxmin evaluation can be *approximated* by a general compound evaluation.

The conclusion (p. 17) points out that, whereas most of the paper takes the

order of resolution of uncertainty as given, things could be reversed and the preference model satisfied could be used to reveal the order of resolution of uncertainty as endogenous. %}

Gul, Faruk & Wolfgang Pesendorfer (2021) "Evaluating Ambiguous Random Variables from Choquet to Maxmin Expected Utility," *Journal of Economic Theory* 192, 105129. https://doi.org/10.1016/j.jet.2020.105129

{% %}

Gul, Faruk & Andrew Postlewaite (1992) "Asymptotic Efficiency in Large Exchange Economies with Asymmetric Information," *Econometrica* 60, 1273–1292.

{% %}

Gul, Faruk & Ennio Stacchetti (1999) "Walrasian Equilibrium with Gross Substitutes," *Journal of Economic Theory* 87, 95–124.

{% %}

Gul, Faruk & Ennio Stacchetti (2000) "The English Auction with Differentiated Commodities," *Journal of Economic Theory* 92, 66–95.

{% %}

Gul, Faruk & Hugo Sonnenschein (1988) "On Delay in Bargaining with One-Sided Uncertainty," *Econometrica* 56, 601–611.

{% %}

Gul, Faruk, Hugo Sonnenschein, & Robert Wilson (1986) "Foundations of Dynamic Monopoly and the Coase Conjecture," *Journal of Economic Theory* 39, 155–190.

{% **second-order probabilities to model ambiguity; updating under ambiguity with sampling**;

Redo a Dutt et al. (2014) study with some modifications. Dutt et al. generate ambiguity through second-order probabilities. But in the DFE treatment they let subjects sample only the outcome with no knowledge of the 2nd order process, so that subjects in fact sample a fifty-fifty 1st order process. This paper lets subjects sample from the 2nd order distribution; i.e., lets them sample what the 1st order composition is. Thus, the subjects experience the 2nd order distribution. The subjects know it is one of three, one dichotomous (1st order p is 0 or 1), one normal, and one uniform. Experience reduces ambiguity aversion relative to description. I agree that this paper better brings out the 2nd order distribution. But a problem is that for all 2nd order distributions, the 1st order distribution is 1/2. If subjects understand this, then they know that it does not matter what the 2nd order distribution is. Both Dutt et al. and this paper, in the experienced ambiguity treatment, renew the procedure each time so that the previous observations don't inform about the actual process faced next.

It is natural that the 50% of subject for whom sampling from ambiguous happened to come out favorably, prefer ambiguous (as reported in last sentence of abstract), and the other 50% disprefer ambiguous. %}

Güney, Şule & Ben R. Newell (2015) "Overcoming Ambiguity Aversion through Experience," *Journal of Behavioral Decision Making* 28, 188–199. https://doi.org/10.1002/bdm.1840

{% Proposes theory to reconcile preference reversals with procedure invariance. Unknown risk attitude can trigger deliberation. An experiment seems to confirm. %}

Guo, Liang (2021) "Contextual Deliberation and the Choice-Valuation Preference Reversal," *Journal of Economic Theory*, 105285.

{% %}

Guo, Xianping (2007) "Continuous-Time Markov Decision Processes with Discounted Rewards: The Case of Polish Spaces," *Mathematics of Operations Research* 32, 73–87.

{% %}

Guppy, Andrew (1992) "Subjective Probability of Accident and Apprehension in Relation to Self-Other Bias, Age, and Reported Behavior," *Accident Analysis and Prevention* 25, 375–382.

{% %}

Gurevich, Gregory, Doron Kliger, & Ori Levy (2009) "Decision-Making under Uncertainty–A Field Study of Cumulative Prospect Theory," *Journal of Banking & Finance* 33, 1221–1229.

{% %}

Gustafsson, Anders, Andreas Herrmann, & Frank Huber (2007) "*Conjoint Measurement: Methods and Applications* (2nd edn.)." Springer, Berlin.

{% The authors provide results in the spirit of Nataf (1948) and Mongin & Pivato (2015), where one optimizes over two components, say individuals and states of nature, and weak separability over the two components implies complete separability. The authors generalize existing results by weakening weak separability for risk to the case of stochastic dominance (so, an incomplete ordering). They also consider variable population sizes where they avoid comparisons between existing and non-existing subjects and variations in correlations. %}

Gustafsson, Johan E., Dean Spears, & Stéphane Zuber (2023) "Utilitarianism Is Implied by Social and Individual Dominance," working paper.

{% P. 342: "Utilities as well as subjective beliefs, e.g. in the form of subjective probabilities, are not directly observable: how should they if they do not exi[s]t?!" %}

Güth, Werner (1995) "On Ultimatum Bargaining Experiments –A Personal Review," *Journal of Economic Behavior and Organization* 27, 329–344.

{% %}

Güth, Werner (2008) "(Non)behavioral Economics: A Programmatic Assessment," *Zeitschrift für Psychologie/Journal of Psychology* 216, 244–253.

{% Seem to find that the strategy method gives different results than posterior choice. %}

Güth, Werner, Steffen Huck, & Wieland Müller (2001) "The Relevance of Equal Splits in Ultimatum Games," *Games and Economic Behavior* 37, 161–169.

{% %}

Guthrie, Chris (2003) "Prospect Theory, Risk Preference, and the Law," *Northwestern University Law Review* 97, 1115–1163.

{% This paper studies source dependence with comparisons between persons and (though less so) also between sources. It uses the source method, defined below. It considers only gains. Biseparable utility is assumed. That is, the binary act $x_E y$ (giving x if event E and y otherwise), for x ≥ y, is evaluated by

$$x_E y \to W(E)U(x) + \big(1 - W(E)\big)U(y). \qquad (1)$$

This model includes source theory, i.e., local probabilistic sophistication, with

$$W(A) = w_{\mathcal{A}}P(A) \qquad (2)$$

where $\mathcal{A}$ is a source (say, subalgebra of events), A an event in $\mathcal{A}$, P an additive probability measure on $\mathcal{A}$, and $w_{\mathcal{A}}$ a probability transformation function that, importantly, depends on the source $\mathcal{A}$. P is called a-neutral and $w_{\mathcal{A}}$ is the source function. This paper considers comparative results using formulas

$$w_{\mathcal{A}} = w_{\mathcal{C}} \circ \varphi \qquad (3)$$

where φ is called the pmatcher from $\mathcal{A}$ to $\mathcal{C}$, depending on $\mathcal{A}$ and $\mathcal{C}$, a dependency not expressed in notation here. I add here that this formula primarily serves within-subject between-source comparisons, as shown theoretically by Baillon, Bleichrodt, Li, & Wakker (2021). For simplicity, it is convenient to assume that $\mathcal{C}$ is a more established source than $\mathcal{A}$ (e.g.,$\mathcal{C}$ is risk with known probabilities) and the pmatcher specifies for every a-neutral probability q of an event in $\mathcal{A}$ the gambling-equivalent a-neutral probability p of an event in $\mathcal{C}$. (It is convenient to assume here that the latter is better understood and is kind of used for calibration.) Thus, if $P(A) = q$ for event A from $\mathcal{A}$, and we want to "calibrate" how much this is liked, then φ tells us, because, with $\varphi(q) = p$, the event C from $\mathcal{C}$ that is gambling-equivalent to A ($x_C 0 \sim x_A 0$ for $x > 0$) has $P(C) = p$. φ gives between-source within-person comparisons. For instance, if $\varphi(p) \le p$ for all p, then events from $\mathcal{A}$ are disliked and there is source preference for $\mathcal{C}$ over $\mathcal{A}$. φ in itself gives no absolute results. If $\mathcal{C}$ is risk (known probabilities), then φ gives matching probabilities and ambiguity attitude, in my interpretation of ambiguity, as shown already by Dimmock, Kouwenberg, & Wakker (2016).

Note that φ in Eq. (1) is to the right of $w_{\mathcal{C}}$, and not to the left as one would see in Pratt-Arrow types of utility transformations. May I use this occasion to qualify this point as a deep insight? It was axiomatically justified by Baillon, Bleichrodt, Li, & Wakker (2023), with a simple version appearing in Wakker (2004 Psychological Review) and it underlied Dimmock, Kouwenberg, & Wakker (2016). The authors of this 2024 paper chose this writing based on intuition, and have me impressed by that.

One can manipulate uncertainty attitudes by bringing in φ. An insensitive φ increases source insensitivity, with source preference likewise. Baillon, Bleichrodt, Li, & Wakker (2023) derive this point axiomatically, for within-subject comparisons (so that fixed utility function cancels, making much life easier).

One can directly measure φ by finding indifferences

$$x_A0 \sim x_C0 \qquad (4)$$

and then, with $P(A) = q$, $P(C) = p$, we gave $\varphi(q) = p$. One can also do it indirectly using transitivity and then using certainty equivalents CE to get $CE(x_A0) = CE(x_C0)$, or using matching probabilities MP to get MP(A) = MP(C). The authors do not use Eq. (4), but use the two indirect methods, presenting them as two separate methods.

The authors do the measurements in three experiments, and do parametric fittings of φ. They take $1–2\varphi(0.5)$ as index of pessimism (anti-index of elevation) and used the derivtive φ' in their index of insensitivity: $1 - \varphi'(0.5)$. The unit of the first index, $1–2\varphi(0.5)$, is probability. It is the probability premium one wants extra to gamble on $\mathcal{A}$ rather than on $\mathcal{C}$. The unit of $\varphi'(0.5)$ is change in weight per probability unit. It shows that to achieve a particular change of weight, one needs $\varphi'(0.5)$ more units of probabilities of $\mathcal{A}$ than of $\mathcal{C}$. The latter holds only in the middle of the probability interval, and near the boundaries it is opposite. What precisely is that middle needs formalization of an insensitivity region, provided by Baillon, Bleichrodt, Li, & Wakker (2023), but this point is complex and better left unformalized in informal papers.

In all three experiments, the authors find source preference for a familiar source $\mathcal{C}$ (home temperature) over an unfamiliar one (foreign temperature), which is natural. In two of the three they find more sensitivity for the familiar source, which is natural. In one they find less sensitivity, which is surprising. They find much individual heterogeneity.

P. 394 reanalyzes the data of Abdellaoui et al. (2011 AER), and nicely shows that the pmatcher φ can be directly obtained without doing any utility estimation. (By using certainty equivalents and transitivity.)

Regarding novelty:

CONTRIBUTION 1 [not in this paper; done before]: Several papers measured W in Eq. 1 and also source functions $w_{\mathcal{A}}$ (and $w_{\mathcal{C}}$) in Eq. 2 before. Several papers also measured single-number indexes (not entire φ) of source attitudes regarding preference and sensitivity, and compared those across subjects and sources. The latter was often done only if $\mathcal{C}$ was risk (known probability), in which case φ captures ambiguity attitude (in my interpretation), but not always (Li, Müller, Wakker, & Wang 2018). In these manners uncertainty attitudes have been measured before, and also comparisons across sources and individuals. Hence, the authors do not have Contribution 1.

CONTRIBUTION 2 [novelty of this paper]: No empirical study went for the general φ in Eq. 3 before, let be if $\mathcal{A}$ and $\mathcal{C}$ can be general uncertainty with no need to have risk involved.

It will not be surprising that I, fan of the source method, am enthusiastic about this paper. It is the first to empirically measure φ of Eq. 3 which, unsurprisingly, I find important. It provides important new empirical insights into uncertainty attitudes. It does not need the assumptions of the Anscombe-Aumann (AA) framework, which are problematic surely in an empirical sense. And, it handles the important insensitivity component well. Again unsurprisingly, I think the paper deserves many follow-ups.

================================

With all these new concepts and components still to be established, there are different interpretations possible that are yet to be settled. In the rest of these annotations, I list three points where my interpretations diverge from the authors'.

POINT 1. I prefer different indexes for source preference and insensitivity than the ones used by the authors, who use $1-2\varphi(0.5)$ and the derivate of φ in $1-\varphi'(0.5)$. Unsurprisingly, I prefer the indexes of Baillon, Bleichrodt, Li, & Wakker (2021). The rest of this point (1) gives details.

DETAILS OF POINT 1: The authors' indexes concern local behavior of φ at $p = 0.5$, whereas it should capture global properties of φ. The total area under the curve φ would be better for source preference, and $(\varphi(0.95)-\varphi(0.05))/0.90$, even while clearly ad hoc, would be better for sensitivity. Unsurprisingly, I prefer yet more the indexes of Baillon, Huang, Selim, & Wakker (2018), which received firm theoretical justifications in Baillon, Bleichrodt, Li, & Wakker (2021). The parameters of the Goldstein-Einhorn family (more than of Prelec) are also preferable. The authors point out that for the parametric families considered their parameters $1–2\varphi(0.5)$ and $1–\varphi'(0.5)$ correspond one-to-one with global properties (p. 400 3rd para). But, as said, global is what is relevant, so better to go for that. Problem is that for other weighting functions, other parametric families of empirical parameter-free measurements, there may be ad hoc local peculiarities at $p = 0.5$ that confound, especially because $p = 0.5$ (fifty-fifty) is known to have many psychological peculiarities.

POINT 2. The authors overstate their novelty claims, ignoring the above Contribution 1.

DETAILS OF POINT 2. Here are six citations ignoring Contribution 1:

P. 379 (abstract): "*there is currently no definition* of source dependence that allows for comparisons across individuals and sources" [italics added]

P. 380: "*there is currently no way* to interpret differences in attitudes across sources in terms of source dependence" [italics added]

P. 381: "Methods … measure ambiguity premia in terms of money and willingness to bet, which do not have the same values for individuals with different risk attitudes. [Other] Approaches … define source dependence as differences in weights that are not easily interpretable. Therefore, *these approaches preclude the direct comparison* of source dependence across individuals or (pairs of) sources." [italics added]

P. 387, §2.3.1: "This case illustrates that differences in the parameters of ambiguity functions *cannot be compared* across individuals with different probability weighting functions for risk. The reason is that ambiguity functions are measured on the scale of known probabilities (willingness to bet), and this scale is different for two individuals who weigh risk differently." [italics added]

P. 388, §2.3.2: "This example illustrates that differences in source function parameters *cannot be compared* across pairs of sources, even within an individual, since differences in source functions correspond to differences in "weight," which have different values depending on the sensitivity toward the sources being considered." [italics added]

P. 408: "While existing methods can capture attitudes toward specific sources, *there is currently* *no sound way* to convert differences in ambiguity attitudes across sources into source dependence." [italics added]

Other approaches did compare source dependence across individuals and sources through single-number indexes, and also indirectly through ambiguity comparisons (e.g., more ambiguity aversion for source $\mathcal{A}$ than $\mathcal{C}$ is equivalent to source preference for $\mathcal{C}$ over $\mathcal{A}$). The authors can exclude Contribution 2 from other studies, but they go too far in excluding Contribution 1 from other studies.

Scenario 1 in §2.3.1, p. 387, shows that two persons with the same uncertainty attitude towards a source can have different ambiguity attitudes. This is a trivial consequence of uncertainty attitude being ambiguity attitude PLUS risk attitude. Unfortunately, the authors misinterpret: "This case illustrates that differences in the parameters of ambiguity functions *cannot be compared* across individuals with different probability weighting functions for risk. The reason is that ambiguity functions are measured on the scale of known probabilities (willingness to bet), and this scale is different for two individuals who weigh risk differently." [italics added] It is true that *ambiguity parameters* cannot just be compared across individuals to *compare uncertainty attitudes*. But, trivially and contrary to the authors' claim, *ambiguity parameters* can be compared across individuals *to compare ambiguity attitudes*.

Scenario 2 in §2.3.2 on p. 388 is similar. Details: It shows that probability units can be different than weight units because of different weighting functions. The authors misinterpret, again: "This example illustrates that differences in source function parameters *cannot be compared across pairs of sources*, even within an individual, since differences in source functions correspond to differences in "weight," which have different values depending on the sensitivity toward the sources being considered." [italics added] It is true that *weights* cannot just be compared across sources *to compare probabilities*. But, trivially and contrary to the authors' claim, *weights* can be compared across sources *to compare weights*.

Scenario 3 on p. 288, §2.3.3 shows similarly that an increase of 0.2 in a pessimism parameter can have different effects on source premiums in different parts of the domain if the effects are nonlinear, with a misinterpretatio similar as above.

POINT 3. I use the term ambiguity in a broad sense, capturing all differences between an uncertain source and a (standard) risky source. The authors mostly use the term ambiguity in a narrow sense, where it captures the difference between unknown and known probabilities with the big ceteris paribus assumption added that there is no other relevant difference. This explains why I claim that φ captures ambiguity (+ risk attitude) whereas the authors claim that φ does not do so and even sometimes that φ is "independent" of ambiguity attitude. DETAILS OF POINT 3. My term ambiguity can capture competence, betrayal aversion, and many other emotions and cognitions. I do not like the narrow sense of ambiguity because it is practically unobservable. In particular, the Ellsberg urns do not measure it at all: they measure the difference between natural uncertainty and weird uncertainty with weird secrets kept for no good reason that one can think of. The literature has as yet mostly been inconsistent. If work to be done, taking the narrow definition and claming that with one Ellsberg experiment all of "the" (as if one thing) ambiguity attitude is captured. If reward to be claimed, taking the broad definition: almost all our decisions involve unknown probabilities, i.e. ambiguity, and, hence, with the little Ellsberg experiment all these decisions can be predicted.

The authors here do take the broad, and not narrow, meaning of ambiguity on p. 384 below Eq. 5, when they write: "Comparing w_S to w characterizes the *ambiguity attitude* toward a given source S. The difference between source functions w_A and w_B of two distinct sources A and B characterizes source dependence, i.e., the fact that *ambiguity attitudes* differ across sources." [italics added] But the rest of the paper adopts the narrow sense, when claiming that source preference is different than ambiguity and even that pmatchers are independent of ambiguity. %}

Gutierrez, Cédric & Emmanuel Kemel (2024) "Measuring Natural Source Preferences," *Experimental Economics* 27, 379–416. https://doi.org/10.1007/s10683-024-09822-4

{% %}

Guttman, Louis (1944) "A Basis for Scaling Qualitative Data," *American Sociological Review* 9, 139–150.

{% **foundations of statistics** %}

Guttman, Louis (1985) "The Illogic of Statistical Inference for Cumulative Science." *In* Omar F. Hamouda & J.C. Robin Rowley (1997, eds.) "*Statistical Foundations for Econometrics.*" Edward Elgar, Cheltenham.

{% **preferring streams of increasing income**

intertemporal separability criticized: sequence effects **%}**

Guyse, Jeffery L., L. Robin Keller, & Thomas Eppel (2002) "Valuing Environmental Outcomes: Preferences for Constant or Improving Sequences," *Organizational Behavior and Human Decision Processes* 87, 253–277.

{% Use hypothetical choice. Given that they consider serious time delays and losses, I agree with their decision.

dominance violation by pref. for increasing income: Not exactly that, but general preferences for sequencing effects, which do imply **intertemporal separability criticized**. Discuss discrepancies between matching vs. choice. They do not consider binary choice but rankings of multiple alternatives. They are maybe the first to investigate the choice-matching discrepancy in intertemporal choice *within subjects*.

decreasing/increasing impatience: find no evidence for decreasing (or increasing) impatience (p. 245, 2nd column, 2nd para: it is interesting to observe that short/long term asymmetry did not surface in our within-subjects design for either elicitation technique." %}

Guyse, Jeffery L. & Jay Simon (2011) "Consistency among Elicitation Techniques for Intertemporal Choice: A within-Subjects Investigation of the Anomalies," *Decision Analysis* 8, 233–246.

{% Seems to have used VAS to measure discounting. %}

Gyrd-Hansen, Dorte (2002) "Comparing the Results of Applying Different Methods of Eliciting Time Preferences for Health," *Health Economics in Prevention and Care* 3, 10–16.

{% **discounting normative**: seems to argue against discounting. %}

Gyrd-Hansen, Dorte & Jes Søgaard (1998) "Discounting Life-Years: Whither Time Preference?," *Health Economics* 7, 121–127.

{% The author expresses an extreme econometric viewpoint in preface 2nd para:

"The method of econometric research aims, essentially, at a conjunction of economic theory and actual measurements, using the theory and technique of statistical inference as a bridge pier. But the bridge itself was never completely built. So far, the common procedure has been, first to construct an economic theory involving exact functional relationships, then to compare this theory with some actual measurements, and, finally, "to judge" whether the correspondence is "good" or "bad."

Tools of statistical inference have been introduced, in some degree, to support such judgments, e.g., the calculation of a few standard errors and multiple-correlation coefficients. The application of such simple "statistics" has been considered legitimate, while, at the same time, the adoption of definite probability models has been deemed a crime in economic research, a violation of the very nature of economic data. That is to say, it has been considered legitimate to use some of the tools developed in statistical theory without accepting the very foundation upon which statistical theory is built. For no tool developed in the theory of statistics has any meaning-except, perhaps, for descriptive purposes-without being referred to some stochastic scheme." %}

Haavelmo, Trygve (1944) "The Probability Approach in Econometrics," *Econometrica* 12, supplement, July 1944, pp. iii-vi+1-115.

{% Presidential address, meeting of Econometric Society, Philadelphia, Dec. 29 1957; P. 351: "econometrics is something that should be done, rather than talked about."P. 354 warns against first using deterministic models and only then bringing in randomnessw/error (usually my preferred approach):

"Sometimes the introduction of reasonable random elements into an originally "exact" theory changes the observational implications of a model very profoundly. This is one reason why one might well doubt whether the kind of "division of labor" between pure theory and econometrics, which we have been relying on, is practical and fruitful. It has become almost too easy to start with hard-boiled and oversimplified "exact" theories, supply them with a few random elements, and come out with models capable of producing realistic-looking data. At the same time the introduction of random elements in the theories has made it possible to account for seemingly rather puzzling phenomena"

The author pleads for the use of subjective probability. "are realities in the minds of people" and "ways and means can and will be found to obtain actual measurements of such data."

P. 357: "I think most of us feel that if we could use explicitly such variables as, e.g., what people think prices or incomes are going to be, or variables expressing what people think the effects of their actions are going to be, we would be able to establish relations that could be more accurate and have more explanatory value. But because the statistics on such variables are not very far developed, we do not take the formulation of theories in terms of these variables seriously enough. It is my belief that if we can develop more explicit and a priori convincing economic models in terms of these variables, which are realities in the minds of people even if

they are not in the current statistical yearbooks, then ways and means can and will eventually be found to obtain actual measurements of such data." %}

Haavelmo, Trygve (1958) "The Role of the Econometrician in the Advancement of Economic Theory," (Presidential address, Econometric Society, Philadelphia, Dec. 29, 1957) *Econometrica* 26, 351–357.

{% Present subjects with hazards and their objective probabilities, and then ask them to express subjective degrees of likelihood/probability. The severity of the hazard does not affect the expressed degrees. %}

Haase, Niels, Frank Renkewitz, & Cornelia Betsch (2013) "The Measurement of Subjective Probability: Evaluating the Sensitivity and Accuracy of Various Scales," *Risk Analysis* 33, 1812–1828.
http://dx.doi.org/10.1111/risa.12025

{% Chapters on cognitive neuroscience, attention, recognition and action, representation of knowledge: neural networks, learning and memory, language, reading and writing, problem solving, reasoning and choice, and applications.

Final page, p. 440/441, discusses whether it is better to investigate cognitive psychology in the laboratory or in the real world. (**cognitive ability related to risk/ambiguity aversion**) %}

Haberlandt, Karl (1994) "*Cognitive Psychology*." Allyn and Bacon, Boston. (2nd edn. 1980, Krieger, New York.)

{% This paper investigates if a status quo, or an expectation just prior to it, serves as reference point.

In the first ("indirect") experiment, a choice list determines the CE (= certainty equivalent) of (0.5: CHF10, 0.5: 0). Payment is in Switzerland CHF. This determines the risk aversion of N = 121 subjects, with the random incentive system used to implement real incentives. This is done for a control treatment and for two experimental treatments. This first receive a sure prior endowment of CHF4, the second receive (0.5: CHF4, 0.5: CHF8), and the third receive (0.75: CHF4, 0.25: CHF12). The two experimental groups have expected prior endowment CHF6. The prior endowments were carried out prior to the choice lists, that is, the lotteries of the two experimental groups were carried out before

the aforementioned measurement of risk aversion. For the subjects who received CHF4 as prior endowment in the control groups, we can see if they take that 4 as reference point so, behave as in the control group, or if they take the CHF6 expectation as reference point and behave differently. It turns out that they, for both experimental groups, are somewhat less risk averse than the control group. (The evidence for group 1 is not so strong, p = 0.04 one-sided.) The two experimental groups are mutually similar. Had they taken the expected CHF6 as their reference point, then the prospect would have been perceived as mixed leading to greater, and not smaller, risk aversion for the experimental groups. So, other things must be going on. %}

Hack, Andreas & Frauke Lammers (2011) "The Role of Expectations in the Formation of Reference Points," working paper.

{% **real incentives/hypothetical choice**: There have been many studies on this. This paper is more thorough than preceding ones in having many subjects, five kinds of measurement, and not only students (n = 415) but also private (n = 821) and professional investors (n = 244). They find no differences between real incentives and hypothetical. They use the staircase method, which has been used for many decades but they only cite Dohmen et al. %}

Hackethal, Andreas, Michael Kirchler, Christine Laudenbach, Michael Razen, & Annika Weber (2023) "On the Role of Monetary Incentives in Risk Preference Elicitation Experiments," *Journal of Risk and Uncertainty* 66, 189–213. https://doi.org/10.1007/s11166-022-09377-w

{% %}

Hacking, Ian (1965) "*Logic of Statistical Inference*." Cambridge University Press, New York.

{% **updating: discussing conditional probability and/or updating**; **dynamic consistency**; %}

Hacking, Ian (1967) "Slightly More Realistic Probability," *Philosophy of Science* 34, 311–325.

{% **foundations of probability**; seems to be very good, authoritative. Seems to write that from the beginning probability had a dual role, one to reflect empirical frequencies, and the other to reflect subjective degree of belief. %}
Hacking, Ian (1975) "*The Emergence of Probability*." Cambridge University Press, New York.

{% Introduce second-order stochastic dominance. %}
Hadar, Joseph & William R. Russell (1969) "Rules for Ordering Uncertain Prospects," *American Economic Review* 59, 25–34.

{% %}
Hadar, Josef & Tae Kun Seo (1995) "Asset Diversification in Yaari's Dual Theory," *European Economic Review* 39, 1171–1180.

{% Seem to find competence effect. %}
Hadar, Liat, Sanjay Sood, & Craig R. Fox (2013) "Subjective Knowledge in Consumer Financial Decisions," *Journal of Marketing Research* 50, 303–316.

{% Argues against C/E (cost-effectiveness) analyses. P. 2219 seems to write: "There is a fact about the human psyche that will inevitably trump the utilitarian rationality that is implicit in cost-effectiveness analysis: people cannot stand idly by when an identified person's life is visibly threatened if effective rescue measures are available." He seems to have proposed, on p. 2223, a rule where "cost is not considered in determining the importance of treatment." %}
Hadorn, David C. (1991) "Setting Health Care Priorities in Oregon: Cost-Effectiveness Meets the Rule of Rescue," *JAMA* 265, 2218–2225.

{% Despite the broad title, they only investigate the Asian disease problem (now in 2024 I find this term politically incorrect) with militaries, to find that those are generally risk seeking. %}
Haerem Thorvald, Bård Kuvaas, Bjørn T. Bakken, & Tone Karlsen (2011) "Do Military Decision Makers Behave as Predicted by Prospect Theory?," *Journal of Behavioral Decision Making* 24, 482–497.

{% **risky utility u = strength of preference v (or other riskless cardinal utility, often called value)** %}
Hagen, Ole (1984) "Neo-Cardinalism." *In* Ole Hagen & Fred Wendstøp (eds.) *Progress in Utility and Risk Theory*, 145–164, Kluwer (was Reidel), Dordrecht.

{% Attribution bias: if you meet someone but the weather is bad, and you therefore think it is an unsympathetic person. %}
Haggag, Kareem, Devin G. Pope, Kinsey B. Bryant-Lees, & Maarten W. Bos (2019) "Attribution Bias in Consumer Choice," *Review of Economic Studies* 86, 2136–2183.

{% Standard reference for showing that atomless countably additive measures are convex-ranged. In their Ch. 1, p. 51, §6. %}
Hahn, Hans & Arthur Rosenthal (1948) "*Set Functions*." University of New Mexico Press, Albuquerque, New Mexico.

{% **measure of similarity** %}
Hahn, Ulrike, Nick Chater, & Lucy B. Richardson (2003) "Similarity as Transformation," *Cognition* 87, 1–32.

{% %}
Hahnemann, W. Michael (1991) "Willingness to Pay and Willingness to Accept: How Much Can They Differ?," *American Economic Review* 81, 635–647.

{% Test Benartzi-Thaler myopic loss aversion, finding it, surprisingly, even more pronounced for professional traders than for students. %}
Haigh, Michael S. & John A. List (2005) "Do Professional Traders Exhibit Myopic Loss Aversion? An Experimental Analysis," *Journal of Finance* 60, 523–534.

{% How can we see how people learn from experience if they get no feedback on results? Their cognitive ability will be informative. This paper shows that meta-cognitive ability can also help. It seems that the authors' term sensitivity is like discrimination in proper scoring rules. The authors correct for the cognitive

accuracy of prediction. It was not clear to me how meta-cognitive and cognitive are separated otherwise. %}

Hainguerlot, Marine, Jean-Christophe Vergnaud, & Vincent de Gardelle (2018) "Metacognitive Ability Predicts Learning Cue-Stimulus Association in the Absence of External Feedback," *Scientific Reports* 8, 5602.

{% Application of ambiguity theory;

ambiguity seeking: dictators prefer ambiguous unfair allocations to unambiguous unfair allocations because then their selfishness is harder to criticize. %}

Haisley, Emily C. & Roberto A. Weber (2010) "Self-Serving Interpretations of Ambiguity in Other-Regarding Behavior," *Games and Economic Behavior* 68, 614–625.

{% **Dutch book**: Under arbitrage, which is the same as a Dutch-book, your neutral decisions can be combined into a sure loss, which is bad. The paper opens with a purported counterargument: Your neutral decisions then can also be combined into a sure gain, and isnt' that something very good for you? Oh well … It continues with many arguments in the same spirit. P. 801: "I have not seen any argument that in virtue of avoiding the inconsistency of Dutch-bookability, at least some coherent agents are guaranteed to avoid all inconsistency." %}

Hájek, Alan (2008) "Arguments for–or against–Probabilism?," *British Journal for the Philosophy of Science* 59, 783–819.

{% %}

Hájek, Alan & Harris Nover (2012) "Rationality and Indeterminate Probabilities," *Synthese* 187, 33–48.

{% Logarithmic utility seems to be induced by a growth-rate optimal model (p. 350); argues strongly against mean-variance, that it violates stoch. dom. etc. %}

Hakansson, Nils H. (1971) "Capital Growth and the Mean-Variance Approach to Portfolio Selection," *Journal of Financial and Quantitative Analysis* 6, 517–557.

{% d**ynamic consistency**

Discussed in Paris on March 8, 1999.

Dynamic consistency condition definition seems to comprise **RCLA**, and is restricted to fixed counterfactual strategies.

Uses a "generalized conditional dominance condition": "If, given every element of a partition, I prefer replacing f by g only given that one element of the partition, then I prefer replacing f by g in total. Given dynamic consistency (which is defined in this paper to imply reduction of events), the condition is weaker than forgone-event independence but is "in that spirit." The condition was introduced independently by Grant, Simon, Atsushi Kajii, & Ben Polak (1999) "Decomposable Choice under Uncertainty," %}

Halevy, Yoram (1998) "Trade between Rational Agents as a Result of Asymmetric Information," .

{% Considers an experiment with four urns with each 10 balls of two colors, red and black.

Urn 1 is fifty-fifty;

Urn 2 is unknown composition

suspicion under ambiguity: as it should, subjects can choose the color on which to gamble, so, no suspicion.

Urn 3 is two-stage, first stage randomly chooses one of the 11 compositions of the urn and then stage two carries out the drawing of the ball from that composition. (**second-order probabilities to model ambiguity**)

Urn 4 is also two-stage, but chooses randomly only a 0-10 or 10-0 composition. So, urn 4 is quite like urn 1.

The author compares the explanation of ambiguity aversion through violations of probabilistic sophistication (Epstein 1999) with the one of Segal that assumes that for the ambiguous urn 2 the subjects subjectively assume a two-stage uncertainty with the first stage uncertainty about the composition of the urn, coupled with violations of **RCLA.** He makes the plausible but debatable assumption that probabilistic sophistication assumes no violation of RCLA. The two theories then differ regarding predictions about urn 3:

The probabilistic-sophistication explanation says urns 1, 3, 4 all have known probabilities and will be treated alike, with only urn 2 valued lower.

The RCLA-violation-explanation says that urns 2 and 3 will be treated similarly, and will be valued lower than urn 1.

The data find the latter prediction, with urns 2 and 3 valued lower than urn 1. At group average level urns 2 and 3 are treated alike, but I guess there remain many differences at the individual level. The author distinguishes two subgroups with different attitudes.

Urn 4 also seems to be treated like urns 2 and 3. Subjects may simply have a general dislike of complex urns. %}

Halevy, Yoram (2007) "Ellsberg Revisited: An Experimental Study," *Econometrica* 75, 503–536.

{% Assumes consumption stream (c_0,c_1, …). Assumes that for each timepoint there is an r probability of death ("implicit risk"), to be modeled as the 0 consumption outcome from there on, so that the probability of consumption of c_t (and then all preceding consumptions) is $(1-r)^t$. In some formal results (Theorem 1) conditions are assumed over all values of r. Risk is processed using nonEU. Each consumption c_t is assumed nonnegative; i.e., it is at least as good as death (stated on p. 1152 2nd para ℓ. 2).

The representation is of the form $\mathrm{SUM}_t g\big((1-r)^t\big)\beta^t u(c_t)$ where u is utility (with the scaling $u(0) = 0$), β is intertemporal discount rate, and g is a probability weighting function. Thus, constant discounting results iff g is linear (EU, discount rate being $(1-r)\beta$), diminishing impatience corresponds with convex g and increasing impatience corresponds with concave g. In this way the immediacy effect of intertemporal choice becomes the certainty effect of decision under risk. This analogy has been alluded to many times in the literature but this paper gives a formal model capturing it.

The author uses "diminishing impatience" for the immediacy effect and otherwise uses the expression strongly diminishing impatience. I next discuss separability issues, resulting from emails with the author in March 09.

(Saito (2011) will show that there is a confusion of these concepts and that in Theorem 1 there (p. 1150) diminishing impatience (in Halevy's terminology) does not imply common ratio, but instead is equivalent to the certainty effect, and it is strong diminishing impatience (in Halevy's terminology) that is equivalent to the common ratio effect.)

OBSERVATION 1. The SUM representation above can be obtained by first aggregating risks at each timepoint, and only then aggregating over time. At each timepoint t, the probability of consuming c_t is $(1-r)^t$ and the probability of consuming 0 is $1 - (1-r)^t$. The RDU value at time t is $g((1-r)^t u(c_t))$. Next these RDU values are aggregated over time, discounted by β, giving the above SUM.

OBSERVATION 2. The SUM representation above can also be obtained by first aggregating over time, i.e., by considering all consumption paths and their probabilities, and then calculating RDU. This is explained in §4, in particular Theorem 2, p. 1154. This is the author's interpretation in the paper.

The two observations displayed here imply that we have weak separability of timepoints (even strong, additive) and also weak separability of the risky events. It is well known, by applications of Gorman's (1968) theorem, that this implies strong complete additive separability of time and risk. So, a puzzle for the readers maybe, how can we then still have nonEU? The answer is that we are considering a restricted, comonotonic, domain. For two uncertain events always the one with the longest life duration has the best outcomes. The events always have the same ranking position and we look at RDU within one comonotonic set. Thus, even the sure-thing principle holds for uncertainty, and replacing a common outcome on an uncertain event by another one will not affect preference. The model very efficiently combines aggregation conveniences of classical expected utility and discounted utility models (making the model tractable) with empirical features of nonexpected utility. %}

Halevy, Yoram (2008) "Strotz Meets Allais: Diminishing Impatience and the Certainty Effect," *American Economic Review* 98, 1145–1162.

{% **DC = stationarity**: This paper carefully distinguishes the three concepts and tests them separately, in particular, employing the longitudinal data required for testing time consistency (also known as dynamic consistency). It is very similar to Casari & Dragone (2015), but the two studies were done independently and do not cite each other.

The paper uses the common term time consistency for what could be called decision-time independence (the calendar time of consumption remains fixed, but the calendar time of decision-taking is changed; it is a between-preference-relations conditon if we take preference relations at different times as different preference relations), the common term stationarity for what could be called consumption-time independence (the calendar time of decison remains fixed, but the calendar time of consumption is changed; it is the only within-preference-relation conditon), and the term time invariance for what could be called age independence (the whole decision situation, with both time of decision and time of consumption) shifted in time. Time invariance means that we can use stopwatch time. Although the terms by themselves do not describe the concepts, and could from this perspective be interchanges, they have several advantages:

- they have all been used before in the sense used here;

- they are short;

- time consistency can be argued to be normative, so, the strong term consistency works well;

- time invariance is not normative but is empirically plausible as ceteris paribus; causes of violation can be taken as distortions; here the immediacy effect does not imply violations; the neutral term variance fits well with this role.

The definitions are in §3, p. 341.

P. 341 Proposition 4 states that every two conditions implies the third. I once jokingly said that this result is a corollary of transitivity of the identity relation. This claim is clearest in Fact 5: Stationarity holds iff $x_2 = x_1$; time invariance iff $x_{21} = x_1$, and time consistency iff $x_{21} = x_2$. One can also do it by each condition requiring that choices in two of three choice situations are the same.

As argued above, violations of time invariance are a bit like violations of ceteris paribus. This paper finds that mostly time invariance is violated. It may be because the late timepoints in the experiment were close to the end of the term, or because students had then gotten used to the experiment, or built up confidence seeing that experiment did pay in early times.

P. 342 following Proof of Proposition 4 points out that much of the literature has taken time invariance implicitly. This annotated bibliography has a keyword **DC = stationarity**: for studies that made this confusion, and studies that did not. %}

Halevy, Yoram (2015) "Time Consistency: Stationarity and Time Invariance," *Econometrica* 83, 335–352.

{% **biseparable utility violated**; Considered a combination of the models of Seo (2009) and Ergin & Gul (2009). Use a domain similar to Seo (2009), with a state space and then objective probabilities both before and after the states. Their domain is actually smaller, with compound lotteries and Savage acts. Thus, they can use the prior probabilities to calibrate subjective probabilities over the state space with matching probabilities as Seo did, and they need not invoke the second-order acts of KMM. They generalize Seo's model by not assuming expected utility within each stage, but only probabilistic sophistication, similar to Ergin & Gul (2009. Their model is supported empirically by evidence from Halevy (2007). %}

Halevy, Yoram, Massimiliano Amarante, & Emre Ozdenoren (2008) "Uncertainty and Compound Lotteries: Calibration," working paper, University of British Columbia.

{% **biseparable utility violated**; Consider unknown urn of Ellsberg as second-order probability distribution. In repeated choice, if the compositions of the various unknown urns are positively correlated, then aversion to mean-preserving spreads will imply aversion to repeated choices + repeated payments on the unknown urn versus the known (would be opposite if the urns are negatively correlated). In single-choice situations people may have been conditioned to act as if repeated. Thus, ambiguity aversion could be generated by aversion to mean-preserving spreads. %}

Halevy, Yoram & Vincent Feltkamp (2005) "A Bayesian Approach to Uncertainty Aversion," *Review of Economic Studies* 72, 449–466.

{% This paper provides a general preference axiomatization for two-stage probabilistic sophistication where RCLA is abondoned. For this, it is a sort of analog of what Machina & Schmeidler (1992) is for probabilistic sophistication. However, the two-stage model is way more complex and less nice, unavoidably, with, for instance, no uniqueness. Further, it needs the extra assumption of objective two-stage lotteries available in the preference domain.

We assume a Savage framework of decision under uncertainty, with acts mapping states to outcomes. For simplicity, assume only finitely many states $s_1,\ldots,s_n$. However, we add objective probability distributions to the preference domain. This also happens in the Anscombe-Aumann framework, but that is more complex by assuming more than one stage. We assume only one stage.

To prepare, I first consider probabilistic sophistication à la Machina & Schmeidler (1992). It holds if and only if there exists an objective probability vector $(p_1,\ldots,p_n)$ such that every act $(s_1{:}x_1,\ldots,s_n,x_n)$ is indifferent to the objective lottery $(p_1{:}x_1,\ldots,p_n,x_n)$. So, the agent does not distinguish between objective and subjective probabilities. One might take this as a Version-1 preference axiomatization, be it trivial and ugly because of the “there exists” clause. We can do better because for each uncertain event s_j we can readily calibrate the objective matching probability (gambling-equivalent) p_j and that is s_j’s subjective probability p_j. So, here we used only two outcomes. Subjective probabilities are readily observable this way and can be used as input in preference axioms, making the above axiom nicer, giving a nicer Version-2 preference axiomatization. Sarin & Wakker (1997) did a similar thing for subjective expected utility instead of probabilistic sophistication, which I consider to be better than Anscombe & Aumann’s (1963) axiomatization of subjective expected utillity.

This paper does something related for two-stage probabilistic sophistication where RCLA is abandoned. Now the preference domain consists of Savage acts and objective two-stage lotteries. We can obtain, trivially and ugly, a Version-1 axiomatization by simply assuming an isomorphic, preference-equivalent, objective two-stage framework. (Details: we consider all first-stage probability distributions $(p_1,\ldots,p_n)$, and then a second-stage distribution over them. Then each act $(s_1{:}x_1,\ldots,s_n{:}x_n)$ is equivalent to the objective two-stage lottery where each $(p_1,\ldots,p_n)$ is replaced by $(p_1{:}x_1,\ldots,p_n{:}x_n)$.) A problem here is that, even with a continuum of outcomes, I guess that the objective two-stage framework may not be unique. Anyway, this paper goes for a Version-2 axiomatization, by first, in Axiom 6, doing calibration using only two outcomes, and then extending to general acts in Axiom 7. But Axiom 6 seems to be somewhere between the above

Version 1/Version 2 by involving a more heavy “there exists” clause, and probably there is no uniqueness. %}

Halevy, Yoram & Emre Ozdenoren (2022) “Uncertainty and Compound Lotteries: Calibration,” *Economic Theory* 74, 373–395.
https://doi.org/10.1007/s00199-022-01453-1

{% %}

Halevy, Yoram, Dotan Persitz, & Lanny Zrill (2018) “Parametric Recoverability of Preferences,” *Journal of Political Economy* 126, 1558–1593.

{% %}

Haliassos, Michael & Christis Hassapis (2001) “Non-Expected Utility, Saving and Portfolios,” *Economic Journal* 111, 69–102.

{% %}

Hall, Jane, Karen Gerard, Glenn Salkfeld, & Jeff Richardson (1992) “A Cost Utility Analysis of Mammography Screening in Australia,” *Social Science and Medicine* 34, 993–1004.

{% %}

Hall, Robert (1988) “Intertemporal Substitution in Consumption,” *Journal of Political Economy* 96, 221–273.

{% Suppose that L is a set of lotteries over a finite set of prizes, and a vNM pref rel. Suppose g of L to L s.t. $\ell > \ell'$ iff $g(\ell) > g(\ell')$. Mayby DM misperceives probabilities and thinks g(l) instead of l? and does vNM (with different u) over various g? This model is described.

Problem: g leaves much freedom. %}

Haller, Hans (1985) “Expected Utility and Revelation of Subjective Probabilities,” *Economics Letters* 17, 305–309.

{% Presented at University of Saerbrücken, Dept. of Economics, July 1996, Saerbrücken, Germany.

equilibrium under nonEU; Nice paper that points out how definition of support for nonadditive measures determines what kind of equilibrium results. The definition of support should not be chosen ad hoc merely to get the kind of equilibrium wanted, but the other way around, first one should find good reasons for defining the support and then one should see what equilibrium results.

The definition of support is important for what people call the consistency requirement of Nash equilibrium. Here consistency requirement means that the equilibrium strategies in the support are all optimal. %}

Haller, Hans (2000) "Non-Additive Beliefs in Solvable Games," *Theory and Decision* 49, 313–338.

{% %}

Halmos, Paul R. (1950) "*Measure Theory*." Van Nostrand, New York.

{% **foundations of statistics**: Seems to write, related to the likeli hood principle: "The theory of sufficiency is in an especially satisfactory state for the case in which the set of probability measures satisfies a certain condition described by the technical term dominated. [...] (A test statistic) T is sufficient if and only if the likelihood ratio of every pair of measures in the set (of probability measures) depends on the outcome through T only. The [...] formulation makes sense even in the not necessarily dominated case but unfortunately it is not true in that case." %}

Halmos, Paul J. & Leonard J. Savage (1949) "Application of the Radon-Nikodym Theorem to the Theory of Sufficient Statistics," *Annals of Mathematical Statistics* 20, 225–241.
https://doi.org/10.1214/aoms/1177730032

{% %}

Halpern, David (2016) "*Inside the Nudge Unit: How Small Changes Can Make a Big Difference*." Ebury Publishing, Penguin Random House, London.

{% **restricting representations to subsets**: For virtually all representation theorems in the literature, richness of structure is essentially. This paper proves this point for Cox's famous axiomatization of probability. See also **criticizing the dangerous role of technical axioms such as continuity** %}

Halpern, Joseph Y. (1999) "A Counterexample to Theorems of Cox and Fine," *Journal of Artificial Intelligence Research* 10, 67–85.

{% %}
Halpern, Joseph Y. (2002) "Characterizing the Common Prior Assumption," *Journal of Economic Theory* 106, 316–355.

{% Theoretically oriented book on reasoning with probabilities and generalizations of probability. Each chapter has many, 40 or so, exercises.
Ch. 1 starts with some classical probability-reasoning puzzles.
Ch. 2 does probability with a betting axiomatization, upper and lower probability, Dempster-Shafer belief, and the most general, possibility measures (assigning max to disjoint union, as in fuzzy logic), and the most general, plausibility measures that generalize weighting functions/capacities by having as range a partially ordered set.
updating under ambiguity; Ch. 3 considers updating for various non-Bayesian belief indexes. Ch. 4 is on independence and Bayesian networks, considering it also for nonadditive measures of beliefs. Ch. 5 is on expectation, inner and outer, and then based on this decision theory in §5.4. §5.4.3 has the marvelous generalized expected utility developed by Chu & Halpern (2008, Theory and Decision). Ch. 6 considers multi-agents, with the important topic of protocols in §6.6. Ch. 7 develops logic for uncertainty reasonings, and Ch. 8 is on defaults and counterfactuals. Ch. 9 is on belief revision, comparing it with conditional logic. Ch. 10 brings 1st order modal logic, and Ch. 11 is on an interesting topic:
"From Statistics to Beliefs,"
discussing for instance reference classes and random worlds. %}
Halpern, Joseph Y. (2003) "*Reasoning about Uncertainty*." The MIT Press, Cambridge, MA.

{% **updating: discussing conditional probability and/or updating**
Presents mathematical relations between the concepts, which can be equivalent under countable additivity, finite state space, and so on. %}
Halpern, Joseph Y. (2009) "Lexicographic Probability, Conditional Probability, and Nonstandard Probability," *Games and Economic Behavior* 68, 155–179.

{% **conservation of influence**: determining causality is like determining influence. Involves counterfactual thinking. %}

Halpern, Joseph Y. (2016) "*Actual Causality*." The MIT Press, Cambridge, MA.

{% **updating: nonadditive measures**; Paper distinguishes between belief functions as "generalized probability," which reflects belief of a person that he is willing to act upon (which may be subjective in my terminology although Joe in a discussion with me in Jan. 2002 never wanted to commit to this term), and that we are born with and keep up updating, and as "evidence," which is a piece of (in my terms, objective) information that need not reflect anybody's belief. For example, evidence may be sample size + relative frequencies in a data set. Paper has the nice interpretation that evidence is to be taken as an updating function mapping prior beliefs to posterior beliefs (claimed as possibly new on p. 290). Two pieces of evidence can be combined as through Dempster/Shafer's formula, a belief can be updated through evidence. The writings of Shafer, Dempster, Smets, do not always fit very clearly/completely in one or other category. P. 289 points out that combining beliefs, as with combining experts, requires subjective judgment of importance weights of the experts.

Second part of paper, starting in §4 on p. 288, assumes the special model as in statistics, where there are hypotheses with nonprobabilized uncertainty and then, conditional on each hypothesis, probabilized uncertainty about the observations. It imposes that evidence, to be proper, should map each Bayesian prior probability towards a posterior Bayesian probability. This then implies that evidence should be like a normalized likelihood function; i.e., as an additive probability (e.g., Theorem 4.6, p. 301). And this is a conclusion of the paper, that evidence is best represented as (Bayesian, additive) probability.

P. 303 gives refs to papers showing that under some axioms à la Cox, evidence must be represented by likelihood. %}

Halpern, Joseph Y. & Ronald Fagin (1992) "Two Views of Belief: Belief as Generalized Probability and Belief as Evidence," *Artificial Intelligence* 54, 275–317.

{% Generalize the model by Chateauneuf & Faro (2009). %}

Halpern, Joseph Y. & Samantha Leung (2016) “Maxmin Weighted Expected Utility: A Simpler Characterization,” *Theory and Decision* 80, 581–610.

{% %}

Halpern, Joseph Y. & Michael O. Rabin (1987) “A Logic to Reason about Likelihood,” *Artificial Intelligence* 32, 379–405.

{% %}

Halpern, Joseph Y. & Mark R. Tuttle (1993) “Knowledge, Probability, and Adversaries,” *Journal of the ACM* 40, 917–960.

{% **foundations of quantum mechanics** %}

Halpin, John E. (1991) “What is the Logical Form of Probability Assignment in Quantum Mechanics,” *Philosophy of Science* 58, 36–61.

{% About half of 1075 (p. 126 bottom) farmers were asked hypothetical questions about willingness to pay or accept for risky gains and losses. Assuming EU, their utility functions were derived. Their utility curvature was related to their kind of business, whether more or less risky, and to other characteristics. Farmers with weak loss aversion (utility steep for losses and shallow for gains) engaged in risky activities such as cash crops en fat-stock feeding. Farmers with strong loss aversion engaged in safe activities such as general farming. Qualitative relations are reported, but no statistics. The authors use an unclear terminology of high and low marginal utility where high for gains probably means more convex, so, more risk seeking, and high for losses means the opposite.

risky utility u = transform of strength of preference v: they clearly and repeatedly favor this view, e.g. footnote 4 p. 119.

Pp. 122-123 lists the vNM axioms without independence, but with a nice point 4 that is like the DUR assumption 2.1.2 of my book (only generated probability distribution over outcomes matters) or like no-framing.

P. 123 penultimate para explains that direct matching would be too complex for subjects, so, they derived from choices. They did like choice lists, but I think not all choices related to one choice list in a row or on one page, but randomly intermingled, and only as binary choices. P. 124 text explains that they took

midpoints between switches of preferences as indifference point. Not very clear to me what exactly their stimuli were in Table 1.

P. 124 note a at the table writes that they only use small probabilities so as to avoid distorting effects of what we nowadays (2013) call probability weighting.

PE doesn't do well: p. 124 note c at table says that variations in outcomes are easier to understand than variations in probability.

P. 131 ℓ. 9 reporst a 26 times higher marginal utility for losses than for gains but it is not clear. %}

Halter, Alfred N. & Christopher Beringer (1960) "Cardinal Utility Functions and Managerial Behavior," *Journal of Farm Economics* 42, 118–132. https://doi.org/10.2307/1235326

{% **risky utility u = strength of preference v (or other riskless cardinal utility, often called value)** %}

Halter, Alfred N. & Gerald W. Dean (1971) "*Decisions under Uncertainty: With Research Applications.*" South-Western Publishing Co., Cincinnati, Ohio.

{% **Real incentives**, **Dutch book**, or **reference dependence test**: Consider repeated private value auctions, where commonly repeated payments are used and it is assumed that prior gains do not affect behavior. These authors, however, show that cash balance does affect bidding behavior.

random incentive system: this paper gives evidence to support it.

Get some evidence for target and aspiration levels. %}

Ham, John C., John H. Kagel, & Steven F. Lehrer (2005) "Randomization, Endogeneity and Laboratory Experiments: The Role of Cash Balances in Private Value Auctions," *Journal of Econometrics* 125, 175–205.

{% %}

Hamao, Yasushi, Ronald W. Masulis, & Victor Ng (1990) "Correlations in Price Changes and Volatility across International Stock Markets," *Review of Financial Studies* 3, 281–307.

{% %}

Hamilton, Barton H. (2000) "Does Entrepreneurship Pay? An Empirical Analysis of the Returns to Self-Employment," *Journal of Political Economy* 108, 604–631.

{% Introduces a mathematical preference model combining health and wealth evaluations, giving preference axiomatizations, and implications for QALY, DALY, and so on. %}

Hammitt, James K. (2013) "Admissible Utility Functions for Health, Longevity, and Wealth: Integrating Monetary and Life-Year Measures," *Journal of Risk and Uncertainty* 47, 311–325.

{% %}

Hammond, John S., Ralph L. Keeney, & Howard Raiffa (1999) "*Smart Choices*." Harvard Business School Press, Boston.

{% **coherentism**: coherence means internal consistency. Correspondence means good relations to external world. %}

Hammond, Kenneth R. (2006) "*Beyond Rationality*." Oxford University Press, New York.

{% **intuitive versus analytical decisions**: cognitive continuum theory: People combine analytic and intuitive judgments. The optimal level of analytic/intuitive depends on the task, and surely need not be the analytic end. %}

Hammond, Kenneth R., Robert M. Hamm, Janeth Grassia, & Tamra Pearson (1987) "Direct Comparison of the Efficacy of Intuitive and Analytical Cognition in Expert Judgments," *IEEE Transactions on Systems, Man, and Cybernetics* 17, 753–770.

{% %}

Hammond, Kenneth R. & Doreen Victor (1988) "Annotated Bibliography for Risk Perception and Risk Communication," Center for Research on Judgment and Policy, University of Colorado at Boulder.

{% **dynamic consistency**: **favors abandoning time consistency, so, favors sophisticated choice,** because he considered precommitment only viable if an

extraneous device is available to implement it (p. 162/163). P. 162 defines sophisticated and myopic choice; also defines precommitment (called resolute choice by McClennen) but, similar to me, thinks that that is not really an available option. Hammond says that if it is indeed available, then it should be added as a new decision option, a new branch in the tree. (To which McClennen would probably reply that precommitment is in the head and needs no additional decision option, and Machina would reply that tastes themselves have changed and thus generate what seems to be precommitment.)

Hammond takes paths (called "branches") as primitives. n = x(t) means that node n occurs at timepoint t in the path x. In a decision node, all paths emanating from it are simply in the choice set. The one actually happening from there on is the one most preferred by the choice function, but not necessarily in a preference sense and a myopic person will therefore end up with addiction. For any subset of paths, one considers the choice between them by simply snipping off all other paths and otherwise leave the tree as is. Then from that one sees what choice is revealed. Preference between two paths x and y in a node n is then inferred by deleting !all! other paths, and then see what is chosen.

Such procedures do not seem to be useful if there are interactions between paths in the sense that the preference between x and y can be affected by another path z, such as happening in game theory when other actors also choose. It is also problematic for DUU and nonEU when there is nonseparability (e.g., my paper "counterfactual").

Coherence: choice function over paths in some fixed node satisfies some revealed preference conditions to agree with a (weak) ordering.

Consistency: choices at different timepoints reveal the same preferences between paths; it is, basically (6.2 suggests, but I am not 100% sure), the thing violated by myopic choice.

Endogeneously changing tastes describe changes due to previous decisions (so, violations of DC (dynamic consistency), e.g., previous decisions of chance). Exogeneously changing tastes describe changes due to the progression of time (say, factors not in the tree; so, violations of stationarity). Seems that first may rather be violation of history-independence and second of stationarity???

The paper shows that in trees where **sophisticated choice** is coherent, it agrees with myopic choice. In other words, whenever myopic choice leads to

irrationality, then sophisticated choice is not coherent.

There may be a point in the last lines of the conclusion. Sophisticated choice may seem like some sort of resolution of changing taste, but it still is incoherent, so the basic irrationality still remains. %}

Hammond, Peter J. (1976) "Changing Tastes and Coherent Dynamic Choice," *Review of Economic Studies* 43, 159–173.

{% **dynamic consistency** %}

Hammond, Peter J. (1977) "Dynamic Restrictions on Metastatic Choice," *Economica* 44, 337–350.

{% **dynamic consistency** %}

Hammond, Peter J. (1983) "Ex-Post Optimality as a Dynamically Consistent Objective for Choice under Uncertainty." *In* Prasanta K. Pattanaik & Maurice Salles (eds.) *Social Choice and Welfare*, 175–205, North-Holland, Amsterdam.

{% **dynamic consistency** %}

Hammond, Peter J. (1986) "Consequentialist Social Norms for Public Decisions." *In* Walter P. Heller, Ross M. Starr, & David A. Starrett (eds.) *Social Choice Public Decision Making: Essays in Honor of Kenneth J. Arrow, Vol. I,* 3–27, Cambridge University Press, Cambridge.

{% %}

Hammond, Peter J. (1987) "Subjective Probabilities with State Independent Utilities on State Dependent Consequence Domains," Stanford University, Institute of Mathematical Studies in the Social Sciences, Economics Technical Report No. 520.

{% Short accessible version of his idea; **dynamic consistency** %}

Hammond, Peter J. (1988) "Consequentialist and the Independence Axiom." *In* Bertrand R. Munier (ed.) *Risk, Decision and Rationality*, 503–515, Reidel, Dordrecht.

{% **dynamic consistency** %}

Hammond, Peter J. (1988) “Consequentialist Foundations for Expected Utility,” *Theory and Decision* 25, 25–78.

First version seems to have been:

Hammond, Peter J. (1985) “Consequential Behavior in Decision Trees and Expected Utility,” Working paper no. 112, Institute for Mathematical Studies in the Social Sciences, Stanford University, Palo Alto, CA, USA.

{%; **dynamic consistency** %}

Hammond, Peter J. (1989) “Consistent Plans, Consequentialism, and Expected Utility,” *Econometrica* 57, 1445–1449.

{% Seems to be strong on the impossibility of interpersonal comparisons of utility. %}

Hammond, Peter J. (1991) “Interpersonal Comparisons of Utility: Why and How They Are and Should Be Made.” *In* John Elster & John E. Roemer (eds.) *Interpersonal Comparisons of Well-Being. Studies in Rationality and Social Change*, Cambridge University Press, New York.

{% %}

Hammond, Peter J. (1998) “Objective Expected Utility.” *In* Salvador Barberà, Peter J. Hammond, & Christian Seidl (eds.) *Handbook of Utility Theory, Vol. 1, Principles*, 145–211, Kluwer Academic Publishers, Dordrecht.

{% %}

Hammond, Peter J. (1998) “Subjective Expected Utility.” *In* Salvador Barberà, Peter J. Hammond, & Christian Seidl (eds.) *Handbook of Utility Theory, Vol. 1, Principles*, 213–271, Kluwer Academic Publishers, Dordrecht.

{% **foundations of statistics**: collect classical papers. %}

Hamouda, Omar F. & J.C. Robin Rowley (1997, eds.) “*Statistical Foundations for Econometrics.*” Edward Elgar, Cheltenham.

{% %}

Hampton, Jean (1994) "The Failure of Expected-Utility Theory as a Theory of Reason," *Economics and Philosophy* 10, 195–242.

{% %}

Hamrich, Harvey J. & Joseph M. Garfunkel (1991) "Clinical Decisions: How Much Analysis and how Much Judgment?" (Editor's Column), *Journal of Pediatrics* 118, 67.

{% A convenience sample of 22 physicians and 11 trainees were interviewed qualitatively about how they handled uncertainty. Strategies consisted of collecting more info, asking others to decide, paying more or less attention to the uncertainties, and other similar strategies. I saw no uses for decision theory. %}

Han, Paul K. J., Tania D. Strout, Caitlin Gutheil, Carl Germann, Brian King, Eirik Ofstad, Pal Gulbrandsen, & Robert Trowbridge (2021) How Physicians Manage Medical Uncertainty: A Qualitative Study and Conceptual Taxonomy," *Medical Decision Making* 41, 275–291.

{% Analyzes newsvendor where only mean and variance are known, and ambiguity aversion is captured through maxmin evaluations. %}

Han, Qiaoming, Donglei Du, & Luis F. Zuluaga (2014) "A Risk- and Ambiguity-Averse Extension of the Max-Min Newsvendor Order Formula, *Operations Research* 62, 535–542.

{% Axiomatize diversification measures using risk measures. %}

Han, Xia, Liyuan Lin, & Ruodu Wang (2024) "Diversification Quotients: Quantifying Diversification via Risk," *Management Science*, forthcoming. https://doi.org/10.1287/mnsc.2023.00513

{% They propose to transform probability estimates so as to reduce biases. They use the Goldstein-Einhorn family (they do not use this term) without the elevation parameter, so it is symmetric and only brings inverse S. This has been done before for discrete events but they do it for continua of events. They consider, for instance, which transformation comes closest to correct data. %}

Han, Ying & David V. Budescu (2022) "Recalibrating Probabilistic Forecasts to Improve Their Accuracy," *Judgment and Decision Making* 17, 91–123.

{% **dynamic consistency**: **favors abandoning forgone-event independence, so, favors resolute choice**; **updating under ambiguity** %}

Hanany, Eran & Peter Klibanoff (2007) "Updating Preferences with Multiple Priors," *Theoretical Economics* 2, 261–298.

{% **game theory for nonexpected utility** %}

Hanany, Eran & Zvi Safra (1998) "Existence and Uniqueness of Ordinal Nash Outcomes," University of Tel-Aviv.

{% %}

Handa, Jagdish (1977) "Risk, Probabilities, and a New Theory of Cardinal Utility," *Journal of Political Economy* 85, 97–122.

{% An American health insurance company forced its clients to change health insurance in 2004. (So, it is not nudge.) Following years, clients were free to change or not. The author can measure inertia and adverse selection (they have data on client claims). He finds that removing inertia primarily increases adverse selection. This agrees with Wakker, Timmermans, & Machielse (2007) who also found that helping clients by providing health-expenses info is not good because it enhances adverse selection too much. %}

Handel, Benjamin R. (2013) "Adverse Selection and Inertia in Health Insurance Markets: When Nudging Hurts," *American Economic Review* 103, 2643–2682. http://dx.doi.org/10.1257/aer.103.7.2643

{% **foundations of statistics**: a revival of Fisher's fiducial approach. Abstract writes: "The main idea of GFI is to carefully transfer randomness from the data to the parameter space using an inverse of a data-generating equation without the use of Bayes' theorem." %}

Hannig, Jan, Hari Iyer, Randy C. S. Lai, & Thomas C. M. Lee (2016) "Generalized Fiducial Inference: A Review and New Results," *Journal of the American Statistical Association* 111, 1346–1361.

{% %}

Hanoch, Giora (1977) "Risk Aversion and Consumer Preferences," *Econometrica* 45, 413–426.

{% **Z&Z**; Examines welfare effects of compulsory insurance versus free-market versus a mix of compulsory plus voluntary, a variation of Dahlby (1981), a paper that seems to be a classic. Assume that all individuals have the same utility function. %}

Hansen, Bodil O. & Hans Keiding (2002) "Alternative Health Insurance Schemes: A Welfare Comparison," *Journal of Health Economics* 21, 739–756.

{% **one-dimensional utility**; considers relative risk premium (risk premium expressed in terms of percentage of wealth) and characterizes its decreasingness in terms of sums of utility functions on a particular domain of prospects. %}

Hansen, Frank (2007) "Decreasing Relative Risk Premium," *B.E. Journal of Theoretical Economics*: Vol. 7: Iss. 1 (Topics), Article 37.

{% %}

Hansen, Kristian Schultz & Lars-Peter Østerdal (2006) "Models of Quality-Adjusted Life Years when Health Varies over Time: Survey and Analysis," *Journal of Economic Surveys* 20, 229–255.

{% Summarizes views from other papers. %}

Hansen, Lars P. (2007) "Beliefs, Doubts and Learning: Valuing Macroeconomic Risk; Richard T. Ely Lecture," *American Economic Review, Papers and Proceedings* 97, 1–30.

{% %}

Hansen, Lars Peter & Massimo Marinacci (2016) "Ambiguity Aversion and Model Misspecification: An Economic Perspective," *Statistical Science* 31, 511–515. https://doi.org/10.1214/16-sts570

{% Maccheroni, Marinacci, & Rustichini (2006 Econometrica) generalize this. For interpretation of attitude/belief, see my annotations on that paper. %}

Hansen, Lars P. & Thomas J. Sargent (2001) "Robust Control and Model Uncertainty," *American Economic Review, Papers and Proceedings* 91, 60–66.

{% %}
Hansen, Peter & Thomas J. Sargent (2007) "Recursive Robust Estimation and Control without Commitment," *Journal of Economic Theory* 136, 1–27.

{% %}
Hansen, Peter & Thomas J. Sargent (2007) "*Robustness*." Princeton University Press, Princeton.

{% **PT, applications**: nonadditive measures, large market-based measures of risk aversion; robust agents want robustness against specification errors about income shocks. **uncertainty amplifies risk**: they seem to argue for this, where uncertainty is model-uncertainty and the phenomenon amplified is aversion. %}
Hansen, Lars Peter, Thomas J. Sargent, & Thomas D. Tallarini (1999) "Robust Permanent Income and Pricing," *Review of Economic Studies* 66, 873–908.

{% P. 78 argues against the dynamically consistent rectangular maxmin EU model that was argued for by Epstein & Schneider (2003) (that had been put forward by Sarin & Wakker, 1998, JRU, pp. 87–119, §2) before. %}
Hansen, Lars Peter, Thomas J. Sargent, Gauhar A. Turmuhambetova, & Noah Williams (2006) "Robust Control and Model Misspecification," *Journal of Economic Theory* 128, 45–90.

{% **proper scoring rules**: invented around end 1995 that one can let people bet on scientific predictions by email, à la W.K.B. Hofstee. %}
Hanson, Robin (2002) Piece entitled "Wanna Bet?" in *Nature* 420, November 2002, pp. 354–355.

{% **revealed preference** %}
Hansson, Bengt (1968) "Choice Structure and Preference Relations," *Synthese* 18, 443–458.

{% Considers combinations P*Q of prospects P and Q, interpreted as receiving both of them where they are played independently. Assumes that if P~Q, then P*C ~ Q*C. Under EU, it is implied by constant absolute risk aversion but need not hold in general, similarly as with Samuelson's colleague-paradox. The author doesn't seem to be aware of this. He points out that P*Q can be nonequivalent to P´*Q even though P ~P´ if P´ is more risky than P, under EU. Taking his operation too seriously, he does not conclude from it that his operation is no good, but instead that EU must be no good and that we should reckon with riskiness beyond EU (p. 181 middle sentence). §2 discusses reference dependence, but lowest para of p. 183 confuses money and utility. P. 184 compares level of U(m,x) with level of U(m´,x´), where m is reference point and x is money, in direct manners. However, the common thinking is that preferences can only compare alternatives under one same reference point. Hence, U(m,x) is a ratio scale that is completely independent of U(m´,x´), and comparisons of their levels is not meaningful. We can compare their degree of concavity yes, but their level no. %}

Hansson, Bengt (1975) "The Appropriateness of the Expected Utility Model," *Erkenntnis* 9, 175–193.

- {% **linear utility for small stakes**: gives a nice argument.
  Nice example, showing that, if a person is indifferent between (.5: W, .5: W+21) and W+7 for sure, for all W, then the person prefers a sure gain of 7 to the gamble (.4: M, .6: 0) for all M! I got this reference from footnote 2 of Rabin (2000, *Econometrica*), who presents similar ideas. Rabin got the reference from Prelec (personal communication). %}

Hansson, Bengt (1988) "Risk Aversion as a Problem of Conjoint Measurement." *In* Peter Gärdenfors & Nils-Eric Sahlin (eds.) *Decision, Probability, and Utility; Selected Readings*, 136–158, Cambridge University Press, Cambridge.

{% **PT, applications** %}

Hansson, Helena & Carl Johan Lagerkvist (2014) "Decision Making for Animal Health and Welfare: Integrating Risk-Benefit Analysis with Prospect Theory," *Risk Analysis* 34, 1149–1159.

{% **probability elicitation**: applied to experimental economics.

They measure matching probabilities of events using BDM (Becker-DeGroot-Marschak), but in a particular way. To "control for belief," and to focus entirely on the (un)clarity of the mechanism, they take matching probabilities of events with known probability, such as the event of winning from a bag A with 10 chips, 2 of which are winning. Let us focus on the latter event. In the "declarative" design (direct matching in fact) they present subjects with an alternative bag B, with an unknown composition of winning chips, which has 1, …, or 9 winning chips, each with probability 1/9 of being the true bag. So, this B is an Ellsberg-type bag with an unknown number of winning chips, generated using second-order probabilities (**second-order probabilities to model ambiguity**). The subjects perceive ambiguity (or second-order probability) at this stage, but will like the unknown bag more because the known one has only two winning chips.

Then the subjects have to submit a number X. If the number of winning chips ≥ X, so, the unknown bag B is more favorable, then the draw will be from B, and otherwise from A. Given that they depict the unknown bag with a question mark, some subjects may have misunderstood and may have erroneously thought that they are supposed to guess the right number of winning chips. Another misunderstanding may be that subjects first make up their mind that they like bag B more, and then think that they always get their preferred bag B if they submit 0, thus encouraging them to submit 0. The design encourages the subjects not to perceive the possible decision situations in isolation, as desirable for BDM (Becker-DeGroot-Marschak), but as an integrated meta-lottery.

Once the subjects understand the decision task properly, they understand that it is a trivial decision task (a test of stochastic dominance). In a lecture in Atlanta Oct. 2010, the first author explained that in the experiment subjects were encouraged to follow their "gut-feeling," so as to make it seem less trivial probably.

The design reminds me some of that of Bohnet et al. (2008 American Economic Review) which, when properly understood, was only the elicitation of a PE probability, but the BDM mechanism was implemented, not through an ambiguous bag, but through the percentage of subjects in an experiment that deceived in a trust game, arousing trust- and indignification emotions with subjects who do not see through the BDM mechanism.

They use a "declarative" and "clock" implementation of BDM, and find that clock is more accurate.

The authors are enthusiastic, expressing it at the end of their abstract: "Our findings hold practical value to anyone interested in eliciting beliefs from representative populations, a goal of increasing importance when conducting large-scale surveys or field experiments." %}

Hao, Li & Daniel Houser (2012) "Belief Elicitation in the Presence of Naïve Respondents: An Experimental Study," *Journal of Risk and Uncertainty* 44, 149–160.

{% Distinguish between strategic uncertainty (market entry game) and what they call state uncertainty, and what might also be called nature uncertainty. Migrants are more likely to enter competition, but have no different risk or ambiguity attitude. It is nice that for using price lists they cite Fox & Tversky (1995) rather than Holt & Laury (2002) (p. 132). They do cite the latter elsewhere. For risk aversion, they measure one CE of a fifty-fifty lottery, and for ambiguity of an ambiguous-two-color urn but, as far as I could see, no control for suspicion (**suspicion under ambiguity**). %}

Hao, Li, Daniel Houser, Lei Mao, & Marie Claire Villeval (2016) "Migrations, Risks, and Uncertainty: A Field Experiment in China," *Journal of Economic Behavior and Organization* 131, 126–140.

{% Takes a general functional representing uncertainty attitude. Uses local derivatives to define probabilities (state-contingent prices) and, thus, SEU/SEV. Decomposes local uncertainty premium as sum of risk premium and ambiguity premium. Is in spirit of Machina (1982). In version that I saw, EU was assumed for risk, so that al of nonEU was taken as ambiguity, in main text. The end suggested generalizations to nonEU risk attitude.

Typical of the spirit of these days (2021) is that the author starts from the Anscombe-Aumann framework, as if the only thing conceivable, and then almost apologetically moves to a Savagean framework. %}

Hara, Chiaki (2021) "Comparative Ambiguity Aversion for Smooth Utility Functions," working paper.

{%Introduces an index of ambiguity aversion and ambiguity premiums. It is a local index near constant acts, involving generalized second derivatives that also work for maxmin expected utility (maxmin EU) and rank-dependent utility. It is second order, which is opposed to first-order. There is a central role for the Peano form of the remainer, being the functional after subtracting the best second-order approximation. The paper throughout assumes the Anscombe-Aumann framework and thus, for instance, assumes expected utility for risk. The index captures the first-order impact of the size of prizes on matching probabilities. As far as I can understand, this means that for biseparable utility with linear utility the index is 0?? %}

Hara, Chiaki (2023) "Measure of Ambiguity Aversion," working paper.

{% Under EU with homogeneous beliefs but heterogeneous utility ("risk aversion"), if all consumers have convex absolute risk aversion then so has representative agent. %}

Hara, Chiaki, James Huang, & Christoph Kuzmics (2007) "Representative Consumer's Risk Aversion and Efficient Risk-Sharing Rules," *Journal of Economic Theory* 137, 652–672.

{% Use smooth ambiguity model to get optimal portfolio, implied ambiguity of portfolio is smallest ambiguity aversion coefficient making the portfolio optimal. Ambiguity perception = part of variability of asset returns that can be attributed to the ambiguity. Relate it to the Sharpe ratio. Use U.S. stock market data to assess how ambiguity averse the representative investor is. %}

Hara, Chiaki & Toshiki (2022) "Honda Implied Ambiguity: Mean-Variance Inefficiency and Pricing Errors," *Management Science* 68, 4246–4260. https://doi.org/10.1287/mnsc.2021.4097

{% %}

Hara, Kazuhiro (2016) "Characterization of Stationary Preferences in a Continuous Time Framework," *Journal of Mathematical Economics* 63, 34–43.

{% Analyze all logical impications of subsets of the vNM EU axioms. They take as nice starting point a characterization of all preference relations that satisfy vNM independence and nothing else. They assume in this that the outcome set is a separable metric space. Then the characterization is that there is a collection of sets of continuous utility functions such that x R y (lottery x is preferred to lottery y) if and only if for every set in the collection there is one utility function whose EU accommodates the preference. So, within each set there is a "there exists" quantification, but across sets there is a "for all" quantification. The first can deliver all required richness, the second all required restrictions. This paper is the linear analog of Nishimura & Ok (2016). With linearity added the results are nicer. There is no clear uniqueness result for the sets to be chosen. As with N&O, because there is much richness in the sets to be chosen, one can always choose the utility functions continuous. The authors call their representation coalitional minmax. %}

Hara, Kazuhiro, Efe A. Ok, Gil Riella (2019) "Coalitional Expected Multi-Utility Theory," *Econometrica* 87, 933–980.

{% **PT falsified**: this paper falsifies any other classical economic theory as well, with its extensive risk seeking, especially for gains.

Choices between one nonzero outcome prospects, and the sure outcome that was always the expectation of the prospect. Did it for children, young adults, and adults, ages 5-8, 9-13, 14-20, and 21-64. Did it for probabilities 0.02, 0.10, 0.80, and 0.98. Find in everything the almost exact opposite of the fourfold pattern predicted by prospect theory: People seem to underweight small probabilities and overweight high probabilities, both for gains and for losses, yielding the exact opposite of the fourfold pattern. As people are older they are closer to expected value maximization (**relation age-risk attitude**). People are closer to expected value maximization for gains than for losses. People are more risk averse for gains than for losses.

Real incentives: **random incentive system** where one choice is played for real. Implementation of losses: through **prior endowment mechanism** to ensure no real loss.

P. 59: people who violated monotonicity tended to be more risk averse.

P. 60 bottom: Strange is that the majority choices, 56%, were risk seeking, and were so mostly for gains. Maybe the design generated a strong joy of gambling? This is evidence against prospect theory, but against any other current theory as well.

linear utility for small stakes: they make this assumption for pragmatic reasons.

The authors conjecture (p. 72 penultimate paragraph) that their deviating findings may be due to their stimuli of risky versus riskless choices, claiming that this is different to almost all prior work. This is not so, Tversky & Kahneman (1992) and many others also considered such choices (not doing WTP but choice). %}

Harbaugh, William T., Kate Krause, & Lise Vesterlund (2002) "Risk Attitudes of Children and Adults: Choices over Small and Large Probability Gains and Losses," *Experimental Economics* 5, 53–84.
https://doi.org/10.1023/A:1016316725855

{% **equate risk aversion with concave utility under nonEU**: p. 597: Unfortunately, they use the term risk neutral for linear utility, also under PT, even though with linear utility there then can still be large deviations from risk neutrality because of probability weighting. They mention that only few studies have tested the fourfold pattern using choices. The following search keywords in this bibliography can give related references:

concave utility for gains, convex utility for losses;

risk averse for gains, risk seeking for losses

PT falsified

risk seeking for small-probability gains

P. 598 last para explains why their 2002 study is so unique.

losses from prior endowment mechanism: Subjects received $22 in beginning, well, it was put on a table in front of them and apparently not yet put in their pocket. They might have to pay back from that.

random incentive system: Each subject was paid twice, so, there is income effect. When they played their first choice they did not yet know a second would come (p. 601 ℓ. 6), so, this can be taken as without the income effect (but then with a minor deception) (**deception when implementing real incentives**). Second time they were, again, endowed with $22.

Although pricing tasks confirm 4-fold pattern, I find it hard to interpret the stimuli and results. Subjects had to pay their WTP to get a gain prospect, so that losses could be involved and it was not really a gain prospect. The authors point this out in footnote 8 (p. 599) and discuss it more in §5, but nevertheless analyze what they call gain prospects as if gain prospects. Further complication is that, with prior endowment put on table before them, it is not clear to me if subjects integrated or not, took it as house money or not, and so on.

P. 602 writes that loss aversion can explain that for losses the WTP in absolute value was usually found to be larger than for gains. If subjects took the prospects as the authors analyze and describe them (gain-prospects and loss-prospects) then there would be no mixed prospects and loss aversion had no role to play. (**loss aversion: erroneously thinking it is reflection**)

Pp. 602-603 finds relations at individual level between gain- and loss-attitudes, different than Cohen, Jaffray, & Said (1987) who found no relation.

In the choice task where subjects chose between prospects and their expected values, but were endowed with $22, not given but put on the table before them. They found mostly nonsignificant deviation from EV, and the deviations all suggested to go opposite to the 4-fold pattern. I find it hard to assess the effect of the prior endowment mechanism though. Much of this evidence does not only go against PT, but against any theory we know.

In some places the authors put forward the dual self theories when discussing their results. %}

Harbaugh, William T., Kate Krause, & Lise Vesterlund (2010) "The Fourfold Pattern of Risk Attitudes in Choice and Pricing Tasks," *Economic Journal* 120, 595–611.

{% Soft discussion of HP-testing %}

Harcum, E. Rae (1990) "Distinction between Tests of Data or Theory: Null versus Disconfirming Results," *American Journal of Psychology* 103, 359–366.

{% **foundations of statistics**; many nice references %}

Harcum, E. Rae (1990) "Deficiency of Education Concerning the Methodological Issues in Accepting Null Hypotheses," *Contemporary Educational Psychology* 5, 199–211.

{% **PT, applications**, loss aversion: seem to find asymmetric price elasticities. %}
Hardie, Bruce G., Eric J. Johnson, & Peter S. Fader (1993) "Modeling Loss Aversion and Reference Dependence Effects on Brand Choice," *Marketing Science* 12, 378–394.

{% %}
Hardin, Curtis & Michael H. Birnbaum (1990) "Malleability of "Ratio" Judgments of Occupational Prestige," *American Journal of Psychology* 103, 1–20.

{% Use hypothetical choice, defended on basis of large outcomes and losses, something that I agree with.

Find that fixed-cost for delay, both for gains and losses, and independent of outcome-magnitude, explains much, and for instance explains a bias, confirmed empirically, to *prefer* immediate losses to future losses, whereas classical theories predict the opposite. %}
Hardisty, David J., Kirstin C. Appelt, & Elke U. Weber (2013) "Good or Bad, We Want It now: Fixed-cost Present Bias for Gains and Losses Explains Magnitude Asymmetries in Intertemporal Choice," *Journal of Behavioral Decision Making* 26, 348–361.

{% The authors show that subjects prefer an uncertain future payment less than an immediate uncertain or a future certain payment, thus confirming risk aversion and impatience.

For losses, people disprefer risky losses, which might contradict risk seeking as predicted by prospect theory were it not that the delay can have led to the dislike. I did not study the paper enough to see how the authors correct for this. For example, I did not understand in the abstract: "While holding the expected value of payouts constant, participants preferred immediate gains and losses if the future was uncertain, and preferred future gains and losses if the present was uncertain." %}
Hardisty, David J. & Jeffrey Pfeffer (2017) "Intertemporal Uncertainty Avoidance: When the Future Is Uncertain, People Prefer the Present, and When the Present Is Uncertain, People Prefer the Future," *Management Science* 63, 519–527.
https://doi.org/10.1287/mnsc.2015.2349

{% Study intertemporal choice, for money, health, and environment, with delays of 0, 1, or 10 years. Use hypothetical choice which I think is best for such intertemporal studies.

For money they assume linear utility, and for health and environment they take number of days (or weeks) of exposure to some gain or loss as unit of which utility is taken linearly just as money when calculating discounting. They find that discounting is similar for money, health, and environment (maybe for gain health some more discounting and for loss health some less), so that this aspect of outcomes does not matter much. But sign of outcome ("valence") matters much, with gains discounted way stronger than losses.

P. 330 column 1 makes the strange claim that the dominant "rational-economic" assumption is that risk attitude should be independent of the outcome. However, I think that no economist will think that utility should be the same for money, wine, life years, and the exponential of money. The authors add a clause "after adjusting for differences in the marginal value of outcomes in different domains" but it is unclear what that marginal value is other than utility, and adjusting for utility gives expected value, so risk neutrality if I understand right. Maybe they think of probability weighting with this claimed to be the same across domains?

To fit data, they use hyperbolic discounting 1/(1+kt) with k the discount parameter. They find strong discounting for gains, with $250 today equivalent to $337.50 next year, and weak for losses, with losing $250 today equivalent to losing $265 next year (pp. 332). Correlations between gains and losses were weak. %}

Hardisty, David J. & Elke U. Weber (2009) "Discounting Future Green: Money versus the Environment," *Journal of Experimental Psychology* 138, 329–340.

{% **bisection > matching**: They measure discounting using matching, choice list (they call it fixed-sequence choice titration), and bisection (they call it dynamic "staircase"). Compare and discuss them. Matching better fits hyperbolic discounting. Choice list better predict real choices. The authors are negative on bisection.

End of §1.1, p. 3: The authors study discounting for periods taking up to 50 years. They use hypothetical choice. They properly motivate this, and I agree:

"Studying the discounting of complex outcome sets on long timescales can be logistically difficult in the lab, if the goal is to make choices consequential: tracking down past participants in order to send them their "future" payoffs is hard enough one year after a study, but doing so in 50 years may well be impossible. Truly consequential designs are even trickier when studying losses, since they require researchers to demand long-since endowed money from participants who may not even remember having participated in the study. Fortunately, hypothetical delay-discounting questions presented in a laboratory setting do appear to correlate with real-world measures of impulsivity such as smoking, overeating, and debt repayment (Chabris et al., 2008; Meier & Sprenger, 2012; Reimers et al., 2009), suggesting that even hypothetical outcomes are worth studying."

As do Ariely, Loewenstein, & Prelec (2001), they use the nice term "coherent arbitrariness" for coherent choices that are coherent biases rather than coherent genuine preference. It is what Loomes, Starmer, & Sugden (2003 EJ) call the shaping hypothesis. Methods that can elicit more inconsistencies/noise can be good. The authors use the nice term "ability to detect inattentive participants" for it.

coherentism: although the authors do not really get into that, the term coherent arbitrariness nicely indicates disagreement with coherentism. %}

Hardisty, David J., Katherine F. Thompson, David H. Krantz, & Elke U. Weber (2013) "How to Measure Time Preferences: An Experimental Comparison of Three Methods," *Judgment and Decision Making* 8, 236–249.

{% All comments below refer to 2nd edn.

Watch out that these authors use the term convex to designate only midpoint convexity. I will use the term in the usual way below.

Section 2.20, the definition of average, reminds me of Blackwell's theorem, but I will not try to check out the link now.

Ch. 3: P. 65 Eq. 3.1.1 writes the quawi-linear functional (CE of EU under risk) but does not do much with it. P. 158, Theorem 215, will characterize it. The Ch. considers probability-contingent prospects (q_1:x_1,…,q_n:x_n) with all q_j's positive and summing to 1 and the x_j's real-valued. They take the prospects as abstract mathematical objects and never refer to probabilities or anything. I could not find out from the text if they assume n variable or fixed. Most theorems and proofs seem to hold for both, as long as n is fixed at at least 2. What they call means are what DUR calls certainty equivalents under expected utility with possibly nonlinear utility U. Theorem 82 shows that the CE (certainty equivalent) is uniquely determined if U is continuous and strictly monotonic. Theorem 83 shows that CEs (certainty equivalents) determine U uniquely up to level and unit and sign of unit. P. 67 bottom states that we can always take U strictly increasing. (For just CEs it does not matter if we take U or –U).

Theorem 84 shows that CE is homogenous, which is equivalent to constant relative risk aversion (CRRA), if and only if U is of the log-power family! This precedes Pfanzagl (1959) and others.

Theorem 85, and also Theorem 92, show the Pratt-Arrow-Yaari result that, undet EU, U has lower certainty equivalents than EU under V iff U is a concave transformation of V. Theorem 243 extends this to nonsimple distributions.

Section 3.5-3.8 give results on convex functions that are useful in decision theory (midpoint convexity and the like).

Section 3.15 compares sums instead of averages, and Section 3.17 compares sets (I am not sure but maybe this book lets set refer to n-tuples, i.e., they are sequences instead of sets).

Section 3.16 has all kinds of results on concavity of higher derivatives, which might be related to prudence.

Observation 88 in §3.7 (p. 73 in 2nd edn.) gives a beautiful result on convexity (full-force, and not just midpoint convexity) for continuous functions: they are convex as soon as for each pair of arguments there exists an argument in between them for which the function is below the chord. Beautiful proof:

"Suppose that PQ is a chord, and R a point on the chord below the curve. Then there is a last point S on PR and a first point T on RQ in which the curve meets the chord: S may be P and T may be Q. The chord ST lies entirely below the curve, contradicting the hypothesis."
http://personal.eur.nl/Wakker/refs//pdf/hardy_et_al((1934)_obs.88.pdf
An illustration and further explanation is here:
http://personal.eur.nl/Wakker/refs//pdf/hardy_et_al((1934)_obs.88.pdf.

Observation 111, §3.18 (p. 91) shows that on any open interval, midpoint convexity plus boundedness on some nondegenerate subinterval imply continuity and full convexity on the whole open interval. They refer to Jessen (1931) and M. Riesz (1927) for this result.

P. 158, Theorem 215 gives the von Neumann-Morgenstern EU axiomatization if certainty equivalents exist!! The domain is the set of all simple prospects over ℝ, as explained in §6.19. The necessary and sufficient conditions for EU with a

continuous strictly increasing utility U are:

[1] CE(x) = x;

[2] Strict stochastic dominance;

[3] CE(F) = CE(F*) $\Rightarrow$ CE(tF+(1-t)G) = CE(tF*+(1-t)G) for all 0 < t < 1.

Condition [3], called quasi-linearity on p. 161, is nothing other than the celebrated independence condition. Footnote a then cites three references, by Nagumo, Kolmogoroff, and … de Finetti(1931) “Sul Concetto di Media”! They then say that they follow de Finetti’s proof. Note how continuity of CE, and the vNM Archimedean axiom, all follow from the conditions, mostly CE existence. P. 161 last two lines state uniqueness up to level and unit.

Theorem 216: velocity averaged by time is less than velocity averaged by distance.

Theorem 236 (p. 168): defines comonotonicity, called similarly ordered there.

Theorem 249 and 250 shows that second-order stochastic dominance is necessary and sufficient for preferability under every concave utility function. This can be seen as follows: Take a = 0, b = 1, and let f be the generalized inverse of the distribution function F of a prospect that I will denote F, and let g be the generalized inverse of the distribution function G of a prospect that I will denote G. Then the integral from 0 to 1 of f is EV(F), and the integral from 0 to 1 of psi(f) is the EU of F under utility function psi. The inequality of integrals written in the beginning means that F is preferred to G under every convex utility. The necessary and sufficient condition is that F and G have the same expected value and every above truncation of the two at level y has higher expectation under F than under G. A discrete analog is in Theorem 108. That theorem compares n-fold sums. We can as well take averages and then have equal-probability lotteries, which captures all rational-probability lotteries. Then the majorization amounts to 2^{nd} stochastic dominance, I guess, but did not try to check more. %}

Hardy, Godfrey H., John E. Littlewood, & George Pòlya (1934) “*Inequalities.*” Cambridge University Press, Cambridge. (2^{nd} edn. 1952, Reprinted 1978.)

{% Shows how errors in choice can affect choice paradoxes. %}

Harin, Alexander (2012) “Data Dispersion in Economics (I)—Possibility of Restrictions,” *Review of Economics & Finance* 2, 59–70.

{% %}

Harin, Alexander (2012) “Data Dispersion in Economics (II)—Inevitability and Consequences of Restrictions,” *Review of Economics & Finance* 2, 24–36.

{% **PT falsified;** They ask subjects introspective question about values of positive and small negative amounts. For small amounts they find stronger evaluations of positive amounts, deviating from loss aversion. For large amounts they find loss aversion. Experiment 1: How nice/unnice is it to gain/lose money. Experiment 2 repeats it for money gained/lost against a bookmaker. A control question could have been how happy subjects feel if they neither gain nor lose, so as to determine what the value of the reference point is and if it is really the neutrality point of the scale the authors use.

Another aside is that loss aversion may be due to the overweighting of the loss experience/anticipation and not to the experience itself.

risk seeking for symmetric fifty-fifty gambles: experiment 3 asks for −x such that (−x, p; y) ~ (−a, p; b) (not incentivized).

Problem with small amounts is that distorting factors such as joy of playing and framing decide. %}

Harinck, Fieke, Eric van Dijk, Ilja van Beest, & Paul Mersmann (2007) “When Gains Loom Larger than Losses,” *Psychological Science* 18, 1099–1105.

{% Hartmann (2020) showed that Savage’s P3 is redundant. This paper shows that, other than that, the axioms are independent and none other is implied by the others. %}

Harju, Mikko, Juuso Liesiö, & Kai Virtanen (2024) “Independent Postulates for Subjective Expected Utility,” *Theory and Decision* 96, 597–606. https://doi.org/10.1007/s11238-023-09959-3

{% **Probability weighting linear in interior**: seems to find it.

Not easy to see if more risk aversion for gains than risk seeking for losses, e.g. because of different prizes. %}

Harless, David W. (1992) “Predictions about Indifference Curves inside the Unit Triangle: A Test of Variants of Expected Utility Theory,” *Journal of Economic Behavior and Organization* 18, 391–414.

{% %}

Harless, David W. (1992) “Actions versus Prospects: The Effect of Problem Representation on Regret,” *American Economic Review* 82, 634–649.

{% **error theory for risky choice**;

results are sensitive to the specifications of the respective theories that were chosen, for instance to whether convexity and concavity are taken strict or weak. For RDU/PT the most relevant specification, i.e., of **inverse S** weighting functions was not investigated.

losses from prior endowment mechanism: real payments with losses are implemented by subtraction from prior endowment. Further comments on this are on p. 1281.

EU is quite good for same supports, but is very bad when different supports (then dominated by either nonEU or EV)

The study deliberately avoids mixed gambles (Camerer, March 2002, personal communication) and, therefore, does not consider loss aversion. Means that one aspect at which prospect theory excels is excluded from the game!

P. 1263 claims that average inconsistency rate is 15–25%, and gives references to it (**inconsistency in repeated risky choice**)

P. 1276 **real incentives/hypothetical choice** [italics from original]: Paying subjects appears to lower the error rate, increasing *rejection* of EU and many other theories rather than inducing conformity to them. P. 1281: no other differences between real and hypothetical payments.

P. 1268 (also 1281, 1282): EU violations in the interior of the triangle are less, but do not disappear.

P. 1281: No reflection for small gains and losses in the interior of the triangle; may be due to the real incentives where losses were subtracted from prior endowment, which for several/many? subjects means that they integrated payments and took these losses as gains. (Suggested in Footnote 24 on that page.)

P. 1281: curvature of indifference curves in depends on stakes

P. 1285: nonlinear weighing of small probabilities is important (gives citation of Morgenstern)

P. 1286: the authors give a piece of their mind to people who cling to EU. %}

Harless, David W. & Colin F. Camerer (1994) “The Predictive Utility of Generalized Expected Utility Theories,” *Econometrica* 62, 1251–1289.

{% %}

Harless, David W. & Colin F. Camerer (1995) “An Error Rate Analysis of Experimental Data Testing Nash Refinements,” *European Economic Review* 39, 649–660.

{% Got this reference from Ido Erev on September 5 1990 %}

Harley, Calvin B. (1981) “Learning the Evolutionarily Stable Strategy,” *Journal of Theoretical Biology* 89, 611–633.

{% Seems to argue for forward induction in game theory. %}

Harper, William L. (1986) “Mixed Strategies and Ratifiability in Causal Decision Theory,” *Erkenntnis* 24, 25–26.

{% Seems to argue for forward induction in game theory. %}

Harper, William L. (1991) “Ratifiability and Refinements in Two-Person Noncooperative Games.” *In* Michael Bacharach & Susan Hurley (eds.) *Foundations of Decision Theory*, 263–293, Basil-Blackwell, Oxford.

{% **foundations of probability**; **foundations of statistics**; **Dutch book**
Discuss matching probabilities and Dutch books, and their role in axiomatizations. But it brings in causal decision theory, and it is the philosophical style where no model is pinned down, making it more ambiguous but also more open to new ideas. %}

Harper, William, Sheldon J. Chow, & Gemma Murray (2012) “Bayesian Chance,” *Synthese* 186, 447–474.

{% **foundations of statistics** and **foundations of probability** %}

Harper, William L. & Clifford A. Hooker (1976, eds.) "*Foundations of Probability Theory, Statistical Inference, and Statistical Theories of Science*;" Vol. I, II, III. Reidel, Dordrecht.

{% Seems to have terms paramorph (model gives good empirical predictions without reflecting underlying process) and homeomorph (model also matches underlying process). %}
Harré, Rom (1970) "*The Principles of Scientific Thinking.*" MacMillan, London.

{% **foundations of statistics**: they seem to plea for using p-values, in their prominent journal. %}
Harrington, David, Ralph B. D'Agostino, Sr., Constantine Gatsonis, Joseph W. Hogan, David J. Hunter, Sharon-Lise T. Normand, Jeffrey M. Drazen, & Mary Beth Hamel (2019) "New Guidelines for Statistical Reporting in the Journal," *New England Journal of Medicine* 381, 285–286. https://doi.org/10.1056/NEJMe1906559

{% Investigates **time preference** for losses. For money discounting is positive (preference for deferring losses), but for other dreadful experiences it can be anything, and often is negative (prefer to have dreadful outcome soon). No relation between discounting for gains and for losses. They considered hypothetical choices (although there were questions about real experiences in Study 5). %}
Harris, Christine R. (2012) "Feelings of Dread and Intertemporal Choice," *Journal of Behavioral Decision Making* 25, 13–28.

{% Adapt the well-known Exponential Euler Equation for equilibrium path in intertemporal consumption to nonconstant, quasi-hyperbolic, discounting. A convex combination of β and δ replaces the classical discount factor. %}
Harris, Christopher & David Laibson (2001) "Dynamic Choices of Hyperbolic Consumers," *Econometrica* 69, 935–957.

{% A sort of continuous extension of quasi-hyperbolic, a variation of Jamison & Jamison's (2011) split rate quasi-hyperbolic discounting (not cited in this paper). Time is taken continuously. Then first during some period, "extended present" (my term) there is constant discounting (say the period during which present self controls), but after it suddenly drops by a factor, but other than that keeps the same exponential. There are some drawbacks to this model (see my comments there). The present paper varies by taking the extended present to be random. A deterministic model would result if we'd take expected discounting as resulting from the above process and take that as deterministic, but no standard mathematical tools can be provided yet (p. 213 last para). I do not see whether or not it avoids the problem of Jamison & Jamison (2011). %}

Harris, Christopher & David Laibson (2013) "Dynamic Choices of Hyperbolic Consumers," *Quarterly Journal of Economics* 128, 205–248.

{% Seems to argue that life duration is incommensurable with quality of life, and never one should be traded for the other. %}

Harris, John (1987) "QALYfying the Value of Life," *Journal of Medical Ethics* 13, 117–123.

{% **Z&Z**; elderly's choices among health plans and supplemental insurances from Minneapolis '88 St. Paul Medicare health plan data. Statistical techniques to also estimate preferences on unobservable attributes. Authors use term IIA not in sense of social choice (Arrow '51), and neither in sense of individual-choice-revealed-preference (Nash '51, Arrow '59), but in probabilistic-choice sense as the central axiom of Luce (1959) where choice proportions are unaltered if third alternatives are dropped. %}

Harris, Katherine M. & Michael P. Keane (1999) "A Model of Health Plan Choice: Inferring Preferences and Perceptions from a Combination of Revealed Preference and Attitudinal Data," *Journal of Econometrics* 89, 131–157.

{% %}

Harris, Lawrence (1991) "Stock Price Clustering and Discreteness," *Review of Finance* 16, 1533–1597.

{% %}
Harris, Matthew C. & Jennifer L. Kohn (2018) "Reference Health and the Demand for Medical Care," *Economic Journal* 128, 2812–2842.

{% Points out that adaptive stimuli can distort incentive compatibility. Apparently BDM (Becker-DeGroot-Marschak) applied their method in an adaptive context and were unaware of the distortion mentioned. Then this paper measures certainty equivalents and risk attitude under EU in a nonadaptive way. %}
Harrison, Glenn W. (1986) "An Experimental Test for Risk Aversion," *Economics Letters* 21, 7–11.

{% First obtains independent measurement of risk attitude, and then considers bargaining behavior of subjects. Discusses the issue of strategically reporting untrue risk attitude so as to improve the outcome of a bargaining game. %}
Harrison, Glenn W. (1986) "Risk Aversion and Preference Distortion in Deterministic Bargaining Experiments," *Economics Letters* 22, 191–196.

{% Raises the "flat-payoff" criticism in the context of experiments by Smith, Walker, & Cox. Argues that Nash equilibrium payoff functions did not provide sufficient payoff saliency/dominance so as to observe deviations from equilibrium, or to distinguish risk-averse from risk-neutral bidders. It is a general difficulty with optimization problems that the payoff functions are flat near the optimum, so that small deviations from the optimum are punished little. Reassuring is that subjects often think long when choosing between options that are almost equivalent, where the value difference is only a few cents. Also reassuring can be, under single choice, that these few cents are only for a few seconds of work. The latter reassurance does not apply under RIS, when the few cents difference concern all efforts throughout the experiment. Harrison (2010, footnote 4, and in his earlier works) cites preceding works, including von Winterfeldt & Edwards (1986, Chapter 11), who raised the flat payoff issue before.

The data do suggest risk aversion.

Seems to criticize BDM (Becker-DeGroot-Marschak). %}
Harrison, Glenn W. (1989) "Theory and Misbehavior of First-Price Auctions," *American Economic Review* 79, 749–762.

{% **Christiane, Veronika & I**: Discusses the issue of changing currency without changing values on p. 233. Mentions the nice term “numeraire illusion.”

real incentives/hypothetical choice: For moderate amounts ($5, $1, $0) 3 out of 20 subjects do Allais with real payment, 7 out of 20 with hypothetical. This difference is not significant.

Criticizes real-incentives experiments by Kahneman & Tversky in sense that payments are too low, and wrong decision in each choice pair constitutes an expected loss of only some cents (the point raised before by Harrison 1989; for further discussion see my comments there).

Bayes rule-performance gets better with real payment and learning. %}

Harrison, Glenn W. (1994) “Expected Utility Theory and the Experimentalists,” *Empirical Economics* 19, 223–253.

{% **real incentives/hypothetical choice**: The topic of this paper. It reanalyzes Battalio, Kagel, & Jiranyakul (1990) and Kagel, MacDonald & Battalio (1990) at individual level, finding that real incentives gives more risk aversion for losses but less (rather than the commonly believed more) for gains. This is also found in the present paper of Harrison, analyzing data of Harrison & Rutström (2005) on hypothetical choice that were collected but not published.

parametric fitting depends on families chosen: P. 61 explains that findings of parametric fittings with error theory and maximum likelihood depend much on the parametric families and error theories chosen.

P. 62 nicely explains that, if unrealistic info is given to subjects in an experiment, then they will replace it with their own ideas about what is plausible.

P. 64:

“In any event, the mere fact that hypothetical and real valuations differ so much tells us that at least one of them is wrong!” %}

Harrison, Glenn W. (2006) “Hypothetical Bias over Uncertain Outcomes.” *In* John A. List (ed.) *Using Experimental Methods in Environmental and Resource Economics*, 41–69, Elgar, Northampton, MA.

{% %}

Harrison, Glenn W. (2007) "Making Choice Studies Incentive Compatible." *In* Barbara Kanninen (ed.) *Valuing Environmental Amenities Using Stated Choice Studies: A Common Sense Guide to Theory and Practice*, Springer, Dordrecht.

{% %}

Harrison, Glenn W. (2010) "The Behavioral Counter-Revolution," *Journal of Economic Behavior and Organization* 73, 49–57.

{% I comment on the version of May 11, 2011.

This paper criticizes the statistical tests in the main text of

Abdellaoui, Baillon, Placido, & Wakker (2011) "The Rich Domain of Uncertainty: Source Functions and Their Experimental Implementation," *American Economic Review* 101, 695–723.

As one of the authors criticized, my role is someone involved rather than outsider commenting.

I mostly use t-tests or Wilcoxon to test (in)equalities. Leaving aside for now my Bayesian sympathies, I like those tests in that they can be used between-subjects, as I usually do, without making any assumption about probabilistic error distributions within-subjects-between-stimuli. In particular, they do not assume those to be statistically independent. They only assume between-subject statistical independence, which I find more convincing.

Many econometric analyses do add assumptions about probabilistic error distributions within-subjects-between-stimuli, and often that they are independent. There are pros and cons, with different preferences in different fields. However, Harrison only knows the latter econometric approach, says that one must specify within-subject errors, does not know that one can do without in t-tests and Wilcoxon, and claims that our tests are wrong for not doing what he knows. My cv on my homepage shows that I have a degree in mathematics with statistics as one specialization, and that until 1995 most of my teaching was in statistics, to mathematical, psychological, and medical students. I should know about t-tests! Harrison is effectively claiming that vitually every t-test used in the literature is wrong. He erroneously thinks that variables that, in his terminology, are estimates, cannot be submitted to t-tests. In regressions as commonly used in econometrics, unlike in t-tests, it is often required that the independent variables have no errors. (See Gillard (2010) for a survey.) Maybe this is confusing Harrison. An alternative source of confusion may be that econometric analyses often impose error assumptions (often normality) on basic measurements, and then for derived concepts one has to investigate how the assumed errors propagate, and one cannot just impose normal distributions on derived concepts. But we do not do anything of this kind.

Details: Abstract and many places; The criticism that we do not worry about sampling errors is because Harrison does not understand that we can avoid assumptions about within-subject errors.

P. 1 footnote 1: We do use calculations within subjects, getting indexes and parameters of utility and so on, sometimes based on minimizing squared distances. These are mathematical calculations and recodings of data. We do not assume any probabilistic theory and, in return, not any statistical claim is associated with these within-subject calculations. The results of such calculations can be submitted to (between-subject) t-tests or Wilcoxon tests. Not any speculation on within-subject errors needs to be made for that. (Errors there will contribute to variance of the t-statistic, but this variance is handled properly.) Harrison confuses recodings of data with estimations-endowed-with-statistical-claims.

A didactical example to clarify the difference between calculation/recoding and statistical estimation: Imagine that one wants to investigate whether the relative density (weight per volume unit) of men is bigger than that of women. One measures the body weight and also body volume of every person in a representative sample. And then, one does mathematical calculation and recoding and not statistical estimation by calculating the ratio of weight per volume for every person. Then one uses a t-test to compare those ratios. Glenn's view is that this is wrong, that our ratio taking was a statistical estimation, that we have not specified the errors involved in this process, and so on. Will he want to forbid to ever use a t-test to test relative density? Maybe he adds a reference to the statistical principle that estimations should be based on more than two observations (our weight-per-volume was calculated using only two observations, weight and volume), and that doing it by only two observations is too unreliable? Would he then want to forbid worldwide that someone ever calculates relative densities of any human being? Anyway, he is just confusing general calculations/recodings with statistical estimations.

P. 4 2nd para: The random incentive system assumes isolation, which is one implication of independence (and a dynamic principle). Independence (+ dynamic) is sufficient, but not necessary, for validity of the random incentive system. Harrison misunderstands this point. Bardsley et al. (2010) explain the point well.

P. 4 footnote 6: This specification, rather than the main text, is required. Comparisons across different sources are not to be done directly through utility values (which are from different scales) but through certainty equivalents.

P. 6 & Table 1 do within-subject statistical tests for every subject. Unlike with us, errors within-subject-between-stimuli are assumed independent here. Our design was not made for this purpose, and the choices per subject are too few to get statistical conclusions this way. (Another problem is that statistical conclusions are inflated because the choices of one individual are not really independent according to my preferred views.) Table 1 indeed shows no statistical power. Harrison blames our design for it rather than his unfortunate test.

Pp. 6-7 criticizes the semi-parametric fitting introduced by Abdellaoui (who has a degree in economnetrics). The method first does parametric fitting to obtain a power utility function. Then, in the second stage, it uses that to estimate the things that interest us most: The event weighting functions. And the latter then is non-parametric. This two-stage way emphasizes that for the weighting function not any parametric assumption is made. For this reason, the first-stage estimates of w(0.5) are not used in the second stage (another thing criticized by Harrison on p. 7). In addition, Abdellaoui uses this method to stay close to techniques in decision analysis. The procedure here is within-subject, with not any probabilistic assumption or statistical conclusion made at that stage. Again Harrison confuses calculations with statistical estimations by criticizing our absence of statistical assumptions/conclusions. The whole rest of the paper is confusing calculations and estimations, and between- and within-subject errors. %}

Harrison, Glenn W. (2011) “The Rich Domain of Uncertainty: Comment,” working paper. Incorporated in

Harrison, Glenn W. (2019) “The Methodologies of Behavioral Econometrics.” *In*

Michiru Nagatsu and Attilia Ruzzene (eds.) *Philosophy and Interdisciplinary Social Science: A Dialogue*, 107–138, Bloomsbury, London.

{% Glenn expresses his characteristic opinions in his characteristic style:

"In general the book confounds scholarship with advocacy in a way that is now all too common in behavioral economics."

"I am tired of reading scholarly work in this vein, and feeling the need to constantly check the record against what is alleged."

That Glenn only knows econometric methods of doing statistics, and thinks that all else unknown to him must be wrong, appears for instance from the following text and its context:

"in general we need both theoretical and econometric assumptions to identify and estimate the latent construct"

Here is how he cites his "friend" Rabin (2000):

"The folk theorem on calibration of risk preferences for "small stakes," originally stated by Hansson (1988) and popularized by others" %}

Harrison, Glenn W. (2015) Book Review of: Daniel Friedman, Mark R. Isaac, James Duncan, & Sunder Shyam (2014) "Risky Curves: On the Empirical Failure of Expected Utility, Routlege, New York," *Journal of Economic Psychology* 48, 121–125.

{% Given that this paper criticizes Abdellaoui, Baillon, Placido, & Wakker (AER 2011), I read it from a defensive perspective. The paper is full with negative claims on behavioral economics, typical of Glenn. P. 108 writes: "Section 4.6 considers empirical evidence for the notion of "source dependence," the hypothesis that risk preferences depend on the source of risk, and shows why we must not confuse point estimates with data." This is on my aforementioned paper.

P. 108 last para ℓ. 2 has a remarkable confusion: "nominal (e.g., integer-valued)"

The paper throughout mostly gives self-references. For instance, p. 112, §4.2.1, writes: "There are now many published statements of the structural models of risk preferences underlying EUT and RDU models, starting with Harrison and Rutström (2008, §2)."

§4.3.1, on measuring time pref., is typical of the author. Andersen, Harrison, Lau, & Rutstrom (2008, Econometrica), Andersen et al. (2008) henceforth, proposed to measure discounting as follows: First estimate the utility function from RISKY choices assuming EU. Then use that function in the discounted utility (DU) model to estimate discounting. In my annotations to that paper I criticized all these steps. One of the many strange points: If measuring utility, why use risk preferences and not intertemporal preferences??? The present §4.3.1 repeats the approach of Andersen et al. (2008). But, very strangely, it assumes that this is the only way possible, and that there can be no other way. Here are sentences showing this frame of mind: "The idea of joint estimation, again, is that one jointly estimates preferences from one structural model in order to correctly identify and estimate preferences of another structural model. The need for joint estimation comes from theory." (p. 115)

"In many settings in experimental economics we want to elicit some preference from a set of choices that also depend on risk attitudes. An example due to Andersen et al. (2008) is the elicitation of individual discount rates. In this case it is the concavity of the utility function, U″, that is important, and under EUT that is synonymous with risk attitudes. Thus the risk aversion task is just a (convenient) vehicle to infer utility over deterministic outcomes. One methodological implication is that we *should* combine a risk elicitation task with a time preference elicitation task, and use them jointly to infer discount rates over utility." (p. 115; italics added here) It is puzzling why the author does not want to elicit utility directly from intertemporal preference, which can well be done also if discounting is only subjective. Another thing the author does now know is that one can estimate discount rates without knowing or assuming anything about utility, e.g. in Attema, Bleichrodt, Gao, Huang, & Wakker (2016 AER). Section 4.3.2, on estimating subjective probabilities, similarly claims that one has to measure utility for it. The author does not know that one can measure subjective probabilities without knowing or assuming anything about utility.

P. 120, §4.4, claims that one can use probability weighting for losses to capture loss aversion, not realizing that by normalization the total decision weight assignable to losses is always 1. Eq. 9.3.2 in Wakker (2010 p. 254) shows this point, with always total decision weight 1 for losses.

P. 122 cites an incorrect claim by Nilsson et al. (2008):

"It is likely that these results are caused by a peculiarity of CPT, that is, its ability to account for loss aversion in multiple ways. The most obvious way for CPT to account for loss aversion is by parameter λ (after all, the purpose of λ is to measure loss aversion). A second way, however, is to decrease the marginal utility at a faster pace for gains than for losses. This occurs when α is

smaller than β. Based on this reasoning, we hypothesized that the parameter estimation routines compensate for the underestimation of λ by assigning lower values to α than to β; in this way, CPT accounts for the existing loss aversion indirectly in a manner that we had not anticipated.”
Utility curvature cannot substitute for loss averion in general. Most one can say is that for particular sets of stimuli, limited and of particular kinds, utility curvature (and also probability weighting) can substitute for loss aversion only within that set.

§4.6, p. 127, aims to criticize Abdellaoui, Baillon, Placido, & Wakker (AER 2011). The title, “Point Estimates Are Not Data: A Case Study of Source Dependence” hints at what the author has in mind. The sentence:
“Unfortunately, their conclusions are an artefact of estimation procedures that do not worry about sampling errors.30 These procedures are now often used in behavioral economics”
also refers to it. I embarked on reading this paper hoping to get here a publically available text that I could then react to. Unfortunately and to my disappointment, the rest of the section does not give a justification of these criticisms, so that they are not available in public. The text refers to an online appendix that I could not find on the author’s website or elsewhere. But it will be what the working paper Harrison (2011) wrote, and what I criticize in my annotations to that working paper. %}

Harrison, Glenn W. (2019) “The Methodologies of Behavioral Econometrics.” *In* Michiru Nagatsu and Attilia Ruzzene (eds.) *Philosophy and Interdisciplinary Social Science: A Dialogue*, 107–138, Bloomsbury, London.

{% People’s risk premiums increased because of Covid. So do beliefs in mortality. The authors use expected utility but also Quiggin’s rank-dependent utility to analyze risk attitudes. %}

Harrison, Glenn W., Andre Hofmeyr, Harold Kincaid, Brian Monroe, Don Ross, Mark Schneider, & J. Todd Swarthout (2022) “Subjective Beliefs and Economic Preferences During the COVID-19 Pandemic,” *Experimental Economics* 25, 795–823.
https://doi.org/10.1007/s10683-021-09738-3

{% **equate risk aversion with concave utility under nonEU**: They explicitly state, somewhere in the middle, that risk aversion, risk seeking, and so on, refers only to utility curvature, also under prospect theory. Confusing, because then we do not know how to refer to what is traditionally called risk aversion (preference of EV, involving both utility, probability weighting, and loss aversion)! Unfortunately, the paper, whereas mentioning original 1979 prospect theory, the separable-weighting generalization often used (though not really prospect theory), and the new 1992 version, but leaves it completely unspecified which of these versions is used in the analysis, for instance, by not giving the formula.

PT falsified: they confirm the violations of inverse S found by Humphrey, & Arjen Verschoor (2004).

They measure probability weighting but use the RIS, something strongly criticized by Harrison & Swarthout (2014). %}

Harrison, Glenn W., Steven J. Humphrey, & Arjen Verschoor (2010) "Choice under Uncertainty: Evidence from Ethiopia, India and Uganda," *Economic Journal* 120, 80–104.

{% **decreasing ARA/increasing RRA**: This is a comment on Holt & Laury (2002, American Economic Review) "Risk Aversion and Incentive Effects." It shows empirically that there is an order effect for the high-real payment treatment, which always followed after the low-real payment treatment. They did it now (for 10 times higher payments, not 20 times) both with and without the order effect, and without the order effect the increase in risk aversion versus the low-payment group was reduced by about a factor two. This order effect may be due to loss aversion (see my comments on the Holt & Laury paper). This study confirms the order effect empirically. On the positive side, it shows that half of the high-low-real-payment difference effect of Holt & Laury is not due to the order effect and is genuine.

Confirm Holt & Laury (2002) on the following: women more risk averse than men for low payment but not for high payment (**gender differences in risk attitudes**). %}

Harrison, Glenn W., Eric Johnson, Melayne M. McInnes, & E. Elisabet Rutström (2005) "Risk Aversion and Incentive Effects: Comment," *American Economic Review* 95, 897–901.

{% **decreasing ARA/increasing RRA**: find increasing RRA.

Point out that empirical studies of the common ratio effect etc. can gain power if conditioning on degree of risk aversion. The first pages mention that in existing studies there can always exist as yet unknown confounding factors, which of course holds for every statistical study. Also point out that subjects may be almost indifferent between al kinds of choices, so that these do not give much information, and estimating their risk aversion helps us detect such almost-indifferences.

They use questions similar as in Holt & Laury (American Economic Review 2002), estimate CRRA parameter from it, and use that as index of risk aversion to condition on. %}

Harrison, Glenn W., Eric Johnson, Melayne M. McInnes, & E. Elisabet Rutström (2003, March) "Individual Choice and Risk Aversion in the Laboratory: A Reconsideration," Dept. of Economics, Moore School of Business, University of South Carolina, USA.

Published as

Harrison, Glenn W., Eric Johnson, Melayne M. McInnes, & E. Elisabet Rutström (2007) "Measurement with Experimental Control." *In* Marcel Boumans (ed.), *Measurement in Economics: A Handbook*, Ch. 4, 79–104, Elsevier, Amsterdam.

{% %}

Harrison, Glenn W. & Morten I. Lau (2005) "Is the Evidence for Hyperbolic Discounting in Humans just an Experimental Artefact?," *Behavioral and Brain Sciences* 28, 657–657.

{% This paper considers the Rabin (2000) paradox, but, unfortunately, has many weaknesses.

Rabin (2000) puts loss aversion forward as the main factor to explain his paradox in the last para of his main text (pp. 1288-1289). This involves reference dependence, the main ingredient of prospect theory, the theory sharing the 2002 Economics Nobel prize with its 1979 introductory paper the 2nd most cited in economics. Reference dependence indeed is the main factor explaining Rabin's paradox. Then how is it possible to write a paper on this topic while never even mentioning reference dependence or loss aversion? Yet this is what this paper does. It also does not cite Kahneman or Tversky.

Although the authors informally use terms utility of final wealth versus utility of income to refer to the aforementioned difference, they do not formalize it, so that they cannot analyze the case properly. Their writing w+x suggests that wealth goes into outcomes (changes-with-respect-to-reference-point) and leaves ambiguous the essence, where w should go into the reference point rather than into the outcome. They should have used a notation such as x_w, denoting the reference point w differently than the outcome x, so that the readers can know. They also do not make this difference explicit in their experiment. The experiment, thus, seems to test constant absolute risk aversion, finding decreasing absolute risk aversion. This has been found in dozens of studies before, and is generally assumed. See the keyword **decreasing ARA/increasing RRA** in this bibliography for many references. It is implied by the common parametrizations of prospect theory, with power utility.

There is another problem. Rabin did not claim that *all* choices are invariant under wealth changes. He only claimed it for the preference $110_{0.5}(-100) \prec 0$. The authors consider 28 different lottery pairs in their Table 1 (p. 27), and not Rabin's pair. So, they tested a different phenomenon and then for different stimuli. (And for a third problem: the largest wealth change is about $120, which is not enough to be very relevant.)

The animosity between experimental economists and behavioral economists that was strong until about 2010, and that is described by Svorenčíkj (2016), but still is very present in this paper, contributing to the confusions and non-objectivity in this paper. (**Prospect theory not cited**) This explains not only why Kahneman & Tversky are not cited, and why the 2017 Nobel prize winner Thaler is insulted in footnote 6, but also that, whenever Rabin is cited, one can recognize an implicit negative suggestion. Below, italics are always added by me, and the first two cases are debatable but fit the picture, and the last case (5) is clearest:

(1) P. 25 1st para: "Rabin (2000) … Although *primarily* used as an argument against EUT, it *is now well known* that this logic applies to a much wider range of models that assume the argument of the utility function to be terminal wealth (Cox and Sadiraj, 2006; Safra and Segal, 2008)."

Here it suggests that Rabin himself did not see the wider implication of terminal wealth being violated. Well, Rabin himself, in his conclusion, immediately *suggested that loss aversion (and, therefore, reference dependence) is the most likely cause, which violates terminal wealth.*

(2) P. 25 3rd & 4th para: "We refer to this claim as the HRC, for "*Hansson–Rabin calibration*," acknowledging Hansson (1988) and Rabin (2000). … using the simple example from Hansson (1988) since it is not widely known and illustrates the basic points. The generalization by Rabin (2000) *can then be quickly stated*."

Here it downplays Rabin's contribution by ascribing much to Hansson. Hansson, cited and credited by Rabin, had part of the idea being the calibration effect, but did not convey the wide implications. As an aside, Hansson's work was brought to Rabin's attention by Prelec (personal communication).

(3) P. 25, 2nd column, 2nd para: "Indeed, the *only* empirical example offered by Rabin (2000) uses a bounded CARA function."

Here it suggests that Rabin was weak on empirical evidence.

(4) Rabin (2000) draws the implication that P must then be false, and that one should employ models of decision-making under risk that relax proposition Q, such as Cumulative Prospect Theory. As a purely logical matter, of course, this is *just one way* to resolve this calibration puzzle.

Here it suggests that Rabin's conclusion is arbitrary.

(5) 2007). "Rabin and Thaler (2002, p.230) make exactly this mistake in misunderstanding the existing experimental literature:

"We refer any reader who believes in risk neutrality to pick up virtually any experimental test of risk attitudes. Dozens of laboratory experiments show that people are averse to far more favorable bets for smaller stakes. The idea that people are not risk neutral in playing for modest stakes is uncontroversial; indeed, nobody to our knowledge interprets the existing evidence as arguing that expected-value maximization (risk neutrality) is a good fit'.'

The authors here insult not only Rabin, but also the 2017 Nobel prize winner Thaler. There is nothing wrong with the content of the text by Rabin & Thaler, although I would have preferred a different style. The text by R&T is fully relevant to the issue at stake here, which escapes Harrison et al. because they are confused on the role of the reference point.

The paper overstates its (claimed) novelty of doing within-subject on p. 25 2nd para ("the absence of empirical tests is remarkable") and 1st para in §3 ("All of the evidence claimed to support the premiss that decision makers in experiments exhibit small stakes risk aversion for a large enough finite interval comes from designs in which subjects come to the lab with varying levels of wealth and are faced with small-stakes lotteries.") because Cox et al. (2013) tested within-subject variations before. The authors only cite Cox et al. for this in a footnote, Footnote 2 on p. 25. (Comes to it what I wrote before, that the authors are doing a within subject test of constant absolute risk aversion which has been done in dozens of papers before. But this is a matter of confusion, rather than deliberately ignoring preceding work.)

As do most papers on individual choice today, the authors use the Random incentive system (RIS), called RLIM by them, to implement real incentives. This is even though the first author, Harrison, has tried to criticize RIS on many occasions by erroneously claiming that it is valid only under expected utility (e.g., Harrison & Swarthout 2014, abstract). Footnote 9 gives a supposed justification. First follows the justification there that motivates everyone. But then, to be consistent with the EU claim made elsewhere, the footnote writes a weak claim: "The second reason was that the null hypothesis being tested is normally stated assuming EUT [expected utility, which I abbreviate EU], and RLIM is valid under EUT." This claim is weak because many studies have shown that expected utility is empirically violated. The stated null hypothesis can immediately be rejected based on an ocean of literature, making further tests redundant!

P. 27 ℓ. −5: for higher levels of wealth, the authors seem to find a tendency for risk seeking (they do not state statistical level), deviating from the common findings of weak aversion. %}

Harrison, Glenn W., Morten I. Lau, Don Ross, & J. Todd Swarthout (2017) "Small Stakes Risk Aversion in the Laboratory: A Reconsideration," *Economics Letters* 160, 24–28.

{% **random incentive system between-subjects** (paying only some subjects): Footnote 16 reports a little side experiment to test the random incentive system by, in one treatment, of each subject one choice was paid, and in the other treatment for each subject at the end the payment was done with probability only 1:10. They found no significant difference of RRA coefficient.

decreasing ARA/increasing RRA: find bit of increasing RRA but close to constant;

253 people from general population, and real incentives; relate to demographic variables; mean power of utility found is 0.36 (= 1 − RRA coefficient). They only

do EU data fitting, and no nonEU.

The Appendix discusses Rabin's calibration argument. The authors correctly cite Rabin's text pointing out that loss aversion is the main explanation and also correctly equate this with what experimental economists call utility of income. That Cox & Sadiraj and Rubinstein then have nothing to add anymore, is not stated clearly but is left ambiguously.

gender differences in risk attitudes: no difference %}

Harrison, Glenn W., Morten I. Lau, & E. Elisabet Rutström (2007) "Estimating Risk Attitudes in Denmark: A Field Experiment," *Scandinavian Journal of Economics* 109, 341–368.

{% One point is that if you randomize subjects then by coincidence one group may have more risk averse subject than the other, which can be prevented by measuring the risk attitudes of the subjects. %}

Harrison, Glenn W., Morten I. Lau, & E. Elisabet Rutström (2009) "Risk Attitudes, Randomization to Treatment, and Self-Selection into Experiments," *Journal of Economic Behavior and Organization* 70, 498–507.

{% Although the paper

Harrison, Lau, & Rutström (2007) "Estimating Risk Attitudes in Denmark: A Field Experiment," *Scandinavian Journal of Economics* 109, 341–368

has been criticized for using the term field experiment for nothing other than that the sample were no students, this paper continues to use the term (smoking is not enough of being a field activity, and is more of a demographic variable).

They use the same data set as Harrison, Lau, & Rutström (2007), and the same estimation of discounting (taking as intertemporal utility the risky utility estimated from risky decisions assuming EU), but now add relations with smoking. I hoped that §2, entitled "Identifying risk and time preferences" would discuss the identification of one with the other, but it did not. Instead, the title refers to just identifying each without looking at the relation between them.

Male smokers discounter more than male nonsmokers. No difference with women. If I understand right, they find no relation between smoking and time inconsistency (parameter of hyperbolic discounting). %}

Harrison, Glenn W., Morten I. Lau, & E. Elisabet Rutström (2010) "Individual Discount Rates and Smoking: Evidence from a Field Experiment in Denmark," *Journal of Health Economics* 29, 708–717.

{% **Prospect theory not cited** (p. 28): "We employ a simple experimental measure for risk aversion called a multiple price list (MPL) developed by Holt and Laury (2002)."

Measure risk attitudes of individuals over own risks, and over risks for others. Is done by usual choice list and assuming EU, as in Holt & Laury (2002). Find no difference if risk attitudes of others are unknown, but more risk aversion for choices concerning others if the risk attitudes of others are known. %}

Harrison, Glenn W., Morten I. Lau, E. Elisabet Rutström, & Marcela Tarazona-Gómez (2012) "Preferences over Social Risk," *Oxford Economic Papers* 65, 25–46.

https://doi.org/10.1093/oep/gps021

{% **real incentives/hypothetical choice, for time preferences**: Use real payments, for discounting of 6 months or … or some three years. Find average discount rate of 28%. Discusses censoring effect, that for too low interest subjects may refuse because the market gives it better, i.e., subjects may arbitrage between experiment and market. Cite a Coller & Williams (1989) paper for this point.

The only text to explain how the future (could be 3 years later) payments were implemented is on p. 1610 near end.

random incentive system between-subjects (paying only some subjects) was used. The authors write:

> Subjects were then told that a single payment option would be chosen at random for payment, and that a single subject would be chosen at random to be paid his preferred payment option for the chosen payoff alternative. The payment mechanism was explained as follows:
>
> > HOW WILL THE ASSIGNEE BE PAID?
> > The Assignee will receive a certificate which is redeemable under the conditions dictated by his or her chosen payment option under the selected payoff alternative.

This certificate is guaranteed by the Social Research Institute. The Social Research Institute will automatically redeem the certificate for a Social Research Institute check, which the Assignee will receive given his or her chosen payment option under the selected payoff alternative. Please note that all payments are subject to income tax, and information on all payments to participants will be given to the tax authorities by the Social Research Institute.

Pp. 1612-1613 acknowledges the point that the subjects may not trust the implementation of the real incentives and may, therefore, discount extra. P. 1613 points out that experiments with hypothetical choices typically find discount rates of even more than the 28% as found here. %}

Harrison, Glenn W., Morten I. Lau, & Melonie B. Williams (2002) "Estimating Individual Discount Rates in Denmark: A Field Experiment," *American Economic Review* 92, 1606–1617.

{% §2.1, p. 1012, gives six criteria for when a study can be considered a field experiment:

The nature of the subject pool;
the nature of the information that the subjects bring to the task;
the nature of the commodity;
the nature of the task or trading rules applied;
the nature of the stakes;
the nature of the environment that the subject operates in.

P. 1027:

"by some arbitrator from hell."

P. 1028 has nice discussion "Context is not a dirty word." About whether choice alternatives should be abstract, or have a concrete context. Is related to my lesson to learn when teaching to medical students: When I tried to attach real diseases etc. to branches in decision trees, the students would start discussing the diseases and not the decision-theoretic risk-tradeoffs. So, I learned to use abstract diseases (disease 1, 2, …, etc.) to designate the branches.

Bardsley et al. (2010 §5.7) properly criticize pp. 1027-1028.

P. 1031, in reply to the criticism of real incentives that they are too small, makes the common mistake of many experimental economists to put forward Holt & Laury (2002) as counterargument. For any practical purpose, the amounts in Holt & Laury (2002) of some hundreds of dollars are SMALL! No one would do a decision analysis for such stakes. Below three months of salary, utility should be linear and nothing going on.

§10 signals a difference of opinion between the two authors, with List (and I) not agreeing with Harrison's qualifying his studies with general population (in Denmark) instead of students, and completely artificial otherwise, as field studies. %}

Harrison, Glenn W. & John A. List (2004) "Field Experiments," *Journal of Economic Literature* 42, 1009–1055.

{% Much of the paper, such as the first half of the abstract, is a general discussion of the pros and cons of a controlled laboratory experiment versus less internally valid but more externally valid field data, a general topic extensively discussed in psychological textbooks and elsewhere.

Do not do experiment with students in lab, but in a major coin show in Orlando with attendants of that show who could participate voluntarily receiving $5 participation fee + performance-contingent payment, serving as an intermediate step between laboratory experiments and real field situations. They consider monetary prizes, and prizes in terms of special coins that have extra uncertainty regarding their value. The finding of this paper is that there is more risk aversion for the second outcomes than for the first. The authors discuss this finding in detail.

They also discuss background risk in detail, in particular that it cannot be ignored. Their study, however, takes background risk in the narrow sense concerning only the extra uncertainty of the special coins and not in the grand sense of all risks that we are facing regarding our investments etc., so that they are overclaiming.

In footnote 3 on p. 434 they argue that regarding the Rabin (2000) paper, they side with the Cox & Sadiraj (2006) and Rubinstein (2002) criticisms (that I strongly disagree with).

SPT instead of OPT: unfortunately, they do not use the correct formula (for x > y > 0)

$$x_py \dashrightarrow w(p)U(x) + (1-w(p))U(y)$$

which is the correct one not only for the 1992 updated ("cumulative") prospect theory BUT ALSO for the original 1979-prospect theory (Kahneman & Tversky 1979, p. 276 Eq. 2). Instead, they make the well-known mistake of using the formula x_py --> w(p)U(x) + w(1-p)U(y), which is separable prospect theory. See their footnote 23 on p. 448 where they apparently think that the correct formula only applies to the new cumulative version, and p. 451 below Eq. 7.

equate risk aversion with concave utility under nonEU: P. 455 makes the same mistake as do so many economists of equating risk attitude with utility curvature if the working hypothesis is not EU but is a nonEU model, prospect theory in this case. When on p. 455 the authors report the results of prospect theory (taking the Tversky & Kahneman 1992 parametric families), they discuss dependence of the (power-) utility parameter in detail, but of the probability weighting parameter they only report the average value of 0.83.

They test power utility $U(x) = x^r/r$ but also the translated power utility $U(x) = (x+w)^r/r$ with w an extra parameter, but find only small values of w (p. 455) (they have no loss outcomes).

Footnote 31, p. 456, shows how far the authors got carried away in their interpretation that their coins with extra risk represent everything relevant in life outside the lab, including every possible background risk, because they apparently feel it necessary to negate this suggestion and explain that for instance for health outcomes things may be different than for their special coins …

P. 456 illustrates again how the authors got carried away with their mission: "Indeed, in transferring the insights gained in the laboratory with student subjects to the field, a *necessary* first step is to explore how market professionals behave in strategically similar situations." [italics added here].

They measure probability weighting but use the RIS, something strongly criticized by Harrison & Swarthout (2014). %}

Harrison, Glenn W., John A. List, & Charles Towe (2007) "Naturally Occurring Preferences and Exogenous Laboratory Experiments: A Case Study of Risk Aversion," *Econometrica* 75, 433–458.

{% Selten, Sadrieh, & Abbink (1999) argued against paying in probability of gaining a prize, but this paper tries to restore. %}

Harrison, Glenn W., Jimmy Martínez-Correa, & J. Todd Swarthout (2013) "Inducing Risk Neutral Preferences with Binary Lotteries: A Reconsideration," *Journal of Economic Behavior and Organization* 94, 145–159.

{% Selten, Sadrieh, & Abbink (1999) argued against paying in probability of gaining a prize, but this paper tries to restore, as did the 2013 paper. %}

Harrison, Glenn W., Jimmy Martínez-Correa, & J. Todd Swarthout (2014) "Eliciting Subjective Probabilities with Binary Lotteries," *Journal of Economic Behavior and Organization* 101, 128–140.

{% Selten, Sadrieh, & Abbink (1999) argued against paying in probability of gaining a prize, but this paper tries to restore, as did the 2013 & 2014 papers. %}

Harrison, Glenn W., Jimmy Martínez-Correa, & J. Todd Swarthout (2015) "Eliciting Subjective Probability Distributions with Binary Lotteries," *Economics Letters* 127, 68–71.

{% %}

Harrison, Glenn W., Jimmy Martínez-Correa, & J. Todd Swarthout (2015) "Reduction of Compound Lotteries with Objective Probabilities: Theory and Evidence," *Journal of Economic Behavior and Organization* 119, 32–55.

{% %}

Harrison, Glenn W., Jimmy Martínez-Correa, J. Todd Swarthout, & Eric R. Ulm (2017) "Scoring Rules for Subjective Probability Distributions," *Journal of Economic Behavior and Organization* 134, 430–448.

{% Ask subjects to rank mortality causes according to their believed likelihood. Give real payment according to how close the reported ranking is to the real statistical ranking.

real incentives/hypothetical choice: hypothetical ranking and real-incentive ranking give same results. %}

Harrison, Glenn W. & E. Elisabet Rutström (2006) "Eliciting Subjective Beliefs about Mortality Risk Ordering," *Environmental & Resource Economics* 33, 325–346.

{% **survey on nonEU**: a comprehensive, colored, review of measurements of risk attitudes.

Appendix F is in apr09 the best reference for Harrison's econometric Stata analysis technique.

Section 1.4, Appendix D seems to criticize BDM (Becker-DeGroot-Marschak). %}

Harrison, Glenn W. & E. Elisabet Rutström (2008) "Risk Aversion in the Laboratory." *In* Jim C. Cox & Glenn W. Harrison (eds.) *Risk Aversion in Experiments*, Research in Experimental Economics Vol. 12, Emerald Group Publishing Limited, Bingley, UK.

{% **random incentive system**: uses it but, to my regret, pays three choices to each subject (p. 138 beginning of §2) so that the main purpose of the system, avoiding income effects, is not served.

Fits mixture model to data, where the mixture is of PT (in fact SPT as explained below; I from now on write SPT) and EU. EU and SPT are not nested because another utility function is taken for EU ($(s+x)^r$ with x the lottery payment and s the prior endowment (**losses from prior endowment mechanism**) at the beginning of the experiment) than for SPT (x^r for gains and $x^{r'}$ for losses). P. 137 has nice history of mixture models in other fields. They measure probability weighting but use the RIS, something strongly criticized by Harrison & Swarthout (2014).

Because the statistical techniques of the authors, apparently, can only handle preference data they, strangely enough, do not use indifferences in their data, even though indifferences are more informative than preferences (p. 139 end of §2 ("indifferences .. to simplify we drop those", with footnote 14 there: "For the specification of likelihoods of strictly binary responses, such observations add no information.") If the technique cannot draw info from indifference, then this is a problem of the technique!

Unfortunately, what this paper calls prospect theory is not prospect theory, neither in the new (1992) version nor in the original (1979) version. The paper writes, incorrectly (p. 140) (**SPT instead of OPT**):

"There are two variants of prospect theory, depending on the manner in which the probability weighting function is combined with utilities. The original version proposed by Kahneman & Tversky (1979) posits some weighting function which is separable in outcomes, and has been usefully termed Separable Prospect Theory (SPT) by Camerer & Ho [1994, p. 185]. …"

True, that 1979 OPT cannot be used for more than two nonzero outcomes. However, the separable Edwards-type version used here, as used by Camerer & Ho (1994), does not work at all for three and more outcomes, leading to great over- and underweightings and violations of highly unrealistic stochastic dominance. All the more reason to turn to the new 92 version of prospect theory!

They suggest that 60 choice questions is about the maximum that can be asked in one experiment.

The mixture model is WITHIN each subject and within each choice. That is, there is a mixture probability π. Consider a single subject. We specify both an EU model and an SPT model for this one subject (specify means choosing a utility function, probability weighting function, and loss aversion parameter, as the case may be). For each choice, there is a probability π such that the subject does EU with probability π and SPT with probability $1 - \pi$. All choices within the subject are independent here. (Later an error theory will be added where the errors for different choices of one subject are related, so that within a subject in that sense there is no complete independence, but this only concerns the choice error and not the theory choice.) Thus the subject is not described by one model, but has a dual self. It is a bit like quantum mechanics, where properties such as location of a particle may be a probability distribution over the locations that in no way can be pinned down deterministically. Conte, Hey, & Moffat (2007) consider a between-subject mixture where a subject with probability π is EU and then does EU for all choices, and with probability $1-\pi$ is SPT and then does SPT for all choices.

I would actually interpret the approach of this paper as representative agent because the same mixture model with parameters will be fit to each subject. It is indeed not one fixed model for all subjects the same, but it is a mixture of two models for all subjects the same.

The authors find that a mix of EU and SPT works well and, hence, the funeral is for the representative agent. Can reinterpret it as a resurrection of the representative agent, where we only need two of them.

If they fit SPT with T&K'92 parameters and with representative agent, then they find loss aversion of about 1.38. If they do a mix model with about half EU and about half the subjects SPT, then for the SPT subjects a loss aversion parameter of 5.78 results. A problem then is that power for losses is different than for gains, so that loss aversion is not well defined. Probability weighting has parameter $\gamma = 0.91$ if not as mixture model.

Intro p. 136 writes that primary methodological contribution is … co-existenc of EUT and SPT …, but §1 describes many applications of mixture models used before in the literature, also in decision under risk (Wang & Fischbeck 2004). Such speaking with two tongues happens in many papers co-authored by Glenn Harrison. So, he can claim things but if criticized can say "look I already wrote this myself on p. …." %}

Harrison, Glenn W. & E. Elisabet Rutström (2009) "Expected Utility Theory and Prospect Theory: One Wedding and a Decent Funeral," *Experimental Economics* 12, 133–158.

{% **backward induction/normal form, descriptive**; **random incentive system**

The paper essentially redoes the test of Starmer & Sugden (1991 American Economic Review) for probability weighting, but, unlike S&S, finds differences. It is written in a misleading manner. First it claims that RIS (the authors call it RLIM) needs EU and that, therefore, all researchers using RIS to investigate probability weighting or other violations of EU are completely wrong (bipolar), for instance in the abstract. But later it points out that RIS can also be justified without EU. Even, in the 3rd para of p. 436, they state that they will continue to use RIS themselves (as do all others in the field, in the absence of a better alternative), which they indeed do in all their other papers. Here is a detailed account:

The authors (H&S henceforth) criticize researchers who estimate deviations from expected utility (EU) but still use the RIS. This would be a valid criticism if those researchers were to defend RIS by assuming EU. Such people could be called bipolar, as proposed by this paper. But this does not happen. Researchers justify RIS assuming something often called isolation. H&S mention this, and counter that violations of a general isolation exist. But the point is, the researchers need not assume general isolation, but only for their particular stimuli, presented in ways that minimize the risk of violations of isolation. This is in fact what H&S do themselves. In the following text, take the first independence condition as just general independence giving EU, and the second as only isolation for the particular stimuli and presentation of the experiment considered. Then H&S write, on p. 436 3rd para:

"A final implication is to just be honest when presenting experimental findings on RDU and CPT models about the assumed neutrality of the experimental payment protocol. In effect this is just saying that there might be two independence axioms at work: one for the evaluation of a given lottery in a binary choice setting, and another one for an evaluation of sets of choices in 1-in-K settings. If one estimates RDU and CPT models with a 1-in-K protocol one might claim to be allowing the first axiom to be relaxed while maintaining the second. It is logically possible for the latter axiom to be empirically false while the former axiom is empirically true. In the absence of better alternatives, we do this in our own ongoing research using 1-in-K protocols."

Another good reason for using RIS, despite any problem it has, is that other mechanisms only have bigger problems. H&S in some places suggest to let each subject make only one single choice, but properly mention the drawbacks: (1) it is very expensive, (2) it gives too little info within any individual, so that one can only make inferences about group averages, and (3) the revealed data may in fact be of low quality because subjects should learn stimuli before revealing their true preferences. H&S (p. 435) also suggest alternative procedures by Cox et al. (2011), now appeared as Cox, Sadiraj, & Schmidt (2015 EE), which concern for instance paying all choices or the average over all choices. I add here that those procedures have obvious problems. In the second, subjects know beforehand that they get about the average payoff, and that whatever choice they do affects their payoff very little.

To check out that the first author himself invariably uses the RIS, also when measuring probability weighting (I had to do this for another purpose), I typed the search words

Glenn Harrison probability weighting

into google scholar on 8 March 2018 and then checked out the five most cited references:

Harrison, Glenn W. & E. Elisabet Rutström (2009) "Expected Utility Theory and

Prospect Theory: One Wedding and a Decent Funeral," *Experimental Economics* 12, 133–158.

P. 138: "After all 60 lottery pairs were evaluated, three were selected at random for payment." [small variation of RIS] Figure 6 last panel reports results on probability weighting.

Harrison, Glenn W., John A. List, & Charles Towe (2007) "Naturally Occurring Preferences and Exogenous Laboratory Experiments: A Case Study of Risk Aversion," *Econometrica* 75, 433–458.

P. 439: "The subject chooses A or B in each row, and one row is later selected at random for payout for that subject." P. 455: "The probability weighting parameter γ is estimated to be 0.83"

*Harrison, Glenn W., Steven J. Humphrey, & Arjen Verschoor (2010) "Choice under Uncertainty: Evidence from Ethiopia, India and Uganda," *Economic Journal* 120, 80–104.

"*At the end of the experiment one of the eight tasks was selected at random for each subject and the lottery chosen in that task was played-out for real money.*" Figure 2, P. 90, reports results on probability weighting.

Andersen, Steffen, John Fountain, Glenn W. Harrison, & E. Elisabet Rutström (2014a) "Estimating Subjective Probabilities," *Journal of Risk and Uncertainty* 48, 207–229.

P. 213: "One choice was selected to be paid out at random after all choices had been entered." P. 219 Figure 3 reports results on probability weighting.

Andersen, Steffen, Glenn W. Harrison, Morten I. Lau, & E. Elisabet Rutström (2014b) "Discounting Behavior: A Reconsideration," *European Economic Review* 71, 15–33.

P. 21: "There were 40 discounting choices and 40 risk attitude choices, and each subject had a 10% chance of being paid for one choice on each block." [small variation of RIS] P. 24:

"*We model lottery choices behavior using a Rank-Dependent Utility (RDU) model, since all choices were in the gain frame, and find evidence of probability weighting*"

I also checked out a recent (at this moment of writing, 8 March 2018) study co-authored by the first author:

Andersen, Steffen, James C. Cox, Glenn W. Harrison, Morten I. Lau, E. Elisabet Rutström, & Vjollca Sadiraj (2018) "Asset Integration and Attitudes toward Risk: Theory and Evidence," *Review of Economics and Statistics* 100, 816–830.

A footnote writes: "For each type of decision task the subjects had a 10% chance of getting paid. If they were paid in the part of the experiment analyzed, one of the 60 decision tasks was randomly selected and the chosen lottery was played out for payment."

The conclusion writes:

"we find evidence of modest probability weighting"

Weird is that in the beginning the authors do not acknowledge ways to reconcile RIS with violations of EU, as properly written in many places later in their paper, but misleadingly write the opposite, overly eager to score their point on claimed bipolarity. Here is the beginning of their abstract:

"If someone claims that individuals behave as if they *violate* the independence axiom (IA) when making decisions over simple lotteries, it is **invariably** on the basis of experiments and theories that **must** *assume* the IA through the use of the random lottery incentive mechanism (RLIM). We refer to someone who holds this view as a Bipolar Behaviorist, exhibiting pessimism about the axiom when it comes to characterizing how individuals directly evaluate two lotteries in a binary choice task, but optimism about the axiom when it comes to characterizing how individuals evaluate multiple lotteries that make up the incentive structure for a multiple-task experiment." [italics from original; bold added]

This text directly contradicts the 3rd para on p. 436, where they write that they themselves will continue to use the RLIM. Therefore, the term bipolar applies to the authors themselves. The authors were so eager to write negative ("bipolar") about others that they allowed themselves this inconsistency. %}

Harrison, Glenn W. & J. Todd Swarthout (2014) "Experimental Payment Protocols and the Bipolar Behaviorist," *Theory and Decision* 77, 423–438.

{% Subjects usually prefer new medical treatments over existing ones. But, if they are pointed out that the new treatment comprises more ambiguity about downsides, then this preference disappears. %}

Harrison, Mark, Carlo A. Marra, & Nick Bansback (2017) "Preferences for 'New' Treatments Diminish in the Face of Ambiguity," *Health Economics* 26, 743–752.

{% **discounting normative**: Argues that discounting is irrational. Unfortunately, the author uses complete discounting, where the future is completely ignored, as a straw man and most of his paper only argues against that. As usual with philosophical writings, clarification and abbreviation could have been obtained by formal notation. The author points out (e.g. p. 47) that discounting often does not result from time per se but from other factors such as uncertainty. Compares discounting of the future with discounting of the past. Direct "psychological" utility with utility derived from future consequences, even if after one's death. P.

56, next-to-last paragraph, brings up a good argument, which is that "reason" (something like normative appropriateness) should be irrespective of time. This argument amounts to **dynamic consistency** (forgone-branch independence), the optimal decision should not depend on the timepoint of decision. %}

Harrison, Ross (1981-1982) "Discounting the Future," *Proceedings of the Aristotelian Society* 82, 45–57.

{% **cancellation axioms**: the authors show that in absence of completeness, the weakest version of cancellation is really weaker than some other versions. %}

Harrison-Trainor, Matthew, Wesley H. Holliday, & Thomas F. Icard III (2016) "A Note on Cancellation Axioms for Comparative Probability," *Theory and Decision* 80, 159–166.

{% **discounting normative**: seems to argue so. %}

Harrod, Roy F. (1948) "*Towards a Dynamic Economics: Some Recent Developments of Economic Theory and Their Application to Policy*." MacMillan, London.

{% Uses the veil of ignorance, mentioned before by Vickrey (1945, p. 329). The term veil of ignorance seems to have been introduced only later, by Rawls. People should accept a social arrangement independently of the position they will have in it. Everyone should be able to imagine that the positions will be exchanged one day. Thus, it should be guided by a probability distribution over these positions. From this Harsanyi derives that welfare- cardinal utility is equal to risky cardinal utility.

risky utility u = strength of preference v (or other riskless cardinal utility, often called value): Harsanyi derives that from his result. %}

Harsanyi, John C. (1953) "Cardinal Utility in Welfare Economics and in the Theory of Risk-Taking," *Journal of Political Economy* 61, 434–435.

{% Individual utility of a social state is consequentialistic in the sense that it can depend on the commodity bundles of the other individuals, equity in the social state, etc. The latter is described as "owing to external economies and diseconomies" (e.g. p. 311 Footnote 5).

P. 311 footnote 5: "the utility enjoyed by each individual will, in general, depend not only on his own income but also, owing to external economies and diseconomies of onsumption, on other people's incomes." This can be taken as defense against ignoring inequality considerations: They should be incorporated into utility. But the drawback is that then utility becomes too general, to the extent of being useless. P. 312 $\ell\ell$. 11-14 reiterates this point, as does the last para of the 1st column.

P. 313 ℓ. 2/3 of first column claims that EU is normative.

P. 315: the individual utilities to be aggregated should be the subjective ones, not the ethical ones.

P. 316: veil of ignorance has equal chances to end up in each position.

P. 317 suggests the term "principle of unwarranted differentiation": If you have observed everything of two individuals that you can think of, and it was all identical, then you can assume that they have the same level of utility. A nice term!

A nice paradox that I like to give to Ph.D. students: Let X be the set of social states, U_i : X --> Re the utility of individual i, n the number of individuals, and W : X --> Re the utility of society. Harsanyi only assumes expected utility for individuals and society (postulates A and B), and Pareto (postulate C); i.e., society is indifferent between two prospects over social states if all individuals are indifferent. How is it possible that this rules out equity considerations, and generates utilitarianism $W(x) = a_1U_1(x) + \ldots + a_nU_n(x)$? Pareto is completely harmless and self-evident, and so are the expected utility assumptions. Harsanyi's paradox! Assume richness; i.e., for every n-tuple of individual utilities, a social state exists that generates this n-tuple.

After a while, I add a hint: Assume the above three postulates, and $W(x) = U_1(x) + \ldots + U_n(x) + U_j(x)$ where j is the individual with lowest utility, $U_j(x) \le U_i(x)$ for all i. W comprises some equity and clearly is not utilitarian, violating joint independence (for $n = 3$ and coordinates utilities, $(1,3,0) \sim (2,2,0)$ but $(1,3,4) \prec (2,2,4)$). Which axiom of Harsanyi is violated??

Answer: Pareto is violated. For $n = 2$, social states denoted as pairs of individual utilities, 0.5 a probability, and prospects written between [], the prospect $(1,1)_{0.5}(0,0)$ is strictly preferred to the prospect $(1,0)_{0.5}(0,1)$ by society, but both individuals are indifferent.

Pareto is strong. It implies that for society the evaluation of a prospect over n-tuples of individual utilities depends only on the marginal distributions and not on correlations etc., which is Fishburn's (1965) additive independence condition. This implies additive decomposibility of W and rules out equity considerations. It also follows that Anscombe & Aumann (1963) is a corollary of Harsanyi (1955).

All these classical theorems are corollaries of a mathematical result, stated as follows by Wakker (1992, Economic Theory): "A linear function is a function of linear functions if and only if the linear function is a linear function of the linear functions."

Harsanyi is a bit sloppy on the domain assumed. Domotor (1979) corrects it. %}

Harsanyi, John C. (1955) "Cardinal Welfare, Individualistic Ethics, and Interpersonal Comparisons of Utility," *Journal of Political Economy* 63, 309–321. https://doi.org/10.1086/257678

{% This work has often been praised, and was a big reason for Harsanyi's Nobel prize in 1994. I never thought much of it. Randomizing something by bringing in an underlying probability space is completely routine for everyone with a training in probability theory. It is not a big move. Then, Harsanyi did something what I even qualify as a mathematical mistake: He has circularity in the definition of types. Types should specify probability distributions over types. Mertens & Zamir (1985) were the first to provide a sound mathematical model, with infinite hierarchies of beliefs, but their paper is almost impossible to read. Several other authors later wrote more accessible papers. Zamir (personal communication) once defended Harsanyi when I criticized him: "Harsanyi made the right mistakes." %}

Harsanyi, John C. (1968) "Games with Incomplete Information Played by "Bayesian" Players, Parts I, II, III," *Management Science* 14, 159–182, 320–334, 486–502. Part I was Reprinted as Harsanyi, John C. (2004) "Games with Incomplete Information Played by "Bayesian" Players, Parts I, II, III," *Management Science* 14, 1804–1817.

{% **risky utility u = strength of preference v (or other riskless cardinal utility, often called value)**: seems to say this, with p. 600 subscribing to Bernoulli's principle. %}

Harsanyi, John C. (1975) “Can the Maximin Principle Serve as a Basis for Morality? A Critique of John Rawls’s Theory,” *American Political Science Review* 69, 594–606.

{% %}
Harsanyi, John C. (1977) “*Rational Behavior and Bargaining Equilibrium in Games and Social Situations*.” Cambridge University Press, Cambridge.

{% **risky utility u = strength of preference v (or other riskless cardinal utility, often called value)** %}
Harsanyi, John C. (1977) “Morality and the Theory of Rational Behavior,” *Social Research* 44, 623–656.

{% **risky utility u = strength of preference v (or other riskless cardinal utility, often called value)**; argues strongly, without nuances, in favor of Bayesianism. P. 225 Footnote 2 argues that Savage’s P4, requiring qualitative ordering of probability, is his weakest axiom and is the main one to be weakened, and puts Anscombe & Aumann (1963) forward as a model that did so. %}
Harsanyi, John C. (1978) “Bayesian Decision Theory and Utilitarian Ethics,” *American Economic Review, Papers and Proceedings* 68, 223–228.

{% Comments: see at Kadane & Larkey (1982) paper (**game theory can/cannot be viewed as decision under uncertainty**) %}
Harsanyi, John C. (1982) “Subjective Probability and the Theory of Games: Comments on Kadane and Larkey’s Paper,” *Management Science* 28, 120–125.

{% **risky utility u = strength of preference v (or other riskless cardinal utility, often called value)**: P. 127 is strong on it: “For, contrary to accepted doctrine, a careful analysis of the vNM axioms will show that the utility functions defined by these axioms have nothing to do with people’s like or dislike for the activity of gambling as such. Rather, they express each person’s willingness (or unwillingness) to take risks as determined by the *relative importance* he or she assigns to alternative desirable or undesirable *outcomes*, that is to say, by the *strength* of his or her *desire* to end up (or not to end up) with any particular outcome.” (Italics from original.) %}

Harsanyi, John C. (1988) “Assessing Other People’s Utilities.” *In* Bertrand R. Munier (ed.) *Risk, Decision and Rationality*, 127–138, Reidel, Dordrecht.

{% %}

Harsanyi, John C. (1991) “Normative Validity and Meaning of von Neumann-Morgenstern Utilities.” *In* Logic, Methodology and Philosophy of Science IX: Proceedings of the Ninth International Conference of Logic, Methodology, and Philosophy of Science, 442–462, Upsala, Sweden.
Reprinted in Kenneth G. Binmore, Alan P. Kirman, & Piero Tani (1993, eds.) Frontiers of Game Theory, 307–319, MIT Press, Cambridge, MA.

{% Argues that not actual preferences, but informed preferences, are to be the basis of normative decisions. %}

Harsanyi, John C. (1997) “Utilities, Preferences, and Substantive Goods,” *Social Choice and Welfare* 14, 129–145.

{% Harsanyi’s ultimate solution to noncooperative game theory;
They seem to argue for the backward induction solution to the game where Kohlberg & Mertens (1986) (and I) think forward induction should apply. %}

Harsanyi, John C. & Reinhard Selten (1988) “*A General Theory of Equilibrium Selection in Games.*” MIT Press, Cambridge, MA.

{% p. 2568, **DC = stationarity**: “so it is inevitable that policy makers will act in a time-inconsistent way.” %}

Harstad, Bard (2020) “Technology and Time Inconsistency,” *Journal of Political Economy* 130, 2653–2689.

{% The paper opens up with “Economics is witnessing the solid beginnings of a revolution in microeconomic theory.” The abstract’s last sentence: “Closer collaboration between theoretic modeling and experiments is clearly seen to be necessary.” %}

Harstad, Ronald M. & Reinhard Selten (2013) “Bounded-Rationality Models: Tasks to Become Intellectually Competitive,” *Journal of Economic Literature* 51, 496–511.

{% **dynamic consistency**: pointed out to me by Dréze in February 1994; pp. 54-55: Criticism on compounding probabilities is, however, that in between more information and other decision options became available. A nice early statement of this point! 25 May 2018 I noticed that Edwards (1954) p. 391 cites Hart for it. %}

Hart, Albert G. (1942) "Risk, Uncertainty, and the Unprofitability of Compounding Probabilities." *In* Oskar Lange, Francis McIntyre, & Theodore O. Yntema (eds.) *Studies in Mathematical Economics and Econometrics: In Memory of Henry Schultz*, 110–118, The University of Chicago Press, Chicago.
Reprinted in American Economic Association (This AEA is to be the editor) (1946) *Readings in the Theory of Income Distribution* (1946) 547–557, Blakiston, Philadelphia.

{% The author proposes two more-risky-than orderings on prospects, one according to the measure introduced by Aumann & Serrano (2008), the other according to the measure introduced by Foster & Hart (2009). Equivalent conditions are given. %}

Hart, Sergiu (2011) "Comparing Risks by Acceptance and Rejection," *Journal of Political Economy* 119, 617–638.

{% **inverse S:** assumes it in his analysis, so does not test it.

Measured utilities/probability weighting (a parameter for every outcome/probability), I think by best-fitting, on three consecutive weeks, to find that they were not stable over time. %}

Hartinger, Armin (1999) "Do Generalized Expected Utility Theories Capture Persisting Properties of Individual Decision Makers?," *Acta Psychologica* 102, 21–42.
https://doi.org/10.1016/S0001-6918(99)00018-9

{% PROMIS is an introspective measurement of quality of life/utility. This paper measures both that and the standard EQ-5D, and finds relations between them, so that PROMIS can be transformed into EQ-5D. N = 2623 subjects, representative adult group in US, were used. %}

Hartman, John D. & Benjamin M. Craig (2018) "Comparing and Transforming PROMIS Utility Values to the EQ-5D," *Quality of Life Research* 27, 725–733.

{% Constant-act dominance (CAD) means that inf(f) ≤ f ≤ sup(f) for an act f, and weakens dominance. In many theorems, monotonicity can be weakened to CAD in the sense that CAD implies monotonicity after all. For instance, if we have the sure-thing principle then CAD readily implies monotonicity for all simple acts, which is all that is needed for many theorems, e.g. Savage (1954). In RDU for uncertainty (Schmeidler 1989 but not necessarily the Anscombe-Aumann framework) CAD is really weaker and leads to a weighting function that can be nonmonotonic. %}

Hartmann, Lorenz (2019) "Constant-Act Dominance: Challenging the Monotonicity Axiom," working paper.

{% As the author writes about his result, expressed in the title: "It is remarkable that this was not noticed before as Savage's axiomatization has been studied and taught by hundreds of researchers for more than six decades."

In Footnote 4, the author points out that replacing Savage's P7 by the somewhat weaker P7 of Fishburn (1970) would not make a difference. I think that this unimportant point was not worth the space it takes, but a referee had insisted on it. The author did not have the space to prove this point. For completeness, Liu (2023) was so kind to provide a proof. Later, Frahm & Hartmann (2025) did so independently. %}

Hartmann, Lorenz (2020) "Savage's P3 Is Redundant," *Econometrica* 88, 203–205. https://doi.org/10.3982/ECTA17428

{% This paper axiomatizes α maxmin EU in the Anscombe-Aumann framework for α ≠ 0.5. Not exactly that. More precisely, for an α given beforehand, it axiomatizes the model given that α. The two new axioms that modify the Gilboa-Schmeidler axioms consider α mixtures of pairs of complementary acts. Two acts are complementary if they provide perfect hedges against each other. That is, in utility units, one is minus the other plus a constant.

The paper can identify the αs in the sense that for each α it can verify whether

the α maxmin model holds for that α. And α and the set of priors can be identified if the other of the two is specified. But there can be several αs and sets of priors that represent the preference relation.

A useful reference is Shiri (2022), with an appealing axiomatization of maxmin EU. %}

Hartmann, Lorenz (2023) "Strength of Preference over Complementary Pairs Aaxiomatizes Alpha-MEU Preferences," *Journal of Economic Theory* 213, 105719.
https://doi.org/10.1016/j.jet.2023.105719

{% The authors assume the Anscombe-Aumann (AA) framework for decision under uncertainty with simple acts, and consider *obvious dominance*, a condition that I have known under the name internality: $f_* \preccurlyeq f \preccurlyeq f^*$ where f_* is the worst outcome of the act and f^* the best. Assuming a utility function u on consequences, some continuity as in AA, and V(f) the utility of f's certainty equivalent so that V represents preference, we have $V(f) = \alpha(f)u(f^*) + (1-\alpha(f))u(f_*)$ for some $0 \le \alpha(f) \le 1$, for all f. We can nicely organize preference conditions in terms of α(f), and this is what the authors do for expected utility, Choquet expected utility, and the latter with convex or neo-additive weighting functions, biseparable utility, and monotonicity. %}

Hartmann, Lorenz & Jean Baccelli (2024) "Obvious Representations," working paper.

{% Theorem 1 in version of 26Sep2017: Assume CEU with linear utility (Anscombe-Aumann). Then capacity is exact iff preference satisfies convexity condition whenever the mix has only two outcomes. Remember here that outcomes are probability distributions, so that a mix of some five-outcome acts can have only two outcomes. %}

Hartmann, Lorenz & T. Florian Kauffeldt (2017) "An Axiomatizion of Exact Capacities," working paper.

{% Characterizes the Einhorn-Hogarth (1987) weighting function. Besides the true probability the agent further generates some internal probabilities also considered

plausible and then minimizes the Kullback Leibler distance. Could be nicely re-interpreted as ambiguity model. %}

Hartmann, Stephan (2017) "Prospect Theory and the Wisdom of the Inner Crowd," working paper.

{% Seems that he criticizes Lucas' use of the representative agent. %}

Hartley, James E. (1996) "Retrospectives: The origins of the Representative Agent," *Journal of Economic Perspectives* 10, 169–177.

{% Relate risk attitudes to individual characteristics.

gender differences in risk attitudes: women are more risk averse than men, civil servants more than self-employed;

decreasing ARA/increasing RRA: they find that rich are less absolute risk averse than poor. %}

Hartog, Joop, Ada Ferrer-i-Carbonell, & Nicole Jonker (2002) "Linking Measured Risk Aversion to Individual Characteristics," *Kyklos* 55, 3–26.

{% %}

Hartman, Stanislaw, Jan Mikusìnski, & Leo F. Boron (1961) "*The Theory of Lebesgue Measure and Integration.*" Pergamon, Oxford.

{% Show that medium prizes in lotteries slow down the decrease over time in agents' inclination to gamble, because of slower learning. %}

Haruvy, Ernan, Ido Erev, & Doron Sonsino (2001) "The Medium Prizes Paradox: Evidence from a Simulated Casino," *Journal of Risk and Uncertainty* 22, 251–261.

{% Alternative characterization of the translated log-power family %}

Harvey, Charles M. (1981) "Conditions on Risk Attitudes for a Single Attribute," *Management Science* 27, 190–203.

{% **present value**; **standard-sequence invariance**: Equal tradeoffs comparisons condition (p. 1126) is of this kind. §3, Theorem 3 uses this idea to characterize concavity of utility etc., very similar to how I did it in those days, such as in my

1986 paper "Concave Additively Decomposable Representing Functions and Risk Aversion."

Tradeoffs midvalues above Eq. 4 contains a way to measure endogenous utility midpoints. (**endogenous midpoints**)

Kirsten&I: Seems to have countably infinitely many timepoints and infinitely many outcomes. Seems to do the following things: Provides an axiomatization for discounted utility. Defines concept like timing neutrality, timing averseness and timing proneness, impatience (different than in Koopmans), temporal inequity aversion, absolute timing preferences, relative timing preferences. The exponential discounting model as well as a "relative value discounting model" is axiomatized. In adition, a few functional forms of the instantaneous utility function are axiomatized. %}

Harvey, Charles M. (1986) "Value Functions for Infinite-Period Planning," *Management Science* 32, 1123–1139.

{% Assumes infinitely many timepoints as in Koopmans (1960), and risk. Formulates many preference conditions that imply functional equations and, hence, particular properties and forms of discounting and utility. Attitudes toward multiperiod risk (p. 648 etc.), for instance, is the intertemporal analog of multivariate risk aversion. %}

Harvey, Charles M. (1988) "Utility Functions for Infinite-Period Planning," *Management Science* 34, 645–665.

{% Assume EU with strictly increasing (I guess) utility. In Theorem 1, the equivalence of (e) and (f) shows that constant absolute risk aversion for all two-outcome prospects with known probabilities implies linear-exponential (CARA) utility, and constant relative risk aversion for all two-outcome prospects with known probabilities implies log-power (CRRA) utility. The theorem considers all transformations of the addition operation. Under continuity of U, conditions only for fifty-fifty prospects is enough. This undervalued paper contains useful general tools for solving functional equations. %}

Harvey, Charles M. (1990) "Structural Prescriptive Models of Risk Attitude," *Management Science* 36, 1479–1501.

{% %}

Harvey, Charles M. (1991) “Models of Tradeoffs in a Hierarchical Structure of Objectives,” *Management Science* 37, 1030–1042.

{% %}

Harvey, Charles M. (1992) “A Slow-Discounting Model for Energy Conservation,” *Interfaces* 22, 47–60.

{% **dynamic consistency**; **DC = stationarity**: uses term “permanence” for DC (dynamic consistency), and distinguishes it carefully from stationarity; **discounting normative**.

P. 35 last para cites studies finding decreasing impatience.

PO/. 39 bottom: the famous “there is no reason that not” aregument.

Kirsten&I: seems to do infinitely and uncoutably many timepoints; countably infinitely many consumptions, discrete and not spread over time. %}

Harvey, Charles M. (1994) “The Reasonableness of Non-Constant Discounting,” *Journal of Public Economics* 53, 31–51.

{% **present value**: P. 386; **Kirsten&I**: seems to do infinitely and uncoutably many timepoints; countably infinitely many consumptions, discrete and not spread over time.

dynamic consistency: absolute timing being constant is same as Koopman’s stationarity;

P. 389, **DC = stationarity**: 2nd paragraph gives nice discussion of difference between stationarity and DC (dynamic consistency) (called permanence there). **discounting normative**, end says:

“We conjecture that many of the normative objections to nonconstant timing preferences are in fact objections to nonpermanent timing preferences.”

linear utility for small stakes: p. 392 mentions it to defend its linear utility. %}

Harvey, Charles M. (1995) “Proportional Discounting of Future Costs and Benefits,” *Mathematics of Operations Research* 20, 381–399.

{% **risky utility u = strength of preference v (or other riskless cardinal utility, often called value)**: argue for the use of strength of preference measurements in health care. %}

Harvey, Charles M. & Lars-Peter Østerdal (2010) "Cardinal Scales for Health Evaluation," *Decision Analysis* 7, 256–281.

{% The authors axiomatize discounted utility where the discount function can be general and need not be constant, for continuous outcome streams over a time interval that can be bounded or unbounded, which is useful to have available. It amounts to a special case of Savage's subjective expected utility, with the time interval as state space.

Techniques of Wakker (1993), who like this paper assumes continuous utility, can be used to get countable additivity (his Proposition 4.4), absolute continuity w.r.t. the Lebesgue measure (every Lebesgue null set of timepoints should be preferentially null and then Radon-Nikodym; this is an easy solution to the open question that the authors state at the end of the first column of p. 286), and only outcome streams with finitely many discontinuities (take algebra of finite unions of intervals and simple functions there, next extend by truncation continuity).

The authors use an alternative route, more directly targeted towards their objective. Note that, as the authors indicate, Kopylov (2010) is the first to have characterized the important special case of constant discounting. The authors use the usual Debreu-Gorman type separability to get general additive decomposability, and then a midpoint axiom to get proportionality (their Condition (E) on p. 287 which can also be done by bisymmetry or tradeoff consistency).

The only real mathematical difference between general (nonconstant) discounted utility and subjective expected utility is that in the former case the total measure of the time space need not be finite (if impatience does not decrease much), whereas under subjective expected utility it always is finite. This complication is delt with in §6.

P.s.: on a personal side, I am happy to see that Harvey, many years after retirement, and after his many solid contributions to intertemporal choice including for instance his valuable and underappreciated Harvey (1990

Management Science), together with his younger co-author who encouraged him, made this work see the light of day. %}

Harvey, Charles M. & Lars Peter Østerdal (2012) "Discounting Models for Outcomes over Continuous Time," *Journal of Mathematical Economics* 48, 284–294.

{% **real incentives/hypothetical choice**: They don't do hypothetical choice, but introspective measurement. That is, they use an unincentivized rating scale, the same scale with incentives, and incentivized WTP, and see how this predicts a binary food-choice task. WTP does worst, and the other two do equally well. %}

Hascher, Joshua, Nitisha Desai, & Ian Krajbich "Incentivized and Non-Incentivized Liking Ratings Outperform Willingness-to-Pay in Predicting Choice," *Judgment and Decision Making* 16, 1464–1484.

{% **dynamic consistency**; They take dynamic consistency differently than I do, say that myopic deciders violate it, but sophisticated don't???? %}

Haslam, Nick & Jonathan Baron (1993) Book Review of: Edward F. McClennen (1990) "Rationality and Dynamic Choice: Foundational Explorations," Cambridge University Press, Cambridge; *Journal of Mathematical Psychology* 37, 143–153.

{% **survey on nonEU**; on judgment and decision making. P. 668, problem 9, says that theories with nonlinear utilities and nonlinear event-weighting functions are most popular. The paper discusses a list of questions put forward by researchers, without very much structure or lines otherwise. %}

Hastie, Reid (2001) "Problems for Judgment and Decision Making," *Annual Review of Psychology* 52, 653–683.

{% %}

Hastie, Reid & Robin M. Dawes (2001) "*Rational Choice in an Uncertain World, the Psychology of Judgment and Decision Making*." Sage Publications, Thousand Oaks, CA.

{% The authors argue that the distinction between prior and statistical probability that Knight (1921) made was already the distinction between decisions from

description and decisions from experience. So, they impose their modern ideas upon classical writings. %}

Hau, Robin, Timothy J. Pleskac, & Ralph Hertwig (2010) "Decisions from Experience and Statistical Probabilities: Why They Trigger Different Choices than A Priori Probabilities," *Journal of Behavioral Decision Making* 23, 48–68.

{% Show that also with large sampling, experienced probabilities are treated differently than described ones. **DFE-DFD gap but no reversal**: I forgot what they find there. %}

Hau, Robin, Timothy J. Pleskac, Jürgen Kiefer, & Ralph Hertwig (2008) "The Description-Experience Gap in Risky Choice: The Role of Sample Size and Experienced Probabilities," *Journal of Behavioral Decision Making* 21, 493–518.

{% **HYE** %}

Hauber, A. Brett (2009) "Healthy-Years Equivalent: Wounded but not yet Dead," *Expert Review of Pharmacoeconomics & Outcomes Research* 9, 265–269.

{% %}

Haug, Jorgen & Jacob Sagi (2005) "Endogenous Regime Changes in the Term Structure of Real Interest Rates?,"

{% In my papers, preference is equated with binary choice. This paper takes the word preference in a different sense, as another primitive besides choice and then not to be equated with it. What Ramsey (1931) called disposition as interpretation of preference is called hypothetical revealed preference in this paper. %}

Hausman, Daniel (2011) "Mistakes about Preferences in the Social Sciences," *Philosophy of the Social Sciences* 41, 3–25.

{% Philosophical book on the meaning of preference. P. 134 seems to write, nicely on behavioral economics, that descriptive theories have to deviate from normative theories, and that one has to use the empirical deviations from rational models to modify preferences: "methodological longing cannot make the theory of rational choice into an accurate theory of actual choice"

Seems to use the term "utility-all-things-considered" for all encompassing

utility as the basis of all action.

Infante, Lecouteux, & Sugden (2016) discuss the book extensively. %}

Hausman, Daniel M. (2012) "*Preference, Value, Choice, and Welfare*." Cambridge University Press, Cambridge, UK.

{% **real incentives/hypothetical choice, for time preferences**: finds annual discount rate of no less than 26.4%. %}

Hausman, Jerry A. (1979) "Individual Discount Rates and the Purchase and Utilisation of Energy-Using Durables," *Bell Journal of Economics* 10, 33–54.

{% %}

Hausman, Jerry A. (1985) "The Econometrics of Nonlinear Budget Sets," *Econometrica* 53, 1255–1282.

{% "embedding": WTP for cleaning up one lake in an area = WTP for cleaning up all lakes in an area. %}

Hausman, Jerry A. (1993) "*Contingent Valuation: A Critical Assessment.*" North Holland, Amsterdam.

{% One of three papers in an issue on contingent evaluation. Argues against contingent vauations, mentioning the many biases. In particular, p. 49 ff. criticizes a study by Carson on Australian cable television. P. 54 is very explicit: " "no number" is still better than a contingent valuation estimate." %}

Hausman, Jerry (2012) "Contingent Valuation: From Dubious to Hopeless," *Journal of Economic Perspectives* 26, 43–56.

{% Considers lexicographic EU. Seems that he shows that the vNM axioms without continuity give lexicographic EU, using techniques from ordered vector spaces. %}

Hausner, Melvin (1954) "Multidimensional Utilities." *In* Robert M. Thrall, Clyde H. Coombs, & Robert L. Davis (eds.) *Decision Processes*, 167–180, Wiley, New York.

{% **Dutch book**; **ordered vector space**; Has Hahn's embedding theorem, which says that every linearly ordered Abelian group can be represented as a subgroup of $\mathbb{R}^{\Omega}$ endowed with the lexicographic ordering, with Ω linearly ordered. %}

Hausner, Melvin & James G. Wendel (1952) "Ordered Vector Spaces," *Proceedings of the American Mathematical Society* 3, 977–982.

{% When chimpanzees face uncertainty depending on reciprocity of other chimpanzee they are ambiguity averse. %}

Haux, Lou M., Jan M. Engelmann, Esther Herrmann, & Ralph Hertwig (2021) "How Chimpanzees Decide in the Face of Social and Nonsocial Uncertainty," *Animal Behaviour* 173, 177–189.
https://doi.org/10.1016/j.anbehav.2021.01.015

{% They test risk and ambiguity attitudes of chimpanzees, finding ambiguity aversion. It is very unclear to me how in animal experiments, where it is always decision from experience, one can distinguish between risk and ambiguity, and in the limited time invested I could not find out from the paper. Note that 2nd order probability simply reduces to 1st order probability. %}

Haux, Lou, Jan M. Engelmann, J. M., Ruben Arslan, Ralph Hertwig, & Ester Herrmann (2023) "Chimpanzee and Human Risk Preferences Show Key Similarities," *Psychological Science* 34, 358–369.
https://doi.org/10.1177/09567976221140326

{% **ubiquity fallacy**: "Even if there is only one possible unified theory, it is just a set of rules and equations. … However, if we discover a complete theory [of physics], it should in time be understandable by everyone, not just by a few scientists. Then we shall all, philosophers, scientists and just ordinary people, be able to take part in the discussion of the question of why it is that we and the universe exist. If we find the answer to that, it would be the ultimate triumph of human reason -- for then we should know the mind of God." The part following the dots is the closing text of the book. Although by intellectual standards this citation is weak and, accordingly, I put this citation under a negative keyword. Still, this kind of writing does help to impress people, increase sales, and increase citation scores. Hawking later wrote: "In the proof stage I nearly cut the last sentence in the book. Had I done so, the sales might have been halved." %}

Hawking, Stephen (1988) "*A Brief History of Time*." Bantam Dell Publishing Group, New York.

{% Nice survey in beginning of paper. %}
Hawkins, Scott A. (1994) "Information Processing Strategies in Riskless Preference Reversals: The Prominence Effect," *Organizational Behavior and Human Decision Processes* 59, 1–26.

{% **questionnaire versus choice utility**: Do what title says. Claim in intro that Rasch analysis, unlike regressions, delivers utilities that satisfy the utility axioms, but I did not find this explained in the paper (did not search line by line). %}
Hawthorne, Graeme, Konstancja Densley, Julie F. Pallant, Duncan Mortimer, & Leonie Segal (2008) "Deriving Utility Scores from the SF-36 Health Instrument Using Rasch Analysis," *Quality of Life Research* 17, 1183–1193.

{% **DC = stationarity**; p. 345 3rd para; Axiomatizes discounted utility, and also quasi-hyperbolic discounted utility by relaxing stationarity regarding the first timepoint. The paper does assume probability distributions over consumption streams and expected utility there, which simplifies the mathematics and makes it fit in the Keeney & Raiffa and Anscombe-Aumann tradition. %}
Hayashi, Takashi (2003) "Quasi-Stationary Cardinal Utility and Present Bias," *Journal of Economic Theory* 112, 343–352.

{% Uses Anscombe-Aumann two-stage model. Characterizes a regret functional for many-option choice functions. That is, from a set of event-contingent prospects ("acts") B, it chooses

the prospect f that minimizes the regret $\Phi\big(\max_{g \in B} u(g(\cdot)) - u(f(\cdot))\big)$.

Here Φ is a functional on event-contingous prospects and u a mixture-linear, continuous, nonconstant, utility function (so, EU) and Φ homothetic and nondecreasing. %}
Hayashi, Takashi (2008) "Regret Aversion and Opportunity Dependence," *Journal of Economic Theory* 139, 242–268.

{% **dynamic consistency**: Also analyzes dependence on opportunities. Argues that such dependency is normative in contexts where the opportunities give info about the choice alternatives. Distinguishes opportunity dependence from info dependence. End of § 1.1 argues that dynamic consistency implies (generalized) Bayesian updating; oh well! %}

Hayashi, Takashi (2011) "Context Dependence and Consistency in Dynamic Choice under Uncertainty: The Case of Anticipated Regret," *Theory and Decision* 70, 399–430.

{% A decision under uncertainty model where learning means hearing about states of nature you thought impossible before (unforeseen states), but now learn about. You then expand your state space, keeping the conditional subjective probability on what was known before unchanged. Very similar to independent work by Karni & Viero (2013). Does it in an Anscombe-Aumann (1963) setup. %}

Hayashi, Takashi (2012) "Expanding State Space and Extension of Beliefs," *Theory and Decision* 73, 591–604.

{% Characterize a recursive dynamic version of the smooth model of ambiguity (KMM), using a recursive evaluation. Assume EU for risk. %}

Hayashi, Takashi & Jianjun Miao (2011) "Intertemporal Substitution and Recursive Smooth Ambiguity Preferences," *Theoretical Economics* 6, 423–475.

{% Study multiple prior models. In fact it is 2^{nd} order objective probability but generated in a way so complex that subjects cannot calculate it (p. 357).

P. 356 clearly discusses that in maxmin EU the set of priors can reflect both anbiguity and ambiguity-aversion. RIS: they randomly select TWO choices and implement them for real, giving some income effect.

Find that not only the max- and min EU from the priors matter, falsifying the multiple prior models, maxmin EU, maxmax EU, and α-maxmin EU. Find that also more than the extremes of the set of priors matter (although mathematically a convex set is entirely characterized by it), falsifying the contraction model. Always, intermediate probabilities in the set of priors, and more of its shape than extremes matters. %}

Hayashi, Takashi & Ryoko Wada (2010) "Choice with Imprecise Information: An Experimental Approach," *Theory and Decision* 69, 355–373.

{% Ambiguity aversion is found for rhesus macaques. %}

Hayden, Benjamin Y., Sarah R. Heilbronner, & Michael L. Platt (2010) "Ambiguity Aversion in Rhesus Macaques," *Frontiers in Neuroscience* 4, Article 166.

{% **real incentives/hypothetical choice**: seems to be on it

Experiments with St. Petersburg paradox, and WTP. For 20 subjects done with real payments and BDM (Becker-DeGroot-Marschak), but unclear to me how the high payments, crucial here, were guaranteed. They find much risk aversion, and find the median outcome as a good predictor (so, something like second-flip outcome). WTP will contribute to that.

The theoretical claims in this paper are sometimes a bit strange. Because the expectation is considered undefined the authors write (p. 6): "It is fallacious therefore to argue that the St. Petersburg paradox has an infinite expected value." Some below it is erroneously suggested that under expected utility repetitions of the game should be disliked extra, whereas the law of large numbers will give the opposite. %}

Hayden, Benjamin Y. & Michael L. Platt (2009) "The Mean, the Median, and the St. Petersburg Paradox," *Judgment and Decision Making* 4, 256–272.

{% %}

Hayek, Friedriech A. (1960) "*The Constitution of Liberty*." Routledge and Kegan Paul, London.

{% %}

Hays, William L. & Robert L. Winkler (1970) "*Statistics: Probability, Inference and Decision*," Volumes I and II. Holt, Rinehart and Winston, New York.

{% %}

Hazen, Gorden B. (1987) "Subjectively Weighted Linear Utility," *Theory and Decision* 23, 261–282.

{% **dynamic consistency**: **favors abandoning time consistency, so, favors sophisticated choice**, discusses forgone-branch independence explicitly and assumes collapse independence implicitly.

Criticizes LaValle & Wapman (1986). The paper, however, seems to assume choice only after the resolution of uncertainty, and not before as do LaValle & Wapman. Therefore, it discusses Alias (1) ⇒ (a) and (a) ⇒ (c). This discussion is useful, pointing out that either resolute choice or sophisticated choice is to be done, and favoring sophisticated choice (not using those terms). The example it gives favoring resolute choice is a different ball game (prior equity in distribution of risks over people). Brings up disadvantage of resolute choice of having to dragg along all past history. %}

Hazen, Gorden B. (1987) "Does Rolling Back Decision Trees Really Require the Independence Axiom?," *Management Science* 33, 807–809.

{% %}

Hazen, Gorden B. (1989) "Ambiguity Aversion and Ambiguity Content in Decision Making under Uncertainty," *Annals of Operations Research* 19, 415–434.

{% %}

Hazen, Gordon, Emanuele Borgonovo, & Xuefei Lu (2023) "Information Density in Decision Analysis," *Decision Analysis* 20, 89–108.
https://doi.org/10.1287/deca.2022.0465

{% **utility elicitation** %}

Hazen, Gorden B., Wallace J. Hopp, James M. Pellisier (1991) "Continuous-Risk Utility Assessment in Medical Decision Making," *Medical Decision Making* 11, 294–304.

{% %}

Hazen, Gorden B. & Jia-Sheng Lee (1991) "Ambiguity Aversion in the Small and in the Large for Weighted Linear Utility," *Journal of Risk and Uncertainty* 4, 177–212.

{% Nice. %}

Hazewinkel, Michiel (1995, ed.) "*Encyclopeadia of Mathematics*." Kluwer Academic Publishers, Dordrecht.

{% They consider 89 decision models and inspect their overlaps/differences using landscape techniques. These inspect how one model can accommodate the phenomena of the other model. %}

He, Lisheng, Wenjia Joyce Zhao, & Sudeep Bhatia (2020) "An Ontology of Decision Models," *Psychological Review* 129, 49–72.
http://dx.doi.org/10.1037/rev0000231

{% **Prospect theory not cited**
Shows that having been exposed to more risky choice situations in the past increases risk aversion. Does so by measuring certainty equivalents using choice lists. The last sentence of the abstract shows the authors' enthusiasm about their finding when they write: "This finding has important theoretical and policy implications."
%}

He, Tai-Sen & Fuhai Hong (2018) "Risk Breeds Risk Aversion," *Experimental Economics* 21, 815–835.
https://doi.org/10.1007/s10683-017-9553-0

{% They assume a preference functional G(EU, PT) where EU is the expected utility of a lottery, PT the 1992 prospect theory value, and G strictly increasing in both variables, +regularity. They consider optimal stopping, where sometimes a naïve agent will never stop playing, and they consider interval strategies (continue playing when in the interval but stopping when hitting the upper or lower bound), for naïve, resolute, and sophisticated agents. %}

He, Xue Dong, & Sang Hu (2024) "Never Stop or never Start? Optimal Stopping under a Mixture of CPT and EUT Preferences," *Journal of Economic Theory* 222, 105925.
https://doi.org/10.1016/j.jet.2024.105925

{% Seems to show that individual stocks and underdiversified portfolios have positive skewness. %}

He, Xue Dong, Roy Kouwenberg, & Xun Yu Zhou (2018) "Inverse S-Shaped Probability Weighting and Its Impact on Investment," *Mathematical Control & Related Fields*, 8, 679–706.
http://dx.doi.org/10.2139/ssrn.3067189

{% Solve/discuss a number of analytical problems in optimizing portfolio choice under PT (they write CPT), giving closed-form solutions. Consider both when reference point is risk-free rate, and when it is different. The paper cites the close Bernard & Ghossoub (2010).

P. 318: Their small u is what Wakker (2010) denotes U and calls global utility. Beware that their u_- (they indicate gain-loss by the subscript) is defined on $\mathbb{R}^+$, and for a loss $x < 0$, $-u_-(-x)$ gives its utility, as it is with Bernard & Ghossoub (2010).

P. 318 ff., §3, discussed in detail the case when the optimal solution is to invest infinitely (ill-posedness). Btw, Kothiyal, Spinu, & Wakker (2011 JRU) give truncation-preference conditions that directly show when the PT value of a prospect is infinite. P. 318 penultimate para, strangely, claims that an infinite-investment solution must mean wrong incentives, with footnote 9 neutralizing the claim.

P. 319: propose a nice new index of loss aversion, being $\lim_{x\to\infty} -U(-x)/U(x)$.

P. 322, 2nd column 2nd para: contrary to what the authors suggest, Köbberling & Wakker (2005) do recommend piecewise utility, e.g. linear or exponential, and only argue against it when power utility. K&W also do point out that the problems do not arise if powers for gains and losses are the same. And K&W do not put inconsistencies of loss aversion central between big and small amounts, but between the same amounts when described in different units (10 dollars versus 1000 cents). %}

He, Xue Dong & Xun Yu Zhou (2011) "Portfolio Choice under Cumulative Prospect Theory: An Analytical Treatment," *Management Science* 57, 315–331.

{% Consider RDU with inverse S-shaped probability weighting. They also give roles to aspiration, fear, and hope levels of Lopes. They propose as index of fear the Pratt-Arrow index of w, which they define for general p but apparently only want to use near p = 1. Indexes of hope and aspiration are also proposed. Numerical illustrations and applications to portfolio optimization are given. %}

He, Xue Dong & Xun Yu Zhou (2016) “Hope, Fear, and Aspirations,” *Mathematical Finance* 26, 3–50.

{% **event/outcome driven ambiguity model: outcome driven**

Considers a two-stage model, called TSE, with backward induction, which is a case of recursive expected utility. An equivalent formulation, actually used here, is a one-stage model with separable events, partitioning the universal event, upon which one can condition. Then one can take them as endogenous endowed with a “there exists” quantifier, a way in which exogenous concepts can always be endogenized. Therefore, I consider the model of this paper to be a case of recursive expected utility.

Say, C_1, …, C_n is a partition of the universal event with separable events. Because the terms “first-order” vs. “second-order” are ambiguous in the literature, I call the C_j events conditioning events. Whereas in the Anscombe-Aumann framework, most commonly used in the literature, the C_j are ambiguous and their subevents are risky, this paper does it the other way around, and has the conditioning events risky. Thus, it is not a horse-lottery, but a lottery-horse, or, as Machina once said, jokingly, the Aumann-Anscombe framework. Jaffray (personal communication) argued in favor of it because the separability required for the conditioning events is more convincing for risky events than for uncertain events. The author nicely cites Jaffray’s view.

Acts depending only on the C_js are called *risky*. The author assumes SEU both for risky acts and acts conditional on every C_j, where the utility functions of the conditional SEU models can depend on C_j. Conditional on each C_j there is ambiguity. Axiomatizations can readily by devised, but are not given in the paper and only in the online appendix. I usually do not read those and they cannot serve to get credit (or to provide proofs of theorems). For a good view on this point, see Spiegler (2023). I could imagine that the events C_j could be taken as risky if they were given beforehand, so were exogenous, with probabilities known. But the author emphasizes the opposite, that they are endogenous. Then why they would be taken as risk I do not understand.

The uncertainty conditional on every Cj is taken as a separate source by the author. Thus, a source partitions only a subset of the universal event. Such a concept of source appeared also in Chew & Sagi (2008). In He's paper, different sources even concern disjoint events. This is different in papers by Tversky and papers by me. There, a source always spans the whole universal event. Different sources can be different algebras of events.

The author does not give experimental evidence, or a preference foundation, in the main text, but discusses many economic applications. Proposition 3 presents an implication that Gul & Pesendorfer's (2014; GP14) expected uncertain utility theory would be a special case of his TSE theory, but it is not clear to me to what extent this is rather for a generalization of his theory with maybe something like hedge-dependent probabilities added. The more so as, conditional on each C_j, GP14 deviate from EU, and the model of the author does not.

The author spends most of the paper on elaborating on economic applications. %}

He, Ying (2021) "Revisiting Ellsberg and Machina's Paradoxes: A Two-stage Evaluation Model under Ambiguity," *Management Science* 67, 6934–6945. https://doi.org/10.1287/mnsc.2020.3835

{% This paper considers a variation of the smooth ambiguity model, or recursive expected utility (EU), with a difference being that the ambiguous events come at the end and not at the beginning. It continues on He (2021 *Management Science*), and in my annotations there I argue in favor of this approach. It gives a dynamic extension to multi-periods. The paper axiomatizes its model. At every intermediate period, agents only have to determine the current probabilities of reaching the first-next node, and not yet of reaching nodes farther in the future. At every intermediate node, there is another two-stage recursive EU model with node-dependent risky events. %}

He, Ying (2024) "Recursive Two-Stage Evaluation Model for Dynamic Decision Making under Ambiguity," *Journal of Mathematical Economics* 113, 103022. https://doi.org/10.1016/j.jmateco.2024.103022

{% Assume a cardinal value function V, representing strength of preference, available, as in the Dyer-Sarin value-utility models. Capture effects of satiation and habit formation. %}

He, Ying, James S. Dyer, & John C. Butler (2013) "On the Axiomatization of the Satiation and Habit Formation Utility Models," *Operations Research* 61, 1399–1410.

{% **discounting normative**: Seems to argue that discounting is irrational. %}

Heal, Geoffrey (2009) "Climate Economics: A Meta-Review and Some Suggestions," *Review of Environmental Economics and Policy* 3, 4–21.

{% %}

Health Psychology (1995) Vol. 14 no. 1, on HIV

{% **value of information**: do expected value of info of sample information, and discuss computability problems. %}

Heath, Anna, Natalia Kunst, Christopher Jackson, Mark Strong, Fernando Alarid-Escudero, Jeremy D. Goldhaber-Fiebert, Gianluca Baio, Nicolas A. Menzies, & Hawre Jalal on behalf of the Collaborative Network for Value of Information (ConVOI) (2020) "Calculating the Expected Value of Sample Information in Practice: Considerations from 3 Case Studies," *Medical Decision Making* 40, 314–326.
https://doi.org/10.1177/0272989X20912402

{% **value of information**: sophisticated calculations of it are done in medical decision making. This paper reviews them. %}

Heath, Anna, Ioanna Manolopoulou, & Gianluca Baio (2017) "A Review of Methods for Analysis of the Expected Value of Information," *Medical Decision Making* 37, 747–758.

{% Investigate stock option exercise by over 50,000 employees. (Shifting) reference points, different from status quo but based for example on maximal past performance, with risk aversion for gains and risk seeking for losses, could explain things. **concave utility for gains, convex utility for losses**: The assumption of concave utility for gains and convex utility for losses explains their data well. The location of the reference point is a central point in their analysis.

The paper never considers loss aversion. I would expect that for the mixed case, where we are close to the reference point and the option may end above but also below the reference point, we would find extreme risk aversion because of loss aversion. Thus, risk aversion is moderate for very low reference points, extreme for intermediate reference points, and low (even risk seeking) for high reference points. But none of that is reported or discussed. %}

Heath, Chip, Steven Huddart, & Mark Lang (1999) "Psychological Factors and Stock Option Exercise," *Quarterly Journal of Economics* 114, 601–627.

{% %}

Heath, Chip, Richard P. Larrick, & George Wu (1999) "Goals as Reference Points," *Cognitive Psychology* 38, 79–109.

{% **ambiguity seeking**: football & politics study reveals ambiguity seeking.

PT: data on probability weighting;

This paper was the first to introduce the basic ideas of source dependence (a term not yet used in this paper) into ambiguity. It is great to see these valuable ideas expressed. Unfortunately, the experiments are not good, having too many confounds, and not being incentive compatible. Tversky & Kahneman (1992) mention the concept source and do use the term, but do not elaborate much on it. Hence, I usually cite Tversky & Fox (1995) for it. This 1991 paper still keeps things narrow by having source dependence driven by competence. There can be many other factors. Tversky & Fox (1995) also quite narrowly focus on the competence effect.

P. 6 $\ell\ell$. 6-7: point out that ambiguity had better be called vagueness.

P. 6: Cites Raiffa (1961) affirmatively on the irrationality of ambiguity: "Several authors, notably Ellsberg (1963), maintain that aversion to ambiguity can be justified on normative grounds, although Raiffa (1961) has shown that it leads to incoherence." It suggests that Tversky considered expected utility to be rational. One can discuss Raiffa's arguments, primarily because it implicitly assumes dynamic decision principles à la Hammond (1988) that are known to imply EU, and that are questioned by nonEUers (not by me Bayesian).

P. 6 penultimate para: "Ellsberg's example, and most of the subsequent experimental research on the response to ambiguity or vagueness, were confined to chance processes, such as drawing a ball from a box, or problems in which the decision maker is provided with a probability estimate. The potential significance of ambiguity, however, stems from its relevance to the evaluation of evidence in the real world. Is ambiguity aversion limited to games of chance and stated probabilities, or does it hold for judgmental probabilities? We found no answer to this question in the literature, but there is evidence that casts some doubt on the generality of ambiguity aversion." (**natural sources of ambiguity**) The next para cites studies casting doubts on ambiguity aversion. The authors use the term chance event for what I often call artificial ambiguity, and judgmental problems involving epistemic uncertainty for (a subset of?) what I often call natural ambiguity.

P. 7 has argued, narrowly, that ambiguity attitude is driven by competence. Then: "We assume that our feeling of competence[1] in a given context is determined by what we know to what can be known. … There are both cognitive and motivational explanations for the competence hypothesis." The text then explains the competence effect as an irrational carry-over from other situations. Suggests that it is more motivational than cognitive, and comes from credit/blame. Then suggests that experts can augment credit after good decision, and reduce blame, suggesting that judgments by others (or other part of the self) is what drives these things.

P. 9 first full para suggests that Ellsberg might be due to difference between pre- and post-diction. Throughout Tversky's writings one sees that he does not believe that the Ellsberg paradox says something substantive about uncertainty/ambiguity attitude.

P. 10, §1.1: Experiment 1 asks for judged probabilities and then matches those with objective probabilities, which is a way to control for beliefs when studying ambiguity. (It is not manipulation-proof if known ahead.) Subjects betted both on events and on their complements (**source preference directly tested**). Part of the subjects were paid for real. They use the term regression hypothesis, referring to Einhorn & Hogarth, for what I now call likelihood insensitivity or **inverse S.** For high probability judgments subjects prefer to bet on the ambiguous events, which is explained by competence. Experiment 5 also considers bets on events and on their complements, but does so between subjects. Tversky (personal communication) pointed out that a problem in the Einhorn-Hogarth studies was that they did not control for (statistical) regression. I think that this Heath & Tversky study, while providing great ideas, has similar problems in its experiments.

P. 14: "We next took the competence hpothesis to the floor of the Republican National

Convention": swollen language.

P. 22 near bottom: points 1 and 2 are similar to the separation between probabilistic sophistication and expectation maximization.

P. 23 ℓ. 8 ff. has a nice sentence: "under the standard interpretation of the Bayesian theory, the two concepts coincide. As we go beyond this theory, however, it is essential to distinguish between the two."

Section 2.1 criticizes Einhorn & Hogarth studies for not properly controlling for belief when studying ambiguity (p. 26 ℓ. 3):
"a regressive shift in the perception of probability".

P. 26: "If willingness to bet on an uncertain event depends on more than the perceived likelihood of that event and the confidence in that estimate, it is exceedingly difficult—if not impossible—to derive underlying beliefs from preferences between bets." %}

Heath, Chip & Amos Tversky (1991) "Preference and Belief: Ambiguity and Competence in Choice under Uncertainty," *Journal of Risk and Uncertainty* 4, 5–28.
https://doi.org/10.1007/BF00057884

{% **Dutch book** etc. %}

Heath, David, David A. Lane, & William D. Sudderth (1972, 1978, 1985, 1989, JRSSB (1980).

{% %}

Heaton, John & Deborah Lucas (1997) "Market Frictions, Savings Behavior, and Portfolio Choice," *Macroeconomic Dynamics* 1, 76–101.

{% Takes some journal on risk and insurance, and gives tables of authors who published most there. In the list of the three elite journals (JRU, *Geneva Risk and Insurance Review*, and *Journal of Risk and Insurance*) 1984 – 2013 I have a 7th place. %}

Heck, Jean (2013) "The Most Prolific Contributing Authors to the Leading Risk Management and Insurance Journals: 1984-2013," working paper.

{% Empirical tests of bargaining solutions %}

Heckathorn, Douglas D. (1978) “A Paradigm for Bargaining and a Test of Two Bargaining Models,” *Behavioral Science* 23, 73–85.

{% Empirical tests of bargaining solutions %}
Heckathorn, Douglas D. (1980) “A Unified Model for Bargaining and Conflict,” *Behavioral Science* 25, 261–284.

{% %}
Heckerling, Paul S., Marion S. Verp, & Teresa A. Hadro (1994) “Preferences of Pregnant Women for Amniocentesis or Chronic Villus Sampling for Prenatal Testing: Comparison of Patients’ Choices and Those of a Decision-Analytic Model,” *Journal of Clinical Epidemiology* 47, 1215–1228.

{% **intuitive versus analytical decisions**; Test whether intuitive choices of women for a prenatal test agree more with decision analysis based on their own value assessments or on physicians’ value assessments, and to what extent that provides arguments for desirability yes-or-no of more autonomy. I disagree with their main discussions and conclusions because they assume that decision rules should agree as much as possible with intuitive natural choice. The latter is the case only for descriptive purposes but not at all for prescriptive purposes, as already Raiffa (1961, p. 690/691) explained nicely. %}
Heckerling, Paul S., Marion S. Verp, & Nancy Albert (1999) “Patient or Physician Preferences for Decision Analyis: The Prenatal Genetic Testing Decision,” *Medical Decision Making* 19, 66–77.

{% expert systems, medical, using Bayesian methods; compare Hanson; contains discussion of certainty-factor, belief functions, etc. %}
Heckerman, David E., Eric J. Horvitz, & Bharat N. Nathwani (1992) “Toward Normative Expert Systems: Part I The Pathfinder Project,” *Methods of Information in Medicin* 31, 90–105.

{% Argue against representative-agent assumption, and for importance of heterogeneity. %}

Heckman, James J. (2001) "Micro Data, Heterogeneity, and the Evaluation of Public Policy: Nobel Lecture," *Journal of Political Economy* 109, 673–748.

{% This paper gives statistical evidence that top universities overweigh the importance of publications in the top-5 journals in economics. It points out that many influential papers appear elsewhere. The abstract ends with the beautiful sentence "Reliance on the T5 to screen talent incentivizes careerism over creativity." This one sentence alone is enough to love this paper! %}

Heckman, James J. & Sidharth Moktan (2020) "Publishing and Promotion in Economics: The Tyranny of the Top Five," *Journal of Economic Literature* 58, 419–470.
https://doi.org/10.1257/jel.20191574

{% **Dutch book**: Discusses relations between beliefs and decision making. End of §3 discusses Schmexpected utility (he uses exactly this term), which is expected utility minus any assumption on the probability numbers. So, he argues for using nonadditive probabilities, and does so with fixed-probability transformation. He just argues that this is acceptable. %}

Hedden, Brian (2013 "Incoherence without Exploitability," *Nous* 47, 482–495.

{% %}

Hedrich, Reiner (2007) "The Internal and External Problems of String Theory: A Philosophical View," *Journal for General Philosophy of Science* 38, 261–278.

{% First saw this presented at the ZIF-Bielefeld on May 18, 2000.
Assumes that society starts with subjective probabilities for each individual. At each next timepoint, people update their probabilities by mixing with subjective probabilities of others. People with similar subjective probabilities are incorporated, those with probabilities more different than some ε-distance, are ignored as too different. Then simulations demonstrate how the viewpoints of society develop. Depending on the weights assigned to others' subjective probabilities, and ε, society converges to one common viewpoint, or to two

extreme viewpoints, or to other things. Nice graphs illustrate this development.
This nice work could be in prominent general-public journals, on tv, etc. %}
Hegselmann, Rainer & A Flache (1998) "Understanding Complex Social Dynamics—A Plea for Cellular Automata Based Modelling," *Journal of Artificial Societies and Social Simulation* 1, no. 3.

{% %}
Heidhues, Paul & Koszegi Botond (2010) "Exploiting Naivite about Self-Control in the Credit Market," *American Economic Review* 100, 2279–2303.

{% **common knowledge**; readable version of Mertens & Zamir (1985) %}
Heifetz, Aviad (1993) "The Bayesian Formulation to Incomplete Information - The Non-Compact Case," *International Journal of Game Theory* 21, 329–338.

{% %}
Heil, Sara H., Jennifer W. Tidey, Heather W. Holmes, & Stephen T. Higgins (2003) "A Contingent Payment Model of Smoking Cessation: Effects of Abstinence and Withdrawal," *Nicotine and Tobacco Research* 5, 205–213.

{% **Dutch book**; nice refs. P. 337 gives an example of !two! book makers for a boat race in 1971 who offered different odds so that a clever client could make book against these two book makers. %}
Heilig, Klaus (1978) "Carnap and de Finetti on Bets and the Probability of Singular Events: The Dutch Book Argument Reconsidered," *British Journal for the Philosophy of Science* 29, 325–346.

{% %}
Heilmann, Conrad & Peter P. Wakker (2017) Interview, *The Reasoner* 11, 26–29.
Direct link to paper

{% Emotions affect risky decisions. This paper considers to what extent this works indirectly, through emotions regulations, rather than directly the emotions. It measures such things using introspective questionnaires. They find that ermotions

regulation does not remove, but does reduce, the effect of emotions. The authors do it for the emotions of fear and trust, induced by movies. %}

Heilman, Renata M., Liviu G. Crisan, & Daniel Houser (2010) "Emotion Regulation and Decision Making under Risk and Uncertainty," *Emotion* 10, 257–265.

{% Beautiful data set of 190,000 traders over 150 countries, who had to submit plans of trading in future situations.

P. 331: "We find that a dynamic framework that features the overweighting of small probabilities, reference dependence, and diminishing sensitivity such as cumulative prospect theory (Tversky and Kahneman 1992) is most consistent with the observed behavioral patterns. As Barberis (2012) demonstrates theoretically, the discrepancy between static and dynamic environments is not driven by the intrinsic nature of the environments per se, but by the fact that people's "loss-exit" strategies in the latter can generate a level of positive skew that is unavailable in the static case. The overweighting of low probability outcomes leads to a greater willingness to accept a risky bet as part of a "loss-exit" strategy than the same bet in isolation."

P. 332: "We document a robust dynamic inconsistency in risky choice. Using a unique brokerage dataset and a series of experiments, we compare people's initial risk-taking plans to their subsequent decisions. Across settings, people accept risk as part of a loss-exit strategy—planning to continue taking risk after gains and stopping after losses. Actual behavior deviates from initial strategies by cutting gains early and chasing losses. More people accept risk when offered a commitment to their initial strategy. Our results help reconcile seemingly contradictory findings on risk-taking in static versus dynamic contexts. We explore implications for theory and welfare." They confirm the disposition effect, and the reflection effect of prospect theory.

In an experiment with prior commitment, subjects are more risk-seeking when they integrate all their decisions rather than when they take them in isolation. Confirms also that people do backward induction rather than resolute. (**dynamic consistency**). P. 336 relates findings to the pretty Cubitt, Starmer, & Sugden (1998 EJ), finding only their time independence violated, in agreement with their finding. %}

Heimer, Rawley, Zwetelina Iliewa, Alex Imas, & Martin Weber (2025) "Dynamic Inconsistency in Risky Choice: Evidence from the Lab and Field," *American Economic Review* 115, 330–363.
https://doi.org/10.1257/aer.20210307

{% %}

Heinemann, Frank, Rosemarie Nagel, & Peter Ockenfels (2004) “The Theory of Global Games on Test: Experimental Analysis of Coordination Games with Public and Private information,” *Econometrica* 72, 1583–1600.

{% **probability elicitation**: applied to experimental economics.

Imagine the 2-player game where each can choose safe (A) or risky (B), with payoffs, for some parameter $0 < x < 15$

	A	B
A	x^x	x^0
B	0^x	15^{15}

The notation A, B is used in the paper. It is a coordination game. If both go risky, they gain $15 > x$. There are two pure NE (Nash equilibria), (A,A) and (B,B). The randomized NE is ((15–x)/15: A, x/15: B) for both players. It has the counterintuitive property of decreasing probability of choosing the safe x as x increases. (Because the more the opponent must be deterred from always choosing x.) It is symmetric but not stable. All NE are symmetric, so, conceivable if both players are chosen randomly from one “uniform/symmetric” population.

The authors measure, for several values of x, whether players prefer A or B. Unsurprisingly, increasing the safe x decreases willingness to choose the risky B. The authors consider variations with $N > 2$ players and a minimum of k B choices needed to get the reward 15 for all who entered (and 0 for the enterers if too few entered), but default below is that I consider only the two-player version.

For each player, the switching value x is called the certainty equivalent (CE) of the player for the game. This is an unconventional interpretation because x itself is part of the definition of the game. With increasing x the probability of sufficiently many others choosing B will decrease, affecting the optimal strategy in the game, as the authors point out in some places (e.g. p. 213 just above the displayed formula “when the alternative safe payoff from A is X_c”).

The authors also measure CEs, conventional now, of lotteries (p:15, 1–p:0), for various parameters p. If a lottery (p:15, 1–p:0) and a game with parameter x have the same CE, and if (subjective) expected utility is assumed (also for the game, and with the same utility function U always (U player-dependent)), then it does follow that p is the subjective probability of an opponent choosing B *in the game with x*, even if x is not a CE in a conventional manner. So, p is a matching probability in this sense. This method of measuring CEs and matching probabilities cannot be applied very generally because of the unconventional nature of CE x (contrary to the authors' suggestion of generality in the final para on p. 219), but here it works. One restriction is, for instance, that the authors can derive the CE only for games that have a sure constant as option, where that constant furthermore has to be exactly the CE. I just derived the matching probability from a kind of transitivity that, in fact, could do without the assumption of EU. The authors, instead, assume EU and derive a utility function U from the risky CEs, which they then use to derive matching probabilities and so on for the game. P. 189 penultimate para discusses this, mentioning that they want to measure risk attitude also. Unlike my transitivity reasoning, the authors' derivation will be distorted by violations of EU. I would interpret the matching probability as capturing ambiguity attitude + beliefs, rather than only beliefs. Working with SEU, the authors suggest, following some other economists, that, the moment subjective probabilities have been assigned, the case is (like) decision under risk. In the source method for ambiguity that I like to work with, this is not so, and there can be different ambiguity attitudes in the game for instance than for the risky lotteries (where it is ambiguity neutrality), even though there are subjective probabilities describing beliefs in the game.

Pp. 189-190 argues that a separate measurement of belief (with an extraneous parameter not part of the (definition of) the game) has the problem of income effect and even influencing the game. P. 213 ℓ. 4/5 reiterates the point. But, procedures have been developed to avoid this, involving that randomly only the game or the belief measurement is implemented. Belief only concerns what the opponent will do, something a player cannot influence. P. 191 4th para writes that, in sessions where beliefs were measured with proper scoring rules, the authors paid both for one randomly chosen game and for one randomly chosen belief measurement.

The authors find plausible results when x, k, or N are varied. Page 182 3rd para (& p. 213 3rd para from below) describe how small probabilities are overestimated and high ones are underestimated (comparing derived subjective probabilities to percentages of subjects choosing B). This confirms likelihood insensitivity (**ambiguity seeking for unlikely**).

Pp. 182-183 discuss the application of individual risk theory to game theory. (**game theory can/cannot be viewed as decision under uncertainty**). They take strategic uncertainty as a case of ambiguity (they call it endogenous uncertainty), relating it to Knight (1921).

P. 213, the derivation in §7.1 could be simplified by normalizing U(0) = 0, U(15) = 1. Some steps in the analysis I did not understand, where I conjecture typos.

P. 216 3rd para points out that altruism/social preferences could lead to more willingness to play B, and overestimation of probabilities. %}

Heinemann, Frank, Rosemarie Nagel, & Peter Ockenfels (2009) “Measuring Strategic Uncertainty in Coordination Games,” *Review of Economic Studies* 76, 181–221.

{% Don’t come all the way to preference axiomatizations, but list many qualitative criteria that come close. %}

Heink, Ulrich & Ingo Kowarik (2010) “What Criteria Should Be Used to Select Biodiversity Indicators?,” *Biodiversity and Conservation* 19, 3769–3797.

{% The smaller the subjective life expectancy of subjects relative to the long-time-duration offered in TTO, the more willing they are to trade off life years to gain health quality. %}

Heintz, Emelie, Marieke Krol, & Lars-Ake Levin (2013) “The Impact of Patients’ Subjective Life Expectancy on Time Tradeoff Valuations,” *Medical Decision Making* 33, 261–270.

{% %}

Heisenberg, Werner (1930) “*The Physical Principles of the Quantum Theory*.” (Translated into English by Carl Eckart & Frank C. Hoyt). Dover Publications, New York.

{% P. 158 about indeterminacy of location/momentum of particle (Heisenberg’s uncertainty principle). Related is Bohr’s principle of complementarity: two quantities are complementary if measurement of one excludes measurement of the other. %}

Heisenberg, Werner (1959) "*Physics and Philosophy*." London.

{% %}
Hek, Paul de & Santanu Roy (2001) "On Sustained Growth under Uncertainty," *International Economic Review* 42, 801–813.

{% This paper displays so-called Vancouver rules of co-authorship in Box 1 on p. 334, which seems to target the health domain although the rules seem to be way too restrictive given the general leniency in the health domain to include many co-authors. It discusses to which extent this can be applied to deceased authors. The paper seeks to be careful but is verbose and slow.

One important argument that I found missing concerns the reputation and fame of the deceased co-author. The authors still alive may wrongly put up a famous deceased person as co-author just to benefit from it. Hence, for famous deceased co-authors the academic community should be extra careful to have him/her appear as co-author, and the role of good proxies (people representing the interests of the deceased author) are then extra important.

I once was a referee of a paper where someone, say X, misused the co-authorship of a famous deceased person to overly praise his own past works and claim wrong priorities in a way that the deceased person would never have allowed. Fortunately, the editor was a good proxy and the paper, which got accepted, had to remove all those wrong claims. %}
Helgesson, Gert, William Bülow, Stefan Eriksson, & Tove E Godskesen (2019) "Should the Deceased Be Listed as Authors?," *Journal of Medical Ethics* 45, 331–338.
https://doi:10.1136/medethics-2018-105304

{% **updating: discussing conditional probability and/or updating**; **foundations of statistics**; about theorem of Birnbaum. %}
Helland, Inge S. (1995) "Simple Counterexamples against the Conditionality Principle," *American Statistician* 49, 351–356.

{% Long-run growth rate of population is by heterogeneous, least and most risk-averse agents maximize EV and EU with log. %}

Heller, Yuval & Ilan Nehamab (2023) "Evolutionary Foundation for Heterogeneity in Risk Aversion," *Journal of Economic Theory* 208, 105617. https://doi.org/10.1016/j.jet.2023.105617

{% The authors present an evolutionary model that explains preference for positive skewness. This also supports inverse S probability weighting of prospect theory, although the authors do not mention that. %}
Heller, Yuval & Arthur Robson (2021) "Evolution, Heritable Risk, and Skewness Loving," *Theoretical Economics* 16, 403–424. https://doi.org/10.3982/TE3949

{% Short-term investments for continuous time: all risk averters behave the same way, as if having constant risk aversion (CARA). %}
Heller, Yuval & Amnon Schreiber (2020) "Short-Term Investments and Indices of Risk," *Theoretical Economics* 15, 891–921. https://doi.org/10.3982/TE3678

{% For brightness, heat, etc., people are more sensitive towards changes from adapted levels than to absolute levels. %}
Helson, Harry (1964) "*Adaptation Level Theory: An Experimental and Systematic Approach to Behavior*." Harper and Row, New York.

{% %}
Hellman, Ziv (2007) "An Imprecise Day at the Races," in preparation; the Shalem Center, Jerusalem, Israel.

{% **Z&Z**; propitious selection is opposite of adverse selection. %}
Hemenway, David (1990) "Propitious Selection," *Quarterly Journal of Economics* 105, 1063–1069.

{% Seems to distinguish between fundamental and derived measurement. %}
Hempel, Carl G. (1952) "*Fundamentals of Concept Formation in Empirical Science*." University of Chicago Press, Chicago.

{% Describes Semmelweis' famous empirical investigation into childbed fever, done in the 1840s in Vienna. %}

Hempel, Carl G. (1966) "*Philosophy of Natural Science.*" Prentice-Hall, Englewood Cliffs, NJ.

{% **updating under ambiguity with sampling**

Urn 1 contains 7 white and 3 orange balls, and Urn2 has these reversed, as is known to subjects in an experiment. As the subjects know, one is randomly chosen by a computer, but which one subjects do not know. A ball is randomly sampled with replacement 7 times. Each time its color is revealed to the subjects, and then they are asked to specify their subjective probability of the urn being Urn1. This whole procedure is in fact done seven times. Thus, every subject does 49 updatings. For so many updatings the correction method of Offerman et al. (2009) is worthwhile, and it is done here.

It is considered if and how subjects deviate from Bayesian updating. The authors consider a double hurdle model. This is a general term for models where people first consider if at all they act (the first hurdle) and then to what extent (the second hurdle). Here the first hurdle is whether at all subjects update, and the second is to what extent. As for the second hurdle, subjects update insufficiently, multiplying by likelihood ratio to the power 0.8 on average, whereas Bayes formula wants it to the power 1. They also consider a complexity treatment, in which info is given in a complex manner, and an inattention treatment, in which a distracting task is given to generate inattention, and these treatments of course bring more deviation from Bayesianism.

The discussion at the end of §2.3, where on the one hand the authors want inattention but on the other they don't, was hard to understand.

There have been many experimental papers on updating in 1960-1990. I was glad to see that the authors cite Phillips & Edwards (1966). (This journal has a bad tradition of ignoring such literature.) %}

Henckel, Timo, Gordon D. Menzies, Peter G. Moffatt, & Daniel J. Zizzo (2022) "Belief Adjustment: A Double Hurdle Model and Experimental Evidence," *Experimental Economics* 25, 26–67. https://doi.org/10.1007/s10683-021-09701-2

{% Finds that PT can accommodate the disposition effect well. %}
Henderson, Vicky (2012) "Prospect Theory, Liquidation, and the Disposition Effect," *Management Science* 58, 445–460.

{% **dynamic consistency**: Ebert & Strack (2015 American Economic Review) presented a model in which prospect theory maximizers always continue gambling. This paper adds the possibility to randomize, defines everything formally, and then shows that everything changes, where agents can stop. %}
Henderson, Vicky, David Hobson, & Alex S.L. Tse (2017) "Randomized Strategies and Prospect Theory in a Dynamic Context," *Journal of Economic Theory* 168, 287–300.

{% Did things similar to Jaffray (1989). %}
Hendon, Ebbe, Hans-Jörgen Jacobsen, Birgitte Sloth, & Torben Tranaes (1994) "Expected Utility with Lower Probabilities," *Journal of Risk and Uncertainty* 8, 197–216.

{% %}
Hendon, Ebbe, Hans-Jörgen Jacobsen, Birgitte Sloth, & Torben Tranaes (1996) "The Product of Capacities and Belief Functions," *Mathematical Social Sciences* 32, 95–108.

{% %}
Hendon, Ebbe, Hans-Jörgen Jacobsen, & Birgitte Sloth (1996) "The One-Shot-Deviation Principle for Sequential Rationality," *Games and Economic Behavior* 12, 274–282.

{% For ambiguous events, asks people to give best-estimate probability, but next asks for interval around it to express uncertainty about it (taken as ambiguity). This is like multiple priors, although strictly formally speaking probability intervals is a bit different than sets of priors. The paper also manipulates the ambiguity of events by moving them more into the future, making them more ambiguous. It also elicits ambiguity indexes as in Baillon, Bleichrodt, Li, & Wakker (2021 Journal of Economic Theory). The order of measuring the indexes and eliciting

subjective probability intervals is randomized, and no order effect is found. This defends against subjects being framed into probability-interval-thinking. The paper finds that the insensitivity index is strongly positively related to the size of the sets of priors, which provides good empirical evidence of what many theoretical papers have conjectured. It is also positively related to the ambiguity of events, again, as is plausible. The author also finds no relation between ambiguity aversion and ambiguity perception. %}

Henkel, Luca (2024) "Experimental Evidence on the Relationship between Perceived Ambiguity and Likelihood Insensitivity," *Games and Economic Behavior* 145, 312–338.
https://doi.org/10.1016/j.geb.2024.03.015

{% Opens with describing societies where it is believed that young boys should fellate and drink semon so as to achieve manhood.

Weird means Western educated, industrialized, rich, and democratic. The authors give many examples where the weird subjects are very different than other people. The authors exaggarate negatively:

"are among the least representative populations one could find" (abstract).

End of §61: Except for students, most people punish/reject hyper-fair offers in the ultimatum game. Pp. 83-135 provide comments by others.

The weird subjects may, even if not very representative, be interesting. Thus, I agree with Rozin's reply on p. 108 ff. They are in the presently dominant society in the world, disseminating its culture through tv and so on more than any other culture.

P. 93, answer by Gaertner et al., is the silly thing of researchers saying that all is wrong that does not study their particular small topic of specialization. Commentary by Maryanski on p 103 ff. rightly points out that the authors exaggarate. %}

Henrich, Joseph, Steven J. Heine, & Ara Norenzayan (2010) "The Weirdest People in the World?," *Behavioral and Brain Sciences* 33, 61–135.

{% Let farmers in rural areas in Chili, and UCLA undergrads, choose between risky prospects (one nonzero outcome) and their expected values. Expectations of prospects were about 1/3 day's salary. Probabilities were 0.05, .020, .050, 0.80.

The farmers were very risk seeking.

real incentives/hypothetical choice: All choices were first administered, and then ALL were played out for real. Hence, there will have been income effects and, in view of law of large numbers, all prospects will have been about indifferent. For these reasons, the data are not very interesting other than for an explicit study of repeated choice.

The undergrads were risk averse for 0.05 and 0.20, risk neutral for 0.80, and very risk seeking for 0.50 [**risk seeking for symmetric fifty-fifty gambles**]. When asked about latter, undergrads said things such as "It's a good chance" or "it's fair." These data go against the fourfold pattern of **inverse S.** %}

Henrich, Joseph & Richard Mcelreat (2002) "Are Peasants Risk-Averse Decision Makers?," *Current Anthropology* 43, 172–181.

{% %}

Henrion, Max, Ross D. Shachter, Laveen N. Kanal, & John F. Lemmer (1990, eds.) "U*ncertainty in Artificial Intelligence* 5'," North-Holland, Amsterdam.

{% %}

Hens, Thorsten (1992) "A Note on Savage's Theorem with a Finite Number of States," *Journal of Risk and Uncertainty* 5, 63–71.

{% %}

Hens, Thorsten & Christian Reichlin (2013) "Three Solutions to the Pricing Kernel Puzzle," *Review of Finance* 17, 1065–1098.

{% Version of June used the outdated term issue instead of the common terms source. "Issue" was introduced by Ergin & Gul (2009), but when they discovered that Tversky's term source is more common they switched to that in later papers.

This paper assumes that the state space is a product set of different sources, and considers aversion to multi-source dependence. %}

Heo, Youngsoo (2021) "Uncertainty Aversion with Multiple Issues," working paper.

{% %}

Herdegen, Martin (2017) "No-Arbitrage in a Numéraire-Independent Modeling Framework," *Mathematical Finance* 27, 568–603.

{% **one-dimensional utility** %}
Herden, Gerhard (1995) "On Some Equivalent Approaches to Mathematical Utility Theory," *Mathematical Social Sciences* 29, 19–31.

{% **one-dimensional utility**; Generalize Debreu topological-separability conditions. %}
Herden, Gerhard & Vladimir L. Levin (2012) "Utility Representation Theorems for Debreu Separable Preorders," *Journal of Mathematical Economics* 48, 148–154.

{% **equity-versus-efficiency**: seems to be on it. %}
Herne, Kaisa & Maria Suojanen (2004) "The Role of Information in Choices over Income Distributions," *Journal of Conflict Resolution* 48, 173–193.

{% **conservation of influence**: citation from Keynes (1921, p. 307): "There is nothing more profitable for a man than to take good counsil with himself; for even if the event turns out contrary to one's hope, still one's decision was right, even though fortune has made it of no effect.: whereas if a man acts contrary to good council, although by luck he gets what he had no right to expect, his decision was not any the less foolish." %}
Herodotus vii. 10.

{% Probability weighting can be due to misperception of probability, as a straight error, but also due to deliberate transformation, which some consider to be rational. These authors firmly choose the first interpretation, that it is misperception. Many authors have pointed out that probability weighing, or, for that matter, any bias can be useful if it neutralizes another bias, possibly brought about by circumstances outside the agent. This paper cites such literature on that in the last para of p. 113 and the first two paras on p. 114. The weak weak Steiner & Stewart (2016 AER) is cited, but the strong van den Steen (2004 American Economic Review) is not. This paper shows that inverse S probability weighting can be good if it neutralizes biases in the utility function. It gives evolutionary interpretations. %}

Herold, Florian & Nick Netzer (2023) "Second-Best Probability Weighting," *Games and Economic Behavior* 138, 112–125.
https://doi.org/10.1016/j.geb.2022.12.005

{% %}
Herrmann, Andreas, Rüdiger von Nitzsch, & Frank Huber (1998) "Referenzpunktbezogenheit, Verlustaversion und Abnehmende Sensitivität bei Kundenzufriedenheitsurteilen," *Zeitschrift für Betriebswirtschaft* 11, 1225–1243.

{% **cognitive ability related to risk/ambiguity aversion**: Test Allais paradox (common ratio) in poor rural area, in North-East Thailand. Find 54% doing violation of EU, which is some more than usually found. This between-study comparison suggests that poor people commit Allais more. Within-study comparisons: Allais violation of EU is enhanced by: Lack of ability (poor education, unemployment, little financial education), general instrospective-questionnaire risk seeking, general instrospective-questionnaire optimism, violation of Tversky-Kahneman-Birnbaum type of stochastic dominance. Not affected by gender or age.
math-related cognitive ability and memory-verbal cognitive ability have 0.37 correlation (p. 145). %}
Herrmann, Tabea, Olaf Hübler, Lukas Menkhoff, & Ulrich Schmidt (2017) "Allais for the Poor: Relations to Ability, Information Processing, and Risk Attitudes," *Journal of Risk and Uncertainty* 54, 129–156.

{% Seems that he proposed the, too broad, term matching law. %}
Herrnstein, Richard J. (1961) "Relative and Absolute Strength of Response as a Function of Frequency of Reinforcement," *Journal of the Experimental Analysis of Behavior* 4, 267–272.

{% **information aversion**, w.r.t. AIDS testing or Huntington's disease (I don't know which) %}
Herrnstein, Richard J. (1990) "Rational Choice Theory: Necessary, but Not Sufficient," *American Psychologist* 45, 356–367.

{% %}

Herrnstein, Richard J., George F. Loewenstein, Drazen Prelec, & William Vaughan, Jr. (1993) "Utility Maximization and Melioration: Internalities in Individual Choice," *Journal of Behavioral Decision Making* 6, 149–185.

{% %}

Herrnstein, Richard J. & Drazen Prelec (1991) "Melioration: A Theory of Distributed Choice," *Journal of Economic Perspectives* 5 no. 3, 137–156.

{% %}

Herron, Richard & Yehuda Izhakian (2020) "Ambiguity, Risk, and Payout Policy," SSRN 2980600.

{% %}

Herron, Richard & Yehuda Izhakian (2020) "Mergers and Acquisitions: The Role of Ambiguity," SSRN 3489549.

{% Use the well-known Ellstein et al. (1986, AJM, on estrogen) to, nicely, illustrate current issues in decision theory.

paternalism/Humean-view-of-preference: they argue that normative theory can help to correct deviations.

P. 207: "When we make decisions for ourselves, consideration of our own regret may be rational (especially if we think we cannot avoid it)." The bracket remark is, I think, the essence.

P. 208 argues that standard gamble utility measurement may be distorted because of certainty effect. "In particular, many people prefer sure things to gambles on general principles, as it were." (**PE doesn't do well**)

Suggest direct measurement of utility difference as alternative.

P. 208: "On the other hand, a feeling of ambiguity is often a sign that there are additional data we ought to be seeking or waiting for."

paternalism/Humean-view-of-preference: p. 210: "Subjects should be confronted with their discrepancies from normative models —or discrepancies between decisions resulting from different ways of presenting the same problem —and asked to explain themselves." %}

Hershey, John C. & Jonathan Baron (1987) "Clinical Reasoning and Cognitive Processes," *Medical Decision Making* 7, 203–211.

{% **inverse S**, **utility elicitation** results suggest such probability transformations; **PE higher than CE**: probability equivalents give more risk aversion than CEs (certainty equivalents).

insurance frame increases risk aversion: some nice things for **Z&Z** on p. 949/950: people are more risk averse when a choice question is formulated as taking insurance than as gambling.

nonlinearity in probabilities %}

Hershey, John C., Howard C. Kunreuther, & Paul J.H. Schoemaker (1982) "Sources of Bias in Assessment Procedures for Utility Functions," *Management Science* 28, 936–953.

{% **PT falsified** & **reflection at individual level for risk**: They present data that violate reflection by measuring risk attitudes for both gains and losses, both between and within subjects. There are no clear patterns and findings, and there are relations in all directions. Unfortunately, they do not report correlations, but only patterns of risk seeking/risk aversion, which is similar to median splits. Tversky & Kahneman (1992, p. 308) will criticize this research for underestimating the unreliability of individual choices.

Table 3 and p. 409: more risk aversion for gains than risk seeking for losses.

risk averse for gains, risk seeking for losses: Table 3 is nice way to inspect data. Fourfold pattern is confirmed with one exception: For gains with probabilities below .01, down to .001, they do not find risk seeking. For probabilities .1 and .2 they do. For losses they do find the fourfold pattern of risk aversion for small probabilities but risk seeking for moderate and high probabilities.

insurance frame increases risk aversion: seems they have that. %}

Hershey, John C. & Paul J.H. Schoemaker (1980) "Prospect Theory's Reflection Hypothesis: A Critical Examination," *Organizational Behavior and Human Performance* 25, 395–418.

{% **insurance frame increases risk aversion**: seem to find that presenting risky decisions in context of insurance enhances risk aversion. %}

Hershey, John C. & Paul J.H. Schoemaker (1980) "Risk Taking and Problem Context in the Domain of Losses: An Expected Utility Analysis," *Journal of Risk and Insurance* 47, 111–132.

{% **utility elicitation**

concave utility for gains, convex utility for losses: find that;

PE higher than CE: Best reference for viewpoint that extreme risk aversion in PE version of standard gamble results from loss aversion. That is, the subject chooses certain outcome as status quo, then gamble becomes mixed (has gain and loss), and then loss aversion leads to extreme risk aversion. Robinson, Loomes, & Jones-Lee (2001) give a nice confirmation through qualitative interviews.

They first had subjects do CE, finding x = CE ~M_pm, but then week later asked questions back finding PE = q st. x ~M_qm. For consistency we should have q = p. They also did it with order of CE and PE reversed, and did it for both gains and losses. I did the same in Wakker (2008, MDM) to falsify the healthy years equivalent method, but never wrote this experiment down. %}

Hershey, John C. & Paul J.H. Schoemaker (1985) "Probability versus Certainty Equivalence Methods in Utility Measurement: Are They Equivalent?," *Management Science* 31, 1213–1231.

{% %}

Herstein, Israel N. & John Milnor (1953) "An Axiomatic Approach to Measurable Utility," *Econometrica* 21, 291–297.

{% A survey.

ubiquity fallacy: intro does the usual overselling of suggesting that "decision from experience" capture all decisions in life that are not "decisions from description." %}

Hertwig, Ralph (2012) "The Psychology and Rationality of Decisions from Experience," *Synthese* 187, 269–292.

{% First three pages give nice overview of the basic approach of DFE. P. 536 seeks to disentangle direct experience and repeated decisions as causes of underweighting of unlikely events, by comparing repeated decisions design with sampling design. These both have that outcomes are not experienced (being informed about points added is not experiencing outcomes I think).

ubiquity fallacy: p. 535:

"Outside the laboratory, however, people often must make choices without a description of possible choice outcomes, let alone their probabilities. Because people can rely ***only*** on personal experience under such conditions, we refer to these as *decisions from experience*. Only a few studies have investigated *decisions from experience* in humans. In one (Barron & Erev 2003) …"

%}

Hertwig, Ralf, Greg Barron, Elke U. Weber, & Ido Erev (2004) "Decisions from Experience and the Effect of Rare Events in Risky Choice," *Psychological Science* 15, 534–539.
https://doi.org/10.1111/j.0956-7976.2004.00715.x

{% **real incentives/hypothetical choice**: Authors discuss topic mostly from an economic perspective (criticizing psychologists). For instance, p. 384 2nd para ends with:

> The experimental standards in psychology, by contrast, are comparatively laissez-faire, allowing for a wider range of practices. The lack of procedural regularity and the imprecisely specified social situation "experiment" that results may help to explain why in the "muddy vineyards" (Rosenthal 1990, p. 775) of soft psychology, empirical results "seem ephemeral and unreplicable" …

This is, indeed, negative about psychology.

Then there follows a very long list of comments by many people, many prominent, and a reply, up to p. 451. Impressive!

P. 402 footnote 9 on definition of deception. %}

Hertwig, Ralf & Andreas Ortmann (2001) "Experimental Practices in Economics: A Challenge for Psychologists?," *Behavioral and Brain Sciences* 24, 383–403.

{% %}

Hertwig, Ralf & Andreas Ortmann (2004) “The Cognitive Illusion Controversy: A Methodological Debate in Disguise That Matters to Economists.” *In* Rami Zwick & Amnon Rapoport (eds.) *Experimental Business Research,* 361–378, Kluwer, Dordrecht.

{% Test comprehension of probability in representative Swiss sample, finding that exposure to games of chance and education increase understanding, but more so in abstract problems than in real-world problems. (**cognitive ability related to risk/ambiguity aversion**) %}

Hertwig, Ralph, Monika Andrea Zangerl, Esther Biedert, & Jürgen Margraf (2008) “The Public’s Probabilistic Numeracy: How Tasks, Education and Exposure to Games of Chance Shape It,” *Journal of Behavioral Decision Making* 21, 457–470.

{% Comments on version of version of 10 June 2024.

Unlike NR (Nielsen & Rehbeck 2022), they do not seek to examine or incentivize the adoption of general axioms or proper ways of reconciling with such axioms, but instead to find out precisely when violations of an axiom were intentional or not (“mistakes”). Hence, in stage 3, all subjects repeated all choices, being completely free to change any way. Roughly, a difference in violation at repetition than at first signals no intention somewhere. The authors develop a more refined classification, for which I refer to the paper. It did not in any way involve the stage-1 prior commitment to an axiom.

The authors retain NR’s “mechanistic” presentation of axioms (calling them choice assistants), letting prior choices automatically imply later ones. Btw., which in itself more often will worsen rather than improve decisions even if the axiom is rational, contrary to NR’s claims, but Herweg et al. do not intend to get into this point and put their focus elsewhere. Thus, they just stay close to NR, and axiom endorsement is implemented as follows, in separate choices only for that in a separate part. In that part, a choice situation is chosen where an axiom would bring an implication based on a prior choice made in stage 2. If the subject chose to endorse the axiom, the implied choice is automatically (“mechanistically”) implied without the subject reconsidering or choosing anything. If the subject did not endorse the axiom, the subject has to “independently” choose again. I disagree with NR and think that also here (if we can ignore decision costs) rational subjects should NEVER endorse an axiom, also if they, like me, think that axiom is rational. Later intuitive choices are, other things equal, better than early choices because of learning and, hence, later choices better overrule early choices than the other way around.

I think that NR's finding of wide acceptance of axioms was a combination of experimenter demand and incomprehensibility of explanations to subjects. Herweg et al. avoid discussing the issue by writing in footnote 7 (in version of 10 June 2024): "In our analysis, we take as given the insight of NR that axiom selection is not driven by experimenter demand effects, avoidance of responsibility or algorithm aversion but reflects a manifestation of genuine preferences over axioms."

Herweg et al. did carry out several improvements in NR's experiment, such as explaining lotteries at first appearance, using graphical presentations, avoiding mixtures, and letting choice axioms truly reduce decision costs. Thus, axioms could be better understood by subjects and their acceptances were not just driven by experimenter demand. Accordingly, unlike NR, Herweg et al. found that subjects could distinguish between the axioms, treating some as more convincing than others. And axioms were considerably less often accepted and way more violations were intentional than with NR. Herweg et al. find that 24% of subjects adhere to the axioms, 24% make occasional mistakes, and 52% deliberate violate axioms.

Herweg et al. use a matrix presentation and a verbal presentation of lotteries (the latter specifies events and not just probabilities, so gives info on correlations). They do not find differences between the two presentations.

Axiom endorsement was taken in badge, i.e., either the axiom was followed in all relevant situations, or not.

Both tests of branch independence involve the certainty effect.

As the authors properly explain, the different violations of stochastic dominance in NR was because NR used tricky stimuli there. %}

Herweg, Fabian, Svenja Hippe, Daniel Muller, & Fabio Romeis (2024) "Axiom Preferences and Choice Mistakes under Risk," working paper.

{% The authors study mathematical relations and differences between regret theory and salience theory of Bordalo, Gennaioli, & Shleifer (2012 QJE). However, they do not use original salience theory, but a continuous variation of it. (I regret that the authors do not state this.) Then it is a special case of generalized regret theory, as explained in my annotations there:

$(p_1{:}x_1,\ldots, p_n{:}x_n) \succcurlyeq (p_1{:}y_1,\ldots, p_n{:}y_n) \;\Leftrightarrow\; \sum_{s=1}^{n}\psi(x_s,y_s) \geq 0$

for a bivariate function Ψ satisfying natural conditions. This paper derives this formally. It also shows that original regret theory is a special case of continuous salience theory.

Here is the authors' definition of salience theory in Eq. 5, p. 7. The decision weight of state s is

$$\frac{f(\sigma(x_s, y_s)),}{\sum_{r=1}^{S} f(\sigma(x_r, y_r))p_r}\, p_s$$

where S denotes the number of states of nature r, each with probability p_r. Note that the normalization in the denominator does not matter because the preference functional is unique up to multiplication by any positive funtion g(x,y) that can entirely depend on the gambles x,y. Only its sign matters. But this is essentially different than salience theory. In salience theory, instead of the above functions $f(\sigma(x_s, y_s))$, there is a function depending also on $\sigma(x_r,y_r)$ for r different than s, through the ranking of $\sigma(x_s,y_s)$ among the $\sigma(x_r,y_r)$. This leads to an essentially different theory. Generalized regret theory as above, and then the authors' Eq. 5, satisfy a strong separability condition across disjoint events. Salience theory does less so, for one reason because the sure-thing principle, that it does satisfy, is not very strong in the absence of transitivity. Diecidue & Somasundaram (2017) introduced a weakening of transitivity, called d-transitivity (dominance-transitivity), saying that the implication of transitivity still holds of one of the two premise preferences is based on dominance. The preceding generalized regret theory satisfies it, but, as can be shown, Bordalo, Gennaioli, & Shleifer's (2012) salience theory does not.

The authors write below eq. 5 that f preserves ranking, which is trivially equivalent to f being strictly increasing, and does not help for the above problem. %}

Herweg, Fabian & Daniel Müller (2021) "A Comparison of Regret Theory and Salience Theory for Decisions under Risk," *Journal of Economic Theory* 193, 105226.

{% Principal-agent with agent loss averse à la Köszegi-Rabin. %}
Herweg, Fabian, Daniel Müller, & Philipp Weinschenk (2010) "Binary Payment Schemes: Moral Hazard and Loss Aversion," *American Economic Review* 100, 2451–2477.

{% Hesiodus is a Greek poet living maybe 8th century before Christ. Not clear if before or after Homerus. Some nice citations for DFE:
"A fool is he who learns not until from experience" (my translation of "Een dwaas is hij die pas door ondervinding wijs wordt", the Dutch translation of the Greek text.)
The fool knows after he's suffered;
The fool by suffering his experience buys
Even a fool learns by experience
Experience is the mistress of fools. %}
Hesiodus (–800). In Wolther Kassies (2002, translator) "*De Geboorte van de Goden van Werken en Dagen.*" Athenaeum—Polak & Van Gennep.

{% Seems to write also on: total harm of seeding hurricanes is reduced but they went to Cuba and Castro objected, so the US stopped. %}
Hess, Wilmot N. (1974) "*Weather and Climate Modification.*" Wiley, New York.

{% **revealed preference**: probabilistically %}
Heufer, Jan (2011) "Stochastic Revealed Preference and Rationalizability," *Theory and Decision* 71, 575–592.

{% Efficient ways to test quasi-concavity of preference in the probability triangle from observed choices from budget-subsets. %}
Heufer, Jan (2012) "Quasiconcave Preferences on the Probability Simplex: A Nonparametric Analysis," *Mathematical Social Sciences* 65, 21–30.

{% **revealed preference**: Shows that deriving SARP from WARP is equivalent to a question on Hamiltonian graphs. Gives graph-theoretic meaning to revealed preference. %}

Heufer, Jan (2014) “A Geometric Approach to Revealed Preference via Hamiltonian Cycles,” *Theory and Decision* 76, 329–341.

{% Revealed-preference implementation of Yaari’s (1969) more-risk-averse relation. Theory and an application to Choi et al.’s (2007) data set. %}
Heufer, Jan (2014) “Nonparametric Comparative Revealed Risk Aversion,” *Journal of Economic Theory* 153, 569–616.

{% Nice history, such as on who was colleague of who, and that von Neumann hired Savage as young assistant. Many references. But no deep understandings. %}
Heukelom, Floris (2015) “A History of the Allais Paradox,” *British Journal for the History of Science* 48, 147–169.
https://doi.org/10.1017/S0007087414000570

{% %}
Hevell, Steven K. & Frederick A.A. Kingdom (2008) “Color in Complex Scenes,” *Annual Review of Psychology* 59, 143–166.

{% %}
Hey, John D. (1984) “The Economics of Optimism and Pessimism,” *Kyklos* 37, 181–205.

{% **error theory for risky choice**; **Best core theory depends on error theory**: seems to be. %}
Hey, John D. (1995) “Experimental Investigations of Errors in Decision Making under Risk,” *European Economic Review* 39, 633–640.

{% Repetition reduces noise for some subjects, but not for all. %}
Hey, John D. (2001) “Does Repetition Improve Consistency,” *Experimental Economics* 4, 5–54.

{% **dynamic consistency**: Paper nicely and clearly emphasizes that plans in themselves cannot be inferred from observed choice in any obvious way. P. 125: “self-reported plans—for which there is no incentive for correct reporting.”

Do a new experiment where people announce a plan and then can deviate if they are willing to pay a little fee for that. Then people do not want to deviate. Maybe, more than the cost of deviating itself, is it that people then become aware that it makes sense to be dynamically consistent. %}

Hey, John D. (2005) "Do People (Want to) Plan?," *Scottish Journal of Political Economy* 52, 122–138.

{% **Best core theory depends on error theory**: seems to be. %}

Hey, John D. (2005) "Why We Should not Be Silent about Noise," *Experimental Economics* 8, 325–345.

{% **survey on nonEU**, regarding ambiguity. %}

Hey, John D. (2014) "Choice under Uncertainty: Empirical Methods and Experimental Results." *In* Mark J. Machina & W. Kip Viscusi (eds.) *Handbook of the Economics of Risk and Uncertainty* Vol. 1, 809–850 (Ch. 14), North-Holland, Amsterdam.

{% They test EU against two betweenness theories, finding that one improves EU but the other does not. %}

Hey, John D. & Daniela Di Cagno (1990) "Circles and Triangles: An Experimental Estimation of Indifference Lines in the Marschak-Machina Triangle," *Journal of Behavioral Decision Making* 3, 279–306.

{% **quasi-concave so deliberate randomization**: take this as hypothesis to justify stochastic choice, and use quadratic utility; empirically it did not work well. %}

Hey, John D. & Enrica Carbone (1995) "Stochastic Choice with Deterministic Preferences: An Experimental Investigation," *Economics Letters* 47, 161–167.

{% **dynamic consistency**; find in experiments that part of the subjects plan through the whole decision tree, and some don't plan at all. %}

Hey, John D. & Julia A. Knoll (2007) "How Far Ahead Do People Plan?," *Economics Letters* 96, 8–13.

{% Let subjects work out three-stage dynamic decision tree with software that makes recoverable what subjects did. Some do backward induction, but most don't do anything clear, and there is no clear conclusion. %}

Hey, John D. & Julia A. Knoll (2011) "Strategies in Dynamic Decision Making – An Experimental Investigation of the Rationality of Decision Behaviour," *Journal of Economic Psychology* 32, 399–409.

{% **random incentive system**: Test it and find it confirmed. Closing sentence (p. 263): "The conclusion seems to be that experimenters can continue to use the random incentive mechanism and that this paper can be used as a defence against referees who argue that the procedure is unsafe." Argue that isolation facilitates the RIS. %}

Hey, John D. & Jinkwon Lee (2005) "Do Subjects Separate (or Are They Sophisticated)?," *Experimental Economics* 8, 233–265.

{% **random incentive system**: Test it and find it confirmed. Test spillover effect—whether answers in experiments are affected by previous questions (like learning)—and find no evidence for it. %}

Hey, John D. & Jinkwon Lee (2005) "Do Subjects Remember the Past?," *Applied Economics* 37, 9–28.

{% **dynamic consistency**; Test the dynamic decision approaches, resolute, naïve, sophisticated, empirically, in a nice design to disentangle them. Also ask for evaluations of trees so as to test for indifference versus strict preference. Unfortunately, the data are noisy and give no clear pattern. The stimuli may have been too complex. There is a confound in their design. In Trees 3 and 4 (p. 8) there is an alternative that clearly dominates one other. It is well known that this generates a context effect of attracting subjects to take the dominating alternative more than the nondominated alternative, as demonstrated by Tversky & Simonson (1993) and many others. It is indeed what happens in the data.

deception when implementing real incentives: I regret much that the authors used deception, not playing for real what is suggested to the subjects in the beginning. There is no good reason for doing so, and the authors did it only to reduce their work load; i.e., the number of subjects to be run and the money to be paid to subjects (p. 13 last para).

Unfortunately, the second sentence of §2 incorrectly claims that the authors are the first to test the conditions with real incentives. They next modify by saying that they will only consider studies with “appropriate” real incentives. (**real incentives/hypothetical choice, explicitly ignoring hypothetical literature**) This is characteristic of a bad convention among experimental economists: If person A first developed some idea, and tested it with hypothetical choice, and then person B does all the same but with real incentives, then experimental economists will credit all priority to person B and completely ignore person A. Even if we ignore this point, the authors have a second problem: Contrary to what they write in footnote 13, Busemeyer et al. (2000) did use real incentives, in their experiments 2 and 3. This paper by Hey & Lotito has enough extra to offer, such as the nice considerations of strengths of preferences. %}

Hey, John D. & Gianna Lotito (2009) “Naïve, Resolute or Sophisticated? A Study of Dynamic Decision Making,” *Journal of Risk and Uncertainty* 38, 1–25.

{% Incentives: use RIS; **losses from prior endowment mechanism** (subjects can lose £10, but are paid £10 a priori).

Use nice bingo blowers, a transparent device containing balls in three colors that are continuously moved around, so that subjects can only vaguely see the composition of the urn and have degrees of ambiguity. The more balls the harder to assess, so, the more ambiguity.

Urn 1 (15 subjects): 2 pink, 5 blue, and 3 yellow balls;
Urn 2 (17 subjects): 4 pink, 10 blue, and 6 yellow balls;
Urn 3 (16 subjects): 8 pink, 20 blue, and 12 yellow balls (p. 90).
Each subject sees only one urn. Each next urn is more ambiguous than the one before.

Nicely, they test all kinds of theories of uncertainty/ambiguity. They consider three outcomes, being –£10, £10, and £100. They use cross-validation: one part of the data set is used to calibrate the parameters of the models, and then another part is used to test predictive performance.

The data set, and the general scheme of testing many popular ambiguity theories, making them all tractable, are great, and could have led to a top paper. Unfortunately, there are many theoretical mistakes. The authors use several wrong formulas especially regarding the two versions of prospect theory. This invalidates the results and claims made.

I here use their notation CPT for the new 92 prospect theory, rather than my own (and Tversky's!) preferred PT. And I use their PT instead of my preferred OPT for the 79 version of prospect theory.

They test:

1. EV, 3 parameters: 2 probabilities and error variance s.

2. EU, 4 parameters: EV-ones + one U parameter (U(−10) = 0; U(100) = 1; U(10) is only U-parameter; p. 89);

3. CEU (Choquet expected utility), 8 parameters: EU-ones + 6 − 2 (instead of 2 subjective probabilities, now 6 for the capacity for six of the eight events, with the empty and universal event not counting because there the capacities are fixed at 0 and 1);

4. CPT of '92, 9 parameters: CEU parameters +, supposedly and incorrectly, one more for loss aversion.

5. PT of Kahneman & Tversky '79, 6 parameters: The EU ones + one more because subjective probabilities need not sum to 1 (or any other constant) + one more for loss aversion. This time loss aversion does genuinly generate an extra parameter, unlike with their CPT, because the decision weights need not sum to 1 implying that the 0 point of U matters.

6. DFT (Decision Field Theory of Busemeyer & Townsend 1993; called random SEU there), 4 parameters: As EU but different error theory. It, nicely, has the randomness on statewise utility differences and their probabilities.

7. Maxmin EU, 5 parameters: like EU, but with 3 minimum probabilities per state (so, the family of all priors where each state has at least that min. probability; the mins are supposed to add to less than 1) instead of 2 subjective probabilities (p. 95 footnote 16 and p. 109 are not clear on whether it is min or max probability, but it is min, as reanalyses by Amit Kothiyal showed).

8. Maxmax EU, 5 parameters: like maxmin.

9. α-maxmin (EU), 6 parameters: like maxmin but α is one more.

10. Maxmin, 1 parameter, probability of trembling-hand theory.

11. Maxmax, 1 parameter like maxmin.

12. Minimal, 1 parameter regret like maxmin.

They do not test the smooth model because they have no multiple stages. P. 103 top, correctly points out that with the two-stage decomposition endogenous, as in the smooth model of KMM, there are too many parameters.

There are two problems with their CPT calculation (p. 88 & p. 108).

PROBLEM 1. They have no sign-dependence of weights. CPT in full generality would have all weights for losses completely independent of those for gains. This in its full generality means more parameters, which is not always good. If we don't want to increase the number of parameters relative to CEU, then a plausible special case is taking the nonadditive measure the same for losses as for gains, but then using the formula of CPT rather than of CEU, which means weighting the losses dually relative to gains (à la reflection), and not the same as under CEU. Then the total weights need not sum to 1 as they do under CEU (and then CEU would not be nested in CPT or vice versa). This non-summing to 1 gives empirical meaning to setting utility 0 at a reference point (say, 0). The authors do the weighting fully the same as under CEU, so that the weights always sum to 1. Given that they also have a fixed reference point (0) under what they call CPT, what they call CPT is a special case of CEU. The utility- and loss-aversion-part is further discussed in the next Problem 2, where I will show that what they call CPT is data-equivalent to what they call CEU.

PROBLEM 2. They think to implement loss aversion for CPT by not normalizing U(–10) = 0 and instead normalizing U(0) = 0 (p. 89 ℓ.–5 of middle para), leaving U(–10) < 0 free. But this does not work. What they call CPT is data-equivalent to CEU. It all has to do with, for a fixed reference point as is the case here (0 is the reference point), CPT generalizing CEU only because of sign-dependence of decision weights which they do not have, and for CEU the rescaling of U(0) = 0 having no empirical impact. Here is a more detailed explanation:

Recall that event-weighting in their CPT is done the same way as in CEU. In particular, the decision weights of the events always sum to 1, something typical of CEU. This means that utility is unique up to unit and level (cardinal, interval scale). In other words, adding any constant to utility and multiplying utility by any positive constant at the outcomes –10, 10, and 100 does not affect the preference relation. The former increases all values of prospects by that same constant which does not affect preference, and the latter multiplies all values of prospects by that same positive constant which again does not affect preference.

OBSERVATION 1. Any CPT representation in their paper is a CEU representation.

PROOF. Denote the utility function under CPT by U. I define a U´ leading to a CEU representation as follows:

$$U´(.) \ = \ [U(.) - U(-10)]/[U(100) - U(-10)].$$

U´(–10) = 0 and U´(100) = 1, as desired. Thus, any representation called CPT in their paper can be turned into a representation called CEU that represents the same preference relation.

QED QED QED QED QED QED QED QED QED QED QED

What they call CPT therefore does not generalize CEU.

OBSERVATION 2. Any CEU representation in their paper is a CPT representation.

PROOF. Denote the utility function under CEU by U. I define a U* leading to a CPT representation. There are several ways to do this. At any rate we will have

$$U^*(100) = U(100) = 1.$$

Further

$$U^*(-10) < U(-10) = 0$$

implies that also

$$U^*(10) < U(10).$$

Further

$$U^*(0) = 0$$

implies

$$U^*(10) > 0.$$

So, we can define

$$U^*(10) = z$$

for any value z with

$$0 < z < U(10) \ (< 1).$$

Then we define, at 100, 10, and –10:

$$U^*(.) \ = \ \{(1-z)/[1-U(10)]\}U(.) \ - \ [U(10)-z]/[1-U(10)].$$

We, indeed, have U*(100) = 1, U*(10) = z, and

$U(-10) = -[U(10)-z]/[1-U(10)] < 0$.

So, we can define

$$U^*(0) = 0$$

which does not affect preference but has utility increasing by being between $U^*(-10)$ and $U^*(10)$.

Thus, if we start from a CEU representation as in this paper, then we can choose any value $U^*(10)$ strictly between 0 and $U(10)$, and then get a CPT representation with that U^* that represents the same preference relation.

QED QED QED QED QED QED QED QED QED QED QED

SUMMARY of Problem 1: what this paper calls CPT is, regarding core theory, identical to what it calls CEU, representing the same preference relations.

Another way to put the point is that for three outcomes −10, 10, and 100, only one parameter of utility is relevant when weights always add to 1 (which in fact is CEU): the ratio of utility differences

$$[U(10) - U(-10)] / [U(100) - U(-10)] .$$

In view of the above, differences in predictions (via statistical fittings) of CEU and CPT can result only from the error theory working out differently numerically under the different scalings of utility (although the division by $V(xmax) - V(xmin)$ on p. 91 ℓ. −3 in their probabilistic theory suggests that rescaling of utility will not matter).

Besides the above two problems for CPT, there are more problems.

PROBLEM 3. This problem concerns the implementation of PT (p. 88 & pp. 107-108). PT of KT 79 was originally defined for risk with given probabilities. This paper extends it to uncertainty by assuming subjective probabilities (probabilistic sophistication) and then applying (supposed to be) PT formulas. Extending to uncertainty this way in itself is fine. One problem is that PT is defined only for two nonzero outcomes, and this paper has three. For some prospects (only two outcomes, and both gains, so being 10 and 100) PT as defined by K&T 79 is RDU, using rank-dependent weighting, but this paper does not do that. What his paper does is more like an attempt to use Edwards-type transformation of separate-outcome probabilities (Wakker 2010 Eq. 5.3.3), which is called Separable Prospect Theory (SPT) by Camerer & Ho (1994, p. 185) for instance. (**SPT instead of OPT**)

However, this is still not what they really do. Problem is that for 2-color events they take as weight simply the sum of the weights of the two colors (this appears for instance from only taking weights of the three single-color events on p. 95 -see also p. 108 top para-, and not of 2-color events), whereas a crucial point of the theories mentioned is nonadditivity: The weight of a 2-color event is NOT the sum of the two 1-color events. So, they just have additivity there. Nonadditivity only shows up with the 3-color event involved.

They write on p. 88 ℓ. 4 that, indeed, their theory is like EU the only difference being that the sum of weights of the three atomic ("singular") events, concerning one color, need not be 1. Big question is then how they take the weight of the (3-color) universal event, relevant for sure outcomes. If they take the sum of the three probabilities then this is just data-equivalent to EU, dropping the normalized probability 1, and there is no violation of monotonicity, but also this is just EU which is bad given that it is called PT. It seems that they take weight 1 for the universal three-color event, and not the sum of the three probabilities, and then there can be violations of monotonicity. Their theory then is EU with the only exception being that sure outcomes are over- or underweighted in utility relative to all else. This is in fact a (probabilistically sophisticated version of) a model called utility of gambling. The latter has EU for nondegenerate prospects but degenerate prospects are evaluated using a different utility function, reflecting the utility of (not) gambling. If the utility function for uncertainty is U then the utility function for certainty is kU for a k not equal to 1. Diecidue, Schmidt, & Wakker (2004, JRU, Observation 7) shows that this necessarily violates stochastic dominance. This also happens if k > 1, where k is the reciprocal of the sum of the three probabilities. This means that subadditivity does not help here, somewhat unlike a suggestion, not very explicitly, in footnote 10 on p. 88. That footnote suggests that they assume subadditivity, and erroneously ascribes it to Kahneman & Tversky (1979). Empirically, superadditivity is commonly found and especially Tversky argued for it in support theory.

SUMMARY OF PROBLEM 3. What they call PT is a version of the utility of gambling models. It is too distinct from PT, and even from the separable version of it, to be called PT.

PROBLEM 4. A fourth unsatisfactory implementation concerns the different treatment of the multiple prior models relative to the rank-dependent models. For multiple priors they take a tractable 3-dimensional subset (of all probability distributions for which the probabilities of the single events exceed a lower bound. The three lower bounds are the parameters. But for CEU/CPT they do not do this and take CEU/CPT in full generality. In a 2007 version of their paper they wrote that multiple priors (then taken in full generality) is simply too general to fit any data. Hence, to make it work they were forced to take a subset of the theory. But for CEU/CPT it would have been fair to do the same. Given that their source of uncertainty (one urn per subject) is reasonably uniform in the terminology of Abdellaoui et al. (American Economic Review, 2011), CEU/CPT would be nice with probabilistic sophistication and a one- or two-parameter fitted weighting function, having only 1 or 2 parameters more than EU, and being the same in this regard as multiple priors.

PROBLEM 5. The fifth problem (p. 85) concerns the distinction between direct decision rules and preference functionals. They consider maxmin and maxmax (and minimal regret) to be direct decision rules, but these obviously are preference functionals just as much, with max or min outcome as preference functional value. The distinction becomes unfortunate because they use different error theories for what they call direct decision rules (p. 91). Because the three direct-decision-rule theories are not very important anyhow, this fifth problem is not important.

The main text suggests that there is another problem with MaxMin and MaxMax, that the appendix however seems to put right. Main text: Whereas for the alpha model the authors seem to appropriately take a set of priors, for G&S MaxMin they seem to take minimum probabilities per event, and not minimums of probability distributions, with similar problems for MaxMax. It may, for instance, happen for MaxMax that to get maximum probability at £100, the probability at £10 should not be maximal. The appendix pp. 108-109 puts things right by having MaxMax and MaxMin as special cases of alpha.

END OF FIVE PROBLEMS

Because of the problems mentioned, the empirical conclusions of this paper are not informative. These conclusions are that maxmax priors does best, maxmin and α maxmin do well also, and others do worse. Big pity that such a nice experimental data set has been analyzed incorrectly.

P. 83: when criticizing statistical testing of theories, the authors only consider the case where one theory is nested within another.

second-order probabilities to model ambiguity: p. 84 4th para: they point out that second-order probabilities are not really ambiguity, and nicely explain that implementing ambiguity is not so easy.

suspicion under ambiguity: p. 84 5th para: They claim that their bingo blower is not subject to suspicion, but do not argue clearly why. Why could not the researcher do visual tricks with it, or systematically have few balls of the winning color hoping for overestimation? That the subjects bet both on and against each color can help to rule out suspicion. A small remaining problem is that subjects may not know this and may still suspect that the ball compositions are deliberately unfavorable for the particular choice they consider.

P. 87 footnote 8 incorrectly suggests that the competence effect is [only] relevant for laboratory data. It also suggests that it can play no role in their study, but it can because urn 3 generates the least competence and urn 1 generates the most. P. 101 continues on this point.

P. 88 writes, erroneously, that CPT assign (subjective) probabilities to events and then transform these. Then CPT would imply probabilistic sophistication, which is not correct. P. 93 will write that CEU is nested within CPT, so that they did not assume probabilistic sophistication. P. 95 writes that for CPT the weights (capacities?) are “weighted probabilities,” but I am pretty sure that they treated them just as the capacities for CEU.

P. 89 writes that explaining BDM (Becker-DeGroot-Marschak) is too complex.

P 89: Every subject must make 162 binary choices. Must take at least 30 seconds per choice. So, the experiment takes more than 81 minutes per person. With so many choices for so much time, subjects can be expected to resort to a particularly simple heuristic. With outcomes 100, 10, and −10 it is mostly optimal to just maximize the chance/likelihood at 100. So, subjects are prone to just do this always (suggested by the authors on p. 103 penultimate para). This may explain why the maxmax model does best, and better than maxmin.

The paper sometimes claims, holding it against CEU and CPT, that models with more parameters always predict better and, hence, should be punished for the extra parameters. More parameters always give better fits, but for predicting they may mostly pick up noise (overfitting) and then predict worse, so, they are no clear advantage for prediction purposes.

They use Bayesian information criterion rather than AIC to account for extra parameters. Sometimes (p. 96 penultimate para, p. 98 2nd para) says that theories with more parameters should be judged more negative for it. But this feels like double counting because the info criteria and predictions already punishes for many parameters.

Summarizing, I admire the empirical setup with marvelous stimuli (based on big money and time investments, with the marvelous idea of the bingo-blower), and also the general plan of testing many ambiguity theories. Maybe from now on every new ambiguity theory should be forced to be calibrated on this data set. But there are several problems with the core-theoretical parts underlying the analyses in this paper, invalidating the empirical claims. %}

Hey, John D., Gianna Lotito, & Anna Maffioletti (2010) "The Descriptive and Predictive Adequacy of Theories of Decision Making under Uncertainty/Ambiguity," *Journal of Risk and Uncertainty* 41, 81–111.

{% **Compare different measurement methods**: real incentives: Everything is incentivized, using RIS. N = 24 subjects were interviewed five times, about half an hour per time. Consider 4 outcomes (0, 10, 30, 40 in £), and 28 probability distributions over them. Consider binary choices, bid-prices, ask-prices, and BDM (Becker-DeGroot-Marschak). Fit EU and RDU with an error theory added. Last para of §2 states that they assume all choices statistically independent, also within subjects. Find that RDU does not fit much better. One clear finding is that binary choice has less noise than the other (matching) procedures. In RDU, utility changes more than probability weighting between different elicitation methods. Utility parameters are even negatively correlated between different elicitation methods. %}

Hey, John D., Andrea Morone, & Ulrich Schmidt (2009) "Noise and Bias in Eliciting Preferences," *Journal of Risk and Uncertainty* 39, 213–235.

{% **error theory for risky choice**; **Best core theory depends on error theory**: seems to be inconsistency of 25% (**inconsistency in repeated risky choice**); conclude that expected utility with noise is most plausible explanation.

Probability weighting linear in interior: seem to find this.

I have a small and a big problem with this paper. The small one is that there is no clear conclusion. The authors' conclusion that expected utility works best is out of the blue, unrelated to their data. The big one is that they take the power family for probability weighting. This cannot incorporate the main empirical finding of the fourfold pattern with inverse S probability weighting. %}

Hey, John D. & Chris Orme (1994) "Investigating Generalizations of Expected Utility Theory Using Experimental Data," *Econometrica* 62, 1291–1326.

{% Use bingo blower (as in Hey, Lotito, & Maffioletti 2010) with three colors. Treatment 1 (66 subjects): 2 pink, 5 blue, and 3 yellow balls (66 subjects); Treatment 2 (63 subjects): 8 pink, 20 blue, and 12 yellow balls (63 subjects). Treatments are between subjects.

Subjects can invest an amound of money x in one event and m−x in another, where one event E_1 concerns one color and the other E_2 either one color (then no payment if the 3rd color) or two other colors. They receive e_1x if E_1 happens and $e_2(m-x)$ if E_2 happens, where the exchange rates e_1 and e_2 are set by the experimenter and vary over choices (if I understand right). A problem with such linear multiple-choice sets is that many functionals will usually predict corner solutions. Functionals that don't (such as with power utility because it has infinite derivative at 0, so, no 0 investment in an optimum) don't do so because of a weak point. In reality subjects choose interior solutions because of the compromise effect and maybe experimenter demand effects.

All prospects considered are two-outcome. 60 randomly chosen questions were used to calibrate the functionals, and then 16 for prediction.

The authors consider five theories that are all special cases of **biseparable utility** (see the unnumbered equation between Eqs. 14 and 15 on p. 16), although the authors use different names. For multiple prior theories they use, as sets of priors, sets with lower bounds for the three probabilities: P(pink) ≥ $\underline{p}_1$, P(blue) ≥

$\underline{p}_2$, P(yellow) ≥ $\underline{p}_3$, with the $\underline{p}_j$ summing to less than 1. (As in Hey, Lotito, & Maffioletti (2010), who did not write this point clearly.) So, it gives three free parameters. They consider no losses, so, CEU is the same as PT.

Their theories (with number of parameters specified on p. 17 ℓ. −3) are:
(1) SEU with 4 parameters (2 subjective probabilities, 1 utility, 1 error variance);
(2) CEU (**biseparable utility** in full generality) with 8 parameters; (6 capacities; 1 utility; 1 error variance);
(3) α-maxmin(AEU) with 6 parameters (3 for set of priors; 1 for α; 1 utility, and 1 error variance)
(4) What they call vector expected utility (VEU), but what in fact is **biseparable utility** with $w(p) = p-\delta$ for a δ that usually is positive but that is also allowed to be negative. This violates stochastic dominance if the best outcome has outcome-probability < δ. The authors always restrict δ to less than the minimal probability occurring in their experiment, but this is ad hoc and this specification of binary RRDU is therefore not useful. (I guess a similar restriction w.r.t. maximal probabilities applies for negative δ, but did not check.) It does the opposite of inverse S for small probabilities, not overestimating them but underestimating them. It is in fact neo-additive probability weighting with the two parameters the same except that one has the wrong sign. This theory has 5 parameters (2 subjective probabilities, 1 for δ, 1 utility, and 1 error variance);
(5) The contraction model (COM); note that the contraction model has the sets of priors Π as exogenously given, whereas this paper takes them as endogenous. Thus, the contraction model simply is identical to maxmin EU. The λ factor in their Eq. 13 is unidentifiable. 6 parameters (3 set of priors; 1 utility; 1 for λ, and 1 error variance);

Specification 1 assumes linear-exponential (CARA) utility, and specification 2 log-power (CRRA) utility. Specification 2 does better, and I think that this is because it accommodates the compromise effect better.

P. 3 discusses the difficulty of testing two-stage models experimentally.

P. 4 2nd para does not understand the role of the subjective (also called ambiguity neutral) probabilities used by Abdellaoui et al. (2011), based on Chew & Sagi (2008), because of which it is NOT the same as CEU but a special case.

In their results (p. 18 top), CEU performs poorly, which happens because it is given way too many parameters, as explained for instance by Kothiyal, Spinu, & Wakker (2014 JRU), leading to great overfitting with the parameters picking up more noise than system; COM (= maxmin EU) performs poorly with its unidentifiable λ; AEU does some better because they don't have redundant parameters, SEU yet better (although AEU is better on p. 25 ℓ. 1), and VEU (vector EU) is best. In the results section they describe statistical tests, but I did not understand why they did not just do Wilcoxon to compare the predictive likelihoods of all theories.

P. 28 last para: for the more ambiguous blower the main change is that subjects take subjective probabilities closer to uniform, nicely confirming the cognitive interpretation of inverse S. (**cognitive ability related to likelihood insensitivity (= inverse S)**) %}

Hey, John D. & Noemi Pace (2014) "The Explanatory and Predictive Power of Non Two-stage-Probability Theories of Decision Making under Ambiguity," *Journal of Risk and Uncertainty* 49, 1–29.

{% **dynamic consistency**: Subjects can divide money over two risky prospects (say investments) in a first stage, and then, after risk of first stage resolved, can divide the remainder again over two risky prospects. They must announce beforehand what their second-stage division will be, but in the second stage get the chance to revise. Thus we can test for dynamic decision principles. By looking at investment we get continuum observation and can test more. The authors fit RDU with the usual 4 dynamic types: Resolute, sophisticated, naïve, and myopic (the latter meaning at stage 1 they only optimize the stage-1 rewards, completely ignoring the investment to be made after). They get, roughly, 55% resolute, 23% sophisticated, 13% myopic and 10% naïve.

As always in John Hey's papers, the 1992 probability weighting function family of Tversky & Kahneman (1992) is ascribed to Quiggin (1982). Footnote 22 of H&P refers to Quiggin "proposing" the T&K family without the 1/g exponent in the denominator. However, this family has been well known long before, and Quiggin properly cites Karmarkar for using it. More precisely, Quiggin and Karmarkar consider a normalized version.) Quiggin then in fact criticizes it, for still violating stochastic dominance in the old fixed-probability transformation theory. %}

Hey, John D. & Luca Panaccione (2011) "Dynamic Decision Making: What Do People Do?," *Journal of Risk and Uncertainty* 42, 85–123.

{% **real incentives/hypothetical choice**: they asked N = 9 subjects to express indifferences. Hypothetical choice that is in a paper by John Hey! %}

Hey, John D. & Elisabetta Strazzera (1989) "Estimation of Indifference Curves in the Marschak-Machina Triangle," *Journal of Behavioral Decision Making* 2, 239–260.

{% Seems to show that moments do not characterize distribution, but I'm not sure. %}

Heyde, Christopher C. (1963) "On a Property of the Lognormal Distribution," *Journal of the Royal Statistical Society, Series B*, 25, 392–393.

{% **crowding-out** %}

Heyes, Anthony (2005) "The Economics of Vocation or 'Why Is a Badly Paid Nurse a Good Nurse'?," *Journal of Health Econonomics* 24, 561–569.

{% Seems to have argued against EU, and for moment models. %}

Hicks, John R. (1931) "The Theory of Uncertainty and Profit," *Economica* 32, 170–189.

{%. Commonly taken as the main paper to establish the ordinal view of utility in economics. Seems to show that indifference curves can be employed to reconstruct the theory of consumer behavior on the basis of ordinal utility, and to have emphasized how much one can do with only ordinal utility. Pareto had made such observations before, but there were unclear parts in his analysis, which still referred to nonordinal concepts such as regarding the possibility to compare utility differences and his reference to diminishing marginal utility. Hicks & Allen (1934) got a clear analysis, e.g. by putting marginal rates of substitution central. Edwards (1954): "This paper was to economics something like the behaviorist revolution in psychology."

Zeuthen (1937) cites parts of it, for example from p. 225: "A theory aiming at establishing the results of human choices in terms of quantities exchanged and the ratios of such quantities (i.e., prices) may dispense with any assumption which is not purely behaviouristic, while a theory of human welfare must go back to psychological introspection." He thus in one blow puts everything exactly right.

In relation to that, seems to be a major paper to make economics exclude survey data and introspection from its domain, and rely exclusively on observable choice.

This paper seems to have introduced the ordinal/cardinal terminology (using it only once). Edgeworth had apparently used it before, but only because of this paper it became generally used. Samuelson would later popularize it. %}

Hicks, John R. & Roy G.D. Allen (1934) "A Reconsideration of the Theory of Value: I; II," *Economica* n.s., 1.1: 52–75; 1.2: 196–219.

{% Consider case where uncertainty can be reduced to uncertainty about own subjective discounting in the future. %}

Higashi, Youichiro, Kazuya Hyogo, & Norio Takeoka (2009) "Subjective Random Discounting and Intertemporal Choice," *Journal of Economic Theory* 144, 1015–1053.

{% Correct a mistake in Mukerji & Tallon (2003 JME). %}

Higashi, Youichiro, Sujoy Mukerji, Noreo Takeoka, & Jean-Marc Tallon (2008) "Comment on "Ellsberg's Two-Color Experiment, Portfolio Inertia and Ambiguity," *International Journal of Economic Theory* 4, 433–444.

{% Considers decision from experience. If subjects can quickly and easily do very much sampling, then they properly estimate probabilities of rare events, so, neither over- nor underweighting. **DFE-DFD gap but no reversal**: this paper is in between. %}

Hilbig, Benjamin E. & Andreas Glöckner (2011) "Yes, They Can! Appropriate Weighting of Small Probabilities as a Function of Information Acquisition," *Acta Psychologica* 138, 390–396.

{% **conservation of influence**: seems to have written: freedom is the opportunity to make decisions. %}
Hildebrand, Kenneth (date unknown).

{% referaat David November 9 1994; **information aversion**: p. 97, aversion to information as normative argument regarding choices of binary tests. %}
Hilden, Joergen (1991) "The Area under the ROC Curve and Its Competitors," *Medical Decision Making* 11, 95–101.

{% **revealed preference** %}
Hildenbrand, Werner (1989) "The Weak Axiom of Revealed Preference for Market Demand is Strong," *Econometrica* 57, 979–985.

{% %}
Hildenbrand, Werner & Alan P. Kirman (1976) "*Introduction to Equilibrium Analysis.*" North-Holland, Amsterdam.

{% Simple proofs of relations between **revealed preference** axioms and Slutski matrix properties. %}
Hildenbrand, Werner & Michael Jerison (1990) "The Demand Theory of the Weak Axioms of Revealed Preference," *Economics Letters* 29, 209–213.

{% %}
Hilhorst, Cokky, Piet Ribbers, Eric van Heck, & Martin Smits (2008) "Using Dempster–Shafer Theory and Real Options Theory to Assess Competing Strategies for Implementing IT Infrastructures: A Case Study," *Decision Support Systems* 46, 344–355.

{% %}
Hill, Brian (2009) "Living without State-Independence of Utility," *Theory and Decision* 67, 405–432.

{% %}

Hill, Brian (2009) "When is there State Independence?," *Journal of Economic Theory* 144, 1119–1134.

{% This paper presents advanced maths, to obtain a state-dependent version of Savage (1954) using useful techniques of Krantz et al. (1971) in an interesting way. It, thus, aims to obtain a genuine state-dependent generalization of Savage (1954). Wakker & Zank (1999, MOR) did some in this direction but, as the author correctly points out, they still needed monotonicity (ordinal state independence). Further, they used richness of outcomes rather than of states.

There still remain some mathematical problems in the results of this paper. A counterexample results from Savage (1954) in his original setup, with the power set of S as sigma algebra (event space). As is well known (Banach & Kuratowski (1929) and Ulam 1930), countable additivity of the probability measure P must be violated here. Then also the EU functional violates countable additivity by considering indiator acts of events revealing the noncountable additivity of P. But, yet, Savage satisfies all axioms (A1-A5) of this paper. The measure U claimed in this paper is supposed to be countably additive though. The problems in the proof leading to this are, first, that the operation 0 for countably many events (p. 2050 line 3 ff.) need not be well defined (it should be shown that it does not matter which countably many representative partial acts are chosen from indifference classes), which gives problems in the derivation of Archimedeanity (point 8 on p. 2053) and in the derivation of countable additivity (Proof of Proposition 2; p. 2053). %}

Hill, Brian (2010) "An Additively Separable Representation in the Savage Framework," *Journal of Economic Theory* 145, 2044–2054.

{% The paper considers preference with a level of confidence in preference playing a role. No uncertainty is considered, but later social choice is considered. A person does not have one preference, but a set of possible preferences; big sets reflect low confidence. For each decision situation an importance level is specified. If the importance is very high, only the most plausible preferences are accepted and, hence, there is more incompleteness. It reminds me of Nau (1992). %}

Hill, Brian (2012) "Confidence in Preferences," *Social Choice and Welfare* 39, 273–302.

{% A generalization of multiple prior models. There is not one set of priors, but there are different levels of confidence (taken ordinally), and for each level of confidence there is a set of priors, being the priors that have at least that confidence. These sets are nested. The level of confidence chosen in a decision problem depends on the stakes of the decision problem. It reminds me of Nau (1992). I wonder how the model of this paper is related to Hill (2012), which seems to be similar. The paper does not discuss this relation. Refining the crude nature of multiple priors (in or out) is desirable of course. The model is very general, in requiring many sets of priors, and assigning such sets of stakes. Given a stake and a set of priors, the paper is pessimistic and does maxmin.

The paper uses Anscombe-Aumann.

P. 681 1st para points out that the paper takes the lowest (nonnull) outcome of an act as stake. So, stake is minimum in this paper. It will suggest an interest in generalizations in §4. Note, to avoid terminological confusion, that stake is the opposite of goodness. Increasing the minimal outcome means decreasing the stake. The paper assumes that decreasing the worst outcome (“increasing the stake”) leads to bigger sets of priors and, hence, more ambiguity aversion. This is empirically violated by the commonly found ambiguity seeking for losses with ambiguity aversion for gains. The model is meant to be normative (Hill 2019 *Economics and Philosophy*). %}

Hill, Brian (2013) “Confidence and Decision,” *Games and Economic Behavior* 82, 675–692.

{% Whereas Hill (2013) maintains completeness and abandons independence, this paper does the opposite. %}

Hill, Brian (2016) “Incomplete Preferences and Confidence,” *Journal of Mathematical Economics* 65, 83–103.

{% **state-dependent utility**

This paper presents a generalization of the maxmin EU model axiomatized by Gilboa & Schmeidler (1989), which used the Anscombe-Aumann framework. This paper maintains the two-stage structure where acts assign lotteries over prizes to states (“horses”), and uses backward induction/CE substitution. It generalizes by not assuming EU maximization over the lotteries. Instead, it assumes a multi-utility representation there. That is, a set v of utility functions over prizes is given, and to each lottery we assign the infimum EU over these. There is state dependence in the sense that the set v depends on the state (horse) s, so it is v(s). This minimization of utility is a bit but not much related to Baucells & Shapley (2008) and Dubra, Maccheroni, & Ok (2004), who also have multi-utility EU, but they let preferences be incomplete by requiring unanimous ordering (rather than taking inf). It is much related to cautious utility (Cerreia-Vioglio, Dillenberger, & Ortoleva 2015), who also take a set of utility functions and minimize over them. Only, the latter minimize certainty equivalents (CE), and Hill's paper minimizes EU. The two would be equivalent if all utility functions in v(s) were normalized the same way, but Hill does not do so, as far as I could see. Hill cites cautious utility as similar but different.

A general problem of state-dependent utility is that the separation of utility and probability/decision-weights cannot be well done. One way out is to assume two prizes state-independent, and they can then be used to calibrate probability/decision weights. This is in a way what this paper does with a best (h-superbar) and worst (h-underbar) act, although the best and worst prizes/consequences can be different for different states. They do exist for every state because utilities are continuous and the set of prizes is assumed compact (p. 1343; i.e., it is bounded and closed in Euclidean spaces). But the best prize x_1 for state s_1 and the best prize x_2 for state s_2 are in a way treated as the same, state-independent, prizes. That is, they are assumed to have the same utility, when the purpose is defining probabilities/decision-weights for events. Then so do all lotteries between them (p. 1345 near bottom). They are, accordingly, called essentially constant on p. 1345 near botrtom. This gives enough richness to get maxmin EU using state-independent techniques. State-dependence can then be arranged afterwards by replacing every lottery by an equivalent lottery between the best and worst consequence, a standard-gamble equivalent so to say.

P. 1348, §4.1: The model is general but can serve as a starting point to derive special cases. One can turn state-dependence, imprecise beliefs, or imprecise tastes (this is how multi-utility is interpreted) on or off by adding axioms to that effect.

criticism of monotonicity in Anscombe-Aumann (1963) for ambiguity:

The state-consistency axiom (p. 1344) means separability of every single state/horse, and is what has often been criticized.

P. 1349 points out that the model with precise tastes (every v(s) has one element, so, we have EU for every state, where the EU model depends on the state) combines state-dependence with uncertainty aversion. Chew & Wakker (1996) is also a state-dependent ambiguity model, and uncertainty aversion could easily be added there.

P. 1350, §4.2, in words explains that the axiomatization can be extended to incorporate variational (Maccheroni, Marinacci, & Rustichini 2006) and confidence (Chateauneuf & Faro 2009) preferences.

§5 gives comparative results. Proposition 4 characterizes more imprecision aversion. It takes best and worst acts for the two agents as (in my interpretation) state-independent and comparable, then has a preference condition of stronger preference for lotteries between the state-independent acts, and shows that this holds iff greater imprecision both and beliefs and tastes. So, here beliefs and tastes are treated jointly. It is in a way assuming that preferences over lotteries between best-worst acts are the same/isomorphic for the two agents. A single-state conditioned version of more imprecision-aversion characterizes greater imprecision for consequences. Restricting the condition to lotteries between the best and worst acts gives greater imprecision of beliefs. %}

Hill, Brian (2019) “A Non-Bayesian Theory of State-Dependent Utility,” *Econometrica* 87, 1341–1366.

{% This paper aims to normatively justify the models of the author of 2013 and 2016.

P. 225 2nd para: “Despite these qualities, the Bayesian hegemony as a normative account of belief and decision making has been increasingly challenged, both by philosophers (Levi 1974, 1986; Bradley 2009; Joyce 2011) and economists (Gilboa et al. 2009; Gilboa and Marinacci 2013), as well as in fields such as decision analysis (Lempert and Collins 2007; Cox 2012).”

P. 225 footnote 2 states exactly my view: “Bayesianism has been argued to reflect something akin to this difference in the resilience of the probability judgements in the face of new information (Skyrms 1977). This claim, which pertains to learning or belief formation, does not affect the central point made here concerning decision, namely that such differences are denied any role in [static] choice.”

P. 228 states what I also think about multiple priors: “As a representation of confidence in beliefs, imprecise probabilities are evidently unsatisfactory, for they treat confidence as an all-or-nothing affair: either you hold a credal judgement with full confidence, or you do not hold it, and have no confidence at all. It does not allow for grades of confidence, of the sort seen above." It is also what I consider more or less to be the definition of multiple priors.

P. 239 2nd para: "The first difference is the subject of a long-standing debate, focusing mainly on whether non-Bayesian models are embarrassed in dynamic or sequential choice situations." To which the author's reply follows some lines later: "it suffices that Bayesianism's limitations in the sorts of severe-uncertainty situations discussed in the Introduction outweigh any advantage it might have as regards dynamic choice."

The author throughout claims to have a separation between doxastic [motivational] and conative [cognitive] attitudes

P. 242 1st para argues that in maxmin EU the set of priors does not separate cognitive and motivational (my terms).

P. 245 ℓℓ. 2-4 argues that for RDU and nonadditive measures there is no clear intuitive story (my opinion: Diecidue & Wakker, 2001, and my 2010 book give such a story, but it should refer to rank-dependent decision weights rather than a nonadditive weighting function), writing: "It has proved difficult to give a solid pre-formal normative intuition or justification for the use of this rule to guide choice under uncertainty."

P. 245 ℓℓ. --6/-1 points out what holds, I think, for many ambiguity models: "As concerns their choice-theoretical properties, they are relatively mild weakenings of the maximin-EU decision rule (3), though we are aware of no defence of their specific weakenings on grounds of rationality. They are motivated by the relationship to the robustness literature …"

P. 246-247 discusses normatively abandoning RCLA, and discusses Marinacci's (2015) justification by taking 1st-order as physical uncertainty and 2nd-order as epistemic (also put forward by KMM). %}

Hill, Brian (2019) "Confidence in Beliefs and Rational Decision Making," *Economics and Philosophy* 35, 223–258.
https://doi.org/10.1017/s0266267118000214

{% % **dynamic consistency**: This paper adds a further refinement to the dissection of the dynamic principles that imply expected utility and, therefore, cannot all be satisfied under nonEU and ambiguity. It targets dynamic consistency. It specifies the "hidden" assumption that the subjective tree faced by the agent is the same as the objective tree used by the decision theorist.

It is well known in probability theory that, when updating after receiving info on the realization of a random variable, it is relevant to know the whole random variable, or information structure as it can be called. If the info is received that an event E obtains, then the default assumption is that the information structure was that always if E obtains, we are informed about that, and always if E^c obtains we are informed about that. The present paper calls that the objective tree, or objective information structure as I will also call it.

More complex info structures can be, and that can matter. The most well-known example is the three-door problem, also known as Monty Halls problem or the three-prisoner's problem. (**three-doors problem**) Imagine you play it and at first chose door 1. The quizz master opens door 2 and informs you: "the prize is not behind door 2." Then it is relevant to know: Would he always inform you about exactly that if it were the case? Also always if the prize is behind your door 1 here? And if the prize were behind door 2, would he have informed you about exactly that? Under the usual assumptions, the information structure is more complex. If the quizz master gives you the aformentioned info, then it gives more info: That all prior probability mass from door 2 has moved to door 3, so it is better to switch door now.

Now consider the three-color Ellsberg paradox. The common outcome is under the ambiguous event B (black). Arguments are well known that the common ambiguity averse preferences violate dynamic consistency under some assumptions such as consequentialism. This involves conditioning on event B, so, on the info of B, and makes the common default assumption of the objective tree. In the objective tree, we get a violation of dynamic consistency. The starting point of this paper is that we can consider other information structures, i.e., trees, called subjective trees, in which no violation of dynamic consistency is directly revealed then. Imagine that the agent (decision maker) is really in a subjective tree situation of the latter kind. Then at least there dynamic consistency is not violated. Put yet differently, if the agent has the regular Ellsberg preferences, and does not violate dynamic consistency in a subjective tree considered by her, then we can be sure that that subjective tree is not the objective one. The author states it the latter way on p. 292: "whenever he does exhibit the Ellsberg preferences [and dynamic consistency is satisfied in his subjective tree], it follows that the assumption does not hold, so he is not using the tree in Fig.1 [objective tree], and the argument does not apply [to his subjective tree].”

The author investigates how all kinds of preferences can be reconciled with dynamic consistency when restricted to particular subjective trees, and also how such preferences need not exhibit aversion to free info at least in particular subjective trees. (**information aversion**) %}

Hill, Brian (2020) “Dynamic Consistency and Ambiguity: A Reappraisal,” *Games and Economic Behavior* 120, 289–310.

{% This paper considers quite general functionals for decision under ambiguity of the form αV(f) + (1−α)V*(f) where V can be any concave (“pessimistic”) functional and V* is its convex dual. The author rewrites these general functionals by means of inf and sup operators as can always be done according to Cerreia-Vioglio, Maccheroni, Marinacci, & Montrucchio (2011) “Uncertainty Averse Preferences,” *Journal of Economic Theory* 146. And he characterizes them. Big tool is that he assumes objectively generated ambiguity present in the preference domain, through objective probability intervals. The subjective intervals/sets can then be identified by finding matching preference-equivalent objective sets. A special case of this model is the popular α-maxmin, where the well-known identifiability problem of α is solved by adding those objective stimuli. Many other models can be specified and axiomatized as special cases, such as rank-dependent (CEU) models.

A paper similar in spirit is Jaffray & Philippe (1997). %}

Hill, Brian (2023) “Beyond Uncertainty Aversion,” *Games and Economic Behavior* 141, 196–222.

{% Remarks about Johnstone’s sufficiency postulate, work on Zipf’s law, also fiducial inference, species problem. %}

Hill, Bruce M., David A. Lane & William D. Sudderth (1987) “Exchangeable Urn Processes,” *Annals of Probability* 15, 1586–1592.

{% %}

Hill, Clara E. & Michael J. Lambert (2004) “Methodological Issues in Studying Psychotherapy Processes and Outcomes.” *In* Michael J. Lambert (ed.) *Bergin and*

Garfield's Handbook of Psychotherapy and Behavior Change, 84–135, Wiley, New York.

{% %}
Hill, R. Carter, William E. Griffiths, & Guay C. Lim (2008) "*Principles of Econometrics*;" 3rd edn. Wiley, New York.

{% Consider welfare models with inequality aversion, diminishing sensitivity (w.r.t. the absolute value of the difference in income), and the Robin Hood principle (take from rich and give to poor), and logical relations between these. %}
Hill, Sarah A. & William Neilson (2007) "Inequality Aversion and Diminishing Sensitivity," *Journal of Economic Psychology* 28, 143–153.

{% Splits up risk premium under RDU into one for utility and one for probability weighting. %}
Hilton, Ronald W. (1988) "Risk Attitude under Two Alternative Theories of Choice under Risk," *Journal of Economic Behaviour and Organization* 9, 119–136.

{% **information aversion** %}
Hilton, Ronald W. (1990) "Failure of Blackwell's Theorem under Machina's Generalization of Expected-Utility Analysis without the Independence Axiom," *Journal of Economic Behavior and Organization* 13, 233–244.

{% Good book for statistics I and II, used by Thom Bezembinder. %}
Hinkle, Dennis E., William Wiersma & Stephen G. Jurs (1988) "*Applied Statistics for the Behavioral Sciences*." Houghton, Boston.

{% %}
Hinnosaar, Toomas (2018) "On the Impossibility of Protecting Risk-Takers," *Economic Journal* 128, 1531–1544.

{% Subjects do risky choices, but visual attention is measured using eye-tracking. Depends on both subjects and stimuli. I would be interested in whether there is more attention for extreme than for intermediate outcomes, and for losses than for gains, as predicted by prospect theory, but my superficial reading did not find it. (**Prospect theory not cited**) %}

Hirmas, Alejandro, Jan B. Engelmann, & Joël van der Weele (2024) "Individual and Contextual Effects of Attention in Risky Choice," *Experimental Economics* 27, 1211–1238.
https://doi.org/10.1007/s10683-024-09849-7

{% Seems to find violation of **RCLA. %**}

Hirsch, Mauric L. Jr. (1978) "Disaggregated Probabilistic Accounting Information: The Effect of Sequential Events on Expected Value Maximization Decisions," *Journal of Accounting Research* 16, 254–269.

{% %}

Hirschman, Albert O. (1992) "*Rival Views of Market Society and Other Recent Essays*." Harvard University Press, Cambridge, MA.

{% Ch. 7 seems to shows that intertemporal preferences have to reckon with subjective preferences if the market is not perfect, with different borrowing and lending rates. %}

Hirshleifer, Jack (1970) "*Investments, Interest, and Capital*." Englewood Cliffs, Prentice-Hall, NJ.

{% Seems to have been the first to show that further info for the society can lead to loss of utility for all. For example, insurance will collapse under perfect information.

value of information %}

Hirshleifer, Jack (1971) "The Private and Social Value of Information and the Reward to Incentive Activity," *American Economic Review* 61, 561–574.

{% **value of information**: Shows that the value of information can be negative for society because it destroys risk sharing. Reminds me of how it can destroy insurance. Zilcha called this the "Hirshleifer effect." %}

Hirshleifer, Jack (1975) "Speculation and Equilibrium: Information, Risk and Markets," *Quarterly Journal of Economics* 89, 519–542.

{% Part I is on DUU.

§1.2 expresses the extreme viewpoint that decision under risk with objective probabilities is illusionary and that probabilities should always be taken as subjective. Argues that Knight's distinction is, therefore, not very useful.

§1.4.2: **substitution-derivation of EU** (P.s.: works only for !extraneous! probabilities, not for subjective/endogenous!)

§1.5 on risk aversion iff U is concave, Friedman & Savage (1948).

§1.6 has framing, Ellsberg, Allais, paradoxes.

Ch. 2 on optimal asset allocation, complete/incomplete markets, state-dependence, mean-variance analysis

Ch. 3 is on comparative statics. Pratt-Arrow index, index of RRA, stochastic dominance.

Ch. 4 is on market equilibrium under uncertainty.

Part II, longest part, is on games with incomplete info, etc.

Seem to say that risk aversion and diminishing marginal utility are two factors that cannot be disentangled. %}

Hirshleifer, Jack & John G. Riley (1992) "*The Analytics of Uncertainty and Information.*" Cambridge University Press, Cambridge.

{% %}

Hirshman, Samuel D. & George Wu (2022) "Tests of Rank-Dependent Probability Weighting in Risky Choice," in preparation.

{% %}

Hisdal, Ellen (1988) "Are Grades of Membership Probabilities?," *Fuzzy Sets and Systems* 25, 325–348.

{% Seem to demonstrate reference dependence when outcomes are combinations of money and time. %}

Hjorth, Katrine & Mogens Fosgerau (2012) "Using Prospect Theory to Investigate the Low Marginal Value of Travel Time for Small Time Changes," *Transportation Research Part B: Methodological* 46, 917–932.

{% %}
Hlouskova, Jaroslava, Ines Fortin, & Panagiotis Tsigaris (2017) “The Consumption–Investment Decision of a Prospect Theory Household: A Two-Period Model,” *Journal of Mathematical Economics* 70, 74–89.

{% **information aversion**: Present an introspective information preference scale for unpleasant but useful info. Show that it predicts real decisions. %}
Ho, Emily H., David Hagmann, & George F. Loewenstein (2021) “Measuring Information Preferences,” *Management Science* 67, 126–145. https://doi.org/10.1287/mnsc.2019.3543

{% Managers are considered in cases where it is as bad to be above benchmark as below benchmark. They mostly preferred further investigation of a dept. with ambiguous performance than with unambiguous.

The paper considers ambiguity about probabilities but also directly about outcomes. %}
Ho, Joanna L.Y., L. Robin Keller, & Pamela Keltyka (2001) “Managers’ Variance Investigation Decisions: An Experimental Examination of Probabilistic and Outcome Ambiguity,” *Journal of Behavioral Decision Making* 14, 257–278.

{% Hypothetical choice.

The paper considers ambiguity about probabilities but also directly about outcomes. (**ambiguous outcomes vs. ambiguous probabilities**)

ambiguity seeking for losses: Find this indeed, and find ambiguity aversion for gains. The ambiguous probabilities are around 0.5, so, not very small. For reference point, the benchmark is taken that is imposed on managers.

reflection at individual level for ambiguity: Table 1 on p. 58 gives info on it. Subjects can choose ambiguous or unambiguous for gains and losses. This can happen for outcome ambiguity and for probability ambiguity.

Outcome ambiguity: The subtable upper right shows that of the subjects ambiguity averse for gains about 2/3 was ambiguity seeking for losses, and for the subjects ambiguity seeking for gains it was about the same. (**ambiguity seeking for losses**) So, this suggests independence of ambiguity attitudes for gains and losses.

Probability ambiguity: The subtable lower right shows that of the subjects ambiguity averse for gains about half was ambiguity seeking for losses, and for the 14 subjects ambiguity seeking for gains a majority was so for losses. So, this provides some counter-evidence against reflection at the individual level, but weak given the small number of ambiguity seekers for gains. The percentages in the table do not correspond with integers (29% out of 40 is strange for instance, because 12 out of 40 is 30% and 11 of 40 is 27.5%), and there may be typos.

The third experiment has only 20 subjects and only 2 ambiguity seekers for gains, and it gives no info on reflection at the individual level.

correlation risk & ambiguity attitude: Section 5.5 reports relations between risk- and ambiguity attitudes. %}

Ho, Joanna L.Y., L. Robin Keller, & Pamela Keltyka (2002) "Effects of Outcome and Probabilistic Ambiguity on Managerial Choices," *Journal of Risk and Uncertainty* 24, 47–74.

{% Use conjoint measurement to investigate how the perception of texture ("bumpiness") and specularity ("glossiness") affect each other. They say that they can capture interactions through a simple additive model, which I do not understand because I would say additivity means no interactions. %}

Ho, Yun-Xian, Michael S. Landy, & Laurence T. Maloney (2008) "Conjoint Measurement of Gloss and Surface Texture," *Psychological Science* 19, 196–204.

{% According to Hammond idea of deriving subjective probabilities from willingness to bet (maybe even under linear utility, EV) is already here;

free will/determinism: Seems that he has defended, here or elsewhere, "compatibilism," meaning that free will and determinism can be combined. %}

Hobbes, Thomas (1650) "*Human Nature or the Fundamental Elements of Policy.*" London. (New edn. 1994, with new introduction by G.A. John Rogers, Thoemmes, Bristol.)

{% **losses give more/less noise**: Behavioral responses in the Autonomic Nervous System are stronger for losses even whereas subjects do not exhibit loss aversion in decisions. %}

Hochman, Guy & Eldad Yechiam (2011) "Loss Aversion in the Eye and in the Heart: The Autonomic Nervous System's Responses to Losses," *Journal of Behavioral Decision Making* 24, 140–156.

{% **revealed preference**: Using British household data, this paper tests some revealed preference conditions implied by weak order maximization, in particular negative semidefiniteness and symmetry of the Slutsky matrix. These conditions are not much violated. %}

Hoderlein, Stefan (2011) "How Many Consumers Are Rational?," *Journal of Econometrics* 164, 294–309.

{% **ordering of subsets**: Choice options are 0-1 functions defined on finite sets. Although the authors never even mention it, the most natural interpretation of such functions is subsets. The authors consider separability for such functions, which is the additivity condition of qualitative probability theory of de Finetti and others (not mentioned in the paper). They categorize the cases in which some sets are separable and others are not, so, kinds of extensions of the Gorman (1968) results to discrete cases. P. 195 cites Gorman's theorem but forgets to mention that the sets S, T considered should not be nested. %}

Hodge, Jonathan K. & Micah TerHaar (2008) "Classifying Interdependence in Multidimensional Binary Preferences," *Mathematical Social Sciences* 55, 190–204.

{% Seem to propose ε contamination. %}

Hodges, Joseph L. & Erich L. Lehmann (1952) "The Use of Previous Experience in Reaching Statistical Decisions," *Annals of Mathematical Statistics* 23, 396–407.

{% Find framing in experiment among senior managers. %}

Hodgkinson, Gerard P., Nicola J. Bown, A. John Maule, Keith W. Glaister, & Alan D. Pearman (1999) "Breaking the Frame: An Analysis of Strategic Cognition and Decision Making under Uncertainty," *Strategic Management Journal* 10, 977–985.

{% Seems to show that, with marginals given, correlation is maximal under comonotonicity. %}

Hoeffding, Wassily (1940) "Masstabinvariante Korrelationstheorie," *Schriften des Mathematischen Instituts und des Instituts für Angewandte Mathematik der Universität Berlin* 5, 179–233.

{% What they call overconfidence is what is more often called unrealistic optimism, i.e., of 80% of people thinking that they belong to the best 10% of car drivers, etc., an alternative term that they also mention. The authors investigate the phenomenon with real incentives, which hasn't been done much before. %}

Hoelzl, Erik & Aldo Rustichini (2005) "Overconfident: Do You Put Your Money on It," *Economic Journal* 115, 305–318.

{% This paper brings a recent discussion. I think that for people well-acquainted with finite additivity and its paradoxes, the case of this paradox is clear. %}

Hoffmann, Christian Hugo (2023) "Rationality Applied: Resolving the Two Envelopes Problem," *Theory and Decision* 94, 555–573. https://doi.org/10.1007/s11238-022-09906-8

{% %}

Hofstede, Geert (1982) "*Culture's Consequences: International Differences in Work-Related Values*." Sage Publications, Beverly Hills, CA.

{% This paper can be credited for introducing the axiomatic system to measurement. It may be credited as the first preference axiomatization but it does not interpret its ordering as preference. Remarkably, its theorem provides in my opinion the strongest tool for doing so (I write this in 2023), and is the basis of Krantz et al. (1971) and of my tradeoff method. Current papers on ambiguity usually use the Anscombe-Aumann framework because they are unaware of Hölder's powerful tool for getting cardinality and linearity. %}

Hölder, Otto (1901) "Die Axiome der Quantität und die Lehre vom Mass," *Berichte Verhand. König. Sächs. Gesell. Wiss.* (Leipzig), *Math. Phys., Classe* 53, 1–64. Part I is translated into English by Joel Michell & Catherine Ernst (1996) "The Axioms of Quantity and the Theory of Measurement," *Journal of Mathematical*

Psychology 40, 235–252. Part II is translated into English by Joel Michell & Catherine Ernst (1997) "The Axioms of Quantity and the Theory of Measurement," *Journal of Mathematical Psychology* 41, 345–356.

{% Proposed Choquet integral for fuzzy measures on finite state space. So, Höhle is one of the independent discoverers of the Choquet integral. %}
Höhle, Ulrich (1982, January) "Integration with respect to Fuzzy Measures," *Proceedings IFAC Symposium on Theory and Application of Digital Control*, New Delhi, 35–37.

{% Suggests fuzzy measures as additive measures on nested sets. %}
Höhle, Ulrich (1982) "A Mathematical Theory of Uncertainty." *In* Ronald R. Yager (ed.) *Fuzzy Sets and Possibility Theory*, Pergamon Press, New York.

{% This paper gives background on the Choquet integral (which Höhle 1982 independently discovered). It shows, as Höhle (23 Feb 2019, personal communication) explained to me, that the Choquet integral naturally follows from regular integration on the space of pseudo-realizations (Lemma 5.2 and Proposition 5.1 and the comment following, with explicit reference to the Choquet integral in Remark 5.2b) and that isotonicity rather than additivity is the essence. %}
Höhle, Ulrich & Siegfried Weber (1997) "Uncertainty Measures, Realizations and Entropies." *In* John Goutsias, Ronald P.S. Mahler & Hung T. Nguyen (eds.) *Random Sets: Theory and Applications*, The IMA Volumes in Mathematics and Its Applications 97, 259–295, Springer, Berlin.

{% %}
Hoffman, Paul J. (1960) "The Paramorphic Representation of Clinical Judgment," *Psychological Bulletin* 57, 116–131.

{% **ubiquity fallacy** %}
Hofmann, Marcel (2018) "All Life Is Electromagnetic,"

{% %}

Hofstee, Willem K.B. (1980) "*De Empirische Discussie, Theorie van het Sociaal-Wetenschappelijk Onderzoek*." Boom, Meppel.

{% Describes in brief the idea of Hofstee (1980), where researches should express their opinions in terms of probability and stake reputation, to be scored with scoring rules. %}

Hofstee, Willem K.B. (1984) "Methodological Decision Rules as Research Policies: A Betting Reconstruction of Empirical Research," *Acta Psychologica* 56, 93–109.

{% %}

Hofstee, Willem K.B. (1988) "Methodological Decision Rules as Research Policies: A Betting Reconstruction of Empirical Research." *In* Katrin Borcherding, Berndt Brehmer, Charles A.J. Vlek, & Willem A. Wagenaar (eds.) *Research Perspectives on Decision Making under Uncertainty: Basics Theory, Methodology, Risk and Applications*. North-Holland, Amsterdam.

{% %}

Hofstee, Willem K.B. & Klaas Nevels (1981) "Do Not Take the Betting Model Literally," *Kwantitatieve Methoden* 3, 70–72.

{% %}

Hogan, Andrew J., James G. Morris, & Howard E. Thompson (1981) "Decision Problems under Risk and Chance Constrained Programming: Dilemmas in the Transition," *Management Science* 27, 698–716.

{% **probability elicitation**

Ch. 1, p. 3: Indeed, it has been said that we are now living a second industrial revolution, but instead of steam, the new revolution is being propelled by information.

More nice sentences %}

Hogarth, Robin M. (1975) "Cognitive Processes and the Assessment of Subjective Probability Distributions," *Journal of the American Statistical Association* 70, 271–289.

{% %}

Hogarth, Robin M. (1980) "*Judgement and Choice: The Psychology of Decision.*" Wiley, Chicester; 2nd edn. 1987.

{% Beginning nicely points out that most models of ambiguity are normative, but the author wants to do a descriptive model.

Tests Einhorn & Hogarth model of ambiguity using small probabilities; considers it in game situations, not clear on **ambiguity seeking for unlikely**; Camerer & Weber (1992) say they find that.

reflection at individual level for ambiguity: no info on it: subjects faced only gains or only losses, or mixed.

P. 32 last sentence:

"; there are too many models chasing too few phenomena." %}

Hogarth, Robin M. (1989) "Ambiguity and Competitive Decision Making: Some Implications and Tests," *Annals of Operations Research* 19, 31–50.

{% blink decisions; gut feeling;

think decisions; conscious deliberation;

smink decisions; heuristic decision rule in sense of model-based decision;

trink decisions; trust an expert %}

Hogarth, Robin M. (2007) "Mapping the World of Decisions," Presidential address, SPUDM 21, August 20, Warsaw, Poland.

{% **decreasing ARA/increasing RRA**: use power utility;

probability weighting depends on outcomes: seems that they found this.

uncertainty amplifies risk: Although I found no place where this was stated explicitly, it is throughout their model and theory. For inverse S it is p. 786 middle, and Table 1 on p. 789 shows it.

ambiguity seeking for losses?: they use only probabilities .10, .50, and .90, and don't find very clear results for one thing because outcome curvature interferes.

Their model has nonadditive probabilities depend on many things, e.g. sign and size of outcomes.

risky utility u = strength of preference v (or other riskless cardinal utility,

often called value): P. 780: "The view adopted here is that the value of an outcome received following a choice made under certainty does not differ intrinsically from the value of the same outcome received following a choice made under risk or uncertainty."

P. 780: "We therefore model the subjective evaluation of decision outcomes by psychophysical functions while the weights given to probabilities are conceptualized as the end result of mental processes that reflect both cognitive and motivational factors." (**cognitive ability related to likelihood insensitivity (= inverse S)**) This supports: **event/outcome driven ambiguity model: event driven**

reflection at individual level for ambiguity & **reflection at individual level for risk**: although they have the within-individual data for gains and losses to see it in all three experiments, they report it in none of their experiments.

P. 791, Experiment 1: N = 96. Hypothetical choice.

P. 791, Experiment 2: N = 146. Hypothetical choice. Experiment 3: N = 49. Real incentives; **losses from prior endowment mechanism** and RIS.

P. 799: "However, it is important that future experimental work address the exact shape of the value function so that, without having to make *a priori* assumptions about either the value or the venture functions, it will be possible to attribute changes in risk attitudes to the value and venture functions as appropriate." Well, the **tradeoff method** of Wakker & Deneffe (1996) shows how to elicit value function properties!

inverse S; **risk averse for gains, risk seeking for losses**: Table 2 on p. 792 suggests some more risk aversion for gains than risk seeking for losses. Table 4 on p. 795 suggests the same for large outcomes, but the opposite for small outcomes.

risk seeking for symmetric fifty-fifty gambles: Table 4 suggests this strange risk seeking for fifty-fifty gambles. There is much risk seeking for small outcomes, probably because they were cents so that the **utility of gambling** may have caused this.

Real incentives: experiments 1 and 2 used hypothetical payments, experiment 3 used real incentives: **random incentive system**. **losses from prior endowment mechanism**: do this.

real incentives/hypothetical choice: Find small differences between real and hypothetical choices for gains, but large differences for losses. I guess that this may be because for losses they did (as always) from prior endowment mechanism. For real incentives they find more statistical power than for hypothetical choice.

P. 800: the coexistence of gambling and insurance can be explained by the overweighting of small probabilities.

P. 797: no clear relations between risk attitude and ambiguity attitude (**correlation risk & ambiguity attitude**). %}

Hogarth, Robin M. & Hillel J. Einhorn (1990) "Venture Theory: A Model of Decision Weights," *Management Science* 36, 780–803.

{% Exactingness: the degree to which one is punished for suboptimal decisions %}

Hogarth Robin M., Brian J. Gibbs BJ, Craig R.M. McKenzie, & Margareth A. Marquis (1991) "Learning from Feedback: Exactingness and Incentives," *Journal of Experimental Psychology, Learning, Memory and Cognition* 17, 734–752.

{% **inverse S:** They find that for losses; i.e., ambiguity aversion for unlikely losses and seeking for likely losses. They find more inverse S for ambiguity than for chance (**uncertainty amplifies risk**). So also: **ambiguity seeking for losses**;

They study losses and there they find reflection, in accordance with what PT predicts, see above.

reflection at individual level for ambiguity: they have only losses, so, no results on this.

They asked what is a reasonable premium for p-prob at losing $100,000, for various probabilities. They also cite market evidence (earth-quake insurance, flood-insurance, etc.) suggesting much ambiguity aversion for small-prob losses. %}

Hogarth Robin M. & Howard C. Kunreuther (1985) "Ambiguity and Insurance Decisions," *American Economic Review, Papers and Proceedings* 75, 386–390.

{% **PT: data on probability weighting**;

ambiguity seeking for losses & ambiguity seeking for unlikely: they consider losses and there the data confirm all the hypotheses of Tversky & Wakker (1995) perfectly well.

reflection at individual level for ambiguity: does not speak to that because only losses.

inverse S: there is risk aversion for small probabilities and risk seeking for high (not stated explicitly in the paper I think, but visible in Table 2, Fig. 2, Tables 4 and 5) (**Z&Z**!). (**uncertainty amplifies risk**) These phenomena are amplified for ambiguity, by ambiguity aversion for small probabilities and ambiguity seeking for high. (Note that only the consumer data are relevant. The “firm” data consider selling of insurance which means both gains and losses, and loss aversion being relevant. As expected by PT, there more risk aversion etc. is indeed found.) Unfortunately, the data for ambiguous probabilities may be prone to distortion by regression to the mean, which can be an alternative explanation of the overestimation of small ambiguous probabilities and understimation of high ambiguous probabilities. I do not understand the analysis in §3.4, in particular why M(p) + M(1−p) = 1 on page 18. If p and 1−p are ambiguous and subject to second-order distributions, they may, as mentioned by the authors, differ from their “anchor values.” The subjects, however, need not know that these referred to complementary events and may distort both downwards.

real incentives/hypothetical choice: they use hypothetical choice, and discuss it nicely on p. 13 penultimate para. %}

Hogarth, Robin M. & Howard C. Kunreuther (1989) “Risk, Ambiguity, and Insurance,” *Journal of Risk and Uncertainty* 2, 5–35.

{% **ambiguity seeking for losses**; **ambiguity seeking for unlikely**: Ambiguity aversion for unlikely losses: Consider only small probability (.001, .01, .1) losses, and there they find risk aversion, the more so as the probabilities are smaller. The result is amplified under ambiguity (**uncertainty amplifies risk**), which may however have been biased by regression to the mean. For price setting of professional actuaries aspects other than ambiguity attitude, such as asymmetric information and avoidance of winner’s curse (p. 38) can play a role.

reflection at individual level for ambiguity: only losses, so do not speak to that. %}

Hogarth, Robin M. & Howard C. Kunreuther (1992) “Pricing Insurance and Warranties: Ambiguity and Correlated Risks,” *Geneva Papers on Risk and Insurance Theory* 17, 35–60.

{% **ambiguous outcomes vs. ambiguous probabilities**: Study cases in which not only probabilities but also outcomes are ambiguous/unknown. Ask subjects about heuristics used. Known/unknown firms that sell VCRs etc. enhances contrast effect. Only small probabilities.

Nice (also done by Heath & Tversky 1991 and Zeckhauser 2006): P. 32 explains that they ask subjects to estimate unknown probabilities, and then later use objective known probabilities equal to those, so as to avoid the problem of ambiguity being confounded with belief effects, for which some earlier studies were criticized by Heath & Tversky (1991).

reflection at individual level for ambiguity: only losses, so do not speak to that. %}

Hogarth, Robin M. & Howard C. Kunreuther (1995) "Decision Making under Ignorance: Arguing with Yourself," *Journal of Risk and Uncertainty* 10, 15–36.

{% Sent messages to students on arbitrary timepoints, asking them for risk perceptions. Mostly, it concerned loss of time or physical injuries.

gender differences in risk attitudes: women did not assess losses of risk as bigger than men, but did consider them more probable. %}

Hogarth, Robin M., Mariona Portell, & Anna Cuxart (2007) "What Risks Do People Perceive in Everyday Life? A Perspective Gained from the Experience Sampling Method (ESM)," *Risk Analysis* 27, 1427–1439.

{% **real incentives/hypothetical choice** %}

Hogarth, Robin M. & Melvin W. Reder (1987, eds.) "*Rational Choice: The Contrast between Economics and Psychology*." University of Chicago Press.

{% Seems that:

real incentives/hypothetical choice, for time preferences; **random incentive system;**

Delays of 1 day, 1 week, and 2 weeks; immediate reward was $5 or $17; interest rates of 1.5% a day or 3.0% a day for calculating the delayed reward. They find that stationarity is not violated, but increasing the interval between payments invites more subjects to choose the delayed payment.

(**decreasing/increasing impatience**) %}

Holcomb, James H., & Paul S. Nelson (1992) "Another Experimental Look at Individual Time Preference," *Rationality and Society* 4, 199–220.

{% **probability elicitation**. Measure beliefs using quadratic scoring rule, matching probabilities, and introspection. Matching probabilities is best, introspection a close second, and QSR is clearly last. For the QSR, subjects get tables with the many numbers indicating the various payments; something I always find difficult, assuming that subjects digest dozens of numbers and even see patterns in them. I did not find how incentive compatibility was explained to the subjects and probably it was left to the subjects. They did not use the term probability when explaining the QSR to subjects. They measure belief in correctness of past guess but also use a perceptual task. %}

Hollard, Guillaume, Sébastien Massoni, & Jean-Christophe Vergnaud (2016) "In Search of Good Probability Assessors: An Experimental Comparison of Elicitation Rules for Confidence Judgments," *Theory and Decision* 80, 363–387.

{% Gives arguments for **random incentive system. %**}

Holler, Manfred J. (1983) "Do Economics Students Choose Rationally? A Research Note," *Social Science Information* 22, 623–630.

{% **PT, applications**

Prospect theory/Rank-Dependent Utility most popular for risk:P. 1070 2^{nd} para %}

Holmes, R. Michael, Jr., Philip Bromiley, Cynthia E. Devers, Tim R. Holcomb, & Jean B. McGuire (2011) "Management Theory Applications of Prospect Theory: Accomplishments, Challenges, and Opportunities," *Journal of Management* 37, 1069–1107.

{% Puts forward a potential theoretical problem for the **random incentive system**. Starmer & Sugden (1991, American Economic Review), Cubitt, Starmer, & Sugden (1998, Experimental Economics), and others subsequently showed that these problems do not arise empirically. The random system is today (2004) the most popular and almost exclusively used system of real incentives for individual choice, mostly because it avoids income and house money effects.

A strange text on p. 514:

"It is well known that many individuals make choices that are direct violations of the independence axiom in other contexts. Therefore *any* theory of rational choice in such contexts must be derived from a set of axioms that does not include or imply the independence axiom, at least not in its usual "strong" form." [Italics from original]

This seems to use descriptive evidence to argue for a normative model?? %}

Holt, Charles A. (1986) "Preference Reversals and the Independence Axiom," *American Economic Review* 76, 508–513.

{% §30.5: For event A with unknown probability, determines the "matching probability" p (without using this term), i.e., the probability p such that (A:x) ~ (p:x), through the BDM (Becker-DeGroot-Marschak) mechanism as follows. The subject chooses a number p for A. So as to give an incentive for truly giving the p satisfying the equivalence just mentioned, a BDM mechanism is used: First a prospect (j/100:x) is chosen randomly, by randomly choosing a number 1 ≤ j ≤ 100. Then the subject gets this lottery if j/100 > p, and (A:x) if j/100 ≤ p. %}

Holt, Charles A. (2007) "*Markets, Games, & Strategic Behavior*." Addison-Wesley, London.

{% A generalization of this paper that, like this paper, uses choices lists to obtain indifferences and utility (OK, CRRA instead of expo-power) to fit data, but that also allows for probability weighting and gain-loss differences and loss aversion, is in Tversky & Kahneman (1992), a paper cited three times moree often than this one, and part of the 2002 Nobel-memorial prize in economics.

They throughout equate risk aversion with utility curvature, as commonly done in economics, which assumes expected utility. I regret this.

This paper has often been cited (e.g., by Harrison & List 2004 p. 1031) as refuting the argument against real incentives that big stakes cannot be implemented, by interpreting the stakes of this experiment as big. I interpret it differently. Stakes of some hundreds of dollars are small. No one would do a decision analysis for those. For such amounts, below two month's salary, utility is close to linear. Whatever risk aversion is found here is due to probability weighting, loss aversion, numerical sensitivity, and other factors, and not due to “real” utility. Big stakes are when buying a house, a car, deciding on mastectomy to avoid risk of breast cancer, etc.

decreasing ARA/increasing RRA: Increasing relative risk aversion and decreasing absolute risk aversion is found. The authors do carefully distinguish between these two.

The paper points out that literature on auctions commonly assumes log/power utility. But then, there is more in this world than auctions …

Choosing between lotteries (p, 2.00; 1.60) and (p, 3.85; 0.10) for p = 1/10, 2/10, ..., 1. These were low payoffs. Also for 20 times higher payoffs, the high payoffs. So, real payments up to $77. (Also 50 and 90 times higher for 19 and 18 subjects, respectively.) So, main group has 20 x 3.85 = $77 as highest possible prize, and the 19/18 subjects have 50 x 3.85 = $192.50 and 90 x 3.85 = $346.50 as maximum outcomes.

real incentives/hypothetical choice: The **random incentive system** was used (good to let know for all the mainstream experimental-economics referees who do not know the individual-choice literature well and start complaining about this incentive system again and again).

Real-incentives low-payoffs and hypothetical high-payoffs had similar risk aversion, and real incentives high-payoffs had more risk aversion (even 40% of subjects doing all choices safe there). Whenever unqualified, these comments, as the paper, take risk aversion in a relative sense. Comparisons were within-subjects. High-real payment came after low-real payment. To participate in the high-real payments, subjects first had to give up their earnings of the low-payment, which they had to declare in writing.

[Failed conjecture of mine] This para is on a failed conjecture of mine. I once conjectured that this procedure might have generated a framing effect, where those who gained $3.85 in the first round will take that as status quo, and because of loss aversion will not want to risk ending up with less in the high-payment choice, which makes them avoid the risky option there in the 20x group (not in 50x and 90x groups because there all payments exceed $3.85). It would imply that those who gained $3.85 in the first round would be more risk averse later than others in 20x. Holt (June 20, 2003, personal communication) let me know that this did not happen in the data. Subjects who gained $3.85 in the first round even seemed to be less risk averse than those who gained the low risky outcome there, \$0.10. So, my conjecture there does not hold.

The idea of this paper that I like best is that they first do low-stake choice for (quasi)real, and then let subjects pay back before doing big-stakes choice for real. Thus, they can observe two real choices without income effect or anything, and do within-subject comparisons of real choices. It has been a fundamental problem of **revealed preference** that only one choice can be really observed, and the authors have found a way around this very fundamental problem. This is impressive. There is a considerable price to pay for what they achieve. That subjects are told that the small-stakes are real incentives even though it is already known at that stage that these incentives will not be paid for real is a mild form of deception (**deception when implementing real incentives**). The having-to-give-back can generate all kinds of emotions such as maybe some kinds of loss aversion, which is another drawback. Yet the fundamental revealed-preference problem solved is such a great thing, that it is worth the price.

The definition of the Saha utility in Eq. 2 is not correct for $r > 1$, when it becomes decreasing. It, therefore, better be divided by $1-r$, similarly to how this is commonly done for CRRA.

My main problem with the hypo-real test here concerns a contrast effect. If subjects have to do hypo but they already know that hypo is surrounded with real before and after, then it is very explicit that there was no necessity for hypo. Subjects will, therefore, not pay much attention to hypo. Because these hypo high-payments came immediately after the low real payments (with the high-real not seen yet), subjects just quickly do there the same as before low real. This is put forward by Harrison, Johnson, McInnes, & Rutström (2003, March) "Risk Aversion and Incentive Effects: Comment," p. 3: "Subjects who are minimizing decision costs are unlikely to think hard about their choices when offered a hypo task even if the payoffs are higher, and thus would be predicted to anchor to their previous response in the first low real task. The responses in the high hypo treatment indeed look much more like the responses in the low real task #1 than they do the subsequent high real task #3."

Hypo can be useful I think, but then subjects have to be well-motivated for it, in other ways than through real incentives. Thus real versus hypo is better tested between-subjects.

The experiment took each subject about an hour (Holt, November 16 '04, personal communication).

The method of eliciting indifferences through lists of ranked choices, where the switching point indicates indifference, while often ascribed to these authors in experimental economics, has been used before in many papers, for example Halter & Beringer (1960), Kahneman, Knetsch, & Thaler (1990), Tversky & Kahneman (1992, described verbally in Subsection 2.1 pp. 305-306, where they do refinement of the indifference interval in a second stage), Tversky & Fox (1995, described verbally on p. 273, with same procedure as in Tversky & Kahneman 1992), Fox & Tversky (1998, p. 882, again same procedure as T&K'92), Coller & Williams (1999), Gonzalez & Wu (1999), with more references in Mitchell & Carson (1989).

gender differences in risk attitudes: women more risk averse than men for low payment but not for high payment (lack of power there!?).

It is unfortunate that this paper ignored decades of preceding literature on risk attitude measurement. (**Prospect theory not cited**) The authors do cite K&T79 on p. 1645 top but only for the question of hypothetical choice, and not for its insights into risk attitudes. The citation of K&T79 on hypothetical choice probably serves to discard them as invalid because of doing hypo. The ignoring of preceding literature reminds me of a quotation by the prominent economist Carver who at the end of his career wrote:

"But if they think that they have built up a complete system and can dispense with all that has gone before, they must be placed in the class with men in other fields, such as chemistry, physics, medicine, or zöology, who, because of some new observations, hasten to announce that all previous work is of no account." Carver wrote this in his paper in QJE in … 1918! %}

Holt, Charles A. & Susan K. Laury (2002) "Risk Aversion and Incentive Effects," *American Economic Review* 92, 1644–1655.

{% **Prospect theory not cited**

Paper confirms and replicates the order effects in Holt & Laury (2002) pointed out by Harrison, Johnson, MvcInnes, & Rutström (2005). It does all choices of Holt & Laury (2002), but between-subjects so that each individual has only one kind of treatment. The increase of risk aversion due to increased stakes indeed becomes smaller but remains. They also do hypo like this, without order effect. Also here, the effects are reduced but do not disappear, although it gets small especially if one compares the random differences between their 2002 and their 2005 data that are of similar size.

real incentives/hypothetical choice: Big problem with hypo here, as in 2002, is that it is surrounded by real-incentive choices, not only for other subjects but also for other experiments that the subjects were involved in simultaneously. So, the order effect due to the preceding low-stake-real-incentive choice of Holt & Laury 2002 was removed, indeed, but there were other order effects because of other experiments, not reported, that the subjects were involved in. This contrast effect encourages the subjects to not take hypo seriously and, hence, what Holt & Laury do here, as in 2002, is not a good hypo experiment. P. 903, footnote 5, cites from instructions for hypo: "Unlike the other tasks that you have done so far today, the earnings for this part of the experiment are hypothetical and will not be added to your previous earnings." That is, the contrast effect is even made explicit. %}

Holt, Charles A. & Susan K. Laury (2005) "Risk Aversion and Incentive Effects: New Data without Order Effects," *American Economic Review* 95, 902–904.

{%: **updating: testing Bayes' formula** Test Bayesian updating by measuring conditional preferences using BDM (Becker-DeGroot-Marschak) to measure matching probabilities. There is not much new because all these things have been done before (e.g. Ward Edwards), but the authors do not cite preceding work. %}

Holt, Charles A. & Angela M. Smith (2009) "An Update on Bayesian Updating," *Journal of Economic Behavior and Organization* 70, 125–134.

{% **probability elicitation**: Proposes to use matching probabilities to measure subjective probabilities. Then it proposes the two-stage choice list to obtain indifferences, in an incentive compatible way. As with Holt & Laury (2002), it is easy and clean for a general audience of nonspecialists, but novelty and positioning are problematic.

The paper never explicitly writes that it assumes expected utility, but all theoretical analyses assume it. The paper claims that matching probabilities provide subjective probabilities while correcting for risk attitude, giving as argument that only two outcomes are involved and that utility can then be normalized (p. 111). Footnote 16 mentions works that use matching probabilities to asses ambiguity attitudes, but does not discuss what the empirical findings of ambiguity aversion, discussed elsewhere, imply for what this paper does. Dimmock, Kouwenberg, & Wakker (2016 MS, Theorem 3.1) gives a more advanced result.

That matching probabilities are not new is clear, and the paper cites many preceding works, such as Savage (1971). They were commonly used in early decision analysis; see also Raiffa (1968, p. 110, "judgmental probability").

The paper suggests novelty of the two-stage choice list procedure with incentive compatibility, but it was done exactly the same before for utility measurement by Anderson et al. (2006; cited in Footnote 11, but without discussing the overlap). The idea is to elicit, in a first stage, preferences between $\gamma_E 0$ (receiving gain $\gamma > 0$ if event E happens and 0 otherwise) and $\gamma_p 0$ for p = 0/10, 1/10, …, 10/10. If preferences switch between, say, p = 3/10 and p = 4/10, then in a second stage such preferences are measured for p = 30/100, 31/100, …, 40/100. A naive implementation of the RIS (random incentive system) would not work because subjects could manipulate by switching late in the first stage, getting nice options in the second stage. Incentive compatibility is achieved by first randomly selecting a choice from the first stage and implementing it, but when the choice involves the switching value only then a choice is randomly selected from the second stage. Again, this was done by Anderson et al. before.

A small variation of this two-stage procedure was introduced by Abdellaoui, Baillon, Paraschiv, & Wakker (2011 American Economic Review). They implemented somewhat differently, in a third stage. In that third stage they put up all 101 preferences between $\gamma_E 0$ and $\gamma_p 0$ for p = j/100, indicated all preferences implied by monotonicity there, asked the subject to confirm, and then randomly selected one of these 101 choices for implementation. I think that in this procedure incentive compatability is clearer to subjects. Because of space limitations, Abdellaoui et al. only explained their implementation in the Web Appendix to their paper. But the procedure was used in several follow-up papers by Baillon and others, for instance by Baillon & Blechrodt (2015 AEJ) in this same journal.

P. 135: the BDM (Becker-DeGroot-Marschak) method, however, is notorious for being confusing to subjects. %}

Holt, Charles A. & Angela M. Smith (2016) "Belief Elicitation with a Synchronized Lottery Choice Menu That Is Invariant to Risk Attitudes," *American Economic Journal: Microeconomics* 8, 110–139.

{% HIV %}

Holtgrave, David R., Ronald O. Valdiserri, A. Russell Gerber, & Alan R. Hinman (1993) "Human Immunodeficiency Virus Counseling, Testing, Referral, and Partner Notification Services," *Archives of Internal Medicine* 153, 1225–1230.

{% **PT, applications**, loss aversion & **decreasing ARA/increasing RRA**: Uses power utility; gaines and losses are treated differently; **risk averse for gains, risk seeking for losses** in his model. He reviews some empirical evidence, a couple of studies with each four or five subjects. %}

Holthausen, Duncan M. (1981) "A Risk-Return Model with Risk and Return Measured as Deviations from a Target Return," *American Economic Review* 71, 182–188.

{% This paper uses four well-known methods of measuring risk attitudes. It finds many differences between them, entailing inconsistencies. This has been found by several preceding papers. The novelty ("innovative contribution" they call it on p. 611) of the paper is that they also ask introspective nonrevealed-preference based questions, to see if subjects are aware of it and then maybe prefer to go for consistency. As they write, end of abstract: "subjects are surprisingly well aware of the variation in the riskiness of their choices. We argue that this calls into question the common interpretation of variation in revealed risk preferences as being inconsistent." However, I have difficulties with this. All the questionnaires do (§3.2) is to ask, on a 1-7 scale, to give an index of "riskiness," with several similar questions, e.g., about complexity and boringness, for the various methods and answers. It is completely vague what these terms are meant to mean. The authors argue, for instance, that deliberately consistent subjects should give the same indexes of riskiness (and others) for the four different methods. The authors interpret the differences found as awareness of the subjects that they give "inconsistent" answers but a deliberate choice to do so. Besides the alternative interpretation that subjects are not even aware/deliberate about all this, other alternative interpretations are that subjects

just let riskiness refer to other attributes than consistency of the degree of risk aversion found. In this respect the study is different than Slovic & Tversky (1974) and related studies.

Prospect-theory avocates will regret that the paper only assumes expected utility with logpower (CRRA) utility. True, if one wants no more than one quick index of risk aversion, then fitting EU with logpower utility is the most pragmatic way to go. But with the richer data here, investigating whether inconsistencies in EU can be accommodated by prospect-theory components, before concluding general inconsistency of preference, would have been desirable.

P. 596 top cites Slovic (1972a) as an early study showing that different methods of measuring risk attitudes can give different results. But the whole rest of the page only cites papers by authors defined as experimental economists. (**Prospect theory not cited**) The keyword **PE higher than CE** in this bibliography gives a little bit of the large preceding literature on it, as there are many studies on preference reversals, the constructive view of preference, and so on. A recent related study not cited is the impressive Pedroni, Frey, Bruhin, Dutilh, Hertwig, & Rieskamp (2017).

P. 598 last para, on choice lists, again only cites experimental economists. ((**Prospect theory not cited**))

P. 601: Unfortunately, to assess similarities of different methods, the authors do not use correlations. Instead, they lose power by adopting a sort of median split technique of either qualifying results as consistent (if difference not too big) or inconsistent. They argue for this in footnote 7 by developing one numerical example where correlation does not fare well. %}

Holzmeister, Felix & Matthias Stefan (2021) "The Risk Elicitation Puzzle Revisited: Across-Methods (In)consistency?, *Experimental Economics* 24, 593–616. https://doi.org/10.1007/s10683-020-09674-8

{% The paper opens with explaining how behavioral ideas have entered macro-economics. It then studies multi-agent models where agents may violate rational expectations and rational learning, and the effects on market equilibria. %}

Hommes, Cars (2021) "Behavioral and Experimental Macroeconomics and Policy Analysis: A Complex Systems Approach," *Journal of Economic Literature* 59, 149–219.

https://doi.org/10.1257/jel.20191434

{% Some places gave people bonusses (5 cents) when they reused a dispoosable bag rather than use a new one. Food retailers had to start it in Washington DC 2010. Other places charged 5 cents less but then gave no bonusses to people who used no new bag, but instead charged 5 cents tax for people who did. The bonusses had almost no effect, but the taxes reduced the use of new bags by over 40%. The authors explain it by loss aversion.

A large part of the study is dedicated to rule out other explanations, as is always difficult in field or real-world data. One alternative explanation to be ruled out is difference of info. iN the case of bonusses, people may not have known about it, but in the case of taxes they did. With questionnaires the authors check out that this is not the case. Still, I think it probably was. There is a difference between being in one's mind, and being on one's mind. The questionnaire checks out that the info is IN everyone's mind. But I conjecture that there is a difference when it comes to being on one's mind. People who do not get a bonus can know in the back of their mind that they missed a bonus, but just do not think of it when buying, not being reminded of it. So, they don't change. Those who pay a tax do think about it when buying, being reminded of it through the tax, so, they this as signal that they should change.

I am a bit amazed that the paper presents advanced formulas with utilities and optimality conditions. Seems to me that we immediately understand the exchange of 5 cents for a minimal extra effort, and that signaling more than utility is relevant here. P. 201 derives from the utility analysis an estimation of loss aversion of 5.3, which is large.

linear utility for small stakes: p. 182 bottom.

The authors conclude that taxes are more effective than bonusses. This was also suggested by Bentham (1828-43) [1782-7 no 236]; see my annotations there. It was also suggested by Thaler (1980). See my annotations there. %}

Homonoff, Tatiana A. (2018) “Can Small Incentives Have Large Effects? The Impact of Taxes versus Bonuses on Disposable Bag Use,” *American Economic Journal: Economic Policy* 10, 177–210.
https://doi.org/10.1257/pol.20150261

{% %}
Hong, Yongmiao & Yoon-Jin Lee (2013) "A Loss Function Approach to Model Specification Testing and its Relative Efficiency," *Annals of Statistics* 41, 1166–1203.

{% Study relations between emotions and ways of violating independence and dynamic decision principles. %}
Hopfensitz, Astrid & Frans Winden (2008) "Dynamic Choice, Independence and Emotions," *Theory and Decision* 64, 249–300.

{% Poor individuals who are intrinsically risk averse can still exhibit risk-seeking behavior if that can reduce inequality and they are also sensitive to that; %}
Hopkins, Ed (2018) "Inequality and Risk-Taking Behaviour," *Games and Economic Behavior* 107, 316–328.

{% **probability elicitation**; linearly combining well-calibrated experts can destroy calibration. %}
Hora, Stephen C. (2004) "Probability Judgments for Continuous Quantities: Linear Combinations and Calibration," *Management Science* 50, 597–604.

{% Welfare where utility of individuals depends on utilities of other individuals, leading to implicit equations to be solved. Gives many preceding discussions of this point and seems to put everything right. %}
Hori, Hajime (2001) "Non-Paternalistic Altruism and Utility Interdependence," *Japanse Economic Review* 52, 137–155.

{% **updating: nonadditive measures** %}
Horie, Mayumi (2013) "Reexamination on Updating Choquet Beliefs," *Journal of Mathematical Economics* 49, 467–470.

{% Gives a joint generalization of Schmeidler's (1989) RDU and Gul's (1992) disappointment aversion. I am glad that the paper does not need the Anscombe-Aumann framework, but instead Savage-style states and outcomes, where richness is in the outcome space, assumed to be a connected separable topological

space. As usual, I am convinced that topological separability is redundant. The paper does consider Anscombe-Aumann as a special case.

She uses endogenous midpoints as in Ghirardato, Maccheroni, Marinacci, & Siniscalchi (2003): Let o denote the binar y operation xoy = CE(x_Ay) for some given event A. Then xoz ~ (xox)o(zoz). We define y as the endgenous midpoint of x and y, given A, if (xox)o(zoz) ~ (xoy)o(yoz). In the usual repeated-event interpretation, $(x_Ay)_A(x_Ay)$ ~ $(x_Az)_A(z_Ay)$ and replacing x conditional on A and then A^c, and also y conditional on A^c and A, by z does not matter. Then she defines a kind of independence à la Gul (1992), but only for comonotonic acts within an indifference class, and in such a way (I guess) that further elation and disappointment go the same way. %}

Horie, Mayumi (2019) "Implicit Rank-Linear Utility under Ambiguity: Disappointment Aversion versus Ambiguity Aversion," working paper.

{% r**eal incentives/hypothetical choice**: seems to be on it %}

Horn, Sebastrian & Alexandra M. Freund (2022) "Adult Age Differences in Monetary Decisions with Real and Hypothetical Reward," *Journal of Behavioral Decision Making* 35, e2253.
https://doi.org/10.1002/bdm.2253

{% %}

Hornberger, John C., Donald A. Redelmeier, & Jordan Peterson (1992) "Variability among Methods to Assess Patients' Well-Being and Consequent Effect on a Cost-Effectiveness Analysis," *Journal of Clinical Epidemiology* 45, 505–512.

{% **real incentives/hypothetical choice, for time preferences**: seems to be. %}

Horowitz, John K. (1991) "Discounting Money Payoffs: An Experimental Analysis." *In* Stanley Kaish & Ben Gilad (eds.) *Handbook of Behavioral Economics*, 2B, 309–324, Greenwich: JAI Press.

{% **DC = stationarity**: §2 nicely and correcty distinguishes between dynamic consistency and stationarity. %}

Horowitz, John K. (1992) "A Test of Intertemporal Consistency," *Journal of Economic Behavior and Organization* 17, 171–182.

{% Proposes a more impatient than relation: Preferring an early increase more than a late one by $\succcurlyeq_1$ should imply the same for $\succcurlyeq_2$. A follow-up paper is Benoît & Ok (2007). %}

Horowitz, John K. (1992) "Comparative Impatience," *Economics Letters* 38, 25–29.

{% If the value of a good to be priced can depend on which random prize one chooses in BDM (Becker-DeGroot-Marschak), then, obviously, incentive compatibility can be distorted in just any way. This is the main point of the paper. At the end, it erroneously claims that BDM is incentive compatible under RDU. The mistake in the proof is that the integration that is used there implicitly assumes backward induction ("isolation"), because it just substitutes the value of the good also if it is a lottery. But with backward induction, every nonEU model would have incentive compatability under BDM. If subjects do not use backward induction but RCLA, then BDM need not be incentive compatible under RDU as it need not under any nonEU model. %}

Horowitz, John K. (2006) "The Becker-DeGroot-Marschak Mechanism Is not Necessarily Incentive Compatible, even for Non-Random Goods," *Economics Letters* 93, 6–11.

{% Opening sentence: "The assumption that having more of a good will lead an individual to place a lower value on an additional unit of that good, which we call diminishing marginal value, is a pervasive component of economists' belief about human behaviour." Then some sentence after they relative it to the "Marginalist Revolution" of the 1870s. This misled me on first reading to think that the authors were after the much more interesting diminishing marginal *utility*, rather than diminishing marginal "value" (which is something like how much money you want to pay). They do distinguish, by e.g. discussing "Gossen's equivalent marginal utilities" in 2nd para on p. 1. But many readers can easily get confused. In reality they test the much less intesting question of whether marginal rate of substitution decreases in a good, with one special case where one of these two goods is money (the more you have of something the less you pay for an additional unit). They claim that diminishing marginal value has not been tested before but I guess that there must have been many investigations by economists and others into the behavior of marginal rates of substitution, especially if it is about how much money you are willing to pay. %}

Horowitz, John K. & John A. List, & Kenneth E. McConnell (2007) "A Test of Diminishing Value," *Economica* 74, 1–14.

{% **real incentives/hypothetical choice**: Review of WTA/WTP. WTA/WTP disparities are not affected much by real-hypothetical choice. Ratio WTA/WTP larger as good is less ordinally. %}

Horowitz, John K. & Kenneth E. McConnell (2003) "A Review of WTA/WTP Studies," *Journal of Environmental Economics and Management* 44, 426–447.

{% Uses prospect theory to solve ethical issues. %}

Horowitz, Tamara (1998) "Philosophical Intuitions and Psychological Theory," *Ethics* 108, 367–385.

{% Contains Pascal's proof of existence of God. %}

Horwich, Paul (1982) "*Probability and Evidence.*" Cambridge University Press, New York.

{% %}

Hosmer, David W., Jr. & Stanley Lemeshow (1989) "*Applied Logistic Regression.*" Wiley, New York.

{% **proper scoring rules**;

The authors paid three decisions, which generates some income effects.

This paper considers paying in probability of gaining a prize in the context of proper scoring rules, so as to have linear utility, given that under EU we have linearity in probability also if no linear utility in money. Thus, in a way, an EU maximizer is turned into an expected value maximizer. Paying in probability underlies the Anscombe-Aumann (1963) model. Selten, Sadrieh, Abbink (1999) made the nice observation that this expected value maximization is in fact generated for every probabilistically sophisticated agent (they did not use this term) who satisfies RCLA and prefers a higher to a lower probability at a prize, so that it is way more general than EU.

The present paper extends the technique to expected value optimization for eliciting variables more general than the subjective probability of an event or the mean of some variable (basically, subjective expected value of any given transformation) and scoring rules, following a preceding observation of this kind by Bhattachar & Pfleiderer (1985), and basically the same as the simultaneous independent Schlag & van der Weele (2013, *Theoretical Economics Letters*), but more general in allowing every transformation. This of course greatly extends the scope. As an example, if the reported number r is punished by |x(s) - r|, being its absolute distance from the realized value to a general random variable x, then under (induced) expected value maximization r will reveal the median of x. The subjective median of any random variable can be elicited this way. (This had been known before for utility linear in money by Bhattachar & Pfleiderer, 1985.) The paper first derives the results assuming subjective expected utility, and then provides the extension that Selten et al. also made, being that EU need not hold and only probabilistic sophistication should.

The paper implements the probabilities through comparisons with uniform rvs. If the value v = R(r,E) of the scoring rule R, depending on the answer r chosen by the subject and the true event E, is below the realization k of a random draw of an independent uniform distribution, then one receives some prize, and otherwise nothing. This means of course that one receives the prize with probability v. I always have some difficulty and need some time before I understand that the comparison with the uniform variable amounts to paying with probability v.

In an experiment, the method, which involves complex stimuli, gets closer to true objective probabilities (known and given to subjects, implying that they could simply take subjective probabilities equal to the objective probabilities readily available) than payment in money with the quadratic scoring rule, a result opposite to Selten, Sadrieh, & Abbink (1999). The authors discuss this point end p. 987 and pp. 997-998. It would be interesting here, and throughout, to redicuss the point using ambiguity theories and probability transformation with backward induction in the two-stage setup of this paper. %}

Hossain, Tanjim & Ryo Okui (2013) "The Binarized Scoring Rule of Belief Elicitation," *Review of Economic Studies* 80, 984–1001. https://doi.org/10.1093/restud/rdt006

{% Making usual mistakes. P. 131 last para erroneously claims that on (intersection of) open domains additive representations are unique up to linear transformation.

P 132 2nd para ("Thus in … domain") on a simply connected domain also need not be true. %}

Hosszù, Miklós (1964) "On Local Solutions of the Generalized Functional Equation of Associativity," *Annales Universitatis Scientia Budapest Eötvõs Loránd Sectio Math.* 7, 129–132.

{% Consider distortion risk measures (i.e., Yaari's 1987 RDU with linear utility), and value-at-risk type measures, when the loss variable is different than the one giving the benchmark.

P. 96 last bulleted point has a nice way of getting probability transformations: Take any distribution function Φ (say normal). Take the inverse $\Phi^{-1}(s)$. Translate it, say by adding a constant λ, into $\Phi^{-1}(s) + \lambda$. Then go back: $\Phi\left(\Phi^{-1}(s) + \lambda\right)$. %}

Hou, Yanxi & Xing Wang (2019) "Nonparametric Inference for Distortion Risk Measures on Tail Regions," *Insurance: Mathematics and Economics* 89, 92–110.

{% **game theory for nonexpected utility**; **Nash bargaining solution**, applying PT. %}

Houba, Harold, Alexander F. Tieman, & Rene Brinksma (1998) "The Nash- and Kalai-Smorodinsky Baraining Solution for Decision Weight Utility Functions," *Economics Letters* 60, 41–48.

{% Characterize Sugeno integral. Axiomatizations can also be used to criticize a model. This paper is remarkable in doing so: It criticizes the axioms (their Axiom 4 is the main one carrying the intuition of the Sugeno integral) and thereby (and also because of inspection of examples) writes (p. 14): "In view of all this, it may be concluded that Sugeno preferences must have a very limited field of application, at least in the realm of decision theory."

The paper does not state uniqueness results. These are, however, interesting, because utility and the capacity//fuzzy measure are jointly-ordinal (if utility is bounded then, after normalization of utility, a common strictly increasing transformation can be applied to the capacity and utility). Hence, the Sugeno

integral can be used as an easy heuristic for an ordinal approach to decision theory. (This point I learned from Dubois in June 2000.) If I remember right (think I saw it proved in some paper for additive measures) the Sugeno integral never deviates by more than 25% from the Choquet integral. So, it can serve as a heuristic. %}

Hougard, Jens Leth & Hans Keiding (1996) "Representation of Preferences on Fuzzy Measures by a Fuzzy Integral," *Mathematical Social Sciences* 31, 1–17.

{% %}

Hougard, Jens Leth & Hans Keiding (2005) "On the Aggregation of Health Status Measures," *Journal of Health Economics* 24, 1154–1173.

{% **Dutch book** %}

Hougard, Jens Leth & Hans Keiding (2005) "Rawlsian Maximin, Dutch Books, and Non-Additive Expected Utility," *Mathematical Social Sciences* 50, 239–251.

{% **one-dimensional utility**: Propose using polynomial functions as utility functions. A pro is that they have a conjugacy-type property in sequential optimization. %}

Houlding, Brett, Frank P. A. Coolen, & Donnacha Bolger (2015) "A Conjugate Class of Utility Functions for Sequential Decision Problems," *Risk Analysis* 35, 1611–1622.

https://doi.org/10.1111/risa.12359

{% Consider the investment/trust game (sender sends X, it is multiplied by 3, and then responder sends back Y, ending in 100-X+Y, 3X-Y), same game but one player is random computer rather than human being, and they measure risk aversion. Find no relation between trust-game against human and the other things. %}

Houser, Daniel, Daniel Schunk, & Joachim Winter (2010) "Distinguishing Trust from Risk: An Anatomy of the Investment Game," *Journal of Economic Behavior and Organization* 74, 72–81.

{% **probability communication**: they try different animations to explain probabilities, but find no differences. %}

Housten, Ashley J., Geetanjali R. Kamath, Therese B. Bevers, Scott B. Cantor, Nickell Dixon, Andre Hite, Michael A. Kallen, Viola B. Leal, Liang Li, & Robert J. Volk (2020) "Does Animation Improve Comprehension of Risk Information in Patients with Low Health Literacy? A Randomized Trial," *Medical Decision Making* 40, 17–28.

{% %}
Hout, Ben A. van, Maiwenn J. Al, Gilhad S. Gordon, & Frans F.H. Rutten (1994) "Costs, Effects and C/E-Ratios alongside a Clinical Trial," *Health Economics* 3, 309–319.

{% **revealed preference** %}
Houthakker, Hendrik S. (1950) "Revealed Preference and the Utility Function," *Economica*, N.S. 17, 159–174.

{% Considers implications of and relations between additive separability of direct demand and indirect demand. %}
Houthakker, Hendrik S. (1960) "Additive Preferences," *Econometrica* 28, 244–257.

{% %}
Howard, Ronald A. (1968) "The Foundations of Decision Analysis," *IEEE Transactions on Systems Science and Cybernetics* 4, 211–219. https://doi.org/10.1109/TSSC.1968.300115

{% **second-order probabilities**; describes the basic issues; not really new %}
Howard, Ronald A. (1988) "Uncertainty about Probability: A Decision Analysis Perspective," *Risk Analysis* 8, 91–98.

{% **(very) small probabilities**: Uses the term micromort for a 10^{-6} probability of dying. Using an EU analysis with a utility function of money and life, we can establish the local exchange rate between money and risk of dying. Although this is only reframing, it will help in clarifying. As the author puts it (p. 408 bottom): "Although this change is cosmetic only, we should remember the size of the cosmetic industry."

The beginning writes about ethical principle that only person self can decide on own life-death versus money. P. 407: "Our ethical assumption is that each person, and only that person, has the right to make or to delegate decisions about risks to his life or well-being." This is a strange principle because, in medical decision making, people have to trade off money for others' lives on a daily basis. P. 411, end of 4th para, on avoiding states of health worse than death: "The restriction to nonnegative weights is, therefore, not a problem for those who have suicide as an option."

Paper is written in the narrow decision-analysis style of thinking about nothing other than how to handle uncertainty and then nothing other than the expected utility formula. %}

Howard, Ronald A. (1988) "On Fates Comparable to Death," *Management Science* 30, 407–422.

{% **(very) small probabilities**: Uses the term micromort for a 10^{-6} probability of dying.

A mostly verbal discussion in the narrow decision-analysis style of thinking about nothing other than how to handle uncertainty and then nothing other than the expected utility formula.

P. 362 ℓ. 7: I don't see why the exchange rate between life duration and money should get infinite at some stage.

Abstract end with a nice sentence: "that precision in language permits the soundness of thought that produces clarity of action and peace of mind." %}

Howard, Ronald A. (1989) "Microrisks for Medical Decision Analysis," *International Journal of Technology Assessment in Health Care* 5, 357–370.

{% **substitution-derivation of EU** "We know from the seminal work of Arrow that there is no group decision process except dictatorship that satisfies a few simple requirements that we would place on any sensible decision process." %}

Howard, Ronald A. (1992) "In Praise of the Old Time Religion." *In* Ward Edwards (ed.) *Utility Theories: Measurement and Applications*, 27–55, Kluwer Academic Publishers, Dordrecht.

{% %}

Howard, Ronald A. & James E. Matheson (1984, eds.) "*The Principles and Applications of Decision Analysis*." (Two volumes), Strategic Decisions Group, Palo Alto, CA.

{% %}
Howard, Ronald A. & James E. Matheson (1984) "Influence Diagrams." *In* Ronald A. Howard & James E. Matheson (eds.) *The Principles and Applications of Decision Analysis*, 719–762, Vol. II, Strategic Decisions Group, Palo Alto.

{% **simple decision analysis cases using EU**; regret; Total harm of seeding hurricanes is reduced, but still it is not done because then other people will be hurt and the agents would be responsible. %}
Howard, Ronald A., James E. Matheson, & D. Warner North (1972) "The Decision to Seed Hurricanes," *Science* 176, 1191–1202.

{% **foundations of statistics**; discussions of evidence for hypothesis that can be derived from an observation in philosophers style, with verbal discussions leading to use of probabilities and simple formulas; citing Hempel and Popper who wrote on the same subject. %}
Howson, Colin (1983) "Statistical Explanation and Statistical Support," *Erkenntnis* 20, 61–78.

{% **foundations of probability** %}
Howson, Colin (1987) "Popper, Prior Probabilities, and Inductive Inference," *British Journal for the Philosophy of Science* 38, 207–224.

{% %}
Howson, Colin (2008) "De Finetti, Countable Additivity, Consistency and Coherence," *British Journal for the Philosophy of Science* 59, 1–23.

{% **foundations of probability**; **Dutch book** Discuss Dutch books, Kyburg's oppositions, and modifications to avoid those oppositions. %}
Howson, Colin (2012) "Modelling Uncertain Inference," *Synthese* 186, 475–492.

{% Argues for finite additivity and against countable additivity. Against conditioning paradoxes the author argues that conditioning should be rejected. %}
Howson, Colin (2014) "Finite Additivity, Another Lottery Paradox and Conditionalisation," *Synthese* 191, 989–1012.
https://doi.org/10.1007/s11229-013-0303-3

{% **foundations of probability** %}
Howson, Colin & Peter Urbach (1989) "*Scientific Reasoning. The Bayesian Approach.*" Open Court, Chicago, 1993.

{% **information aversion**: under ambiguity aversion, people can dislike receiving info because info may turn known probabilities into unknown probabilities, as with dilation. %}
Hoy, Michael, Richard Peter, & Andreas Richter (2014) "Take-Up for Genetic Tests and Ambiguity," *Journal of Risk and Uncertainty* 48, 111–133.

{% In separate evaluation, people pay too much attention to attribute that is easy to evaluate in isolation, rather than to important attribute. ("Evaluability hypothesis"). For example, a first dictionary has a torn cover and 20,000 entries. A second has no defects but 10,000 entries. If you evaluate them separately, you don't know how to judge number of entries, ignore it, and pay more for the second. But in direct choice between them, you see that 20,000 is much better then 10,000, and prefer the first. Attributes that are hard to judge are (too) much ignored. %}
Hsee, Christopher K. (1996) "The Evaluability Hypothesis: An Explanation for Preference Reversals between Joint and Separate Evaluations of Alternatives," *Organizational Behavior and Human Decision Prcesses* 67, 247–257.
https://doi.org/10.1006/obhd.1996.0077

{% Violations of monotonicity generated by "evaluability hypothesis" (see his OBHDP 96 paper) in separate evaluations. For example, if people receive an overfilled ice cream serving with 7 oz of ice cream they like it more than an underfilled serving with 8 oz of ice cream. If people receive a dinnerware set with

24 intact pieces, they judge it more favorably than 31 intact pieces (including the same 24) plus a few broken ones. %}

Hsee, Christopher K. (1998) "Less is Better: When Low-Value Options are Valued more Highly than High-Value Options," *Journal of Behavioral Decision Making* 11, 107–122.

{% **time preference**;

preferring streams of increasing income: stream of salary and percentile rankings in class: they prefer rising outcome to constant high outcome (with same final outcome), and they prefer constant low outcome to falling outcome (with same final outcome) %}

Hsee, Christopher K. & Robert P. Abelson (1991) "Velocity Relation: Satisfaction as a Function of the First Derivative of Outcome over Time," *Journal of Personality and Social Psychology* 60, 341–347.

{% %}

Hsee, Christopher K., Robert P. Abelson, & Peter Salovey (1991) "The Relative Weighting of Position and Velocity in Satisfaction," *Psychological Science* 2, 263–266.

{% Evaluability hypothesis: Attributes receive more weight when evaluated jointly than when evaluated separately, because separately people see no way to evaluate whereas jointly they have something to compare. This can play a role in the inter- versus intra-personal tests of the Ellsberg paradox.

Paper discusses a new preference reversal based not on difference in evaluation scale, but on difference in evaluation mode (joint versus separate evaluation), citing papers that did it before. %}

Hsee, Christopher K., Sally Blount, George F. Loewenstein, & Max H. Bazerman (1999) "Preference Reversals between Joint and Separate Evaluations of Options: A Review and Theoretical Analysis," *Psychological Bulletin* 125, 576–590.

{% Short survey of many biases that make people not choose what is best:

1. Prediction biases: impact bias, projection bias, distinction bias, memory bias, belief bias.

2. Failures to follow predictions: impulsivity, rule-based decisiosns, lay rationalism, medium-maximization.

They also discuss interactions. %}

Hsee, Christopher K. & Reid Hastie (2006) "Decision and Experience: Why Don't We Choose What Makes Us Happy?" *TRENDS in Cognitive Sciences* 10, 31–37.

{% %}

Hsee, Christopher K. & Howard C. Kunreuther (2000) "The Affection Effect in Insurance Decisions," *Journal of Risk and Uncertainty* 20, 141–159.

{% %}

Hsee, Christopher K. & Yuval Rottenstreich (2004) "Music, Pandas, and Muggers: On the Affective Psychology of Value," *Journal of Experimental Psychological: General* 133, 23–30.

{% Choices are hypothetical.

Let subjects (students) express own preference between a risky and a riskless prospect, let them guess what an anonymous other person would prefer, and let them guess what their neighbor (a concrete other) would prefer. Subjects predict that abstract others are more risk seeking (both for gains and for losses), but concrete others are the same. A risk-as-feeling hypothesis is put forward to explain. It is that subjects perceive of their deviation from risk neutrality as a nontypical emotional point, less applying to neutral others. This works for losses because for losses they find, opposite to prospect theory's prediction (not pointed out by the authors), more risk aversion than risk seeking (see their Figure 1B). This complicates the finding. If, as usual, people are risk seeking for losses, then risk-as-feeling and others being more risk seeking become contradictory and it is not clear from this paper what to expect then. They also consider, but discard, other explanations such as a stereo-type explanation (others are Americans and their stereo-type is, as the authors claim, that Americans are venturous and risk-taking), where then it is apparently assumed that the other is defined as a member of a particular group, being American here.

P. 45 2nd para claims that people consider risk seeking to be an admirable property. But I expect that most people find risk aversion to be more appropriate.

P. 45 penultimate para: I do not understand why the term “risk-as-feelinigs hypothesis” is chosen.

P. 47 penultimate para of 1st column writes: “Consistent with prospect theory (Kahneman & Tversky, 1979), participants were more risk seeking in the loss condition than in the gain condition” but it does not mention that, contrary to prospect theory, they find risk aversion for losses rather than risk seeking.

In study 3 they try to incentivize the prediction of the other choice: Students were paired, seated next to each other, and received $50 if they predicted their neighbor’s choice correctly (p. 51 1st para). However, this is not a good incentive because it encourages everyone to choose, not what one likes, but what one expects one’s neighbor to predict. A practical problem is that it also encourages cribbing and communication. P. 51 end of 3rd para writes that not every right prediction gets rewarded, contrary to the 1st para, but only for 2 students out of 141 students. So, the expected value of this is about 66 cents. Also, for the abstract other, a right prediction of majority-preference was rewarded. %}

Hsee, Christopher K. & Elke U. Weber (1997) “A Fundamental Prediction Error: Self-Others Discrepancies in Risk Preference,” *Journal of Experimental Psychology: General* 126, 45–53.

{% %}

Hsee, Christopher K. & Elke U. Weber (1999) “Cross-National Differences in Risk Preference and Lay Predictions,” *Journal of Behavioral Decision Making* 12, 165–179.

{% **equity-versus-efficiency** %}

Hsu, Ming, Cédric Anen, & Steven R. Quartz (2008) “The Right and the Good: Distributive Justice and Neural Encoding of Equity and Efficiency,” *Science* 320, 1092–1095.

{% Degree of ambiguity in choices correlates positively with particular parts of the brains. Complete ambiguity is Ellsberg urn, other extreme is known urn. Then there are questions about temperatures in other cities, which are in between in ambiguity. There is also a guessing game against a better-informed opponent. In studies of ambiguity a difficulty is always how to control for belief. That is, people should avoid the unknown-probability event not because they consider it to be less likely as every Bayesian ambiguity neutral expected utility maximizer would then do the same way, but they should do it for other reasons unlike Bayesians. Unfortunately, this study does not control for level of beliefs. Thus, in the knowledge questions subjects may prefer betting on high temperature in New York to betting on unknown city not because of ambiguity aversion, but simply because they consider it to be more likely in New York. (They can choose to bet on or against so will bet where the event more likely than its complement is most likely.) In the informed opponent game it is even worse, because every ambiguity neutral Bayesian person and every person I can think of should rather play the uninformed opponent, then the probabilities simply being better.

Ambiguity arouses the same effects as the opponent-game. People with a particular brain damage are risk- and ambiguity neutral (although accepting a null with 6 subjects does not mean much), so, what many including me I consider rational.

The data in the electronic web companion is strange. Table S6 reports the parameters of risk and ambiguity aversion. For the card-deck data there is a clear majority of ambiguity seeking! (**ambiguity seeking**) This deviates from common findings in the literature and from suggestions in the main text (p 1681 bottom of 1st column describes ambiguity aversion for the card-deck as the usual thing; p. 1682 bottom of 1st column has a null not rejected which, given 12 (or 16 as in table S6?) subjects, is problematic). For the knowledge question there is a clear majority risk seeking, which is also weird.

When fitting the source function (where in many cases I do not know how they got the input p for the ambiguous events) they use the power family with the power as index of ambiguity aversion. %}

Hsu, Ming, Meghana Bhatt, Ralph Adolphs, Daniel Tranel, & Colin F. Camerer (2005) "Neural Systems Responding to Degrees of Uncertainty in Human Decision Making," *Science* 310, 9 Dec., 1680–1683.

{% %}

Hsu, Ming, Chen Zhao, & Colin F. Camerer (2006) "Nonlinear Probability Weighting in the Brain," CalTech.

{% A theoretical study of the effect of risk attitude on a two-stage English premium auction. %}

Hu, Audrey, Theo Offerman, & Liang Zou (2011) “Premium Auctions and Risk Preferences,” *Journal of Economic Theory* 146, 2420–2439.

{% **PT, applications**: Considers transportation-waiting time as outcome, for risk decisions. Tests EU versus weighted utility, RDU, and PT. Only PT provides a slight improvement in fit. In EU, EV does as well as power or exponential utility, so they take EV (linear utility). For RDU considers Prelec 1 and 2 parameter families, T&K’92 family, and Goldstein & Einhorn (1987; they cite Gonzalez & Wu (1999) for it. For PT they do rank-dependent, with *reference point endogenously estimated*, with 8.8 minutes the resulting best reference point, and the only one that brings significant improvement. Seems that here they assume no parametric weighting functions but, with gains and losses weighted differently, can take the weight of each probability as a different parameter. %}

Hu, Guotao, Aruna Sivakumar, & John W. Polak (2012) “Modelling Travellers Risky Choice in a Revealed Preference Context: A Comparison of EUT and Non-EUT Approaches,” *Transportation* 39, 825–841.

{% Consider casino gambler who cam gamble repeatedly and maximizes prospect theory, and is allowed to randomize. The optimal behavior will then depend much on what dynamic optimization principles are assumed. %}

Hu, Sang, Jan Obłój, & Xun Yu Zhou (2023) “A Casino Gambling Model under Cumulative Prospect Theory: Analysis and Algorithm,” *Management Science* 69, 2474–2496.
https://doi.org/10.1287/mnsc.2022.4414

{% This paper introduces coherent measures of variability that satisfy comonotonic additivity and are based on distances of of distorted probabilities from nondistorted.

P. 175 Eq. 2.6: some risk premiums are a linear combination of a coherent risk measure and a coherent measure of variability. %}

Hu, Taizhong & Ouxiang Chen (2021) “On a Family of Coherent Measures of Variability,” *Insurance: Mathematics and Economics* 95, 173–182.

{% Nice empirical study on reference dependence in choices for food with reference levels within attributes. %}
Hu, Wuyang, Wiktor L. Adamowicz, & Michelle M. Veeman (2006) "Labeling Context and Reference Point Effects in Models of Food Attribute Demand," *American Journal of Agricultural Economics* 88, 1034–1049.

{% Using tail comonotonicity in constructing multivariate distributions. %}
Hua, Lei & Harry Joe (2012) "Tail Comonotonicity: Properties, Constructions, and Asymptotic Additivity of Risk Measures," *Insurance: Mathematics and Economics* 51, 492–503.

{% %}
Hua, Wenxiu (1988) "The Properties of some Non-Additive Measures," *Fuzzy Sets and Systems* 27, 373–377.

{% P. 16: robustness of EU results, demonstrated by Machina, is argument in favor of EU!! %}
Huang, Chi-Fu & Robert H. Litzenberger (1988) "*Foundations for Financial Economics.*" North-Holland, Amsterdam.

{% %}
Huang, Roger D. & Hans R. Stoll (2001) "Tick Size, Bid-Ask Spreads, and Market Structure," *Journal of Financial and Quantitative Analysis* 36, 503–522.

{% Preceding papers considered Choquet integrals of set-valued functions that were set-valued. This paper proposes one that is real-valued. %}
Huang, Yan & Congxin Wu (2014) "Real-Valued Choquet Integrals for Set-Valued Mappings," *International Journal of Approximate Reasoning* 55, 683–688.

{% **Christiane, Veronika & I**: Subjects ("agents") should maximize the utility for someone else ("principal"), which consists of aggregating three components (ski vacation with price, probability of snow, and quality of slope). They are told exactly how to aggregate the values of the separate components, through a

weighted sum with both attribute weights and attribute values specified. Only, the values are not given numerically, but are indicated through points on a line (i.e., a kind of VAS score) without any ruler provided. So, the whole value system has been specified and only the numerical processing matters. The subjects were first trained through 7 choice and 9 matching questions in the first experiment, and a few more in a second experiment, where they received rewards as they were closer to the true values.

At the end, p. 88, the authors distinguish two steps in preference valuations: (1) Creating an internal representation of the information [values] and (2) expressing these representations through a specific task. I guess that, in our terminology, (1) refers to intrinsic value, (2) to, a.o., numerical sensitivity.

There are three modes of response, matching, choice, and rating. The authors write in the "paternalistic" way that I like, where biases are things to be corrected for (**paternalism/Humean-view-of-preference)**. They consider "negativity bias" (also called level focusing) which may be more general than loss aversion but with these data (three levels per attribute) is the same.

P. 86, on **Choice enhances noncompensatory heuristics**: the authors only mention it in passing by, "Given the noncompensatory heuristics that have been associated with choice," but instruct their subjects so much that in choice they still do compensatory.

Findings (pp. 86-87):

Strong scale compatibility. No prominence effect, if anything, the opposite.

- Choice: Authors are happily surprised that the subjects make compensatory tradeoffs among attributes, rather than resort to noncompensatory heuristics. The authors had deliberately instructed the subjects to this effect. There still is considerable loss aversion.

- Ratings: take less than half of time of other modes of response, have about half the loss aversion of choice, noisier.

- Matching: most difficult. Curvature of scale is best captured, no loss aversion

(rationale on p. 70: Matching pairs provides its own reference points), only problem is much scale compatibility. So, it's good for relative comparisons of the nonmatching dimensions. P. 73, however, suggests that matching enhances looking only at differences of attribute, thus to "overlinearization" (may contribute to: C**E bias towards EV**). Note, however, that linear processing of attributes seems to be rational in this empirical study, given that these are already evaluations of attributes.

Subjects judge that choice (not binary but always from triples) is best, then matching, last rating.

IMPORTANT: As the authors remark on p. 88, 3rd para, their finding is important because it shows that loss aversion occurs not (merely) at the level of intrinsic values, but also is a bias in the weighting of intrinsic values. So, it is not just in utility but alo in weighting: "In many settings, one cannot tell whether loss aversion is a bias or merely a reflection of the fact that losses have more emotional impact than gains of equal magnitude. In our choice and rating tasks, however, we found clear evidence that agents motivated to accurately represent the preferences of others gave more weight to negative outcomes than is appropriate." %}

Huber, Joel, Dan Ariely, & Gregory Fischer (2001) "Expressing Preference in a Principal-Agent Task: A Comparison of Choice, Rating, and Matching," *Organizational Behavior and Human Decision Processes* 87, 66–90. https://doi.org/10.1006/obhd.2001.2955

{% **measure of similarity;** context-dependence, violation of IIA, called "attraction effect" (or "asymmetric dominance" or "decoy effect") where adding a dominated alternative increases choice percentage of chosen alternative à la Tversky & Simonson. Seems that this 1982 paper was the first. %}

Huber, Joel, John W. Payne, & Christopher Puto (1982) "Adding Asymmetrically Dominated Alternatives: Violations of Regularity and the Similarity Hypothesis," *Journal of Consumer Research* 9, 90–98.

{% Subjects hypothetically judge quality of areas based on cost of living and quality of water in lakes and rivers. Reference dependence and loss aversion can clearly be generated by proper framing. In iterated choice, the first option offered and the last one before choosing now have much effect. %}

Huber, Joel, W. Kip Viscusi, & Jason Bell (2008) "Reference Dependence in Iterative Choices," *Organizational Behavior and Human Decision Processes* 106, 143–152.

{% %}

Huber, Joel, Dick R. Wittink, John A. Fiedler, & Richard Miller (1993) "The Effectiveness of Alternative Preference Elicitation Procedures in Predicting Choices," *Journal of Marketing Research* 30, 105–114.

{% %}
Huber, Peter J. (1973) "The Use of Choquet Capacities in Statistics," *Bulletin de l'Institut International de Statistique* 45, 181–191.

{% %}
Huber, Peter J. (1981) "*Robust Statistics*." Wiley, New York.

{% %}
Huber, Peter J. & Volker Strassen (1973) "Minimax Tests and the Neyman-Pearson Lemma for Capacities," *Annals of Statistics* 1, 251–263.

{% %}
Huber, Tobias (2022) "Comparative Risk Aversion in Two Periods: An Application to Self-Insurance and Self-Protection," *Journal of Risk and Insurance* 89, 97–130. https://doi.org/10.1111/jori.12353

{% **Prospect theory not cited**
Subjects play a computer game (the mobile game "Crashy Cakes") where they can gain points that give nice things in the game to follow. The outcomes only concern the game and nothing outside the game. In particular, subjects do not gain or lose any money. Risk attitudes are measured for lotteries with these points as outcomes. The authors find decreasing absolute risk aversion, which is common, but also decreasing relative risk aversion, which is uncommon (**decreasing ARA/increasing RRA**). %}
Huber, Tobias, Johannes G. Jaspersen, Andreas Richter, & Dennis Strümpel (2023) "On the Change of Risk Aversion in Wealth: A Field Experiment in a Closed Economic System," *Experimental Economics* 26, 1–26. https://doi.org/10.1007/s10683-022-09762-x

{% **homebias**: seems to show that within same country there is a kind of homebias for own region. %}

Huberman, Gur (2000) "Familiarity Breeds Investment," *Review of Financial Studies* 46, 3–28.

{% %}

Hubert, Lawrence (1974) "Some Applications of Graph Theory and Related Non-Metric Techniques to Problems of Approximate Seriation: The Case of Symmetric Proximity Measures," *British Journal of Mathematical and Statistical Psychology* 27, 133–153.

{% %}

Hubert, Lawrence (1974) "Problems of Seriation Using a Subject by Item Response Matrix," *Psychological Bulletin* 81, 976–983.

{% %}

Hubert, Lawrence (1974) "Some Applications of Graph Theory to Clustering," *Psychometrika* 39, 283–309.

{% %}

Hubert, Lawrence (1976) "Seriation Using Asymmetric Proximity Measures," *British Journal of Mathematical and Statistical Psychology* 29, 32–52.

{% %}

Hubert, Lawrence & James Schultz (1976) "Quadratic Assignment as a General Data Analysis Strategy," *British Journal of Mathematical and Statistical Psychology* 29, 190–241.

{% Extend Koopmans to algebraic structure, first for bounded structures. Also present a result for unbounded structures but, correctly, point out in the Concluding Remarks that these conditions are not directly testable. Wakker's (1993, MOR) truncation continuity would provide an alternative way to go here. %}

Hübner, Ronald & Reinhard Suck (1993) "Algebraic Representation of Additive Structure with an Infinite Number of Components," *Journal of Mathematical Psychology* 37, 629–639.

{% In bargaining situations it can be advantageous to commit to the endowment effect. The authors derive evolutionary arguments for the endowment effect from this observation. %}

Huck, Steffen, Georg Kirchsteiger, & Jörg Oechssler (2005) "Learning to Like What You Have—Explaining the Endowment Effect," *Economic Journal* 115, 689–702.

{% **real incentives/hypothetical choice**: Do Allais paradox, with high hypothetical payoffs, with low hypothetical, and with low real. For representative CentER panel, and for student group. Find rather low violation rates for low payments. More violations in population than in student group. More violations for low-educated. %}

Huck, Steffen & Wieland Müller (2012) "Allais for All: Revisiting the Paradox in a Large Representative Sample," *Journal of Risk and Uncertainty* 44, 261–293.

{% **coalescing**: Find complexity aversion. That is, other things equal, subjects prefer lotteries with fewer outcomes. %}

Huck, Steffen & Georg Weizsäcker (1999) "Risk, Complexity, and Deviations from Expected-Value Maximization: Results of a Lottery Choice Experiment," *Journal of Economic Psychology* 20, 699–715.

{% **probability elicitation**: Applied to experimental economics; Use **proper scoring rules** (the quadratic rule) and the measurement of matching probabilities, derived from certainty equivalents using linear utility (eliciting certainty equivalents through BDM (Becker-DeGroot-Marschak)) to measure beliefs about percentages of strategy choices of other players in other games. The quadratic scoring rules are more accurate. Beliefs are conservative; i.e., biased towards 0.5 (e.g. p. 72 penultimate para). They did not give explanation about properness of the quadratic scoring rule, and just did it (p. 75 footnote 9), but just asked for probability judgment and applied the scoring rule. %}

Huck, Steffen & Georg Weizsäcker (2002) "Do Players Correctly Estimate What Others Do? Evidence of Conservatism in Beliefs," *Journal of Economic Behavior and Organization* 47, 71–85.
https://doi.org/10.1016/S0167-4870(99)00031-8

{% **coherentism**: the whole issue no. 3 of Synthese is on coherentism. %}

Huemer, Michael (2007) "Weak Bayesian Coherentism," *Synthese* 157, 337–346.

{% Consider two-outcome prospects. Ambiguity was generated as second-order probability, with reduced probabilities 0.25, 0.50, and 0.75, and in ambiguity always one outcome was 0 (**second-order probabilities to model ambiguity**). It was not explained to the subjects what the reduced probabilities under ambiguity would be but subjects saw several drawings so that after a while they could figure out a bit about different levels of likelihood when deciding under ambiguity. For risky choice they assumed EU with relative risk aversion indexing risk attitude. For ambiguity they took the utility function inferred from risky choice, and then did α-maxmin for α from [0,1]; i.e., the model $(1-\alpha)u(x_1) + \alpha u(x_2)$ with $x_1 > x_2$. It is the usual two-outcome RDU or prospect theory or biseparable model, or Arrow-Hurwicz model (extended to multiple priors by Ghirardato & Marinacci 2004) given that subjects cannot know, apparently, what the level of likelihood is under ambiguity. They find that different parts of the brain get activated under ambiguity than under risk (e.g. p. 772: [risk and ambiguity] "represent two types of decision making that are supported by distinct [brain] mechanisms.". This is indirect evidence that risk and ambiguity are not related (**correlation risk & ambiguity attitude**). Although they have the data, they do not report relations between risk and ambiguity attitudes. %}

Huettel, Scott A., C. Jill Stowe, Evan M. Gordon, Brent T. Warner, & Michael L. Platt (2006) "Neural Signatures of Economic Preferences for Risk and Ambiguity," *Neuron* 49, 765–775.

{% **information aversion**!!! If person is tested on HD (Huntington's Disease), it is found out if person is risky (97% chance of getting HD), or not risky (3% chance of getting HD). But this is then also done for the members of the family. Then these members can, without any more trouble, get to know if they are risky or not. Similar, if child in mother is tested (to be aborted if risky) then mother is also tested and be informed. Often mothers prefer not to know about themselves. %}

Huggins, Marlene, Maurice Bloch, Shelin Kanani, Oliver W.J. Quarrell, Jane Theilman, Amy Hedrick, Brnard Dickens, Abbyann Lynch, & Michael Hayden (1990) "Ethical and Legal Dilemmas Arising during Predictive Testing for Adult-Onset Disease: The Experience of Huntington Disease," *American Journal of Human Genetics* 47, 4–12.

{% Gotten from Palli Sipos; **foundations of quantum mechanics** %}

Hughes, Robin I.G. (1981) "Quantum Logic," *Scientific American* 245 (No. 4), 146–157.

{% %}

Hughly, Philip & Charles Sayward (1990) "Can there Be a Proof That Some Unprovable Arithmetic Sentence is True?," *Dialectica* 43, 289–292.

{% **finite additivity** %}

Huisman, Leendert (2015) "Reflecting on Finite Additivity," *Synthese* 192, 1785–1797.

{% (ISBN: 0-13-149908-4) %}

Hull, John C. (2017) "*Options, Futures, and Other Derivatives*." Englewood Cliffs, Prentice-Hall, NJ (10th edn.).

{% %}

Hull, John C. (2006) "*Options, Futures, and Other Derivatives: Solutions Manual.*" (ISBN: 0-13-149906-8) Englewood Cliffs, Prentice-Hall, NJ.

Hull, John C. (2013) "*Options, Futures, and Other Derivatives*." Englewood Cliffs, Prentice-Hall, NJ (9th edn.).

Hull, John C. (2017) "*Options, Futures, and Other Derivatives*." Englewood Cliffs, Prentice-Hall, NJ (10th edn.).

{% %}

Hüllermeier, Eyke (2007) "*Case-based Approximate Reasoning*." Springer, Berlin.

{% **conservation of influence**: Part 1, 118 seems to write: "[t]here is implanted in the human mind a perception of pain and pleasure as the chief spring and moving principle of all its actions"

paternalism/Humean-view-of-preference: Part 3 Of the will and direct passions, Sect. 3 Of the influencing motives of the will writes: "What may at first occur on this head, is, that as nothing can be contrary to truth or reason, except what has a reference to it, and as the judgments of our understanding only have this reference, it must follow, that passions can be contrary to reason only so far as they are accompany'd with some judgment or opinion. According to this principle, which is so obvious and natural, 'tis only in two senses, that any affection can be call'd unreasonable. First, When a passion, such as hope or fear, grief or joy, despair or security, is founded on the supposition or the existence of objects, which really do not exist. Secondly, When in exerting any passion in action, we chuse means insufficient for the design'd end, and deceive ourselves in our judgment of causes and effects. Where a passion is neither founded on false suppositions, nor chuses means insufficient for the end, the understanding can neither justify nor condemn it. 'Tis not contrary to reason to prefer the destruction of the whole world to the scratching of my finger. 'Tis not contrary to reason for me to chuse my total ruin, to prevent the least uneasiness of an Indian or person wholly unknown to me. 'Tis as little contrary to reason to prefer even my own acknowledge'd lesser good to my greater, and have a more ardent affection for the former than the latter. A trivial good may, from certain circumstances, produce a desire superior to what arises from the greatest and most valuable enjoyment; nor is there any thing more extraordinary in this, than in mechanics to see one pound weight raise up a hundred by the advantage of its situation. In short, a passion must be accompany'd with some false judgment. in order to its being unreasonable; and even then 'tis not the passion, properly speaking, which is unreasonable, but the judgment."

Seems to have said (p. 413): "Reason alone can never be a motive to any action of the will;" (p. 415): "reason is, and ought only to be the slave of the passions."

"a passion must be accompay'd with some false judgment, in order to its being unreasonable."

A nice citation of the immediacy effect, on p. 536 (may be in a 1896 edition), taken from Cohen, Ericson, Laibson, & White (2020 JEL):

"In reflecting on any action, which I am to perform a twelve-month hence, I always resolve to prefer the greater good, whether at that time it will be more contiguous or remote; nor does any difference in that particular make a difference in my present intentions and resolutions. My distance from the final determination makes all those minute differences vanish, nor am I affected by any thing, but the general and more discernible qualities of good and evil. But on my nearer approach, those circumstances, which I at first over-looked, begin to appear, and have an influence on my conduct and affections. A new inclination to the present good springs up, and makes it difficult for me to adhere inflexibly to my first purpose and resolution. This natural infirmity I may very much regret, and I may endeavour, by all possible means, to free my self from it. I may have recourse to study and reflection within myself; to the advice of friends; to frequent meditation, and repeated resolution: And having experienced how ineffectual all these are, I may embrace with pleasure any other expedient, by which I may impose a restraint upon myself, and guard against this weakness." %}

Hume, David (1740) "*A Treatise of Human Nature.*" (1978, Clarendon Press, Oxford.)

Cohen, Ericson, Laibson, & White (2020 JEL) give the following bibliographic info: Hume, David. 1896. A Treatise of Human Nature by David Hume, Reprinted from the Original Edition in Three Volumes and Edited, with an Analytical Index by L. A. Selby-Bigge, M.A. Oxford: Clarendon Press.
[1738].

{% **conservation of influence**: at the end of the section that deals with causation, Hume states:

"we may define cause to be an object followed by another, and where all the objects, similar to the first, are followed by objects similar to the second. Or, in other words, where, if the first object had not been, the second never had existed."

Second formulation is a difference-making idea. A cause makes a difference to whether its effect obtains: without it, the effect would not have obtained. %}

Hume, David (1995) "*An Inquiry Concerning Human Understanding*." Upper Saddle River: Prentice Hall.

{% Survey on effectiveness of nudge units %}

Humme, Dennis & Alexander Maedche (2019) "How Effective Is Nudging? A Quantitative Review on the Effect Sizes and Limits of Empirical Nudging Studies," *Journal of Behavioral and Experimental Economics* 80, 47–58.

{% **coalescing**; Clearly finds ESE (event-splitting effect). P. 272 last para or paper writes: "Finally, it is worth reiterating that the ESEs discovered in this experiment are consistent with simple WUT, assuming post-combination and subadditivity." Here WUT refers to 1979 separable prospect theory à la Edwards. §2 defines subadditivity as $w(p) + w(q) >$ w(p+q), with w my notation of probability weighting (he writes π). %}

Humphrey, Steven J. (1995) "Regret Aversion or Event-Splitting Effects? More Evidence under Risk and Uncertainty," *Journal of Risk and Uncertainty* 11, 263–274.
https://doi.org/10.1007/BF01207789

{% **coalescing**; only shows that there was no anchoring in Humphrey (2005) %}

Humphrey, Steven J. (1996) "Do Anchoring Effects Underlie Event-Splitting Effects? An Experimental Test," *Economics Letters* 51, 303–308.

{% **coalescing** ; modifies a Neilson (1992) theory by bringing in a dependence on sign, distinguishing between gains and losses. Does not bring in probability weighting. %}

Humphrey, Steven J. (1998) "More Mixed Results on Boundary Effects," *Economics Letters* 61, 79–84.

{% **coalescing** ; In a situation where subjects learn about probabilitis from observed frequencies, no clear event-splitting effect is found. So, neither complexity aversion nor seeking. %}

Humphrey, Steven J. (1999) "Probability Learning, Event-Splitting Effects and the Economic Theory of Choice," *Theory and Decision* 46, 51–78.

{% **coalescing**; Finds evidence of event splitting in some stimuli, but neutrality in others. %}

Humphrey, Steven J. (2000) "The Common Consequence Effect: Testing a Unified Explanation of Recent Mixed Evidence," *Journal of Economic Behavior and Organization* 41, 239–263.
https://doi.org/10.1016/S0167-2681(99)00075-X

{% **coalescing**; finds weak evidence of ESE, i.e., violation of coalescing in the direction of complexity-seeking, but not much. 2 out of 21 (p. 94) significant means, if corrected for multiple testing, close-to-perfect H_0. %}

Humphrey, Steven J. (2001) "Non-transitive Choice: Event-Splitting Effects or Framing Effects?," *Economica* 68, 77–96.
https://doi.org/10.1111/1468-0335.00234

{% **coalescing**; Finds evidence of event splitting %}

Humphrey, Steven J. (2001) "Are Event-Splitting Effects Actually Boundary Effects?," *Journal of Risk and Uncertainty* 22, 79–93.
https://doi.org/10.1023/A:1011105607742

{% %}

Humphrey, Steven J. (2004) "Feedback-Conditional Regret Theory and Testing Regret Aversion in Risky Choice," *Journal of Economic Psychology* 25, 839–857.

{% **coalescing**; Investigates effects of learning on violations of monotonicity, coalescing, and the common consequence effects (more complex than Allais, with no sure option available). Certainty equivalents of prospects are elicited through matching. From that, choices are derived indirectly. In the learning treatment, subjects are shown 10 drawings of each prospect before deciding. These drawings were manipulated so as to be representative (**deception when implementing real incentives)**. Some deviations from expected utility were reduced but others were enhanced. The author is, understandably, more enthusiastic about his own research speciality, event splitting, than about other topics when he writes (p. 97): "Event-splitting effects are unlike many choice anomalies because there exists a range of real world decision-making contexts where one observed analogous behaviour." %}

Humphrey, Steven J. (2006) "Does Learning Diminish Violations of Independence, Coalescing and Monotonicity?," *Theory and Decision* 61, 93–128.
https://doi.org/10.1007/s11238-006-8047-x

{% This paper redoes the well-known Slovic & Tversky (1974) study, but better implemented experimentally. P. 2 writes, modestly: "Whilst this contribution is modest in terms of innovation" I think the paper is useful.

P. 2 writes affirmatively: "the widely held view that the normativity of choice principles should be settled empirically (e.g. Tversky & Kahneman, 1986, p. S273; Gilboa, 2010, p. 4; Sunstein, 2018, p. 2)." I disagree. It is best determined by deep thinkers and specialists. The opinion of the average person has little to contribute, similarly as with the best move in a chess position or the best medical treatment of a disease. The citation of T&K86 is incorrect. T&K consider the question of whether incentives etc. can improve rationality, and not what rationality is. At the risk of being rude: T&K are too intelligent to write such a claim. Footnote 1 then adds: "Baron (2004) is a notable dissenter, who argues that normative theory should be determined solely through philosophical debate." Sunstein may only have argued that whether people want to be nudged is an empirical question, in which case the above citation of him would also be wrong, but I did not check in detail. I similarly disagree with the authors' criticism of Friedmann & Savage (1952) in the first two paras of §2 (p. 3 bottom). As I, Bayesian, disagree with the authors' normative conclusion in their Conclusion on p. 11, that they think to derive from their empirical finding: "Our data indicate that Maurice Allais was correct: it can be reasonable to violate the sure-thing principle."

The paper presents subjects both with an argument for satisfying the sure-thing principle, and for violating it as in the Allais paradox because of the certainty effect. It finds that more subjects are convinced by the certainty effect and switch to satisfy it than with the s.th.pr. (e.g., . 8). This finding is quite at variance with the finding of Nielsen & Rehbeck (2022), and the authors discuss it. My opinion: Nielsen & Rehbeck (2022) found purely demand effect. Their claimed test of that effect was way too weak.

Crucial for this paper is how the arguments for Savage and Allais are described. Here they are (p. 7):

Savage's position:

"In problem 1, if a ticket between 26 and 100 is drawn it does not matter whether I choose R or S. I would win € 14 irrespectively of how I choose. So I will ignore tickets 26 to 100. In problem 2 the same is true. If a ticket between 26 and 100 is drawn, it doesn't matter whether I choose R' or S'. I win nothing, irrespectively of how I choose. So I will ignore lottery tickets 26 to 100. Therefore, because I should always ignore tickets 26 to 100, the problems are exactly the same. In both problems, tickets 1 to 25 in options S and S' always pay me € 14. In both problems, tickets 1 to 20 in options R and R' always pay € 20, and tickets 21 to 25 pay nothing. It therefore makes no sense to switch choices between the problems. So I would choose either options R and R', or options S and S'."

Allais' Position:

"I would choose option S over option R in problem 1 and R' over S' in problem 2. In problem 1, I have the choice between € 14 for sure or a gamble where I might end up with nothing. Why gamble? The small probability of missing the chance of winning something seems very unattractive to me. In problem 2, there is a good chance that I will end up with nothing no matter how I choose. The chances of getting € 20 are almost as good as getting € 14, so I might as well go for the € 20 and choose option R' over S'." %}

Humphrey, Steven J. & Nadia-Yasmine Kruse (2024) "Who Accepts Savage's Axiom now?," *Theory and Decision* 96, 1–17. https://doi.org/10.1007/s11238-023-09938-8

{% Probably does with stationarity what Humphrey & Kruse (2024) do for Savage's sure-thing principle, and has the same finding: that people are more convinced by the bias (present/certainty effect versus stationarity/sure-thing principle. %}

Humphrey, Steven J. & Felix C. Meickmann (2022) "Who Accepts the Stationarity Principle?," working paper, University of Osnabrück.

{% **PT falsified** & **inverse S:** They test the common consequence effect and find risk aversion increasing and not decreasing, which is the exact opposite of inverse S. This independently replicates the same finding as by Birnbaum, for instance in Birnbaum & Chavez (1997). Their test of their problems [1] and [2] are also a violation of the certainty effect (**violation of certainty effect**).

Use random incentive system. Did it with poor farmers from the countries mentioned in the title.

More elaborate results, with error theories added, are in Humphrey &

Verschoor (2004, *Journal of African Economies*). Unfortunately, the papers have no cross references to explain their overlap and priority. %}

Humphrey, Steven J. & Arjan Verschoor (2004) "The Probability Weighting Function: Experimental Evidence from Uganda, India and Ethiopia," *Economics Letters* 84, 419–425.
https://doi.org/10.1016/j.econlet.2004.02.015

{% **PT falsified** & **inverse S:** Do same as their 2004 Economics Letters paper, but more elaborate, with error theory added. Then still they prefer RDU with error better than EU with error. (e.g. p. 82 & 84) %}

Humphrey, Steven J. & Arjan Verschoor (2004) "Decision-Making under Risk among Small Farmers in East Uganda," *Journal of African Economies* 13, 44–101.

{% **updating: discussing conditional probability and/or updating** %}

Humphreys, Paul (2004) "Some Considerations on Conditional Chances," *British Journal for the Philosophy of Science* 55, 667–680.

{% **dynamic consistency** %}

Huntley, Nathan & Matthias C.M. Troffaes (2012) "Normal Form Backward Induction for Decision Trees with Coherent Lower Previsions," *Annals of Operations Research* 195, 111–134.

{% Schijnt al IIA-versie gehad te hebben. %}

Huntington, Edward V. (1938) "A Paradox in the Scoring of Competing Teams," *Science* 88, 287–288.

{% P. 2 writes, to my joy: "the superb and widely praised book Utility Theory for Decision Making (Fishburn 1970a)" %}

Hupman, Andrea C. & Jay Simon (2023) "The Legacy of Peter Fishburn: Foundational Work and Lasting Impact," *Decision Analysis* 20, 1–15.
https://doi.org/10.1287/deca.2022.0461

{% %}

Hurd, Michael D. & Kathleen McGarry (2002) “The Predictive Validity of Subjective Probabilities of Survival,” *Economic Journal* 112, 966–985.

{% %}
Hurkens, Sjaak (1996) “Multi-Sided Pre-play Communication by Burning Money,” *Journal of Economic Theory* 69, 186–197.

{% Seems to show that subjects like to answer truthfully, and not lie, also if no incentive. %}
Hurkens, Sjaak & Navin Kartik (2009) “Would I Lie to You? On Social Preferences and Lying Aversion,” *Experimental Economics* 12, 180–192.

{% Put red and white poker chips in bag (actually, coffee can), say 5 red and 3 white, 8 in total. Then asked subjects to predict how many reds there would be in, say, 5 drawings, always with replacement. Subjects received a prize if they guessed right. They should obviously gamble on the most likely result of the five drawings. Seems that they did not do this very well, but for small real probability of red acted as if this probability was higher, and for large real probability as if it was smaller (**inverse S**). I did not understand on p. 176 the discussions of work of Karni, first because for given probabilities state-dependence does not seem to be plausible, second, how they could escape from it if it would nevertheless arise.

Conclude that previous conclusions in the literature about divergence of subjective and objective probabilities may be based on faulty assumptions, such as strict rationality. %}
Hurley, Terrence M. & Jason F. Shogren (2005) “An Experimental Comparison of Induced and Elicited Beliefs,” *Journal of Risk and Uncertainty* 30, 169–188.

{% Suggest that overbetting on outsiders and underbetting on favorites may be due to cost of information, and other things. So, variation on information-sensitivity. Their data do not find much, H_0. %}
Hurley, William & Lawrence McDonough (1995) “A Note on the Hayek Hypothesis and the Favorite-Longshot Bias in Parimutual Betting,” *American Economic Review* 85, 949–955.

{% %}
Hurvich, Leo M. & Dorothea Jameson (1951) "Psychophysical Study of White. I. Neutral Adaptation," *Journal of the Optical Society of America* 41, 521–527.

{% **event/outcome driven ambiguity model: event driven**
Introduced the α-maxmin model in its Remark 4, a little below the displayed equation. Well, Good (1950) had it for statistical inference. %}
Hurwicz, Leonid (1951) "Some Specification Problems and Applications to Econometric Models" (Abstract), *Econometrica* 19, 343–344.

{% %}
Hurwicz, Leonid (1951) "Optimality Criteria for Decision Making under Ignorance," Cowles Commission Discussion Paper, Statistics, No. 370, mimeographed.

{% %}
Hurwicz, Leonid (1960) "Optimality and Informational Efficiency in Resource Allocation." *In* Kenneth J. Arrow, Samuel Karlin, & Patrick Suppes (1960, eds.) *Mathematical Methods in the Social Sciences,* 17–46, Stanford University Press, Stanford, CA.

{% Is credited by Nobel-2007 committee for having introduced incentive compatibility. Incentive compatibility occurred before in **proper scoring rules** by Brier (1950) and de Finetti (1962). %}
Hurwicz, Leonid (1972) "On Informationally Decentralized Systems." *In* Charles Bartlett McGuire & Roy Radner (eds.) *Decision and Organization*, 297–336, North-Holland, Amsterdam.

{% **revealed preference** %}
Hurwicz, Leonid & Marcel K. Richter (1971) "Revealed Preference without Demand continuity Assumptions." *In* John S. Chipman, Leonid Hurwicz, Marcel K. Richter, & Hugo F. Sonnenschein (eds.) Ch. 3, "*Preferences, Utility, and Demand,*" Hartcourt, New York.

{% P. 34 seems to define good through pleasure, an object is good if it creates pleasure. Looks already quite like utility. %}

Hutcheson, Francis (1728) “*An Essay on the Nature and Conduct of the Passions and Affections*.” J. Osborne and T. Longman, London.

{% %}

Hutton Barron, Francis & Bruce E. Barrett (1996) “Decision Quality Using Ranked Attribute Weights,” *Management Science* 42, 1515–1523.

{% Found high convergence between risky and riskless utility. Derive theoretical relations, if one is additive, the other is multiplicative, then, by Cauchy’s equation ... etc. Find that linear relation gives good fit. Exponential transform provides little gain.

utility elicitation; **risky utility u = transform of strength of preference v**

%}

Hutton Barron, Francis, Detlof von Winterfeldt, & Gregory W. Fischer (1984) “Empirical and Theoretical Relationships between Value and Utility Functions,” *Acta Psychologica* 56, 233–244.

{% Seems to formulate principle of expected value. Blaise Pascal seems to have encouraged him to write this book. %}

Huygens, Christiaan (1657) “*Tractatus de Ratiociniis in Ludo Aleane.*” Amsterdam. Translated into Dutch by Frans van Schooten: Van Reeckening in Spelen van Geluck.

{% %}

Hwang, Ching Lai & Kwangsun Yoon (1981) “*Multiple Attribute Decision Making.*” Springer, Berlin.

{% %}

Hwang, Ching Lai, Abu S.M. Masud (1979) (in collaboration with Sudhar R. Paidy & Kwangsun Yoon) “*Multiple Objective Decision Making: Methods and Applications: A State-of-the-Art Survey.*” Springer, Berlin.

{% %}

Ibanez Marcela, Simon Czermak, & Matthias Sutter (2009) "Searching for a Better Deal. On the Influence of Group Decision Making, Time Pressure and Gender in a Search Experiment," *Journal of Economic Psychology* 30, 1–10.

{% **time preference: comparing risky and intertemporal utility**
real incentives/hypothetical choice: "stated preference," often combined with discrete choice models, is a common term for using hypothetical/introspective data instead of revealed preference.

The authors let people do hypothetical choices between payments (one nonzero) with both risk and delay, assume constant discounting and EU with CRRA, and fit the parameters simultaneously. Had they assumed prospect theory instead of expected utility for risk, they would have had the problem that a common power of probability weighing, discounting, and expected utility would be unidentifiable. But they assume expected utility for risk, whence the problem does not arise.

They call their method new but Andersen et al. (2008 Econometrica) and Chapman (1996) and others preceded them in using EU utility to estimate discounting. They correlate their findings with smoking behavior. %}

Ida, Takanori & Rei Goto (2009) "Simultaneous Measurement of Time and Risk Preferences: Stated Preference Discrete Choice Modeling Analysis Depending On Smoking Behavior," *International Economic Review* 50, 1169–1182.

{% P. 244: "It seems wiser to treat numerical estimates of chance as *behavioral indicators* of underlying evidence." [italics from original] Give arguments favoring qualitative rather than quantitative expressions of uncertainty. %}

Idson, Lorraine Chen, David H. Krantz, Daniel Osherson, & Nicolao Bonini (2001) "The Relation between Probability and Evidence Judgment: An Extension of Support Theory," *Journal of Risk and Uncertainty* 22, 227–249.

{% Big study in Japan finds that discounting, also hyperbolic, is related to body weight. Natural that obesity and the like will be related to this. Sign dependence is also related to it. %}

Ikeda, Shinsuke, Myong-Il Kang, & Fumio Ohtake (2010) "Hyperbolic Discounting, the Sign Effect, and the Body Mass Index," *Journal of Health Economics* 29, 268–284.

{% **one-dimensional utility**: Pareto utility is power utility with initial wealth incorporated. The author discuss advantages of this family. %}

Ikefuji, Masako, Roger J. A. Laeven, Jan R. Magnus, & Chris Muris (2013) "Pareto Utility," *Theory and Decision* 75, 43–57.

{% Application of ambiguity theory;
Studies financial markets, with optimal portfolios and equilibrium asset prices, and the effects of ambiguity aversion as in maxmin EU of Gilboa & Schmeidler (1989). The implied desire to hedge leads to portfolio inertia (also if free market, and also for investors who do participate in the market). Small pieces of news can lead to drastic changes and excess volatility. Interaction between risk and ambiguity may explain spikes in stock price volatility. %}

Illeditsch, Philipp Karl (2011) "Ambiguous Information, Portfolio Inertia, and Excess Volatility," *Journal of Finance* 66, 2213–2247.

{% %}

Imai, Taisuke, Tom A. Rutter, & Colin F. Camerer (2021) "Meta-Analysis of Present-Bias Estimation Using Convex Time Budgets," *Economic Journal* 131, 1788–1814.
https://doi.org/10.1093/ej/ueaa115

{% In finance, people can have "non-realized" losses: They know their stocks have decreased in value, but they did not sell them yet and do not feel it so much. Realizing means they sold them and really lost. This paper seems to show that after a realized loss, individuals' risk-taking decreases, whereas it increases after an unrealized (paper) loss, the "realization effect." Merkle, Müller-Dethard, & Weber (2021 EE) is a follow-up. %}

Imas, Alex (2016) "The Realization Effect: Risk-Taking after Realized versus Paper Losses," *American Economic Review* 106, 2086–2109.

{% Subjects have to work for either positive payment, or negative payment (meaning they receive prior endowment and then have to pay back). Negative payment gives more work, in agreement with loss aversion. (In agreement with Bentham (1828-43) [1782-7], [1782-7]: 236.) However, subjects prefer negative payment to positive payment, which maybe can be taken as evidence against loss aversion although this is debatable. %}

Imas, Alex, Sally Sadoff, & Anya Samek (2017) "Do People Anticipate Loss Aversion?," *Management Science* 63, 1271–1284. https://doi.org/10.1287/mnsc.2015.2402

{% **foundations of statistics**

Expresses some sympathy for p-values, so, is no full Bayesian.

A text of the "there is no reason that not" type that is typical of this paper is the italiced part in: "Although I agree with much of the sentiment that small p-values are not sufficient for concluding that the null hypothesis should be abandoned in favor of the alternative hypothesis, I do think that small p-values are necessary for such a conclusion. More specifically, in cases where researchers test null hypotheses on which we place substantial prior probability, *it is difficult to see how one could induce anyone to abandon that belief without having a very small p-value*." [italics added] (p. 158) %}

Imbens, Guido W. (2021) "Statistical Significance, p-Values, and the Reporting of Uncertainty," *Journal of Economic Perspectives* 35, 157–174. https://doi.org/10.1257/jep.35.3.157

{% Find that the Allais paradox is much stronger if a zero outcome is involved as minimum, than if not. Argue that it is more due to the zero effect than the certainty effect. A special role for the 0 outcome has also been studied by Birnbaum, Coffey, Mellers, & Weiss (1992), who use it to get violations of monotonicity, Payne (2005), Diecidue & van de Ven (2008), and Diecidue, Levy, & van de Ven (2015). %}

Incekara-Hafalir, Elif, Eungsik Kim, & Jack D. Stecher (2021) "Is the Allais Paradox Due due to to Appeal of Certainty or Aversion to Zero?," *Experimental Economics* 24, 751–771. https://doi.org/10.1007/s10683-020-09678-4

{% %}

Incekara-Hafalir, Elif & Jack D. Stecher (2025) "Allais Paradox, Certainty Effect, and Zero Effect," in Elgar Encyclopedia.

{% This paper criticizes nudging techniques because advocates (including me) assume the existence of true correct best values. They assume that there is "something down there" (my words). The authors argue that this assumption is unfounded. For example, p. 13: "Thus, Hausman's analysis does not resolve the problem we identified in the literature of behavioural welfare economics. That problem was to justify the implicit assumption that, for any given individual, there exists some mode of latent reasoning that generates complete and context-independent subjective preferences." P. 22 (conclusion): "We need a normative economics that does not presuppose a kind of rational human agency for which there is no known psychological foundation."

The paper often cites Kahneman as an authority. It takes space to put every possible detail right.

P. 1 1st para describes what I call the Bayesian twin, although here it is broader:

"The task for welfare economics is then to reconstruct the preferences that the individual would have acted on, had her reasoning not been distorted by whatever psychological mechanisms were responsible for the mistakes, and to use the satisfaction of these reconstructed preferences as a normative criterion."

The paper sometimes calls that "preference purification" (title of §2 and elsewhere).

P. 2 3rd para: "Although there is a clear sense in which the choices made (or preferences revealed or judgements expressed) by the person in different contexts are inconsistent with one another, it is not at all obvious which (if any) of these choices is correct – or even how 'correctness' should be defined."

P. 7, on the often cited Bernheim & Rangel (2007, 2009): "Bernheim and Rangel's first line of approach is to propose a criterion that respects the individual's revealed preferences over pairs of objects if those preferences are not affected by changes in ancillary conditions, and instructs the planner 'to live with whatever ambiguity remains' (2009, p. 53). They then suggest that this *rather unhelpful criterion* might be given more bite by the deletion of 'suspect' GCSs. A GCS is deemed to be suspect if its ancillary conditions induce impairments in the individual's ability to attend to or process information or to implement desired courses of action." [Italics added]

P. 13 cites Hausman & Welch (2010 p. 128) pointing out that nudge does not fully 100% respect free will:

"something paternalistic, not merely beneficent …in addition to or apart from rational persuasion, they may 'push' individuals to make one choice rather than another … their autonomy – the extent to which they have control over their own evaluations and deliberations – is diminished. Their actions reflect the tactics of the choice architect rather than exclusively their own evaluation of alternatives. … limiting what choices are available or shaping choices risks circumventing the individual's will." (p. 130)

Infante et al. call the Bayesian twin the "inner rational agent." P. 14:

"We will call this disembodied entity the inner rational agent. … Preference purification can be thought of as an attempt to reconstruct the preferences of the inner rational agent by abstracting from the distorting effects of – by 'seeing through' – the psychological shell. … if the faults in the psychological shell were corrected."

Several parts discuss Bleichrodt, Pinto, & Wakker (2001), abbreviated BPW, in interesting manners. Little surprise that I disagree sometimes, in two places. The first is p. 20:

"BPW's purification methodology treats the non-linearity of the probability weighting function as a reasoning error … But where is the error? …

had used decision weights in the mistaken belief that they were objective probabilities. But that is not a remotely plausible account … remember that when people respond to Allais' problems, they are told all the relevant objective probabilities."

This discussion interprets probability weighting too narrowly. It need not just be wrong cognitive belief about probability. It can also be wrong FEELING while right knowing (imperfect numerical sensitivity), or pessimistic overattention to worst outcomes, or deliberate nonlinear decision weighting, e.g. by researchers who think that nonEU for risk is rational (which I Bayesian then still consider to be a mistake to be corrected for). The overly narrow interpretation of probability weighting here is called the second misunderstanding in Fox, Erner, & Walters (2015 p. 55).

P. 21 3rd para, middle of page, writes that BPW would not go by the preferences of the subject but by those of the professional: "Viewed in this way, what seems to be required is not an inference about the hypothetical choices of the client's inner rational agent, but rather a way of regularising the available data about the client's preferences so that it is compatible with the particular model of decisionmaking that the professional wants to use." However, BPW assume as default that the only thing the professional wants to do is maximize the subject's preferences. The professional does not have an own agenda.

P. 21 penultimate para goes a long way agreeing with BPW, despite the ("religious") difference in view on the existence of true values:

"In the same way, a medical decision-maker might reasonably use BPW's methodology to construct a tractable model of the client's preferences, regularised so as to be consistent with expected utility theory, without claiming that the preferences in the model were latent in the client. The arguments we have developed in this paper would not be objections to a version of behavioural welfare economics that claimed only to regularise revealed preferences that were inconsistent with conventional theory, without interpreting this process as the identification and correction of errors, or as a way of helping individuals to make better choices. But that is not the version of behavioural welfare economics that is to be found in the literature." The authors introduce the term regularisation for the pragmatic application of BPW (so, in fact, EU) described in the above para, where no latent preferences are assumed to exist and EU is not assumed to be normative, but it is done pragmatically in the absence of what else to do. %}

Infante, Gerardo, Guilhem Lecouteux, & Robert Sugden (2016) "Preference Purification and the Inner Rational Agent: A Critique of the Conventional Wisdom of Behavioural Welfare Economics," *Journal of Economic Methodology* 23, 1–25.
https://doi.org/10.1080/1350178X.2015.1070527

{% Seems to discuss HARA utility in detail. %}

Ingersoll, Jonathan E. Jr. (1987) "*Theory of Financial Decision Making*." Rowland and Littlefield, Savage, MD.

{% Theoretical analysis of stock market and CAPM under '92 PT, with effects of probability weighting and loss aversion. %}

Ingersoll, Jonathan E. Jr. (2014) "Cumulative Prospect Theory, Aggregation, and Pricing," *Crirical Financial Review* 4, 1–55.

{% %}

Ingersoll, Jonathan E. & Stephen A. Ross (1992) "Waiting to Invest: Investment and Uncertainty," *Journal of Business* 65, 1–29.

{% **foundations on statistics**; Points out that Fisher did not consider significance levels as objective, and that Pearson was also open to the interpretation of probability as degree of belief. %}

Inman, Henry F. (1994) "Karl Pearson and R.A. Fisher on Statistical Tests: A 1935 Exchange from Nature," *American Statistician* 48, 2–11.

{% **one-dimensional utility**: uses a kind of mixture-continuity, some weaker than Debreu's (1959) continuity. %}

Inoue, Tomoki (2010) "A Utility Representation Theorem with Weaker Continuity Condition," *Journal of Mathematical Economics* 46, 122–127.

{% **foundations of statistics**. For pregistration of statistical tests in medicine %}

International Committee of Medical Journal Editors (ICMJE), www.icmje.org/recommendations/browse/publishing-and-editorial-issues/clinical-trial-registration.html

{% **anonymity protection** %}

International Journal of Uncertainty, Fuzziness & Knowledge-Based System 20, Dec2012, Vol. 20 Issue 6: Special Issue on Computational Definitions of Privacy and Anonymity.

{% P. 1171: N = 122. Do hypothetical choice because of losses involved in the three-color Ellsberg.

ambiguity seeking for losses: They find ambiguity aversion for losses. However, as usual in this case, they did not control for suspicion (**suspicion under ambiguity**). Subjects could not choose the color to gamble on. What the authors call subadditivity is the usual violation of the s.th.pr. in Ellsberg 3-color. They do not do neuromeasurement but cite much literature on it. %}

Inukai, Keigo & Taiki Takahasi (2009) "Decision under Ambiguity: Effects of Sign and Magnitude," *International Journal of Neuroscience* 119, 1170–1178.

{% %}

Ioannidis, John P. A. (2005) "Why Most Published Research Findings Are False," *PLoS Medicine*.

http://dx.doi.org/10.1371/journal.pmed.0020124

{% Telling patient that an elective 1-hour procedure has 0.01% probability of death may be hard for people to relate to. Comparing to similar risks, such as same-age and same-sex people having a 0.01% death risk over 1 month, may help. This paper proposes several such ways to explain. Reminds me of an idea of Ron Howard (1988), to introduce a new unit for a small probability of dying, the microort, to help people in communication. %}

Ioannidis, John P. A. (2013) "Expressing Death Risk as Condensed Life Experience and Death Intensity," *Medical Decision Making* 33, 860–868.

{% %}

Ioannidis John P.A., Kevin W. Boyack, & Jeroen Baas (2020) "Updated Science-Wide Author Databases of Standardized Citation Indicators," *PLOS Biology* 18(10): e3000918. https://doi.org/10.1371/journal.pbio.3000918

{% **gender differences in risk attitude**: women are more risk averse than men.

They measure risk aversion assuming EU and finding CRRA. They measure subjective discount rate by fitting hyperbolic discounting, where they take some indifferences and assume linear utility. Because they have utility curvature for CRRA risk aversion they could use this utility function to correct discounting for utility curvature, as in Andersen et al. (2008 Econometrica) and others. But they are not clear on whether they did so and probably they didn't, and simply assumed linear utility. The latter is better than the Andersen et al. method because EU utility is more distorted by nonEU risk factors than that it brings true utility for risk, let be for intertemporal.

For risk and time attitudes, they consider two different outcomes: Money and number of plants planted that are good for the environment. They call these monetary and environmental environments. The differences they claim in risk and time attitudes can be due simply to different utility of the two kinds of outcomes. Utility curvature of money can be different than of plants, as these can be different than for apples, pears, quantity of wine drunk, and so on. %}

Ioannou, Christos A. & Jana Sadeh (2016) "Time Preferences and Risk Aversion: Tests on Domain Differences," *Journal of Risk and Uncertainty* 53, 29–54.

https://doi.org/10.1007/s11166-016-9245-8

{% %}
Irtel, Hans (1987) "A Conjoint Grassmann Structure for Testing the Additivity of Binocular Color Mixtures," *Journal of Mathematical Psychology* 31, 192–202.

{% Seems to describe optimism. %}
Irwin, Francis W. (1953) "Stated Expectations as Functions of Probability and Desirability of Outcomes," *Journal of Personality* 21, 329–335.

{% **real incentives/hypothetical choice**: small differences/same effects %}
Irwin, Julie R., Gary H. McClelland, & William D. Schulze (1992) "Hypothetical and Real Consequences in Experimental Auctions for Insurance against Low-Probability Risks," *Journal of Behavioral Decision Making* 5, 107–116.

{% Seem to find even negative correlation between risk aversion measurements in different contexts. %}
Isaac, R. Mark & Duncan James (2000) "Just Who Are You Calling Risk Averse," *Journal of Risk and Uncertainty* 20, 177–187.

{% Finds that people are more risk averse if they feel good. %}
Isen, Alice M. (1993) "Positive Affect and Decision Making." *In* Michael Lewis & Jeanette M. Haviland-Jones (eds.) *Handbook of Emotions*, 261–277, Guilford Press, New York.

{% Proposes a bad-deal aversion to explain data better than with loss aversion. %}
Isoni, Andrea (2011) "The Willingness-to-Accept/Willingness-to-Pay Disparity in Repeated Markets: Loss Aversion or 'Bad-Deal' Aversion?," *Theory and Decision* 71, 409–430.

{% Redo Plott & Zeiler (2005), and confirm it for mugs but not at all for lotteries. They thus criticize the generality claims of P&Z, and suggest that P&Z's nonreporting of their lottery data is unfortunate. In their reply, P&Z explain that their lottery data were only meant for learning, and contained many anomalies

making them too unreliable. P&Z disagree with many other things.

Oh well, I think that loss aversion is strong but volatile, and small details can change it. %}

Isoni, Andrea, Graham Loomes, & Robert Sugden (2011) “The Willingness to Pay−Willingness to Accept Gap, the “Endowment Effect”, Subject Misconceptions, and Experimental Procedures for Eliciting Valuations: Comment,” *American Economic Review* 101, 991–1011.

{% Nice. %}

Ito, Kiyosi (1996, ed.) “*Encyclopedic Dictionary of Mathematics*; 3rd edn.; translated from Japanese. MIT, Cambridge, MA.

{% Public good games with framing as gain or as loss (in latter case subjects first get endowed with the public good). Prospect theory’s predictions work. The paper uses repeated payments in each game again, and not a RIS. This in itself can move in the direction of expected value. %}

Iturbe-Ormaetxe, Iñigo, Giovanni Ponti, Josefa Tomás, & Luis Ubeda (2011) “Framing Effects in Public Goods: Prospect Theory and Experimental Evidence,” *Games and Economic Behavior* 72, 439–447.

{% **probability elicitation**: applied to experimental economics. Measures matching probabilities of the right to play a strategic game against an opponent. Interprets playing the game as ambiguity. This is often done. One usually does not know the probability of what the opponent does. But a difference may be that strategic considerations concern more than what is usually called uncertainty (or ambiguity).

Very correctly, points out that we can’t measure ambiguity attitude without speculating on beliefs. However, belief is then simply measured by direct questioning, nonincentivized (discussed in §7.2), and is taken to be additive. This is similar to what some (Fox, Tversky, Wu, Gonzalez) have called the two-stage model, although they allowed for nonadditive beliefs. Given additivity of beliefs assumed, it is in fact the source method.

Next, matching probabilities are measured (if I understand right) from binary choices between playing the game and playing a lottery. From this, subjects are categorized into three categories: Ambiguity averse, ambiguity neutral, and ambiguity seeking. They are also divided into three categories of risk averse, risk neutral, or risk seeking, and in three categories regarding sophistication or naivite (naïve is taken here very strictly to mean not reckoning at all with the opponent's side and taking the probabilities over his strategies uniformly; 10% of the subjects will be that) versus sophisticated (reckoning with other's plans in any way). The percentages of **ambiguity seeking,** ambiguity neutrality, and ambiguity averse are 32/46/22, so that ambiguity aversion is the least prevalent. Not very surprising given that here other, strategic, aspects play a role. (**game theory as ambiguity**)

nonadditive measures are too general: P. 367 4th para rightfully says that nonadditive capacities are too general, and then assumes in fact the source method of Abdellaoui et al. (2011): probabilistic sophistication within the ambiguous (meaning game) source and the risky source, with the weighting function (I would call it source function) different for the two sources so, no global probabilistic sophistication. P. 369 para −4 erroneously cites Epstein for this approach. Epstein took probabilistic sophistication as designating unambiguity (risk), and took deviations from probabilistic sophistication as ambiguity. He with much emphasis did not want any exogenous concept of unambiguous. Thus, if there is probabilistic sophistication within two sources, as is the case here (and as also in Ellsberg 2-color), then he had no tool for saying which is unambiguous (his event-derivatives are impractical in this experiment, as everywhere). Ivanov takes neo-additive weighting functions with only one parameter, the pessimism parameter, by multiplying beliefs by (1−c) (p. 360 para −2). Thus, he can only capture the pessimism component, and only the positive part of it (negative pessimism, i.e., optimism, is excluded beforehand) and he also does not capture the orthogonal insensitivity component.

correlation risk & ambiguity attitude: the author does not explicitly discuss this, but from Figure 2 (p. 384) lowest panel one can see that risk aversion is negatively correlated with ambiguity aversion, where the latter is described above is not just common ambiguity but also involves preference for strategic uncertainty. %}

Ivanov, Asen (2011) “Attitudes to Ambiguity in One-Shot Normal-Form Games: An Experimental Study,” *Games and Economic Behavior* 71, 366–394. https://doi.org/10.1016/j.geb.2010.05.009

{% Seem to use sophistocated probabilistic choice-statistical re-analysis of Tversky (1969, Intransitivity of Preferences) that casts doubt on whether there really was intransitivity in the data. %}

Iverson, Geoffrey I. & Jean-Claude Falmagne (1985) “Statistical Issues in Measurement,” *Mathematical Social Sciences* 10, 131–153.

{% A remarkable variation of the smooth KMM model. For the 2nd order acts the authors do not impose EU axioms, but Yaari’s (1987) dual axioms (which means giving up smoothness). Linear utility in the 2nd stage is very reasonable because 1st stage utils are input here. They are kind of axiomatizing using RDU for ambiguity! %}

Iwaki, Hideki & Yusuke Osaki (2014) “The Dual Theory of the Smooth Ambiguity Model,” *Economic Theory* 56, 275–289.

{% The authors use Izhakian’s ambiguity theory to further explain the disposition effect. The authors, erroneouysly, think that not only 1979 prospect theory, but also 1992 prospect theory, are only for risk with known probabilities and not for ambiguity. They write on p. 2: “PT. It considers attitudes toward risk and specifies a single probability distribution, which is a limitation.” This is not so. The main extension of 1992 prospect theory is that it can also handle ambiguity. %}

Iwaki, Hideki & Daisuke Yoshikawa (2025) “Does Ambiguity Drive the Disposition Effect?,” *International Review of Financial Analysis* 98, 103887. https://doi.org/10.1016/j.irfa.2024.103887

{% **preference for flexibility** %}

Iyengar, Sheena S., & Emir Kamenica (2010) “Choice Proliferation, Simplicity Seeking, and Asset Allocation,” *Journal of Public Economics* 94, 530–539. https://doi.org/10.1016/j.jpubeco.2010.03.006

{% **preference for flexibility** %}

Iyengar, Sheena S., & Mark R. Lepper (2000) “When Choice Is Demotivating: Can One Desire too Much of a Good Thing?,” *Journal of Personality and Social Psychology* 79, 995–1006.
https://doi.org/10.1037/0022-3514.79.6.995

{% **preference for flexibility** %}

Iyengar, Sheena S., Wei Jiang, & Gur Huberman (2003) “How Much Choice Is Too Much: Contributions to 401(k) Retirement Plans,” Pension Research Council Working Paper 2003-10.

{% %}

Iyanaga, Shôkichi & Yukiyosi Kawada (1977/1980) “*Encyclopedic Dictionary of Mathematics*, Vols 1 and 2.” Mit-Press, Cambridge, MA.

{% One should watch out that probability can mean nonadditive measure in this paper (footnote 4). But the probability measures in the prior set $\mathcal{P}$, and the second-order measure ξ, are meant to be additive (Izhakian, personal communication, April 24, 2017).

The author introduces a new ambiguity model (name: see title of paper), combining ideas of the smooth model with Schmeidler’s RDU. It takes a two-stage approach as the smooth model does. For risk, known probabilities, it still assumes EU so that a vNM utility function U captures risk attitude. But then, unlike smooth, the second order integral does not involve an extra utility transformation, but an RDU Choquet-type integral with the nonadditive measure capturing ambiguity attitude. (Reminiscent of Giraud 2014.) Whereas an ambiguity-neutral person would use goodnews probabilities that are linearly weighted (through 2nd order probabilities) averages of goodnews probabilities, the author here inserts a transformation Υ (this is a capital upsilon and it is called the outlook function) on [0,1] giving a quasilinear mean, doing mathematically with goodnews probabilities what certainty equivalents in EU do with outcomes. This “certainty-equivalent probability” is called perceived probability, and is a matching probability. The expected probability of an event is the probability assigned by the ambiguity neutral twin. Concavity of the transformation Υ pushes down all the resulting goodnews probabilities, bringing extra pessimism and, hence, ambiguity aversion, and with convexity it all is opposite.

Interestingly, if the aforementioned transformation ϒ is S-shaped (opposite of inverse S) in the sense of convex then concave, then this gives likelihood insensitivity: The goodnews probabilities for best outcomes are small and all move in the area where the transformation ϒ is convex, giving overestimation and extra optimism there. For worst outcomes we similarly get underestimation of the goodnews probabilities and extra pessimism. Because these things do not involve direct convex combinations I can't see through the behavioral implications completely. It also seems that not the absolute level of the transformation ϒ, but its local degree of convexity/concavity, determines its effects here. Besides the outlook function there also is a capital gamma Γ function that further affects how the events are weighted in an overall Choquet-type integral.

The model has attitudes referring to (the set of) probabilities and, thus, is event driven rather than outcome driven. (**event/outcome driven ambiguity model: event driven**). For losses, the author does not use a reflected integral, as with PT, but the same integral, as with CEU/RDU. If I understand right, this is taken as reference- or sign dependence.

For the aversion to mean-preserving spreads to which concavity of ϒ is equivalent, we need 2nd order probabilities exogenously given to make this directly observable. %}

Izhakian, Yehuda (2017) "Expected Utility with Uncertain Probabilities Theory," *Journal of Mathematical Economics* 69, 91–103.

{% This paper is criticized by Fu, Melenberg, & Schweizer (2023), with a reply by Izhakian (2024).

event/outcome driven ambiguity model: event driven: The degree of ambiguity depends on the partition generated by the outcome-relevant events, but not on the outcomes otherwise. The author puts this very central. He also emphasizes that it is independent of risk attitude, although his job here is simplified by assuming expected utility for risk so that risk attitude is purely outcome driven. He uses his 2017 EUUP model, and uses a generalized expected volatility of the 2nd order probability distribution as an index of ambiguity. This

paper gives theoretical background to the empirical Brenner & Izhakian (2018).

The more-ambiguous-than ordering of events in Def. 2 can only be done for events with the same (what I would call the) a-neutral probability, i.e., expected probability where the expectation is taken over 2nd order probabilities. Definition 3 gives a behavioral equivalent but one problem is that it still requires the, not directly observable, restriction of same a-neutral probabilities and, further, quantifies over all ambiguity averse agents.

P. 25, last para of §6, correctly writes that the ambiguity indexes of Baillon et al. (2018 ECMA) do not distinguish ambiguity in info/events from ambiguity attitude. Unlike other popular ambiguity theories, the theory of Baillon et al. does not want to claim such a separation. I think that it is too early to claim such separations, and the claimed separations in the literature are ad hoc. %}

Izhakian, Yehuda (2020) "A Theoretical Foundation of Ambiguity Measurement," *Journal of Economic Theory* 187, 105001.

{% %}

Izhakian, Yehuda (2020) "Knight Meets Sharpe: Capital Asset Pricing under Ambiguity," SSRN 3074917.

{% %}

Izhakian, Yehuda (2024) "A Theoretical Foundation of Ambiguity Measurement: A Reply," working paper.

{% Calculates uncertainty premium for smooth model in money units. %}

Izhakian, Yehuda & Menachem Brenner (2011) "The Uncertainty Premium in an Ambiguous Economy," *Quarterly Journal of Finance* 1, 323–354.

{% **natural sources of ambiguity; uncertainty amplifies risk**; **event/outcome driven ambiguity model: event driven**

For bonds, possibility to default is main source of ambiguity. Ambiguity may be concentrated in one tail. The paper assumes ambiguity, and ambiguity attitudes, independent of outcomes. %}

Izhakian, Yehuda, Ryan C. Lewis, & Jaime F. Zender (2021) "Ambiguity and Corporate Yield Spreads," in preparation.

{% **loss aversion: erroneously thinking it is reflection**: P. 68, footnote 10: "we do not assume different attitudes toward risk for losses and for gains (i.e., loss aversion)." This paper uses Izhakian's ambiguity model to fit data from the financial market. It takes an, exogenously set, two-stage model of ambiguity like the smooth model only using RDU-type goodnews probability transformation rather than the utility-transformation of the smooth model. Then it does parametric data fitting to assess 2nd order beliefs and the rest. It finds that, whereas extra risk-volatility makes people exercise options later, a common and plausible phenomenon, ambiguity does the opposite. %}

Izhakian, Yehuda & David Yermack (2017) "Risk, Ambiguity, and the Exercise of Employee Stock Options," *Journal of Financial Economics* 124, 65–85.

{% **natural sources of ambiguity; uncertainty amplifies risk**; **event/outcome driven ambiguity model: event driven**

This paper applies Izhakian's ambiguity theory of expected utility with uncertain probabilities (EUUP) to finance.

Footnote 20 writes that the indexes of Baillon et al. (2018) only work for exactly three events. However, Baillon et al. indicate that the extension to any number of events of three or more is provided in a follow-up paper, now appeared as Baillon, Bleichrodt, Li, & Wakker (2021 JET). The authors are right that the insensitivity index of Baillon et al. is attitude dependent, whereas they take an ambiguity index exogenously generated by data and not by attitude.

P. 4091 claims that most ambiguity models today are outcome dependent, citing the smooth ambiguity model that I also consider to be outcome dependent. However, they claim that maxmin EU is also outcome dependent, whereas I consider it to be event dependent. Other event dependent ambiguity models, such as Schmeidler (1989) and its variations Tversky & Kahneman (1992) or Abdellaoui, Baillon, Placido, & Wakker (2011) are not cited here. Later the authors EUUP is presented as a variation of Schmeidler (1989).

This paper derives the exogenous ambiguity from volatility over time and turns that into a set of priors. Greater risk leads firms to decrease leverage. but greater ambiguity to the opposite, increase leverage. Many people take ambiguity as a sort of increased risk and then this result is surprising. %}

Izhakian, Yehuda, David Yermack, & Jaime F. Zender (2022) "Ambiguity and the Tradeoff Theory of Capital Structure," *Management Science* 68, 4090–4111. https://doi.org/10.1287/mnsc.2021.4074

{% **Z&Z** %}

Jack, William & Louise Sheiner (1997) "Welfare-Improving Health Expenditure Subsidies," *American Economic Review* 87, 206–221.

{% %}

Jackson, Mathew O. (1986) "Continuous Utility Functions in Consumer Theory (A set of duality theorems)," *Journal of Mathematical Economics* 15, 63–77.

{% Course, not survey, on implementation. It does not take game theory as given, but investigates what game structure has best properties, which makes it primarily a normative field. §7.1, p. 691 ff., discusses incentive compatibility, which becomes an issue in games with incomplete and private information. %}

Jackson, Mathew O. (2001) "A Crash Course in Implementation Theory," *Social Choice and Welfare* 18, 655–708.

{% Nicely distinguishes between economists as scientists (Samuelson), fablists (Rubinstein: economists just do what other economists do without reference to any real world), engineers (Roth), or plumbers (Duflo: just fix small problems where they arise and make concrete things work).

If I may express a personal opinion: Big data can make one think that one needs less theory, because the data are so rich that one can get what one wants anyhow. But it can also make one think that one needs more theory, because all data want theory to organize it and the more data the more theory. The author puts up the hypothesis that big data may make theory obsolete, to then discard this, but it is a straw man.

The author considers general topics from the perspective of his own expertises, giving central roles to mechanism design, general equilibrium, and game theory. %}

Jackson, Matthew O. (2019) "The Role of Theory in an Age of Design and Big Data," working paper

{% This paper starts from the well-known fact that time inconsistency at group level can be generated from aggregation where all individuals are time consistent. It experimentally tests it. 3/4 of subjects is present-biased and 1/4 future-biased or unspecified. So as to separate genuine time preference (as of consumption) from market-driven cash-flow, they use a special system of paying in tokens leading to discounted payoffs (p. 4192 bottom). (**time preference, fungibility problem**) %}

Jackson, Matthew O. & Leeat Yariv (2014) "Present Bias and Collective Dynamic Choice in the Lab," *American Economic Review* 104, 4184–4204.

{% Shows further problems of aggregating time preferences under heterogeneity: Any Pareto nondictatorial rule must be time inconsistent. They also obtain intransitivity results. %}

Jackson, Matthew O. & Leeat Yariv (2015) "Collective Dynamic Choice: The Necessity of Time Inconsistency," *American Economic Journal: Microeconomics* 7, 150–178.

{% %}

Jackwerth, Jens Carsten & Mark Rubinstein (1996) "Recovering Probability Distributions from Option Prices," *Journal of Finance* 51, 1611–1631.

{% **Newcomb's problem** %}

Jacobi, Northon (1993) "Newcomb's Paradox: A Realistic Resolution," *Theory and Decision* 35, 1–17.

{% ISBN 0521635381) %}

Jacobs, Donald P., Ehud Kalai, & Morton I. Kamien (1998) "*Frontiers of Research in Economic Theory: The Nancy L. Schwartz Memorial Lectures, 1983 - 1997*." Cambridge University Press.

{% Children use more base-rates as they get older; use of representativeness heuristic is also examined. %}

Jacobs, Janis E. & Maria Potenza (1991) "The Use of Judgment Heuristics to Make Social and Object Decisions: A Development Perspective," *Child Development* 62, 166–178.

{% **Nash equilibrium discussion** %}
Jacobsen, Hans-Jörgen (1996) "On the Foundations of Nash Equilibrium," *Economics and Philosophy* 12, 67–88.

{% **law and decision theory**: Subject had to predict jury decisions, receiving info on judgments by others. Decision bias (discount information of others too much in our decisions) in a law context. Stronger with real experienced attorneys (although better calibrated) than with students. Experience enhances costly mistake! %}
Jacobson, Jonas, Jasmine Dobbs-Marsh, Varda Liberman, & Julia A. Minson (2011) "Predicting Civil Jury Verdicts: How Attorneys Use (and Misuse) a Second Opinion," *Journal of Empirical Legal Studies* 8, 99–119.

{% **real incentives/hypothetical choice**: seems to be on it
Sample of N = 700 rural people in Rwanda. Subjects are qualified as inconsistent if they prefer a lottery with lower expectation and higher variance. Subjects qualified as inconsistent this way make worse financial decisions elsewhere. %}
Jacobson, Sarah & Ragan Petrie (2009) "Learning from mistakes: What Do Inconsistent Choices over Risk Tell Us?," *Journal of Risk and Uncertainty* 38, 143–158.
https://doi.org/10.1007/s11166-009-9063-3

{% %}
Jacowitz, Karen E., and Daniel Kahneman (1995) "Measures of Anchoring in Estimation Tasks," *Personality and Social Psychology Bulletin* 21, 1161–1166.

{% %}
Jacquement, Nicolas & Olivier l'Haridon (2018) "*Experimental Economics: Method and Applications.*" Cambridge University Press, Cambridge.

{% **equity-versus-efficiency** %}

Jacquement, Nicolas & Adam Zylbersztejn (2014) “What Drives Failure to Maximize Payoffs in the Lab? A Test for the Inequality Aversion Hypothesis,” *Review of Economic Design* 18, 243–264.

{% %}

Jaffray, Jean-Yves (1974) “Existence, Propriétés de Continuité, Additivité de Fonctions d’Utilité sur un Espace Partiellement ou Totalement Ordonné.” Ph.D. dissertation, Université de Paris VI, Paris.

{% **cancellation axioms**: Necessary and sufficient conditions for additive representability in full generality!! A true classic. It uses the cancellation axioms but brings in an Archimedeanity on preference differences (all derived from ordinal revealed preference).

P. 422, Condirion H: A_i’s must be large enough relative to p_i’s ($n_i/p_i > L(x^i, y^i, z^i, t^i)$).

P. 435 ℓ. 2: $X_1 \cup X_2$: are they disjoint!? (in line above seccond displayed formula, for x_1+x_2). %}

Jaffray, Jean-Yves (1974) “On the Extension of Additive Utilities to Infinite Sets,” *Journal of Mathematical Psychology* 11, 431–452.
https://doi.org/10.1016/0022-2496(74)90031-5

{% **one-dimensional utility** %}

Jaffray, Jean-Yves (1975) “Existence of a Continuous Utility Function: An Elementary Proof,” *Econometrica* 43, 981–983.
https://doi.org/10.2307/1911340

{% %}

Jaffray, Jean-Yves (1975) “Semicontinuous Extension of a Partial Order,” *Journal of Mathematical Economics* 2, 395–406.

{% **EU+a*sup+b*inf** %}

Jaffray, Jean-Yves (1988) "Choice under Risk and the Security Factor," *Theory and Decision* 24, 169–200.

{% %}

Jaffray, Jean-Yves (1988) "Applications of Linear Utility Theory to Belief Functions." *In* Bernadette Bouchon & Ronald R. Yager (eds.) (eds.) *Uncertainty and Intelligent Systems*, Springer, Berlin.

{% %}

Jaffray, Jean-Yves (1989) "Généralisation du Critère de l'Utilité Espérée aux Choix dans l'Incertain Régulier," *RAIRO-RO/Operations Research* 23, 237–267.

{% **event/outcome driven ambiguity model**: Partly event driven, through belief-function limits of contained objective-probability events, but also partly outcome driven, through the function α that depends on the minimal outcome m and the maximal outcome M.

Gives a separation of ambiguity into information and attitude, and is the first to provide so cleanly. Whereas Jaffray was fine with subjectivity in utility functions, he abhorrored of subjectivity in the processing of information. Hence, he preferred to split up ambiguity into a risk part, where objective probabilities are given, and a part where it is not, but then the latter should also be treated in some objective manner. Combining risk with uncertainty happens in the well-known Anscombe-Aumann (AA) framework, but this is unfortunate because it puts the nonprobabilized uncertainty in the first stage and conditions on it, which is unfortunate because it is better to condition on risk than on uncertainty. (My criticism here applies to the AA framework as used nowadays, 2022 and before, to analyze ambiguity, which is not what AA (1963) themselves did.) Hence, Jaffray put the risk part first, and conditioned on risk. It leads to the following model, where the 1st stage events can be anything but they are called messages. First, with probability p_i, a message M_i is received. The p_i are often called mass distribution (or basic probability). After that a stage of ambiguity results, where there is no more objective info. Jaffray used his model of complete absence of info, in the spirit of Cohen & Jaffray (1980). The only info one receives from the message is what the set of possible outcomes is that will result.

Two-stage info as above, an objective probability distribution over subsets of outcomes, amounts to Dempster's (1967) model of random messages, and can be captured by a belief function. Given the belief function, the probabilities over the subsets of consequences can be gotten back as the Möbius inverse of the belief function. Möbius inverses can be calculated for every nonadditive set function, but they are nonnegative if and only if the nonadditive set function is a belief function. A belief function is very convex/pessimistic, and is a lower probability. One can also capture the info through the dual of the belief function, the plausibility function, which is very concave/optimistic. Shafer's (1976) belief functions are similar, the only difference being that the probabilities over the messages are subjective, which is what Jaffray would not want.

Now follow details and notation. Let X be an outcome set (it is that more than a state space, as it is originally called in this paper), F the set of all belief functions (could be extended to capacities) on X, and let a preference relation over F be given. We can mix belief functions, and impose the usual vNM mixture-independence condition on preferences (this is best conceivable if the belief functions are exogenously given). It characterizes a preference functional over belief functions, linear w.r.t. mixing. Through Möbius inverses, belief functions can be considered linear mixtures of elementary set functions e_B (e_B(A) is 1 if A contains B, and is zero otherwise). Under a monotonicity axiom, amounting to complete absence of information for such elementary set functions, the preference value of B can depend only on its supremum and infimum (like α-Hurwicz but α depends on outcomes). This can be taken as **ambiguous outcomes vs. ambiguous probabilities**, but properly assumed to concern the state space. We can interpret the mixture weights of the Möbius inverse as probabilized uncertainty, and the e_Bs as the nonprobabilized information which is to be treated as total absence of information, so as to avoid any subjective inputs (this latter avoidance is a central point in all of Jaffray's work).

A justification of mixture operation for belief functions can be found in Jaffray's 1991 publication in the FUR-IV proceedings (Chikan ed.). %}

Jaffray, Jean-Yves (1989) "Linear Utility Theory for Belief Functions," *Operations Research Letters* 8, 107–112.

https://doi.org/10.1016/0167-6377(89)90010-2

{% **Dutch book**: for belief functions, by using the linear structure of belief functions. %}

Jaffray, Jean-Yves (1989) "Coherent Bets under Partially Resolving Uncertainty and Belief Functions," *Theory and Decision* 26, 99–105.

{% **updating: nonadditive measures** %}

Jaffray, Jean-Yves (1990) "Bayesian Updating and Belief Functions." Proceedings of the 3rd International Conference on Information Processing and Management of Uncertainty in Knowledge-Based Systems (IPMU'90), Paris, July 1990, 449–451 (published by ENSTA, Paris).

{% §2 briefly discusses the separation of ambiguity in decision situation and ambiguity attitude. %}

Jaffray, Jean-Yves (1991) "Belief Functions, Convex Capacities, and Decision Making." *In* Jean-Paul Doignon & Jean-Claude Falmagne (eds.) *Mathematical Psychology: Current Developments*, 127–134, Springer, Berlin.

{% This paper justifies the independence for belief functions. %}

Jaffray, Jean-Yves (1991) "Linear Utility Theory and Belief Functions: A Discussion." *In* Atilla Chikan (ed.) *Progress in Decision, Utility and Risk Theory*. Kluwer Academic Publishers, Dordrecht.

Link to paper

{% **updating: nonadditive measures**: Proposes a way to update belief functions, and proves that this method, unlike the Dempster/Shafer method, will again yield a belief function. One direction of the result was obtained independently by Fagin & Halpern (1991), but this paper very nicely adds the more difficult direction, showing equivalence. %}

Jaffray, Jean-Yves (1992) "Bayesian Updating and Belief Functions," *IEEE Transactions on Systems, Man, and Cybernetics* 22, 1144–1152.

{% **event/outcome driven ambiguity model: event driven**

§3 summarizes Jaffray's model and its arguments. **Important**: §3.4.3 characterizes α maxmin if the set of priors is objectively given.

This paper shows that the α-Hurwicz criterion a priori plus same criterion a posterior violate **dynamic consistency**. It, therefore, shows in fact that the criterion violates the meta-version of dynamic consistency of Epstein & Le Breton. %}

Jaffray, Jean-Yves (1994) "Dynamic Decision Making with Belief Functions." *In* Ronald R. Yager, Mario Fedrizzi, & Janus Kacprzyk (eds.) *Advances in the Dempster-Shafer Theory of Evidence*, 331–352, Wiley, New York.
Link to paper

{% **dynamic consistency** %}

Jaffray, Jean-Yves (1998) "Implementing Resolute Choice under Uncertainty." In Chris Mellish (ed.) *Proceedings of the Fourteenth Conference Annual Conference on Uncertainty in Artificial Intelligence (UAI-98),* 282–288, Morgan Kaufmann, San Francisco, CA.

{% %}

Jaffray, Jean-Yves (2006) "Bayesian Networks." *In* Denis Bouyssou, Didier Dubois, Henri Prade, & Marc Pilot (eds.) *Decision-Making Process: Concepts and Methods*, Ch. 13, 505–539, Wiley, New York.

{% %}

Jaffray, Jean-Yves & Meglena Jeleva (2003) "How to Deal with Partially Analyzed Acts?." *In Proceedings of the 3rd International Symposium on Imprecise Probabilities and Their Applications* (ISIPTA'03), 290–304.

{% %}

Jaffray, Jean-Yves & Meglena Jeleva (2011) "How to Deal with Partially Analyzed Acts?," *Theory and Decision* 71, 129–149.

{% %}

Jaffray, Jean-Yves & Edi Karni (1999) "Elicitation of Subjective Probabilities when the Initial Endowment is Unobservable," *Journal of Risk and Uncertainty* 18, 5–20.

{% P. 165 2nd para describes matching probabilities. 3rd para points out that they can violate additivity.

paternalism/Humean-view-of-preference: P. 165 4th para puts it right: "As in medicine, prescriptions should rest on diagnoses and diagnoses rely on the study of pathologies. Judgment psychology had identified several sources of 'biases,' "

P. 175 Proposition 1, Corollary 1, and p. 176: This paper characterizes the special case of CEU/RDU where the weighting function/capacity a convex combination (with constant mixing weight α) of a lower and upper probability. (P. 168 ℓ. below Eq. 7 points out that in general lower probabilities need not be convex but are only superadditive—what I like to call subadditive.) In the special case of f convex it is, therefore, also a special case of α maxmin. NOTATION: The capacity v is αf + (1–α)F, with f denoting a lower probability and F an upper probability. The upper and lower probabilities are exogenously given.

The main structural restriction (p. 179 (A1)) is that the authors assume a rich set of risky events available, i.e., with known probabilities, that can be used to mix a rich set of ambiguous events in a kind of Aumann-Anscombe model (so, the roulette wheel precedes the horse race, which is better than the more common other way around). This extra structure is called objective imprecise risk. The authors assume that here the Jaffray (1989) model holds. This assumes expected utility for risk.

The paper was not written in an accessible manner because it gives many mathematical derivations and results in the flow of the text. %}

Jaffray, Jean-Yves & Fabrice Philippe (1997) "On the Existence of Subjective Upper and Lower Probabilities," *Mathematics of Operations Research* 22, 165–185. https://doi.org/10.1287/moor.22.1.165

{% %}

Jaffray, Jean-Yves & Jean-Charles Pomerol (1989) "A Direct Proof of the Kuhn-Tucker Necessary Optimality Theorem for Convex and Affine Inequalities," *SIAM Review* 31, 671–674.

{% %}
Jaffray, Jean-Yves & Tanios Said (1994) "Optimal Hypothesis Testing with a Vague Prior." *In* Sixto Rios (ed.) *Decision Theory and Decision Analysis: Trends and Challenges*, 261–277, Kluwer Academic Publishers, Dordrecht.

{% **criticism of monotonicity in Anscombe-Aumann (1963) for ambiguity**: when working on this paper, Jaffray, who considered EU to be normative for risk but not for ambiguity, explained to me that one should condition only on unambiguous events, and not on ambiguous ones. So, the Anscombe-Aumann framework as used in the ambiguity literature today (I write this in 2016) does it the wrong way around. Jaffray's papers and also this one do it the right way. %}
Jaffray, Jean-Yves & Peter P. Wakker (1993) "Decision Making with Belief Functions: Compatibility and Incompatibility with the Sure-Thing Principle," *Journal of Risk and Uncertainty* 7, 255–271.
https://doi.org/10.1007/BF01079626
Direct link to paper

{% **conservation of influence**: justifications of counterfactual reasoning %}
Jago, Mark (2021) "Knowing how Things Might Have Been," *Synthese* 198, S1981–S1999.
https://doi.org/10.1007/s11229-018-1869-6

{% **CBDT** %}
Jahnke, Herman, Anne Chwolka, & Dirk Simons (2005) "Coordinating Service-Sensitive Demand and Capacity by Adaptive Decision Making: An Application of Case-Based Decision Theory," *Decision Sciences* 36, 1–32.

{% **measure of similarity** %}
Jain, Ramesh, Rangachar Kasturi, & Brian G. Shunk (1995) "*Machine Vision*." McGraw-Hill, New York.

{% In welfare evaluations with variable population size, it is important to choose a proper 0 level of utility. In health, it is also important. This paper reanalyzes a

data set on the EQ-5D-5L instrument, and shows that better results are obtained if a more sophisticated person-dependent 0 level of utility is chosen. %}

Jakubczyk, Micha1 (2023) "Re-revisiting the Utilities of Health States Worse than Dead: The Problem Remains," *Medical Decision Making* 43, 875–885. https://doi.org/10.1177/0272989X231201147

{% "It is only when they go wrong that machines remind you how powerful they are." %}

James, Clive (1976, November 14)

{% P. 190: "Common sense says, we lose our fortune, are sorry and weep; we meet a bear, are frightened and run; we are insulted by a rival, are angry and strike. The hypothesis here to be defended says that this order of sequence is incorrect, that the one mental state is not immediately induced by the other, that the bodily manifestations must first be interposed between, and that the more rational statement is that we feel sorry because we cry, angry because we strike, afraid because we tremble, and not that we cry, strike, or tremble, because we are sorry, angry, or fearful, as the case may be." %}

James, William (1884) "What is an Emotion?," *Mind* 9, 188–205.

{% **free will/determinism**

This paper has the lively beautiful style that research papers written before 1930 typically have. The author uses an overdramatic style of writing. Or maybe I should say speaking, because it was a lecture. For example, the opening lines on there not being a less worn out topic than free will/determinism. End of opening para seems to say that whether free will exists cannot be proved by arguments, but is a choice of free will itself.

2nd para seems to confuse "is" and "ought" in "If a certain formula for expressing the nature of the world violates my moral demand, I shall feel as free to throw it overboard," but probably I misunderstand something here, the more so as I do not understand the rest of this para.

The author throughout seems to take the word chance to refer to physical, rather than epistemic, uncertainty, and the latter concept, so central in my thinking, seems to play no role in this text. Hence, forn him, the existence of chance contradicts determinism.

Soft determinism seems to refer to the combination of determinism with free will, which is quite my view (although I more favor not committing to (in)determinism), and I agree with “for freedom is only necessity understood” as the author describes soft determinism, where I side with the cited Mr. Hodgson who is said to call himself a “free-will determinist.” (Later, in a para starting with “So much for subjectivism!”, James will prefer subjectivism (soft determinism) to pessimism (hard determinism).) James cites the nice

“And the first morning of creation wrote

What the last dawn of reckoning shall read.”

This text puts it well: “Both sides admit that a volition, for instance, has occurred. The indeterminists say another volition might have occurred in its place: the determinists swear that nothing could possibly have occurred in its place.”

The authors argues that facts will never show if there are/were several possibilities (i.e., indeterminism) or only one (determinism), but it is our sentiment of what we find more rational. The author uses the term “rational” not in the decision-theory way, but as sort of intellectually acceptable/plausible.

The author seems to consider only one kind of chance; due to due to uncertainty about decisions by others. Not chance purely in nature. This is not really said, but surely suggested, by “Indeterminate future volitions do mean chance.”

conservation of influence: He brings up an essential ingredient in what I call influence: regret. You think about what would have happened had you done something else than you did.

Funny is the story “Hardly any one can remain entirely optimistic after reading the confession of the murderer at Brockton the other day: how, to get rid of the wife whose continued existence bored him, he inveigled her into a desert spot, shot her four times, and then, as she lay on the ground and said to him, ‘You didn’t do it on purpose, did you, dear?’ replied, ‘No, I didn’t do it on purpose,’ as he raised a rock and smashed her skull.” He later nicely describes regret “though it *couldn’t* be, yet it *would* have been a better universe with something different from …” [italics from original]

Nice sentences:

“Not the doing either of good or evil is what nature cares for, but the knowing of them.” James calls this subjectivism, a term he prefers to gnosticism.

“if determinism is to escape pessimism, it must leave off looking at the goods and ills of life in a simple objective way, and regard them as materials, indifferent in themselves, for the production of consciousness, scientific and ethical [subjective], in us."

"But then the moral judgments seem the main thing, and the outward facts mere perishing instruments for their production. This is subjectivism."

"Not the saint, but the sinner that repenteth, is he to whom the full length and breadth, and height and depth, of life's meaning is revealed."

"Look to thyself, O Universe,

Thou are better and not worse,

we may say in that philosophy, the moment we have done our stroke of conduct, however small."

On a philosophy of objective conduct: "But this means a complete rupture with the subjectivist philosophy of things. It says conduct, and not sensibility, is the ultimate fact for our recognition." I must admit that I don't see an inconsistency between subjectivism and the philosophy of objective conduct.

At end James states his own view. He cannot imagine qualifying things as good or bad, and feeling regret about one's (bad) actions, unless the world is indeterministic: "And if I still wish to think of the world as a totality, it lets me feel that a world with a chance in it of being altogether good, even if the chance never come to pass, is better than a world with no such chance at all." I did not discover any more argument advanced by him. He does restate that whether free will exists cannot be proved by arguments, but is a choice of free will itself.

He ends with reconciling indeterminism ("chance") with the existence of the allmighty providence. The allmighty providence gives us small local freedom, but on a larger scale takes care that everything goes his way still. Like a good chess player not knowing what exact moves his weak opponent will make, but yet knowing he will end winning the game. %}

James, William (1884) "The Dilemma of Determinism," lecture to Harvard Divinity School students.

{% **measure of similarity**;

Ideomotor theory: the notion that conscious goals and images are inherently impulsive, and tend to be carried out by default, unless they are inhibited by other conscious thoughts or intentions.

free will/determinism: Seems to have written: "Now how do we ever get up under such circumstances? … We suddenly find that we have got up. A fortunate lapse of consciousness occurs; we forget both the warmth and the cold;… the (spontaneous) idea flashes across us, “Hollo, I must lie here no longer” --- an idea which at that lucky instant awakens no contradictory or paralyzing suggestions, and consequently produces immediately its appropriate motor effects. ... This case seems to me to contain … the data for an entire psychology of volition” %}

James, William (1890) “*Principles of Psychology*.” Holt, New York.

{% Table 1 in a nice didactical way indicates relations between discount factor, discount rate, present value, and other things.

They also propose a sort of continuous extension of quasi-hyperbolic. Time is taken continuously. Then first during some period, “extended present” (my term) there is constant discounting (say the period during which present self controls), but after it suddenly drops by a factor, but other than that keeps the same exponential. There are some drawbacks to this model, as I read in a paper by Pan, Webb, & Zank. For instance, to accommodate (day 0: 1 apple) ≻ (day 1: 2 apples) and (day 365: 1 apple) ≺ (day 366: 2 apples), the well-known violation of stationarity put forward by Thaler, the point of change of regime must be either between day 0 and day 1 or between day 365 and day 366. This is too restrictive. %}

Jamison, Dean T. & Julian Jamison (2011) “Characterizing the Amount and Speed of Discounting Procedures,” *Journal of Benefit-Cost Analysis* 2:2, Article 1. https://doi.org/10.2202/2152-2812.1031

{% Seems to be: d**ecision under stress**: general conflict theory of decision making, with stress-syndroms and their effects on decision making.

P. 11 seems to write that there is “no dependable way of objectively assessing the success of a decision” which is qualified as a “somewhat demoralizing” conclusion. %}

Janis, Irving L. & Leon Mann (1977) “*Decision Making; A Study of Conflict, Choice and Commitment.*” The Free Press, New York.

{% %}

Janowitz, Melvin F. (1988) “Induced Social Welfare Functions,” *Mathematical Social Sciences* 15, 261–276.

{% %}

Jansen, Sylvia J.T. (2000) “The Impact of Experience.” Ph.D. dissertation, Leiden University Medical Center, Leiden, the Netherlands.

{% **utility elicitation** %}

Jansen, Sylvia J.T., Job Kievit, Marianne A. Nooij, & Anne M. Stiggelbout (2001) “The Impact of Experience,” *Medical Decision Making* 21, 295–306.

{% **total utility theory**; **utility elicitation**; find that higher evaluation of their situation by patients when in health state is generated not only by their more positive evaluation of outcomes but also by their more optimistic assessment of probabilities. P.s.: kind of more probabilistic attitude towards probabilistic risk. %}

Jansen, Sylvia J.T., Wilma Otten, Monique C.M. Baas-Thijssen, Cock J.H. van de Velde, J.W.R. Nortier, & Anne M. Stiggelbout (2005) “Explaining Differences in Attitude towards Adjuvant Chemotherapy between Experienced and Inexperienced Breast Cancer Patients,”

{% **total utility theory**; **utility elicitation** %}

Jansen, Sylvia J.T., Anne M. Stiggelbout, Peter P. Wakker, Marianne A. Nooij, Evert M. Noordijk, & Job Kievit (2000) “Unstable Preferences: A Shift in Valuation or an Effect of the Elicitation Procedure?,” *Medical Decision Making* 20, 62–71.
https://doi.org/10.1177/0272989X0002000108
Direct link to paper

{% Keywords. utility assessment, Standard gamble, Time Trade-off, breast cancer, chemotherapy, radiotherapy.

PE most missing answers (**PE doesn’t do well**) (they call it SG) %}

Jansen, Sylvia J.T., Anne M. Stiggelbout, Peter P. Wakker, Thea P.M. Vliet Vlieland, Jan-Willem H. Leer, Marianne A. Nooy, & Job Kievit (1998) “Patient Utilities for Cancer Treatments: A Study of the Chained Procedure for the Standard Gamble and Time Tradeoff,” *Medical Decision Making* 18, 391–399.
https://doi.org/10.1177/0272989X0002000108
Direct link to paper

{% **real incentives/hypothetical choice**: Study discrepancy hypothetical/actual within and between patients. %}

Jansen, Sylvia J.T., Anne M. Stiggelbout, Marianne A. Nooy, & Job Kievit (2000) “The Effect of Individually Assessed Preference Weights on the Relationship between Holistic and Nonpreference-Based Assessment,” *Quality of Life Research* 9, 541–557.

{% Study discrepancy hypothetical/actual within and between patients. %}

Jansen, Sylvia J.T., Anne M. Stiggelbout, Marianne A. Nooy, & Job Kievit (2000) “The Stability of Preferences for Adjuvant Chemotherapy: Perspective of Early-Stage Breast-Cancer Patients,”

{% %}

Janssen, Maarten C. & Peran van Reeven (1998) “Price as a Signal of Illegality,” *International Review of Law and Economics* 18, 51–60.

{% %}

Janssens, Wendy (2007) “Social Capital and Cooperation: An Impact Evaluation of a Women’s Empowerment Programme in Rural India,” Dept. of Economics, VU, Amsterdam.

{% **conservation of influence**: seems to have said: het is geen uitdaging te zien wat er is, maar wat er geweest zou kunnen zijn. %}

Japin, Arthur (date unknown)

{% Under PT, if a loss is large, its marginal utility can be smaller than the marginal utility for small positive gains, so much that it can even overcome loss aversion. Then splitting up a big loss into a somewhat bigger loss and a small gain can, if these are evaluated separately as with mental accounting, be an improvement. The paper shows it theoretically and experimentally. %}

Jarnebrant, Peter, Olivier Toubia, & Eric Johnson (2009) “The Silver Lining Effect: Formal Analysis and Experiments,” *Management Science* 55, 1832–1841.

{% Hypothetical choice, with also losses. More numerate subjects go more by expected value. (**cognitive ability related to risk/ambiguity aversion**) In particular, they are less risk seeking if the risky prospect has lower EV and involves a loss. %}

Jasper, John D., Chandrima Bhattacharya, Irwin P. Levin, Lance Jones & Elaine Bossard (2013) "Numeracy as a Predictor of Adaptive Risky Decision Making," *Journal of Behavioral Decision Making* 26, 164–173.

{% %}

Jaspersen, Johannes G. & Marc A. Ragin (2020) "A Model of Anchoring and Adjustment for Decision-Making under Risk," working paper.

{% This paper measures the general introspective risk aversion question (GRQ) used by Dohmen et al. (2011) and others. N = 1730 subjects from Qualtrics and 378 subjects in the lab. It also measures lottery choices through choice lists. For the latter it does PT data fitting with five parameters: Concavity of utility for gains, concavity of utility for losses, loss aversion, likelihood insensitivity for probability weighting for gains, and likelihood insensitivity for probability weighting for losses. GRQ is correlated with loss aversion and concavity of utility for losses, but not with the other three parameters. It suggests that people take the GRQ to primarily concern losses. Linguistically, risk indeed is often taken to refer only to losses. I was glad to see that the authors consider likelihood insensitivity. %}

Jaspersen, Johannes G., Marc A. Ragin, & Justin R. Sydnor (2020) "Linking Subjective and Incentivized Risk Attitudes: The Importance of Losses," *Journal of Risk and Uncertainty* 60, 187–206.
https://doi.org/10.1007/s11166-020-09327-4

{% Formulate second-order stochastic dominance conditions in terms of RDU. %}

Javanmardi, Leili & Yuri Lawryshyn (2016) "A New Rank Dependent Utility Approach to Model Risk Averse Preferences in Portfolio Optimization," *Annals of Operations Research* 237, 161–176.

{% %}

Jaynes, Edwin T. (1968) "Prior Probability," *IEEE Transactions on Systems Science and Cybernetics* 4, 227–241.

{% **foundations of probability**; **foundations of statistics** %}
Jaynes, Edwin T. (2003) "*Probability Theory: The Logic of Science*." Cambridge University Press, Cambridge.

{% %}
Jech, Thomas (1978) "*Set Theory.*" Academic Press, New York.

{% %}
Jech, Thomas (193) "*Axiom of Choice.*" North-Holland, Amsterdam.

{% **R.C. Jeffrey model** %}
Jeffrey, Richard C. (1965) "*The Logic of Decision.*" McGraw-Hill, New York. (2nd edn. 1983, University of Chicago Press, Chicago.)

{% **foundations of probability**; p. 85: a preference relation should be extendable while preserving good preference conditions. (**desirable to extend preferences while satisfying/maintaining conditions**) %}
Jeffrey, Richard C. (1992) "*Probability and the Art of Judgment.*" Cambridge University Press, Cambridge.

{% Previous studies have shown that people are risk seeking when below a goal. This agrees with the risk seeking for losses that PT predicts. The present study considers the case of all outcomes above the goal. PT would predict risk aversion for gains. They, however, find risk seeking. %}
Jeffrey, Scott A., Selcuk Onay, & Richard P. Larrick (2010) "Goal Attainment as a Resource: The Cushion Effect in Risky Choice above a Goal," *Journal of Behavioral Decision Making* 23, 191–202.

{% %}
Jehle, Geoffrey & Philip Reny (2001) "*Advanced Microeconomic Theory*; 2nd edn. Pearson Education, Reading, Mass.

{% **real incentives/hypothetical choice**?, no, for learning experiments %}
Jenkins, William O. & Julian C. Stanley Jr. (1950) "Partial Reinforcement: A Review and Critique," *Psychological Bulletin* 47, 193–234.

{% Discusses stopping rules Bayesianist//frequentist. %}
Jennison, Christopher & Bruce W. Turnbull (1990) "Statistical Approaches to Interim Monitoring of Medical Trials: A Review," *Statistical Science* 5, 299–317.

{% Didactical paper on influence diagrams, Bayesian networks, and so on. %}
Jensen, Finn V. & Thomas Dyhre Nielsen (2013) "Probabilistic Decision Graphs for Optimization under Uncertainty," *Annals of Operations Research* 204, 223–248.

{% **proper scoring rules**; **real incentives/hypothetical choice**: Found, for estimating probabilities, that real rewards through quadratic scoring rule versus no reward do not affect the results much. P. 316 discusses that losses are overweighted relative to gains (loss aversion avant la lettre!) so that it may be wiser to let all outcomes have the same sign. %}
Jensen, Floyd A. & Cameron R. Peterson (1973) "Psychological Effects of Proper Scoring Rules," *Organizational Behavior and Human Performance* 9, 307–317.

{% Contains his vNM EU derivation. %}
Jensen, Niels-Erik (1967) "An Introduction to Bernoullian Utility Theory, I," *Swedish Journal of Economics* 69, 163–183.
https://doi.org/10.2307/3439089

{% %}
Jensen, Niels-Erik (1967) "An Introduction to Bernoullian Utility Theory, II," *Swedish Journal of Economics* 69, 229–247.
https://doi.org/10.2307/3439377

{% %}
Jensen, Niels-Erik (1967) "An Introduction to Bernoullian Utility Theory, I, II," *Swedish Journal of Economics* 69, 163–183, 229–247.

{% Estimate index of relative risk aversion from market data. Using EU it ranges from 7.4 to 15, and using maxmin EU it ranges from 1 to 8. %}

Jeong, Daehee, Hwagyun Kim, Joon Y. Park (2015) “Does Ambiguity Matter? Estimating Asset Pricing Models with a Multiple-Priors Recursive Utility,” *Journal of Financial Economics* 115, 361–382.

{% %}

Jessen, Børge (1931) “Bemaerkinger om Konvekse Funktiner og Uligheder imellem Middelvaerdier (I),” *Maematisk Tidsskrift* B 2, 17–28.

{% **marginal utility is diminishing**: Jn 1889 edn. seems to be stated on p. 173.

decreasing ARA/increasing RRA: 1889 edn. seems to have stated it on p. 172/173.

Seems that Jevons resolved the paradox of value (water is more useful than diamonds but we pay less for it) by considering marginal utility and, thus, turned utility into a central concept for economics. This constitutes the revolution of marginal utility of around 1870, where also Menger (1971) and Walras (1874) came up with the idea of marginal utility. Sugden wrote that they showed that for any pair of goods and for any consumer who maximises utility, the ratio of the marginal utilities of those goods is equal to the ratio of their prices.

Seems that Jevons used the term hedonic force for utility (**conservation of influence**). Edgeworth later also seems to have done.

P. 6 of 1911 edn. seems to write: “Utility is plainly the subject-matter of economics from beginning to end … the object of Economics is to maximize happiness by purchasing pleasure, as it were, at the lowest cost of pain.”

P. 36 of 1911 edn. seems to express/suggest the thought that a person could find out about his strength of preference through introspection; this str. of pr. then could as well serve as vNM utility, certainly in a normative sense.

Was like Bentham but formalized more/better (Selten grouped these two together) Seems that he was not very good at doing formal analyses.

P. 51:

“Utility may be treated as a quantity of two dimensions.”

Those are intensity and time.

Pp. 61-62 seems to write: “the final degree of utility is that function upon which the whole Theory of Economy will be found to turn.”

Pp. 72-73: d**iscounting normative**: Argues against discounting (unless for uncertainty). Strotz (1956) cites Jevons, pp. 77-80, as: “people of good sense will not discount the future except for uncertainty-but people do discount the future in accordance with its remoteness.”

P. 85 seems to state impossibility of interpersonal comparison of utility.

Stigler cites him as pessimistic on measuring utility. %}

Jevons, W. Stanley (1871) “*The Theory of Political Economy.*” (5th edn. 1957, Kelley and MacMillan, New York; other edn. Penguin, 1970.)

{% Act f is more ambiguous (I) than act g if an ambiguity averse DM prefers g to f whereas an ambiguity neutral replica of himself is indifferent. It is extended to more ambiguous (II) if, the more ambiguity averse the agent, the more compensation he requires for f. Is analyzed for α maxmin and smooth ambiguity model. The use of ambiguity neutral replica is reminiscent of the ambiguity definitions of Epstein and Ghirardato & Marinacci, who chose either probabilistically sophisticated or expected-utility maximizing replicas of the DM as ambiguity neutral, and the difficulty is that such replicas are not easily observable. The separation of ambiguity and ambiguity attitude is by assuming ambiguity attitude constant. %}

Jewitt, Ian & Sujoy Mukerji (2017) “Ordering Ambiguous Acts,” *Journal of Economic Theory* 171, 213–267.

{% %}

Jia, Jianmin, James S. Dyer, & John C. Butler (2001) “Generalized Disappointment Models,” *Journal of Risk and Uncertainty* 22, 59–78.

{% Use simulation to see which methods for determining attibute weights in MAUT work best. %}

Jia, Jianmin, Gregory W. Fischer, & James S. Dyer (1998) “Attribute Weighting Methods and Decision Quality in the Presence of Response Error: A Simulation Study,” *Journal of Behavioral Decision Making* 11, 85–105.

{% Measures elicited additive subjective probabilities. Shows they are impacted by prior received outcomes. %}

Jiao, Peiran (2020) "Payoff-Based Belief Distortion," *Economic Journal* 130, 1416–1444.

https://doi.org/10.1093/ej/ueaa019

{% **gender differences in risk attitude**: %}

Jianakoplos, Nancy Ammon & Alexandra Bernasek (1998) "Are Women more Risk Averse?," *Economic Inquiry* 36, 620–630.

due to

{% **dominance violation by pref. for increasing income**: Not exactly that but close and also a violation of dominance due to contrast effects and special effects of the 0 outcome much in the spirit of Birnbaum, Coffey, Mellers, & Weiss (1992). Follows up on Scholten & Read (2014) and show that the violations also occur when the preference for increasing outcomes, put forward by S&R, cannot explain it. %}

Jiang, Cheng-Ming, Hong-Mei Sun, Long-Fei Zhu, Lei Zhao, Hong-Zhi Liu, & Hong-Yue Sun (2017) "Better is Worse, Worse Is Better: Reexamination of Violations of Dominance in Intertemporal Choice," *Judgment and Decision Making* 12, 253–259.

{% %}

Jiang, Long (2006) "A Note on g-Expectation with Comonotonic Additivity," *Statistics & Probability Letters* 76, 1895–1903.

{% **probability communication**: People perceived a higher risk of COVID-19 from a total-cases format than from frequency formats when the denominators are relatively small, and the lowest risk from a proportion format. Finds also some denominator neglect. %}

Jie, Yun (2022) "Frequency or Total Number? A Comparison of Different Presentation Formats on Risk Perception During COVID-19," *Judgment and Decision Making* 17, 215–236.

{% Seems to show that individual stocks and underdiversified portfolios have positive skewness. %}
Jin, Hanqing & Xun Yu Zhou (2008) "Behavioral Portfolio Selection in Continuous Time," *Mathematical Finance* 18, 385–426.

{% Consider to what extent an agent wants to move from a probability distribution towards a preferred one for various costs. In some situations the Pratt-Arrow measure arises as relevant index, in other situations the Ross characterization. %}
Jindapona, Paan & William S. Neilson (2007) "Higher-Order Generalizations of Arrow–Pratt and Ross Risk Aversion: A Comparative Statics Approach," *Journal of Economic Theory* 136, 719–728.

{% Elo-ratings %}
Joe, Harry (1990) "Extended Use of Paired Comparison Models, with Application to Chess Rankings," *Applied Statistics* 39, 85–93.

{% %}
Johannesson, Magnus (1994) "QALYs, HYEs, and Individual Preferences - A Graphical Illustration," *Social Science and Medicine* 39, 1623–1632.

{% %}
Johannesson, Magnus (1995) "Quality-Adjusted Life-Years versus Healthy-Years Equivalents- A Comment," *Journal of Health Economics* 14, 9–16.

{% %}
Johannesson, Magnus (1995) "The Ranking Properties of Healthy-Years Equivalents and Quality-Adjusted Life-Years under Certainty and Uncertainty," *International Journal of Technology Assessment in Health Care* 11, 40–48.

{% %}
Johannesson, Magnus (1995) "QALYs: A Comment," *Journal of Public Economics* 56, 327–328.

{% %}

Johannesson, Magnus (1995) “A Second Opinion: On the Estimation of Cost-Effectiveness Ratios,” *Health Policy* 31, 225–229.

{% %}

Johannesson, Magnus (1995) “A Note on the Depreciation of the Societal Perspective in Economic Evaluation in Health Care,” *Health Policy* 33, 59–66.

{% %}

Johannesson, Magnus (1996) “A Note on the Relationship between Ex Ante and Expected Willingness to Pay for Health Care,” *Social Science & Medicine* 42, 305–311.

{% **measure of similarity** %}

Johannesson, Magnus (2000) “Modelling Asymmetric Similarity with Prominence,” *British Journal of Mathematical and Statistical Psychology* 53, 121–139.

{% **real incentives/hypothetical choice**: study method of Blumenschein, Johannesson, Blomquist, Liljas, & O’Conor (1998; *Southern Economic Journal* 65). %}

Johannesson, Magnus, Glenn C. Blomquist, Karen Blumenschein, Per-Olof Johannson, Bengt Liljas, & Richard M. O’Conor (1999) “Calibrating Hypothetical Willingness to Pay Responses,” *Journal of Risk and Uncertainty* 8, 21–32.

{% %}

Johannesson, Magnus & Ulf G. Gerdtham (1995) “A Pilot Test of Using the Veil of Ignorance Approach to Estimate a Social Welfare Function for Income,” *Applied Economics Letters* 2, 400–402.

{% Marc referaat Jan 20, 1993. Ask people how much they want to pay for a preventive measure, how high they estimate their subjective risk with and without the therapy. The open contingent valuation did bad. %}

Johannesson, Magnus, Bengt Jönsson, & Lars Borgquist (1991) “Willingness to Pay for Antihypertensive Therapy—Results of a Swedish Pilot Study,” *Journal of Health Economics* 10, 461–474.

{% P. 283 does not commit to utilities having to be elicited from general public. P. 286: additive separability underlies Markov models.

Pp. 289-292: nice discussion of WTP history, e.g. NOAA. %}

Johannesson, Magnus, Bengt Jönsson, & Goran Karlsson (1996) “Outcome Measurement in Economic Evaluation. Health Economics,” *Health Economics* 5, 279–296.

{% %}

Johannesson, Magnus & Per-Olov Johansson (1996) “To Be, or not to Be, That Is the Question: An Empirical Study of the WTP for an Increased Life Expectancy at an Advanced Age,” *Journal of Risk and Uncertainty* 13, 163–174.

{% %}

Johannesson, Magnus & Goran Karlsson (1997) “The Friction Cost Method: A Comment,” *Journal of Health Economics* 16, 249–255.

{% %}

Johannesson, Magnus, Bengt Liljas, & Per-Olov Johansson (1995) “Homegrown Values and Hypothetical Surveys: A Comment.”

{% %}

Johannesson, Magnus, Joseph S. Pliskin, & Milton C. Weinstein (1993) “Are Healthy-Years Equivalents an Improvement over Quality-Adjusted Life Years?,” *Medical Decision Making* 13, 281–286.

{% %}

Johannesson, Magnus, Joseph S. Pliskin, & Milton C. Weinstein (1994) “A Note on QALYs, Time Tradeoff, and Discounting,” *Medical Decision Making* 14, 188–193.

{% **paternalism/Humean-view-of-preference**: Many references. Analyzes cases of discrepancies between objective probabilities and probabilities as perceived by the public. Assumes that the correct probabilities should be used, but that the public's misperception enters directly as a loss in the utility function. So, this is not consequentialist utility but a kind of meta- and perception-driven utility. Given that utility component, deviations from conventional efficiency rules. Makes prospect-theory **inverse S** assumptions about misperceived risks. Then analyzes if taxes and (costly) information-provision can improve total welfare. In some situations can if people overestimate risks but not if they underestimate. %}
Johansson-Stenman, Olof (2008) "Mad Cows, Terrorism and Junk Food: Should Public Policy Reflect Perceived or Objective Risks?," *Journal of Health Economics* 27, 234–248.

{% Defends Rabin's (2000) critique against the criticisms by Cox & Sadiraj (2006) and by Rubinstein (2006). It takes data of Holt & Laury (2002), fits this into an economic model with all the flesh and bones of lifelong consumption etc., and shows that under expected utility the risk aversion found by Holt & Laury in terms of lifelong utility implies absurd curvature of utility. %}
Johansson-Stenman, Olof (2010) "Risk Behavior and Expected Utility of Consumption over Time," *Games and Economic Behavior* 68, 208–219.

{% Loss aversion of prospect theory is useful in this study. %}
John, Leslie K. & Baruch Fischhoff (2010) "Changes of Heart: The Switch-Value Method for Assessing Value Uncertainty," *Medical Decision Making* 30, 388–397.

{% %}
John, Reinhard (1995) "A Simple Cycle Preserving Extension of a Demand Function," *Journal of Economic Theory* 72, 442–445.

{% **foundations of probability**: Proposes a definition of probability (or chance; am not sure if he distinguishes between the two) that is objective but still epistemic: physical chance is the degree of belief if one has maximal knowledge of all causes. It is a definition that cannot be reconciled with a deterministic view of the

world. The author argues that his definition unifies many existing ones. His definition fits well with the spirit of current (2022) ambiguity theory: that objective probabilities is the highest state of knowledge. It does not at all fit with my opinion on this point though …

Section 2 opens up, enthusiastically, with: "The only fully-developed epistemic theory of chance is my own theory, presented in Johns (2002)," %}

Johns, Richard (2020) "Epistemic Theories of Objective Chance," *Synthese* 197, 703–730.
https://doi.org/10.1007/s11229-018-1719-6

{% Show that consistency does not imply EU. (Time) consistency is **dynamic consistency**, forgone-branch independence (often called consequentialism) is incorporated by letting 2nd period utility be independent of unrealised alternatives; more precisely, their assumption of Conditional Weak Independence holds iff one can get forgone-branch independence satisfied. They have no uncertainty in 2nd stage. %}

Johnsen, Thore H. & John B. Donaldson (1985) "The Structure of Intertemporal Preferences under Uncertainty and Time Consistent Plans," *Econometrica* 53, 1451–1458.

{% Generalizations of result that every pair of three events can be independent but not the triple. %}

Johnson, Bruce R. & Benjamin J. Tilly (1996) "On the Construction of Independence Counterexamples," *American Statistician* 50, 14–16.

{% The Prince method introduced in this paper improves existing implementations of the Random Incentive System (RIS). I consider it to be one of the best papers I ever co-authored, and the time investment was infinite. At the beginning of the experiment, subjects receive a sealed envelope that already contains a description of the choice situation that will be implemented at the end, called the real choice situation. This treatment much enhances the "isolation" perception needed for validity of RIS. It also combines the pros of matching (subjects directly state the value to make them indifferent; takes little time to get precise info) with the pros of choice lists (easy to understand for subjects and to implement). Drawback:

implementing Prince takes nontrivial prior work for the experimenter. In chained/adaptive experiments, it takes predicting what choice situations may plausibly arise, but gives a big pro in return: no possibility for subjects to manipulate, and zero perception at their end of such a possibility.

Some studies used a variation of Prince where not the choice situation is contained in the envelope given beforehand, but only a number indicating what the real choice situation will be. See Loomes, Starmer, & Sugden (1989 EJ) and Epstein & Halevy (2018 p. 674 §3.3). This loses most of the punch. Number of choice situation is-not choice situation. For instance, the experimenter may change the numbering during the experiment, depending on what the cheapest choice is that the subject(s) made. The point is discussed on p. 21 2nd para of §6. %}

Johnson, Cathleen, Aurélien Baillon, Han Bleichrodt, Zhihua Li, Dennie van Dolder, & Peter P. Wakker (2021) "Prince: An Improved Method for Measuring Incentivized Preferences," *Journal of Risk and Uncertainty* 62, 1–28. https://doi.org/10.1007/s11166-021-09346-9
Direct link to paper

{% %}
Johnson, Cathleen, Jim Engle-Warnick, & Catherine Eckel (2007) "Adaptively Eliciting Risk Preferences through an Incentive Compatible Mechanism." Working paper, University of Arizona.

{% A short and accessible account of the influence of default on decisions. %}
Johnson, Eric J. & Daniel Goldstein (2003) "Do Defaults Save Lives?," *Science* 302, 21 November 2003, 1338–1339.

{% Observed that subjects pay more for flight insurance that explicitly listed certain events covered by the policy (e.g., death resulting from an act or terrorism or mechanical failure) than for a more inclusive policy that did not list specific events (e.g., death from any cause).

Choices are hypothetical. Authors do cite some real-choice evidence in agreement with their findings. %}

Johnson, Eric J., John C. Hershey, Jacqueline Meszaros, & Howard C. Kunreuther (1993) "Framing, Probability Distortions, and Insurance Decisions," *Journal of Risk and Uncertainty* 7, 35–51.

{% %}
Johnson, Eric J., John W. Payne, & James R. Bettman (1989) "Information Displays and Preference Reversals," *Organizational Behavior and Human Decision Processes* 42, 1–21.

{% **PE higher than CE**; **utility elicitation**; extended Hershey & Schoemaker (1985) by broader range of stimuli; conclude that reframing cannot account for all of their own data and propose that response mechanisms also intervene.

CE bias towards EV: a process analysis showed that 9 of 24 subjects used an EV heuristic in CEs (certainty equivalents). %}
Johnson, Eric J. & David A. Schkade (1989) "Bias in Utility Assessments: Further Evidence and Explanations," *Management Science* 35, 406–424.

{% %}
Johnson, Eric J., Michael Schulte-Mecklenbeck, & Martijn C. Willemsen (2008) "Process Models Deserve Process Data: Comment on Brandstätter, Gigerenzer, and Hertwig (2006)," *Psychological Review* 115, 263–272.

{% %}
Johnson, Eric J., Michael Schulte-Mecklenbeck, & Martijn C. Willemsen (2008) "Postscript: Rejoinder to Brandstätter, Gigerenzer, and Hertwig (2008)," *Psychological Review* 115, 272–273.

{% **risk averse for gains, risk seeking for losses**: find the predictions of prospect theory for below-target banks confirmed for data from 142 banks.

P. 86: "Theoretically, if the utility functions of bank managers do contain convex segments below target, models of the banking firm that assume universal risk aversion or risk neutrality are improperly specified. The results of this study suggest that the concepts of target outcome and distance below target should be incorporated into models that rely on risk preference assumptions. The target return is the point of inflection of the utility function and outcomes below target may

induce significantly different levels of risk tolerance. Furthermore, the distance below target can affect the degree of change in risk tolerance. It is clear that models of the banking firm may be at best imprecise without considering the possibility of convex segments of the utility function below target."

PT, applications: different risk attitude for gains than for losses. %}

Johnson, Hazel J. (1994) "Prospect Theory in the Commercial Banking Industry," *Journal of Financial and Strategic Decisions* 7, 73–89.

{% A meta-analysis of relations between time-preferences and risk preferences. Unclear and weak results are found. It was not clear to me which component(s?) of risk attitude the authors considered. They use the term probability discounting for probability weighting (I guess), but which parameters of it they use and, for instance, if utility curvature plays a role, did not become clear to me in the limited time I spent reading. Do they consider rank-dependent weighting, or something different? %}

Johnson, Kelli L., Michael T. Bixter, & Christian C. Luhmann (2020) " Delay Discounting and Risky Choice: Meta-Analytic Evidence Regarding Single-Process Theories," *Judgment and Decision Making* 15, 381–400.

{% **real incentives/hypothetical choice, for time preferences**; N = 6 subjects, screened for a history of psychiatric disorder. Choices until an indifference point was reached. Choices between immediate reward and delayed reward. Immediate reward was adjusted. Delayed rewards were between $10 and $250. Every subject answered the same set of questions. Both hypothetical and real rewards were done for each of the four amounts. One of the choices in the session for each of the four amounts was paid in the real treatment. (Despite adaptive experiment, but subjects cannot notice.) Thus, subjects received four real payments. Random incentive system but 4 times, so still income effect. Delays ranged from 1 day to 6 months. In the hypothetical treatment the delays of 1 year, 5 years and 25 years were added, along with the rewards $1000 and $2500. Session lasted for about 2.5 hrs with two 5 mins breaks in between. Mazur discounting, exponential discounting. Linear utility. Magnitude effect was found. Statistical analysis may be weak. They tested whether there was correlation between real and hypothetical treatment, but did not test whether this correlation is 1. %}

Johnson, Matthew W., & Warren K. Bickel (2002) "Within-Subject Comparison of Real and Hypothetical Money Rewards in Delay Discounting," *Journal of the Experimental Analysis of Behavior* 77, 129–146.

{% %}

Johnson, Norman L. & Samuel Kotz (1970) "*Continuous Univariate Distributions*" 2. Wiley, New York.

{% %}

Johnson, Richard M. (1974) "Trade-off Analysis of Consumer Values," *Journal of Marketing Research* 11, 121–127.

{% **probability elicitation**: applied to experimental economics**; proper scoring rules**: Consider, more generally, incentive compatibility, with proper scoring rules as a special case. Assume risk neutrality throughout.

P. 877, condition TR (truth revelation, referring to Myerson 1982 for it) means there is a one-to-one relation between types and answers. Incentive compatibility can be achieved, under some assumptions, if center's info depends—perhaps solely through messages—stochastically, however slightly, on all relevant private info. Note that the payments scheme need not observe the types in the end. In this sense it may be related to Prelec (2004). %}

Johnson, Scott, John W. Pratt, & Richard J. Zeckhauser (1990) "Efficiency despite Mutually Payoff-Relevant Private Information: The Finite Case," *Econometrica* 58, 873–900.

{% **probability elicitation**: review of subjective probability measurements in the medical literature, primarily based on direct judgments, but citing Winkler, Savage, and others. %}

Johnson, Sindhu R., George A. Tomlinson, Gillian A. Hawker, John T. Granton, & Brian M. Feldman (2010) "Methods to Elicit Beliefs for Bayesian Priors: A Systematic Review," *Journal of Clinical Epidemiology* 63, 355–369.

{% **probability elicitation**: seems that they consider continous distributions %}
Johnson, Sindhu R., George A. Tomlinson, Gillian A. Hawker., John T. Granton, Haddas A. Grosbein, & Brian M. Feldman (2010) "A Valid and Reliable Belief Elicitation Method for Bayesian Priors," *Journal of Clinical Epidemiology,* 63(4), 370–383.

{% **risky utility u = transform of strength of preference v, latter doesn't exist**: paper seems to argue for ordinal approach. %}
Johnson, William E. (1913) "The Pure Theory of Utility Curves," *Economic Journal* 23, 483–513.

{% P. 183 seems to have already wrtitten de Finetti's exchangeability condition, called "permutation postulate." %}
Johnson, William E. (1924) "*Logic: Part III. The Logical Foundations of Science.*" Cambridge University Press. Reprinted 1964, New York.

{% According to Zabell (1982), he already characterized Dirichlet priors, as later characterized so nicely by Carnap, although he seems to have missed that one needs at least three events and erroneously claimed it also for two events. %}
Johnson, William E. (1932) "Probability: The Inductive and Deductive Problems," *Mind* 49, 409–423. (Appendix on pp. 421-423 edited by Richard B. Braithwaite)

{% **adaptive utility elicitation**; p. 220: health states with negative utility were given utility 0 ··· !!?? %}
Johnston, Katharine, Jackie Brown, Karen Gerard, Moira O'Hanlon, & Alison Morton (1998) "Valuing Temporary and Chronic Health States Associated with Breast Screening," *Social Science and Medicine* 47, 213–222.

{% **foundations of statistics** %}
Johnstone, David J. (1988) "Hypothesis Tests and Confidence Intervals in the Single Case," *British Journal for the Philosophy of Science* 39, 353–360.

{% **proper scoring rules**: shows that in betting market proper scoring rules better classify analysts than their monetary consequences. %}

Johnstone, David J. (2007) "Economic Darwinism: Who Has the Best Probabilities," *Theory and Decision* 62, 47–96.

{% **proper scoring rules**; People in proper scoring rules are better off, a.o. in view of concave utility, if they do it jointly as a group and share their profits afterwards. Can be related to hedging in CAPM. %}

Johnstone, David J. (2007) "The Value of Probability Forecast from Portfolio Theory," *Theory and Decision* 63, 153–203.

{% Maximum likelihood probability estimate is equivalent to maximization of log utility. The paper examines how several kinds of risk aversion utility functions impact probability estimations, and optimal collections of info. %}

Johnstone, David J. (2012) "Economic Interpretation of Probabilities Estimated by Maximum Likelihood or Score," *Management Science* 57, 308–314.

{% **foundations of statistics** %}

Johnstone, David J. & Dennis V. Lindley (1995) "Bayesian Inference Given Data 'Significant at α': Tests of Point Hypothesis," *Theory and Decision* 38, 51–60.

{% Discuss the history of Borch's argument that mean-variance analyses will always lead to violations of stochastic dominance. It can be escaped by restricting the payoff domain, or by restricting the probability distributions considered (restricting to normal is popular for this purpose). %}

Johnstone, David & Dennis Lindley (2013) "Mean–Variance and Expected Utility: The Borch Paradox," *Statistical Science* 28, 223–237. http://dx.doi.org/10.1214/12-STS408

{% **Christiane, Veronika & I**: If German people had to judge on salaries or prices in their own home-country, then they treated €λ too much as if λDM, so went by numerical effects not just by value. If people had to judge on foreign currencies or prices in € in a foreign country, they did not do this. %}

Jonas, Eva, Tobias Greitemeyer, Dieter Frey, & Stefan Schulz-Hardt (2002) "Psychological Effects of the Euro—Experimental Research on the Perception of Salaries and Price Estimations," *European Journal of Social Psychology* 32, 147–169.

{% %}

Jones, Martin & Robert Sugden (2001) "Positive Confirmation Bias in the Acquisition of Information," *Theory and Decision* 50, 59–99.

{% Paper presented in Oslo. %}

Jones-Lee, Michael W. & Graham Loomes (1997) "Valuing Health and Safety: Some Economic and Psychological Issues." *In* Robert F. Nau, Erik Gr∅nn, Mark J. Machina, & Olvar Bergland (eds.) *Economic and Environmental Risk and Uncertainty*, 3–32, Kluwer, Dordrecht.

{% Critically discuss the applications of behavioral economics by the UK government. %}

Jones, Rhys, Jessica Pykett, & Mark Whitehead (2011) "Governing Temptation: Changing Behaviour in an Age of Libertarian Paternalism," *Progress in Human Geography* 35, 483–501.

{% On Behavioral insights team installed in the UK by Cameron. %}

Jones, Rhys, Jessica Pykett, & Mark Whitehead (2013) "*On the Rise of the Psychological State*." Edward Elgar Publishers, Cheltenham, UK.

{% They consider infinite streams of outcomes, and preference orders that are anonymous (which is not easy for infinite streams). They consider overtaking criterion $\lim_{j\to\infty}\sum_{j=1}^{n}(x_j - y_j) \geq 0$, and axiomatize it better than in preceding papers. Their 2018 paper will introduce the more general limit-discounted utilitarian criterion. %}

Jonsson, Adam & Mark Voorneveld (2015) "Utilitarianism on Infinite Utility Streams: Summable Differences and Finite Averages," *Economic Theory Bulletin* 3, 19–31.

https://doi.org/10.1007/s40505-014-0056-2

{% Consider infinite streams of outcomes, and consider preference orders that are anonymous (which is not easy for infinite streams). Characterize maximization of $\sum_{j=1}^{\infty} x_j$ over real-valued bounded infinite streams $(x_1,x_2,\ldots)$. They consider the more general overtaking criterion $\lim_{j\to\infty}\sum_{j=1}^{n}(x_j - y_j) \geq 0$ and eventually periodic streams, as in their 2015 paper. The novelty of this paper is a generalization: the limit-discounted utilitarian criterion (LDU), which takes liminf instead of lim above but adds a discount factor tending to 1. This generalizes overtaking criteria and refines by having more strict preferences. The main characterizing preference condition is the compensation principle: postposing all outcomes by one period and compensating by giving the average in the first period, leaves the sequence indifferent. Pivato (2022 pp. 8-9) explained how LDU refines AU overtaking representations, by turning some indifferences into strict preferences and thus restoring strong Pareto, which then is reconciled with fairness. These representations do not satisfy completeness on the domain considered. %}

Jonsson, Adam & Mark Voorneveld (2018) “The Limit of Discounted Utilitarianism,” *Theoretical Economics* 13, 19–37.
https://doi.org/10.3982/TE1836

{% %}

Joore, Manuela A., Danielle Brunenberg, Horst Zank, Hans van der Stel, Lucien Anteunis, Gijs Boas, & Hans J.M. Peters (2002) “Development of a Questionnaire to Measure Hearing-Related Health State Preferences Framed in an Overall Health Perspective,” *International Journal of Technology Assessment in Health Care* 18, 528–539.

{% History of St. Petersburg paradox. %}

Jorland, Gérard (1987) “The Saint Petersburg Paradox 1713–1937.” *In* Lorenz Krüger, Lorraine J. Daston & Michael Heidelberg (eds.) *The Probabilistic Revolution: Vol. 1, Ideas in History*, 157–190, MIT Press, Cambridge, MA.

{% **proper scoring rules**; Show that in a mathematical sense scoring rules amount to the same as optimizing particular utility functions in decision situations and to measures of entropy.

They take the family of utility with risk tolerance (reciprocal of Pratt-Arrow index of risk aversion) linear in money x. The slope β is the power of power utility and is index of risk aversion. Exponential utility is when slope β is 0. So, level of absolute risk aversion does not count.

Eq. 1: I guess that the capital delta, described as the gradient of V(r,r) w.r.t. r (also denoted as V(r) or as V by the authors), should be the linear function p --> V(r,p) − V(r,r) (which is its own gradient). %}

Jose, Victor Richmond R., Robert F. Nau, & Robert L. Winkler (2008) "Scoring Rules, Generalized Entropy, and Utility Maximization," *Operations Research* 56, 1146–1157.

{% Imagine we want an agent to reveal his α quantile x_L of a probability distribution over the reals. That is, for a random variable X, $P(X \leq x_L) = \alpha$. Then we ask him to state x_L' and, after observing X, we pay him $\alpha x_L' - (x_L' - X)1_{[X \leq x_L']}$. Under EV, the optimal answer is $x_L' = x_L$. A nice result! A dual to **proper scoring rules** that was much needed, and was only invented in 2009. Congratulations to the authors. %}

Jose, Victor Richmond R. & Robert L. Winkler (2009) "Evaluating Quantile Assessments," *Operations Research* 57, 1287–1297.

{% %}

Jose, Victor Richmond R., Robert F. Nau, & Robert L. Winkler (2009) "Sensitivity to Distance and Baseline Distributions in Forecast Evaluation," *Management Science* 55, 582–590.

{% %}

Jouini, Elyès, Jean-Michel Marin, & Clotilde Napp (2010) "Discounting and Divergence of Opinion," *Journal of Economic Theory* 145, 812–829.

{% %}

Jouini, Elyès & Clotilde Napp (2003) "Comonotonic Processes," *Insurance: Mathematics and Economics* 32, 255–265.

{% On representative agent. Take an otherwise standard Arrow-Debreu model but deviate from representative agent by considering heterogeneous beliefs, which introduce a kind of extra risk. The same equilibrium results with homogeneous agents with "consensus" probabilities, that may be more optimistic or more pessimistic depending on the degree of risk aversion in the utility function. Use Ito to analyze. %}

Jouini, Elyès & Clotilde Napp (2007) "Consensus Consumer and Intertemporal Asset Pricing with Heterogeneous Beliefs," *Review of Economic Studies* 74, 1149–1174.

{% Investigate how changes in individual risk tolerance can affect the aggregate risk tolerance, which is not always monotonically. %}

Jouini, Elyès, Clotilde Napp, & Diego Nocetti (2013) "Collective Risk Aversion," *Social Choice and Welfare* 40, 411–437.

{% %}

Jouini, Elyès, Walter Schachermayer, & Nizar Touzi (2008) "Optimal Risk Sharing for Law Invariant Monetary Utility Functions," *Mathematical Finance* 18, 269–292.

{% %}

Journal of Behavioral Decision Making 20, Issue 5, 2007: Special Issue: Decision Making and the Law.

{% **proper scoring rules**: seems to bring in epistemic criterion (closeness to true state of nature I guess) besides behavioral ("pragmatic") criteria, and get impossibility results for sets of priors. P. 103: p. 85: a preference relation should be extendable while preserving good preference conditions. (**desirable to extend preferences while satisfying/maintaining conditions**) %}

Joyce, James M. (1998) "A Nonpragmatic Vindication of Probabilism," *Philosophy of Science* 65, 575–603.

https://doi.org/10.1086/392661

{% **utility = representational**: seems to write:

“decision theory must throw off the pragmatist / behaviourist straitjacket that has hindered its progress for the past seventy years” (p. 254). %}

Joyce, James M. (1999) “*The Foundations of Causal Decision Theory*.” Cambridge University Press, Cambridge.

{% For subjective probabilities, makes the well-known distinction between balance and weight. Then there is a third dimension, specificity. It apparently means something like whether all pieces of info that led to the probability assessment supported that probability assessment, or if some pieces supported higher probability assessments and others supported lower ones. Probably similar to expert aggregation where a difference is made between imprecise and conflicting expert judgments. In the author’s approach if no probability measure is known then it must be a set of probability measures (as with people who always exclusively think in terms of sets of priors). Then specificity for some event is maximal if all probability measures in the set of priors assign the same probability to that event. I do not really see that this would be a new dimension apart from balance and weight.

The paper assumes that if your credal state is not reflected by one probability measure, then it is by a set of probability measures. (I did not see it refer to higher-order beliefs with 2nd-order probabilities over those probability measures.) It does not look much into alternatives. P. 154 claims to show that it can only be this. The paper also takes Bayesianism not to assume completeness of preference and, hence, not one unique probability measure (§2 ℓ. 2).

The paper uses the term bias not in the sense of mistake, but in the sense of subjective info.

P. 168: U4 is a case of an urn with colored balls with total absence of info on the composition, and the author really does not want the principle of insufficient reason then (“it is clearly wrong in the fourth,” middle of p. 168).

Sentences such as that subjective probabilities accurately reflect total evidence are fine if reflect means the weak depend on, reckon with. They are off if reflect means that they completely capture everything relevant. %}

Joyce, James M. (2005) “How Probabilities Reflect Evidence,” *Philosophical Perspectives* 19, 153–178.

{% Seems that he used the term credal committee to express that the set of priors in multiple priors/imprecise probabilities is the set of all probability distributions consistent with one’s evidence. So, each probability measure is a member of the committee. %}

Joyce, James M. (2011) “A Defense of Imprecise Credence in Inference and Decision,” *Philosophical Perspectives* 24, 281–323.

{% A.o., p. 653 reviews discussions of the game that convinced me of forward induction. §6, p. 658 etc discusses **small worlds**. They suggest that Savage’s model be “partition-dependent.” I do not see this but didn’t study it in detail. %}

Joyce, James M. & Allan Gibbard (1998) “Causal Decision Theory.” *In* Salvador Barberà, Peter J. Hammond, & Christian Seidl (eds.) *Handbook of Utility Theory, Vol. 1, Principles*, 627–666, Kluwer Academic Publishers, Dordrecht.

{% Application of ambiguity theory;

Assume repeated decisions at timepoints 1, 2, …, where at each timepoint the smooth model of KMM holds, and a recursive model is used. They emphasize that they get a clear separation between risk attitude (vNM utility), ambiguity (the 2nd order probability distribution of the smooth model), ambiguity aversion (through the second-order utility function φ of the smooth model), and intertemporal preference. Many models in the literature are special cases of their general setup. They take a tractable version of their model and use it to analyze dynamic asset-price phenomena, where they can accommodate many phenomena. A problem may be that the model is very general.

P. 560 top cites puzzles in asset markets/macroeconomics.

P. 561 Footnote 3 cites ambiguity/robustness for finance.

Pp. 563-564 hits the nail on the head when explaining that the smooth model of ambiguity is popular for being tractable, allowing to analyze ambiguity attitude as traditional risk attitude. (I add: using the familiar utility curvature.) %}

Ju, Nengjiu & Jianjun Miao (2012) "Ambiguity, Learning, and Asset Returns," *Econometrica* 80, 559–591.

{% %}
Judge, Timothy A., Carl J. Thoresen, Vladimir Pucik, Theresa M. Welbourne (1999) "Managerial Coping with Organizational Change: A Dispositional Perspective," *Journal of Applied Psychology* 84, 107–122. https://doi.org/10.1037/0021-9010.84.1.107

{% **Christiane, Veronika & I** %}
Juliusson, Asgeir, Amelie Gamble, & Tommy Gärling (2006) "Learning Unit Prices in a New Currency," *International Journal of Consumer Studies* 30, 1–7.

{% **Christiane, Veronika & I**; examines factors influencing how quickly people learn to think in terms of a new unit of money (the Euro). %}
Juliusson, Asgeir, Amelie Gamble, & Tommy Gärling (2006) "Learning the Value of a New Currency from Prices," *Journal of Experimental Psychology: Applied* 11, 45–52.

{% **PT, applications**, loss aversion; Presented in Chantilly, 1997; Consider data of 10 years of horse race betting in UK. Note that this concerns a population that is more risk seeking than average. So, for instance, the certainty effect typically should not be expected to occur; it indeed didn't.

They observe what the betting odds are for many races. This and the results of the races is the only data they use, and they do not use data about the stakes bet on various horses. They assume one representative agent, and assume that the betting odds are such that the agent is indifferent between all horses. This follows from market equilibrium: If one horse was better, betting on it would increase and, hence, its prices. From this assumption alone (their Eq. 1), they can derive both the probabilities of horses winning and the (risk-)preference functional of the bettors. It works as follows. First, for each preference functional given, the indifference between all horses gives n–1 equations, enough to get the n probabilities (that add to 1). Then, for each preference functional, a proper scoring rule is calculated relative to the actual winning horses. Finally, the preference functional is chosen with the best scoring rule.

Find that RDU does not improve on EU, but PT does. They cannot incorporate loss aversion (utility more steep for losses than for gains) because the data do not permit. The better performance of PT results from different probability weighting for gains than for losses.

Weighted utility does not seem to fit the data well (p. 528).

The data do not suggest **inverse S.** PT estimations suggest convex (pessimistic) w for gains, concave for losses (also pessimistic, because of dual integration for losses that PT does). For losses they seem to find risk aversion, for gains a little risk seeking. This is contrary to the common empirical findings although their footnote 17 suggests that it is in agreement with common findings. This population of betters can of course not be expected to agree with general findings. %}

Jullien, Bruno & Bernard Salanié (2000) "Estimating Preferences under Risk: The Case of Racetrack Bettors," *Journal of Political Economy* 108, 503–530.

{% %}

Jullien, Bruno, Bernard Salanié, & François Salanié (2007) "Screening Risk-Averse Agents under Moral Hazard: Single-Crossing and the Cara Case," *EconomicTheory* 30, 151–169.

{% **game theory for nonexpected utility**

The fixed-point reasoning leading to Nash equilibrium can be extended to ambiguity without expected utility. %}

Jungbauer, Thomas & Klaus Ritzberger (2011) "Strategic Games beyond Expected Utility," *Economic Theory* 48, 377–398.

{% Estimate concavity of utility under EU from agricultural data, and find so much concavity that they say it can't be. So, nonEU is desirable. They confirm Rabin's (2000) calibration idea. %}

Just, David R. & Hikaru Hanawa Peterson (2003) "Diminishing Marginal Utility of Wealth and Calibration of Risk in Agriculture," *American Journal of Agricultural Economics* 85, 1234–1241.

{% Distinguish between standard risk aversion, which concerns final wealth, and marginal risk aversion, which concerns taking a prospect as reference point and evaluating changes from there. So, exactly Sugden's (2003) random reference theory. The authors' approach has also been studied under the heading of background risks, as in Barberis, Huang, & Thaler (2006, American Economic Review).

10 interviewers interviewed 290 households in India, asking about real decisions made first, then about hypothetical seeding decisions that were presented as objective probability distributions over outcomes. One sentence (p. 618 last one) says that payment was performance-based, but I did not find how and if it was really real-incentive. The authors consider probability weighting but it is not clear if for three-outcome prospects as considered in their experiment they do rank-dependent or separate outcome transformation. They do not seem to consider loss aversion, only different utility and probability weighting for losses, only mentioning once that they find no "discrete loss aversion" (p. 624 just above Conclusion) without specifying what it means. They measure risk aversion as preference for increasing variance.

risk averse for gains, risk seeking for losses: p. 620 3rd para reports risk seeking for the only loss prospect they consider (relative to the reference prospect). %}

Just, David R. & Travis J. Lybbert (2009) "Risk Averters that Love Risk? Marginal Risk Aversion in Comparison to a Reference Gamble," *American Journal of Agricultural Economics* 91, 612–626.

{% %}

Just, Richard E. (1974) "An Investigation of the Importance of Risk in Farmers Decisions," *American Journal of Agricultural Economics* 56, 14–25.

{% %}

Just, Richard E. (1975) "Risk Response Models and Their Use in Agricultural Policy Evaluation," *American Journal of Agricultural Economics* 57, 836–843.

{% Proposition 1 seems to show that revealed preference data cannot identify utility and subjective probability, but I do not understand. I do not see what domain is assumed. Surely, with rich enough domains, revealed preference can uniquely identify utility and subjective probability. %}

Just, Richard E. & David R. Just (2011) "Global Identification of Risk Preferences with Revealed Preference Data," *Journal of Econometrics* 162, 6–17.

{% **questionnaire versus choice utility**: negative conclusions on predicting actual behavior from verbal expressions of expectations. %}

Juster, F. Thomas (1964) "*Anticipations and Purchases: An Analysis of Consumer Behavior.*" Princeton University Press, Princeton NJ.

{% %}

Kaas, Rob, Jan Dhaene, & Marc J. Goovaerts (2000) "Upper and Lower Bounds for Sums of Random Variables," *Insurance: Mathematics and Economics* 27, 151–168.

{% Seems that pattern of increasing/constant/decreasing impatience was not affected by adding front-end delays. %}

Kable, Joseph W. & Paul W. Glimcher (2010) "An "As soon as Possible" Effect in Human Inter-Temporal Decision Making: Behavioral Evidence and Neural Mechanisms," *Journal of Neurophysiology* 103, 2513–2531. http://dx.doi.org/10.1152/jn.00177.2009

{% For variability of quantity of food, animals are risk averse. But for variability of delay time they are risk seeking. %}

Kacelnik, Alex & Melissa Bateson (1996) "Risk Theories—The Effects of Variance on Foraging Decisions," *American Zoologist* 36, 402–434.

{% **inverse S**; **real incentives/hypothetical choice**, discussion of it on p. 1121; ask certainty equivalents; Seems that for Canadian students with one group they paid out exactly, and for another group they took 100 times higher payments in the experimental questions but in implementation of incentives divided them by 100.

decreasing ARA/increasing RRA: Increasing RRA for Chinese students with

actual, high, monetary rewards; constant for Canadian/US students with only moderate or with hypothetical monetary rewards. %}

Kachelmeier, Steven J. & Mohamed Shehata (1992) "Examining Risk Preferences under High Monetary Incentives: Experimental Evidence from the People's Republic of China," *American Economic Review* 82, 1120–1141; for comment see Steven J. Kachelmeier & Mohammed Shehata (1994) *American Economic Review* 84, 1104–1106.

{% Proposes explaining Allais and Ellsberg within SEU from subjective beliefs (e.g. suspicion; **suspicion under ambiguity**) %}

Kadane, Joseph B. (1992) "Healthy Scepticism as an Expected-utility Explanation of the Phenomena of Allais and Ellsberg," *Theory and Decision* 32 57–64.

{% **anonymity protection**: describe a way to present only sufficient statistics regarding tables with data. %}

Kadane, Joseph B., Ramayya Krishnan, & Galit Shmueli (2006) "A Data Disclosure Policy for Count Data Based on the COM-Poisson Distribution," *Management Science* 52, 1610–1617.

{% Argue that game theory is "just" a special case of DUU and that it should therefore be solved by SEU where one should think about the probability distribution over opponents' strategy choice. Consider this to be a reason to criticize the study of solution concepts. In discussions of the paper printed in the pages following it, Harsanyi appropriately criticizes it (although I don't like the circularity in his minimax reasoning at the bottom of p. 121). On p. 122 he calls the "SEU-for-game-theory" a "highly uninformative statement" and on p. 121 he writes "But this immediately poses the question of *how this probability distribution is to be chosen.*" [Italics from original]) That's how it is. If one assumes that the Savage analysis can be applied to game theory and that opponents' strategy choices can be treated like states of nature, then game theory can be considered to be the study of how the subjective probabilities over strategy choices of opponent should be chosen. Later papers trying to do so are Aumann & Drèze (2009) and Gilboa & Schmeidler (2003 GEB), but they both use highly hypothetical thought experiments. (**game theory can/cannot be viewed as decision under uncertainty**) %}

Kadane, Joseph B. & Patrick D. Larkey (1982) "Subjective Probability and the Theory of Games," *Management Science* 28, 113–120.

{% Continue on their 1982 paper. Didn't change my views regarding the 82 paper. (**game theory can/cannot be viewed as decision under uncertainty**) %}

Kadane, Joseph B. & Patrick D. Larkey (1983) "The Conflict of Is and Ought in Game Theoretic Contexts," *Management Science* 29, 1365–1379.

{% Show when probability defined on arbitrary subset, can be extended to all subsets. %}

Kadane, Joseph B. & Anthony O'Hagan (1995) "Using Finitely Additive Probability: Uniform Distributions on the Natural Numbers," *Journal of the American Statistical Association* 90, 626–631.

{% Usual trickeries with finite additivity. Then you can set up a partition ("experiment") such that conditional on *each* outcome, a prior hypothesis becomes more probable. You can also be averse to cost-free information. (**information aversion**) %}

Kadane, Joseph B., Mark J. Schervish, & Teddy Seidenfeld (1996) "Reasoning to a Foregone Conclusion," *Journal of the American Statistical Association* 91, 1228–1235.

{% **value of information**: Consider cases where individual Bayesian has information aversion, such as when information has value by itself, in which case it can be incorporated into the utility function. They also consider its violation in maxmin EU, and if the probability measure is not countably additive. %}

Kadane, Joseph B., Mark J. Schervish, & Teddy Seidenfeld (2008) "Is Ignoorance Bliss?," *Journal of Philosophy* 105, 5–36.
https://doi.org/10.5840/jphil200810518

{% The importance of convex capacities in statistics is explained on p. 1251.

Characterize extreme points of upper distribution functions corresponding to

coherent symmetric (i.e., transforms of Lebesgue measure) capacities on [0,1]. %}

Kadane, Joseph B. & Larry E. Wasserman (1996) "Symmetric, Coherent, Choquet Capacities," *Annals of Statistics* 24, 1250–1264.

{% **utility elicitation**; **probability elicitation**; how these can be distorted by hidden stakes. %}

Kadane, Joseph B. & Robert L. Winkler (1988) "Separating Probability Elicitation from Utilities," *Journal of the American Statistical Association* 83, 357–363.

{% On grading students, with an extra option "don't know" and discussions about how best to score it. This topic is adjacent to: **proper scoring rules**. %}

Kaernbach, Christian (2001) "Adaptive Threshold Estimation with Unforced-Choice Tasks," *Perception & Psychophysics* 63, 1377–1388.

{% %}

Kafry, Ditsa, & Daniel Kahneman (1977) "Capacity Sharing and Refractoriness in Successive Reactions," *Perceptual and Motor Skills* 44, 327–335.

{% %}

Kagel, John H. & Raymond C. Battalio (1975) "Experimental Studies of Consumer Behavior Using Laboratory Animals," *Economic Inquiry* 13, 22–38.

{% %}

Kagel, John H., Raymond C. Battalio, & Leonard Green (1995) "*Economic Choice Theory: An Experimental Analysis of Animal Behavior*." Cambridge University Press, Cambridge.

{% **losses from prior endowment mechanism**: seem to do this
real incentives/hypothetical choice: seem to do this. %}

Kagel, John H., Don N. MacDonald, & Raymond C. Battalio (1990) "Tests of 'Fanning Out' of Indifference Curves: Results from Animal and Human Experiments," *American Economic Review* 80, 912–921.

{% %}
Kagel, John H. & Alvin E. Roth (1995, eds.) "*Handbook of Experimental Economics*." Princeton University Press, Princeton NJ.

{% %}
Khan, Urmee & Maxwell B. Stinchcombe (2018) "Planning for the Long Run: Programming with Patient, Pareto Responsive Preferences," *Journal of Economic Theory* 176, 444–478.
https://doi.org/10.1016/j.jet.2018.04.0010022-0531

{% **criticizing the dangerous role of technical axioms such as continuity**: the authors explain this well.
This paper brings useful and complete results on the logical dependencies between completeness, transitivity, and connectedness of the order topology, and various weakenings of these conditions. Bits and pieces have been around before in the literature, but this paper brings it all toether. It displays great knowledge of the literature, e.g. by citing the impressive works of Pfanzagl.

The basic result (Theorem 2) is as follows, where continuity of a binary relation means that both weak upper and lower sets are closed, and strict upper and lower sets are open. If a binary relation is continuous in a connected space, and even if it is in a space with no more than two connected components, then transitivity implies completeness, and [completeness & transitivity] is implied by antisymmetry, also by transitivity of the symmetric part with connected sections, and transitivity of the symmetric part with semi-transitivity. Theorems 3 and 4 derive connectedness, or existence of no more than two components, from other properties imposed on all continuous relations.

one-dimensional utility: some results in §4.4.

The authors replace the common terms complete and transitivity by the uncommon terms decisive and consistent. It escapes my why. %}
Khan, M. Ali & Metin Uyanik (2021) "Topological Connectedness and Behavioral Assumptions on Preferences: A Two-Way Relationship," *Economic Theory* 71, 411–460.

{% The experiment in this paper is weak, and the theory not very important, but the discussions and interpretations are superb, showing deep understanding. I therefore like to cite this paper.

P. 268 gives profound text on how people confuse knowledge about process with knowledge about outcome, which I also think is the mistake that Ellsberg-paradox researchers make: "This example shows the "irrational" nature of ambiguity avoidance. For example, if an ambiguity averse subject chooses less than 100 red balls to indicate indifference, then s/he is limiting his/her opportunity of winning to gain the false sense of security of thinking s/he knows more about the outcome. It is true that the subject knows more about the process of winning in the first urn than in the second urn, but s/he does not know any more about the probability of the outcome, information s/he mistakenly thinks s/he is "buying" by sacrificing the number of red balls in choosing an indifference value." This is the essence, I think, of what misleads many researchers to think that ambiguity aversion is rational. I think that in the known Ellsberg urn you do not have better information than in the unknown but, if anything, the opposite: Jn the known urn you are sure to have the worst information that could be.

P. 268 uses matching probabilities to measure weight of ambiguous events. It is similarly done by Viscusi & Magat (1992 Eq. 7).

P. 268/269, ambiguous thumbtack versus fair coin, of 54 MBA students, 18 preferred fair coin, 21 preferred tack; On latter: "This group may represent some people who would pay to seek ambiguity, but does represent some people who believe that they have more information about the probability of winning with the tack and, hence, will pay more for that information." **ambiguity seeking for unlikely** (below .1 or .3 according to Camerer & Weber, 1992) **second-order probabilities to model ambiguity**; generate ambiguity this way, and use a parametric model for that; p. 267 1st column 2nd para

ambiguity seeking for losses; p. 270: "In the gains domain, there is ambiguity seeking at low mean probabilities and ambiguity aversion at high mean probabilities. In the loss domain, a reflection effect occurs with ambiguity aversion at low mean probabilities and ambiguity seeking at high mean probabilities. ... Therefore, the presence of ambiguity may accentuate the attitude toward risk."

uncertainty amplifies risk: p. 270: "Therefore, the presence of ambiguity may accentuate the attitude toward risk."

reflection at individual level for ambiguity: although the last experiment (p. 270) has within-subject data, it is not reported. %}

Kahn, Barbara E. & Rakesh K. Sarin (1988) “Modeling Ambiguity in Decisions under Uncertainty,” *Journal of Consumer Research* 15, 265–272.

{% %}

Kahneman, Daniel (1961) “An Analytical Model of the Semantic Differential.” Ph.D. Thesis.

{% %}

Kahneman, Daniel (1963) “The Semantic Differential and the Structure of Inferences among Attributes,” *American Journal of Psychology* 76, 554–567.

{% %}

Kahneman, Daniel (1964) “Temporal Summation in Acuity Tasks at Different Energy Levels: A Study of the Determinants of Summation,” *Vision Research* 4, 557–566.

{% %}

Kahneman, Daniel (1965) “Control of Spurious Association and the Reliability of the Controlled Variable,” *Psychological Bulletin* 64, 326–329.

{% %}

Kahneman, Daniel (1965) “Exposure Duration and Effective Figure-Ground Contrast,” *Quarterly Journal of Experimental Psychology* 17, 308–314.

{% %}

Kahneman, Daniel (1966) “Time-Intensity Reciprocity in Acuity as a Function of Luminance and Figure-Ground Contrast,” *Vision Research* 6, 207–215.

{% %}

Kahneman, Daniel (1966) “Time-Intensity Reciprocity under Various Conditions of Adaptation and Backward Masking,” *Journal of Experimental Psychology* 71, 543–549.

{% %}

Kahneman, Daniel (1967) “An Onset-Onset Law for One Case of Apparent Motion and Metacontrast,” *Perception and Psychophysics* 2, 577–584.

{% %}

Kahneman, Daniel (1967) “Temporal Effects in the Perception of Light and Form.” *In* Weiant Wathen-Dunn (ed.) *Models for the Perception of Speech and Visual Form*, 157–170, MIT Press, Cambridge, MA.

{% %}

Kahneman, Daniel (1968) “Effects of Verbalization and Incentive on the Pupillary Response to Mental Activity,” *Canadian Journal of Psychology* 22, 186–196.

{% %}

Kahneman, Daniel (1968) “Methods, Findings and Theory in Studies of Visual Masking,” *Psychological Bulletin* 70, 404–425.

{% %}

Kahneman, Daniel (1970) “Changes in Pupil Size and Visual Discrimination During Mental Effort.” *In* John R. Pierce (ed.) *Visual Science*. University of Indiana Press, Bloomington.

{% %}

Kahneman, Daniel (1970) “Remarks on Attention Control.” *In* Andries F. Sanders (ed.) *Attention and Performance* III, 118–131.

{% %}

Kahneman, Daniel (1973) “*Attention and Effort.*” Prentice-Hall, Englewood Cliffs, NJ.

{% %}

Kahneman, Daniel (1974) “Cognitive Limitations and Public Decision Making. Science and Absolute Values.” Pr*oceedings of the Third International Conference on the Unity of the Sciences*, 1261–1281, International Cultural Foundation, London.

{% %}

Kahneman, Daniel (1975) “Effort, Recognition and Recall in Auditory Attention.” *In* Patrick M.A. Rabbitt & Stanislav Dornic (eds.) *Attention and Performance* IV, 65–80, New York, Academic Press.

{% %}

Kahneman, Daniel (1979) “Mechanisms that Produce Critical Durations,” *Behavioral and Brain Sciences* 2, 265–266.

{% %}

Kahneman, Daniel (1980) “A Review of M. Posner’s “An Experimental Study of Consciousness”,” *Contemporary Psychology* 25, 3–5.

{% %}

Kahneman, Daniel (1980) “*Human Engineering of Decisions, in Ethics in an Age of Pervasive Technology*.” Westview Press, Boulder.

{% %}

Kahneman, Daniel (1986) “Valuing Environmental Goods: An Assessment of the Contingent Valuation Method: The, Review Panel’s Assessment: Comments.” *In* Ronald G. Cummings, David S. Brookshire, & W222 D. Schulze (eds.) *Valuing Environmental Goods: An Assessment of the Contingent Valuation Method*, 185–194, Littlefield, Adams, Rowman and Allanheld, Totowa, NJ.

{% %}

Kahneman, Daniel (1988) “Experimental Economics: A Psychological Perspective.” *In* Reinhard Tietz, Wulf Albers, & Reinhard Selten (eds.) *Bounded Rational Behavior in Experimental Games and Markets*, Lecture Notes in Economics and Mathematical Systems series 314, 11–18, Springer, Berlin.

{% %}

Kahneman, Daniel (1991) “Judgment and Decision Making: A Personal View,” *Psychological Science* 2, 142–145.

{% %}

Kahneman, Daniel (1992) “Reference Points, Anchors, Norms, and Mixed Feelings. Special Issue: Decision Processes in Negotiation,” *Organizational Behavior and Human Decision Processes* 51, 296–312.

{% Kahneman thinks that violations of expected utility as in the Allais and Ellsberg paradoxes are not irrational: p. 19: “Furthermore, the preferences that Allais and Ellsberg described do not appear foolish or unreasonable, …” Some later Kahneman writes, on p. 19: “Indeed, the ambiguous normative status of the Allais and Ellsberg patterns has inspired many attempts to reconcile observed preferences with rationality by adopting a more permissive definition of rational choice (Tversky and Kahneman [1986]).” Kahneman’s viewpoint here is opposite to Tversky’s who considered expected utility to be normative. Kahneman’s citation of Tversky & Kahneman (1986) is incorrect. The latter reference nowhere says that violations of expected utility can be normatively acceptable. To the contrary, it advances further arguments for the normative status of expected utility.

paternalism/Humean-view-of-preference: p. 20: “More provocatively, the observed deficiencies suggest the outline of a case in favor of some paternalistic interventions, when it is plausible that the state knows more about an individual’s future tastes than the individual knows presently.” %}

Kahneman, Daniel (1994) “New Challenges to the Rationality Assumption,” *Journal of Institutional and Theoretical Economics* 150, 18–36.

{% %}

Kahneman, Daniel (1995) “Varieties of Counterfactual Thinking.” *In* Neal J. Roese & James M. Olson (eds.): W*hat Might Have Been: The Social Psychology of Counterfactual Thinking*, Ch. 14. Erlabum, Hillsdale, NJ.

{% %}

Kahneman, Daniel (1996) “Comment.” *In* Kenneth J. Arrow, Enrico Colombatto, Mark Perlman, & Christian Schmidt (eds.) *The Rational Foundations of Economic Behavior: Proceedings of the IEA Conference Held in Turin, Italy*, 251–254, St. Martins Press, New York.

{% %}

Kahneman, Daniel (2000), letter of October 4.

{% P. 163: Kahneman does not seem to consider expected utility to be normative: "Unlike the paradoxes of expected-utility theory, violations of invariance cannot be defended as normative." although it is not 100% stated.

Kahneman & Tversky (1979, p. 277) stated the opposite.

P. 163: "As I will show, reference-independence can also be viewed as an aspect of rationality."

P. 164 supports the Rabin calibration argument.

P. 164 says loss aversion is about 2 on average. %}

Kahneman, Daniel (2003) "A Psychological Perspective on Economics," *American Economic Review Papers and Proceedings* 93, 162–168.
https://doi.org/10.1257/000282803321946985

{% Further comments are in comments on the Kahneman (2003) American Economic Review paper. Here I only discuss things not in American Economic Review.

P. 697: "… that intuitive judgments occupy a position—perhaps corresponding to evolutionary history—between the automatic operations of perception and the deliberate operations of reasoning."

P. 702, 2d para, has a remarkable sentence negating the value of theory: "… accessibility … the lack of a theory does little damage to the usefulness of the concept." I did not find a similar sentence in his American Economic Review 2003 paper. This may agree with Kahneman's opinion that the success of the '79 prospect theory paper is mostly an academic coincidence, where Kahneman ignores the importance of the theoretical content of that '79 paper (p. 702 3rd para), including the essence of that paper: that it could combine empirics and theory.

P. 703: "Guided by the analogy of perception, we expected the evaluation of decision outcomes to be reference dependent."

P. 704 lacks nuances when writing: "I call it Bernoulli's error. Bernoulli's (1738/1954) model of utility is flawed beccause it is *reference independent*:" [italics from original)

P. 705, 2nd para:

"… because the value function is a psychophysical mapping."

Such a universal claim is not in his American Economic Review 2002 paper.

utility concave near ruin: p. 705, 2nd para: "However, the value function is not expected to describe preferences for losses that are large relative to total assets, where ruin or near ruin is a possible outcome."

P. 707 2nd column 1st para: "… people who are confronted with a difficult question sometimes answer an easier one instead." P. 713 4th para nicely follows up on this: "The probability of Linda being a bank teller is an extensional variable, but her resemblance to a typical bank teller is a prototype attribute."

P. 710 2nd para of 2nd column, and elsewhere explains that Kahneman & Tversky emphasized cognitive aspects and not emotional because, in their days, psychologists automatically assumed that everything was emotional, and cognitive aspects were new then.

P. 712 3rd para: within-subjects designs have problem for study of intuitive non-reasoned tasks that they may trigger reasoning.

P. 726, 2/3 at 2nd column: "The concept of loss aversion was, I believe, our [Tversky & Kahneman] most useful contribution to the study of decision making." %}

Kahneman, Daniel (2003) "A Perspective on Judgment and Choice: Mapping Bounded Rationality," *American Psychologist* 58, 697–720. https://doi.org/10.1037/0003-066X.58.9.697

{% In what follows, "AP" refers to Kahneman (2003, American Psychologist), which, like this paper, is a summary of Kahneman's Nobel-lecture.

P. 1453, para on 1st/2nd column: Discussion that distinguishing between good and bad, approach/avoidance, is very basic. Is in AP at p. 701, end of 1st column.

P. 1454, last para, presents reference dependence in perception as universal: "A general property of perceptual systems is that they are designed to enhance the accessibility of changes and differences. Perception is reference dependent …"

paternalism/Humean-view-of-preference: §VII, pp. 1467-1469 discusses corrections/avoidance of biases. AP has it on pp. 710-712.

P. 1456, on prospect-theory's departure from rationality: "One novelty of prospect theory was that it was explicitly presented as a formal descriptive theory of the choices that people actually make, not as a normative model. This was a departure from a long history of choice models that served double duty as normative logics and as idealized descriptive models."

P. 1457, 3rd para (also AP p. 705, 3rd para): "Bernoulli's error—the assumption that the carriers of utility are final states—…"

P. 1457, end of 1st column:

"The core idea of prospect theory—that the value function is kinked at the reference point and loss averse—…" %}

Kahneman, Daniel (2003) "Maps of Bounded Rationality: Psychology for Behavioral Economics," *American Economic Review* 93, 1449–1475.
https://www.jstor.org/stable/3132137

{% P. 726, 2/3 at 2nd column: "The concept of loss aversion was, I believe, our [Tversky & Kahneman] most useful contribution to the study of decision making."

P. 727, top of 2nd column, suggests that the success of prospect theory is by arbitrary processes. I disagree. The success is because 1979 prospect theory was the first rational theory of irrational behavior, which is a major intellectual breakthrough.

dynamic consistency: p. 727, 2nd column, bottom, describes that Amos and he considered dynamic decision principles, which they indeed did in their magnificent Science 1981 paper, way before Hammond (1988) and others. %}

Kahneman, Daniel (2003) "Experiences of Collaborative Research," *American Psychologist* 58, 723–730.

{% §4.5, in a discussion of the Allais paradox, states explicitly that Amos Tversky considered deviations from expected utility as in the Allais paradox to be irrational, and that he developed prospect theory only for modeling irrational behavior. In a preliminary January 2011 version of the chapter that Daniel wrote and that I commented on, Daniel wrote:

"Most theorists, notably including Allais, maintained their belief in human rationality and tried to bend the rules of rational choice to make the Allais pattern permissible. Over the years there have been multiple attempts to find a plausible justification for the certainty effect, none very convincing. Amos had little patience for these efforts – he called the theorists who tried to rationalize violations of utility theory "lawyers for the misguided." We went in another direction: we retained utility theory as a logic of rational choice, but abandoned the idea that people are perfectly rational agents. We took on the task of developing a psychological theory that would describe the choices that people make, whether or not they are rational. In prospect theory, decision weights would not be identical to probabilities." %}

Kahneman, Daniel (2011) book in preparation.

{% P. 300 writes, overselling: "The concept of loss aversion is certainly the most significant contribution of psychology to behavioral economics."

P. 314, in a discussion of the Allais paradox, states explicitly that Amos Tversky considered deviations from expected utility as in the Allais paradox to be irrational, and that he developed prospect theory only for modeling irrational behavior:

"Most theorists, notably including Allais, maintained their belief in human rationality and tried to bend the rules of rational choice to make the Allais pattern permissible. Over the years there have been multiple attempts to find a plausible justification for the certainty effect, none very convincing. Amos had little patience for these efforts; he called the theorists who tried to rationalize violations of utility theory "lawyers for the misguided." We went in another direction: we retained utility theory as a logic of rational choice but abandoned the idea that people are perfectly rational choosers. We took on the task of developing a psychological theory that would describe the choices that people make, regardless of whether they are rational. In prospect theory, decision weights would not be identical to probabilities." %}

Kahneman, Daniel (2011) "*Thinking: Fast and Slow*." Penguin Books, London.

{% Email of 25 Februari 2023: He accepts my terminology of OPT and PT in Wakker (2023 *Theory and Decision*), writing: "So I am perfectly content with the existence of two separate theories, OPT and PT (I don't mind your terminology), but I am still sentimentally attached to OPT and to two non-zero outcomes." %}

Kahneman, Daniel (2023); personal communivation.

{% %}

Kahneman, Daniel & Jean Beatty (1966) "Pupil Diameter and Load on Memory," *Science*154, 1583–1585.

{% %}

Kahneman, Daniel & Jean Beatty (1967) "Pupillary Responses in a Pitch-Discrimination Task," *Perception and Psychophysics* 2, 101–105.

{% They distinguish emotional and (a thinking-based) life evaluation. They anayze > 450,000 responses to the Gallup-Healthways Well-Being Index (in US) and do regressions. Income and education are closely related to life evaluation. Health, care giving, loneliness, and smoking are closely related to daily emotions. Life evaluation always increases in income, but emotional stops after annual income of $75,000. %}

Kahneman, Daniel & Angus Deaton (2010) “High Income Improves Evaluation of Life but not Emotional Well-Being,” *Proceedings of the National Academy of Sciences* 107, 16489–16493.

{% %}

Kahneman, Daniel, Jean Beatty, & Irwin Pollack (1967) “Perceptual Deficit During a Mental Task,” *Science* 157, 218–219.

{% %}

Kahneman, Daniel, Rachel Ben-Ishai, & Michael Lotan (1973) “Relation of a Test of Attention to Road Accidents,” *Journal of Applied Psychology* 58, 113–115.

{% %}

Kahneman, Daniel & Diane Chajczyk (1983) “Tests of the Automaticity of Reading: Dilution of Stroop Effects by Color-Irrelevant Stimuli,” *Journal of Experimental Psychology: Human Perception and Performance* 9, 497–509.

{% %}

Kahneman, Daniel, Barbara L. Fredrickson, Charles A. Schreiber, & Donald A. Redelmeier (1993) “When More Pain is Preferred to Less: Adding a Better End,” *Psychological Science* 4, 401–405.

{% %}

Kahneman, Daniel & Edwin E. Ghiselli (1962) “Validity and Nonlinear Heteroschedastic Models,” *Personnel Psychology* 1–12.

{% %}

Kahneman, Daniel & Avishai Henik (1976) “Effects of Visual Grouping on Immediate Recall and Selective Attention.” *In* Stanislav Dornic (ed.) *Attention and Performance* V, 307–332, Academic Press, New York.

{% %}

Kahneman, Daniel & Avishai Henik (1981) "Perceptual Organization and Attention." *In* Michael Kubovy & James R. Pomerantz (eds.) *Perceptual Organization*, Erlbaum, Hillsdale, NJ.

{% Contingent valuation responses reflect the willingness to pay for the moral satisfaction of contributing to public goods, not the economic value of these goods. Scope insensitivity/embedding effect: Jf you ask people how much money it is worth to them to save the polar bear, they answer an amount that in fact reflects the total value they want to spend on helping animals. %}
Kahneman, Daniel & Jack L. Knetsch (1992) "Valuing Public Goods: The Purchase of Moral Satisfaction," *Journal of Environmental Economics and Management* 22, pages 57–70.

{% %}
Kahneman, Daniel & Jack L. Knetsch (1992) "Contingent Valuation and the Value of Public Goods: Reply," *Journal of Environmental Economics and Management* 22, 90–94.

{% %}
Kahneman, Daniel, Jack L. Knetsch, & Richard H. Thaler (1986) "Fairness and the Assumptions of Economics," *Journal of Business* 59, S285–300.

{% Telephone surveys on fair prices/wages %}
Kahneman, Daniel, Jack L. Knetsch, & Richard H. Thaler (1986) "Fairness as a Constraint on Profit Seeking: Entitlements in the Market," *American Economic Review* 76, 728–741.

{% %}
Kahneman, Daniel, Jack L. Knetsch, & Richard H. Thaler (1990) "Experimental Tests of the Endowment Effect and the Coase Theorem," *Journal of Political Economy* 98, 1325–1348.
Reprinted *in* Richard H. Thaler (ed.) *Quasi -Rational Economics*, 167–188, New York, Russell Sage Foundation.

{% **PT, applications**, loss aversion; consider buyers, sellers, and choosers. %}
Kahneman, Daniel, Jack L. Knetsch, & Richard H. Thaler (1991) "The Endowment Effect, Loss Aversion, and Status Quo Bias: Anomalies," *Journal of Economic Perspectives* 5 no. 1, 193–206.

{% P. 4 equates Bentham's utility with Kahneman's experienced utility, as if solely to be aggregated over time, even though Bentham also considered aggregations over other dimensions. Argue for various concepts of utility, not one (**risky utility u = transform of strength of preference v**). New contribution of this paper is proposing the U-index: Let subjects categorize all kinds of aspects and specify their intensity. Each timepoint is categorized as negative if the most negative score over attributes exceeds in absolute value the most positive score over attributes. The U-index then specifies the percentage of time with a negative score. The authors point out that in this way information is lost and call the index ordinal in this respect (although it compares positive distances from 0 to negative ones), but reassure the readers by stating that they see this as an advantage. %}
Kahneman, Daniel & Alan B. Krueger (2006) "Developments in the Measurement of Subjective Well-Being," *Journal of Economic Perspectives* 20, 3–24.

{% **total utility theory**. Kahneman argued in several papers that it may be useful not to let people decide/choose over episodes, because there are biases in time aggregation. In such cases, let people only evaluate instant utility through introspection at that moment, and let researchers/policy makers integrate these (total utility or ERM). Getting such introspections can be cumbersome and costly. This paper proposes DRM, a tractable alternative: Let people retrieve from memory their instant utility of the past day, by letting them partition that day into episodes, letting them recall the events and instant utility of those episodes, and let them report those. (This also gives info on time budgeting.) It was done with a convenience sample of N = 909 women who had worked the day before.

Subjects reconstruct experiences of preceding day. For some things, there is a nice contrast between what this method measures and what global overal satisfaction judgment gives. The latter may say "I enjoy my kids," whereas the former shows that all activities related to children were perceived of as a burden. DRM may avoid social desirability, but missing out on global overall value that is not easily allocated to particular time and on valuable long-term things that are not perceived as an instant change (with supposedly flowers bringing more happiness than a couch). %}

Kahneman, Daniel, Alan B. Krueger, David A. Schkade, Norbert Schwarz, & Arthur A. Stone (2004) “A Survey Method for Characterizing Daily Life Experience: The Day Reconstruction Method,” *Science* 306, 1776–1780.

{% This papers discusses, first, the ESM (Experience Sampling Method) where people several times per day receive the request to describe their experiences at that moment, so that instant utilituy is measured truly as meant to be. The authors call this the gold standard (p. 431 ℓ. 1). Then it discusses the DRM (daily reconstruction method), where people at end of day are asked what happened. It is a pragmatic alternative to the ESM. Then it discusses the ERM (Event Recall Method), another pragmatic alternative. Proposes to use these measurements to measure national well being. %}

Kahneman, Daniel, Alan B. Krueger, David A. Schkade, Norbert Schwarz, & Arthur A. Stone (2004) “Toward National Well-Being Accounts,” *American Economic Review, Papers and Proceedings* 94, 429–434.

{% **linear utility for small stakes**: Claim that this is normative although empirically violated. Claim that people are generally too risk averse, for one thing because they isolate choices too much. In this point they preceded the narrow bracketing of Read, Loewenstein, & Rabin (1999) and the myopic loss aversion of Benartzi & Thaler (1995).

Kahneman (January 22, 2008, personal communication, email) pointed out that the arguments in this paper should only concern moderate stakes that are not a substantial portion of total wealth. They wanted to have this restriction. Kahneman checked out the paper and saw that they had forgotten to write it. %}

Kahneman, Daniel & Dan Lovallo (1993) “Timid Choices and Bold Forecasts: A Cognitive Perspective on Risk Taking,” *Management Science* 39, 17–31.

{% %}

Kahneman, Daniel & Dale T. Miller (1986) “Norm Theory: Comparing Reality to Its Alternatives,” *Psychological Review* 93, 136–153.

{% %}
Kahneman, Daniel & Joel Norman (1964) "The Time-Intensity Relation in Visual Perception as a Function of Observer's Task," *Journal of Experimental Psychology* 68, 215–220.

{% %}
Kahneman, Daniel, Joel Norman, & Michael Kubovy (1967) "Critical Duration for the Resolution of Form: Centrally or Peripherally Determined?," *Journal of Experimental Psychology* 73, 323–327.

{% %}
Kahneman, Daniel, L. Onuska, & Ruth E. Wolman (1968) "Effects of Grouping on the Pupillary Response in a Short-Term Memory Task," *Quarterly Journal of Experimental Psychology* 20, 309–311.

{% %}
Kahneman, Daniel & W. Scott Peavler (1969) "Incentive Effects and Pupillary Changes in Association Learning," *Journal of Experimental Psychology* 79, 312–318.

{% Argue that known biases are all in favor of hawks, so that they more often win in politics than doves. Relate it to the current war (2007) in Iraque. %}
Kahneman, Daniel & Jonathan Renshon (2007) "Why Hawks Win," *Foreign Policy Magazine*.
Translated into Dutch as "Over Oorlog en Vrede Wordt niet Rationeel Beslist: Waarom Haviken vaak Winnen van Duiven" in NRC Handelsblad, February 3&4 2007, Opinie en Debat, p. 17.

{% %}
Kahneman, Daniel & Ilana Ritov (1994) "Determinants of Stated Willingness to Pay for Public Goods: A Study in the Headline Method," *Journal of Risk and Uncertainty* 9, 5–38.

{% %}
Kahneman, Daniel, Ilana Ritov, Karen E. Jacowitz, & Paul Grant (1993) "Stated Willingness to Pay for Public Goods: A Psychological Perspective," *Psychological Science* 4, 310–315.

{% **conservation of influence**: If it is violated, then behavior is just noise. The authors state this point for choice inconsistencies in companies. %}
Kahneman, Daniel, Andrew M. Rosenfield, Linnea Gandhi, & Tom Blaser (2016) "Noise: How to Overcome the High, Hidden Cost of Inconsistent Decision Making," *Harvard Business Review* October 2016, 40–46.

{% %}
Kahneman, Daniel & Ozer Schild (1966) "Training Agents of Social Change in Israel: Definitions of Objectives and a Training Approach," *Human Organization* 25, 323–327.

{% Seem to write: "observe that "human experts are easily outperformed by simple formulas" and advocate "in favor of using noise-free methods: rules and algorithms." (**intuitive versus analytical decisions**) %}
Kahneman, Daniel, Oliver Sibony, & Cass R. Sunstein (2021). "*Noise: A Flaw in Human Judgment.*" Hachette UK, London.

{% %}
Kahneman, Daniel, Paul Slovic, & Amos Tversky (1982, eds.) "*Judgment under Uncertainty: Heuristics and Biases.*" Cambridge University Press, Cambridge.

{% **Christiane, Veronika & I**
risky utility u = transform of strength of preference v: People think that after some days of headache, an additional day of headache brings more extra suffering than the first day, so, the suffering escalates and the utility function seems to be convex. Still, in risky choices, they are risk averse suggesting that the utility function is concave. Some might interpret this finding as a difference between risky and riskless utility. I would ascribe the risk aversion to taking numbers numerically rather than as values. %}

Kahneman, Daniel & Jackie S. Snell (1990) “Predicting Utility.” *In* Robin M. Hogarth (ed.) *A Tribute to Hillel J. Einhorn*, 295–310, University of Chicago Press, Chicago.

{% %}

Kahneman, Daniel & Jackie S. Snell (1992) “Predicting a Changing Taste: Do People know What They Will Like?,” *Journal of Behavioral Decision Making* 5, 187–200.

{% Authors distinguish between experienced and decision utility. Consider ways to optimize the perceived joy of receipt of income, suggesting it is maximized with gradually increasing income and now and then a bonus that does not change the perception of status quo. %}

Kahneman, Daniel & Richard H. Thaler (1991) “Economic Analysis and the Psychology of Utility: Applications to Compensation Policy,” *American Economic Review, Papers and Proceedings* 81, 341–346.

{% Cite evidence that people don’t predict their future tastes properly sometimes. %}

Kahneman, Daniel & Richard H. Thaler (2006) “Utility Maximization and Experienced Utility,” *Journal of Economic Perspectives* 20, 221–234.

{% %}

Kahneman, Daniel & Anne Treisman (1984) “Changing Views of Attention and Automaticity.” *In* Raja Parasuraman, D. Roy Davies, & Jean Beatty (eds.) *Variants of Attention*, 29–61, New York: Academic Press.

{% %}

Kahneman, Daniel, Anne Treisman, & Jacquelyn Burkell (1983) “The Cost of Visual Filtering,” *Journal of Experimental Psychology: Human Perception and Performance* 9, 510–522.

{% %}

Kahneman, Daniel, Anne Treisman, & Brian J. Gibbs (1992) "The Reviewing of Object Files: Object-Specific Integration of Information," *Cognitive Psychology* 24, 175–219.

{% %}

Kahneman, Daniel & Amos Tversky (1972) "Subjective Probability: A Judgment of Representativeness," *Cognitive Psychology* 3, 430–454.

Abbreviated version as Ch. 3 in Daniel Kahneman, Paul Slovic, & Amos Tversky (1982, eds.) *Judgment under Uncertainty: Heuristics and Biases*, Cambridge University Press, Cambridge.

{% %}

Kahneman, Daniel & Amos Tversky (1973) "On the Psychology of Prediction," *Psychological Review* 80, 237–251.

Reprinted as Ch. 4 in Daniel Kahneman, Paul Slovic, & Amos Tversky (1982, eds.) *Judgment under Uncertainty: Heuristics and Biases*, Cambridge University Press, Cambridge.

{% An early version of their 1979 Econometrica prospect theory paper.

Use term uncertainty weight instead of decision weight.

P. 9 ff. lets isolation refer only to outcomes being changes w.r.t. reference point. 1979 paper will take isolation more general.

P. 12: "Hence, it appears that over a reasonably wide range of assets the value function is approximately the same."

Remarkably, for pure prospects (x,p,y) with x > y > 0, they take CE(x,p,y) = y + CE(x−y,p,0), which deviates from their 1979 version and is less satisfactory in the sense that it cannot be defined for nonquantitative outcomes.

P. 14 is explicit on the "two-stage" model (term not used there) where first probability judgments are made and then these are transformed as objective probabilities would. This is not explicit in the 1979 version, only some text on p. 281 paragraph −2.

uncertainty amplifies risk: p. 15 2nd para repeats the two-stage model, and writes: "In these cases, the regressiveness of uncertainty weights with respect to objective probabilities will be further enhanced by the tendency to overestimate low probabilities and

underestimate high ones." This is exactly the condition in my (oh well) 2004 psychological review paper. Wow!

P. 18: (**SPT instead of OPT**): Although they here use a slightly different version of the PT formula than in their published 1979 paper, with utility of outcome differences rather than utility differences, this page and how it extends p. 12 clearly shows what they had in mind for many-outcome prospects.

Pp. 19 ff is very remarkable on **dynamic consistency**, already containing the idea of Hammond (1988) and Burks (1977 Ch. 5), to derive independence from dynamic principles, and preceding both of these. Well, at least, they show it for the Allais paradox, but it is typical of any violation of independence. They first have choices between A_1 and A_2, and then their scaled-down versions B_1 and B_2. Then come the sequential C_1 and C_2. They first explain that from the prior perspective, because of RCLA, C_1 and C_2 are identical to B_1 and B_2. This is analyzing using dynamic consistency + RCLA, optimizing from the prior perspective. Then they explain that subjects, in a figure that presents the decision node in the 2nd stage, ignore the lower branch and take the 2nd stage choice in isolation. This is what Machina (1989) called consequentialism. Thus, they show that to do the Allais paradox one either has to violate DC + RCLA or consequentialism. They claim it more generally, for the certainty effect (which in this paper they formally define as what they will later call subadditivity). They do not claim it in full generality for independence, but they are very close and deserve crediting. I realized this for their 1975 paper (preceding Ch. 5 in Burks 1977!) only 9 Dec. 2012, whereas for their 1979 published version I realized it around 2008.

P. 23: "In this theory insurance and gambling occur in spite of the value function, not because of it." Nice, very explicit, statement.

P. 24: "Utility theory can be viewed as an attempt to eliminate the concept of attitude to risk or uncertainty and to explain risky choices solely in terms of attitudes to money or wealth."

P. 25: "Value theory does not purport to account for all forms of risk-seeking and risk-aversion. Many factors not included in this theory (e.g., regret., social pressure, superstition, magical thinking) probably play an important role in risky choices. Value theory is an attempt to modify those assumptions of utility theory that are most severely violated, so as to achieve a more realistic account of choice behavior."

second-order probabilities to model ambiguity: There is a whole section on

Ellsberg (pp. 30-33) suggesting that Ellsberg is second-order probability (without **RCLA**), and then the somewhat far-fetched idea that people then treat 1st order probabilities of winning as outcomes and process them concavely, suggesting a kind of second-order-probability risk aversion. Note that this is a special version of the smooth ambiguity model of KMM (2005): It is already the smooth model when there are only two outcomes! (**event/outcome driven ambiguity model: outcome driven**)

Whereas the 1979 paper is explicit about expected utility being normative, this paper has a nice discussion on normative implications without ever committing to a normative status of expected utility.

paternalism/Humean-view-of-preference; P. 35: "The observation that people's preference vary with the formulation of problems underscores the need for decision aids to help people make more consistent and rational choices." P. 36 has this argument that, for example, regret must be accepted if it cannot be avoided: "If man is constructed in such a way that he is much more sensitive to gains and losses than to absolute wealth, then any attempt to maximize human welfare must recognize this fact. More generally, a normative approach to decision must take into account the nature of man as a pleasure machine."

They call certainty effect what in their 1979 version they will call subadditivity. %}

Kahneman, Daniel & Amos Tversky (1975) "Value Theory: An Analysis of Choices under Risk," paper presented at the ISRACON conference on Public Economics, Jerusalem, 1975.

Link to paper

{% Merigó, Rocafort, & Aznar-Alarcón (2016) Table 2 and p. 402 wrote that this is the most-cited paper in business and economics. Kim, Morse, & Zingales (2006, Table 2) had it as the 2nd most cited.

I follow this paper here in writing π rather than w for the probability weighting function.

PT: data on probability weighting;

risk averse for gains, risk seeking for losses; **inverse S**; **real incentives/hypothetical choice**, p. 265;

P. 263, abstract: Certainty effect is defined as also implying possibility effect. This deviates from the common terminology in the field, and from most of their own other writings, for instance, their 1975 working paper, or Tversky & Fox (1995 p. 272).

P. 272: In this Allais paradox, in the figure with the decision node after the 1st chance node, the gains are maximally correlated giving a certainty-effect perception, whereas in the figure with the decision node before the chance nodes the outcomes are perceived as independent.

P. 273, in showing reference dependence, the authors take good care that the decision situations are the same in terms of final wealth and that it must really be the change in reference point.

P. 276 Eq. 2: Contrary to what many think, for prospects with two outcomes, both nonzero, and either both gains or both losses, the value of a prospect x_py is NOT $\pi(p)v(x) + \pi\ (p)v(y)$. P. 276 ℓ. 15: "The evaluation of strictly positive and strictly negative prospects follows a different rule." What happens is that for such prospects, PT is RDU w.r.t. w for gains, and RDU w.r.t. the dual of π for losses. That is, for $x > y > 0$ it is $\pi(p)v(x) + (1 - \pi(p))v(y)$. For losses with $x < y < 0$ it is also $\pi(p)v(x) + (1 - \pi(p))v(y)$, meaning it is RDU with reflected π there. See Wakker (2023, Theory and Decision).

paternalism/Humean-view-of-preference: p. 277:

> The equations of prospect theory retain the general bilinear form that underlies expected utility theory. However, in order to accom[m]odate the effects described in the first part of the paper, we are compelled to assume that values are attached to changes rather than to final states, and that decision weights do not coincide with stated probabilities. These departures from expected utility must lead to normatively unacceptable consequences, such as inconsistencies, intransitivities, and violations of dominance. Such anomalies of preference are normally corrected by the agent when he becomes aware that his preferences are inconsistent, intransitive, or inadmissible. In many situations, however, the agent lacks the opportunity to discover that his preferences could violate decision rules that he wishes to obey. In these circumstances the anomalies implied by prospect theory are expected to occur.

Here they state that expected utility is normative. Kahneman (2003, *American Economic Review, Papers and Proceedings*, p. 163) will state the opposite.

P. 277 explains reference dependence by saying that the utility function is a book, each page describing it for a difference reference point, which metaphor was also used by Edwards (1962, p. 116) be it not for utility.

P. 277: Many people erroneously think that, according to prospect theory, preference depends only on the differences of outcomes with the reference point, and not on the reference point otherwise. This is not so. For different reference points the value function and probability weighting function (and loss aversion) can be different. Here is what the authors write: "The emphasis on changes as the carriers of value should not be taken to imply that the value of a particular change is independent of initial position." But they then point out that the dependence is weak: "However, the preference order of prospects is not greatly altered by small or even moderate variations in asset position. The certainty equivalent of the prospect (1,000, .50), for example, lies between 300 and 400 for most people, in a wide range of asset positions. Consequently, the representation of value as a function in one argument generally provides a satisfactory approximation." (The last sentence finished on p. 278.)

P. 277: d**ecreasing ARA/increasing RRA**: it suggests decreasing absolute risk aversion.

Pp. 278-279: that utilities are locally nonsmooth. At wealth level where you can just buy a house, you have a high marginal utility of money.

P. 279 1st para: that concavity of utility for losses is more common than convexity for gains.

P. 279: **risk seeking for symmetric fifty-fifty gambles. The** authors do not think this and speculate that people are highly averse to such risks.

utility concave near ruin: P. 279 says that utility for losses may have concave regions for large losses, that necessitate changes of life style. Do not explicitly relate it to ruin.

P. 280: "decision weights … should not be interpreted as measures of degree or[of] belief."

P. 280: "the decision weight attached to an event could be influenced by other factors, e.g., ambiguity."

P. 281 top: what they call subadditivity in fact is subproportionality.

uncertainty amplifies risk (for **inverse S** probability weighting): p. 281, penultimate para: "It is important to distinguish overweighting, which refers to a property of decision weights, from the overestimation that is commonly found in the assessment of the probability of rare events. … In many real-life situations, overestimation and overweighting may both operate to increase the impact of rare events" This relates to the preference condition in my 2004-Psych. Rev. paper! Similarly, p. 289 $\ell\ell$. 5-6: "Consequently, subcertainty should be more pronounced for vague than for clear probabilities."

P. 281: subcertainty means $\pi(p) + \pi(1\text{-}p) < 1$.

P. 282: "The slope of π in the interval (0,1) can be viewed as a measure of the sensitivity of preferences to changes in probability." Then follows an error. The authors write that subcertainty implies low sensitivity. This is not so. Subcertainty is about the *absolute level* of probability, not about the *change* in probability.

P. 282: "This quantal effect may reflect the *categorical distinction* between certainty and uncertainty." [italics added] Here the quantal effect refers to a smallest unit of perception and discontinuity of π at $p = 1$.

Pp. 282-283: **(very) small probabilities**: that small probabilities can be overweighted or ignored.

P. 283: "probabilities of identical outcomes are combined in the editing or prospects."

P. 283/284 point out that their theory may violate dominance and say that editing can prevent that, but then indirectly (through transitivity) it can still happen.

P. 286 $\ell\ell$. 2-4 point out that utility curvature works opposite to the overweighting of small probabilities.

P. 287 bottom: The authors write that utility, if final wealth is perceived, will be concave. I assume this means that they assume concavity of utility to be more rational than convexity. They also assume that then the reference point is at 0 and all outcomes are perceived as gains. Gains rather than losses seems to be plausible, but I cannot think of a 100% argument why not the reference point then is the maximum wealth level and all outcomes are perceived as losses.

P. 288 4th para claims that the extension of prospect theory to many-valued prospects is straightforward, but does not give the formulas. Wakker (2023 Theory and Decision) explains the case.

biseparable utility: Unlike what many think, biseparable utility is satisfied by the original prospect theory of this paper when restricted to gains or when restricted to losses.

P. 289 ℓ. 1: The text says that PERCEIVED LIKELIHOOD primarily determine decision weights. This does not say that most of the nonadditivity is generated by cognitive factors, but goes a little bit in that direction. Here is the

para: "The decision weight associated with an event will depend primarily on the perceived likelihood of that event, which could be subject to major biases [45] [Their Science 74 paper on heuristics and biases] In addition, decision weights may be affected by other considerations, such as ambiguity or vagueness. The work of Ellsberg [10] and Fellner [12] indeed implies that vagueness reduces decision weights. Consequently, subcertainty should be more pronounced for vague than for clear probabilities." (**uncertainty amplifies risk**)

The journal pushed the authors to produce preference axioms. Hence, the appendix has some, suggested by David Krantz, but it does not really axiomatize the theory. %}

Kahneman, Daniel & Amos Tversky (1979) "Prospect Theory: An Analysis of Decision under Risk," *Econometrica* 47, 263–291.
https://doi.org/10.2307/1914185

{% %}

Kahneman, Daniel & Amos Tversky (1979) "Intuitive Prediction: Biases and Corrective Procedures," *TIMS Studies in Management Science* 12, 313–327. Reprinted as Ch. 30 in Daniel Kahneman, Paul Slovic, & Amos Tversky (1982, eds.) *Judgment under Uncertainty: Heuristics and Biases*, Cambridge University Press, Cambridge.

{% %}

Kahneman, Daniel & Amos Tversky (1982) "The Psychology of Preferences," *Scientific American* 246 (1, Jan.), 160–173.

{% **paternalism/Humean-view-of-preference**: p. 124 seems to write: "lthough errors of judgment are but a method by which some cognitive processes are studied, the method has become a significant part of the message" %}

Kahneman, Daniel & Amos Tversky (1982) "On the Study of Statistical Intuitions," *Cognition* 11, 123–141.
Reprinted as Ch. 34 in Daniel Kahneman, Paul Slovic, & Amos Tversky (1982, eds.) *Judgment under Uncertainty: Heuristics and Biases*, Cambridge University Press, Cambridge.

{% %}

Kahneman, Daniel & Amos Tversky (1982) “Variants of Uncertainty,” *Cognition* 11, 143–157.
Reprinted as Ch. 35 in Daniel Kahneman, Paul Slovic, & Amos Tversky (1982, eds.) *Judgment under Uncertainty: Heuristics and Biases*, Cambridge University Press, Cambridge.

{% %}
Kahneman, Daniel & Amos Tversky (1982) “Judgment of and by Representativeness.” *In* Daniel Kahneman, Paul Slovic, & Amos Tversky (eds.) *Judgment under Uncertainty: Heuristics and Biases*. Cambridge University Press, Cambridge.

{% %}
Kahneman, Daniel & Amos Tversky (1982) “The Simulation Heuristic.” *In* Daniel Kahneman, Paul Slovic, & Amos Tversky (eds.) *Judgment under Uncertainty: Heuristics and Biases*, 201–208, Cambridge University Press, Cambridge.

{% Seem to describe probability weighting function as “psychophysics of chance” on p. 344 %}
Kahneman, Daniel & Amos Tversky (1984) “Choices, Values, and Frames,” *American Psychologist* 39, 341–350.

{% %}
Kahneman, Daniel & Amos Tversky (1995) “Conflict Resolution: A Cognitive Perspective.” *In* Kenneth J. Arrow et al. (eds.) *Barriers to Conflict Resolution*, Ch. 3. Norton, New York.

{% A long list of points on which the authors disagree with Gigerenzer’s criticisms. Many are misunderstandings or different wordings. For example, if Gigerenzer criticizes the Linda example for ignoring context and content, he means that the question how likely it is that Linda is a feminist bank teller can be taken by subjects as referring to *conditional probability* rather than unconditional as it is meant. This is different than K&T use the term. K&T reply here that they tested for this confound, but then, this is less clear, and, … In short, hard to judge for

outsiders.

P. 582: "Similarly, the role of availability in frequency judgments can be demonstrated by comparing two classes that are equal in objective frequency but differ in the memorability of their instances."

P. 582, about their biases and heuristics:

"However, it soon became apparent that although errors of judgment are but a method by which some cognitive processes are studied, the method has become a significant part of the message" (Kahneman & Tversky, 1982a, p. 124).

P. 589, last sentence of paper, on Gigerenzer's emphasizing of relative frequencies (reminds me also of the experienced-uncertainty approach of Erev et al.):

"The view that "both single-case and frequency judgments are explained by learned frequencies (probability cues), albeit by frequencies that relate to different reference classes" (Gigerenzer, 1991, p. 106) appears far too restrictive for a general treatment of judgment under uncertainty. First, this treatment does not apply to events that are unique for the individual and therefore excludes some of the most important evidential and decision problems in people's lives. Second, it ignores the role of similarity, analogy, association, and causality. There is far more to inductive reasoning and judgment under uncertainty than the retrieval of learned frequencies." %}

Kahneman, Daniel & Amos Tversky (1996) "On the Reality of Cognitive Illusions," *Psychological Review* 103, 582–591.

{% Seem to write:

"As with the fruit fly, we study gambles in the hope that the principles that govern the simple case will extend in recognizable form to complex situations" (p. xi). Lopes (1983) also used the metaphor of what she spelled in one word as a fruitfly. %}

Kahneman, Daniel & Amos Tversky (2000, eds.) "*Choices, Values, and Frames.*" Cambridge University Press, New York.

{% %}

Kahneman, Daniel, Bernard Tursky, David Shapiro, & Andrew Crider (1969) "Pupillary Heart Rate and Skin Resistance Changes During a Mental Task," *Journal of Experimental Psychology* 79, 164–167.

{% %}

Kahneman, Daniel & Carol A. Varey (1990) “Propensities and Counterfactuals: The Loser that Almost Won,” *Journal of Personality and Social Psychology* 59, 1101–1110.

{% %}

Kahneman, Daniel & Carol A. Varey, (1991) “Notes on the Psychology of Utility.” *In* John Elster & John E. Roemer (eds.) *Interpersonal Comparisons of Well-Being. Studies in Rationality and Social Change*, 127–163, Cambridge University Press, New York.

{% **coherentism**; **discounting normative**; **paternalism/Humean-view-of-preference**

A good dish is enjoyed three times: when happily anticipating, during the eating itself, and when remembering in complete satisfaction. %}

Kahneman, Daniel, Peter P. Wakker, & Rakesh K. Sarin (1997) “Back to Bentham? Explorations of Experienced Utility,” *Quarterly Journal of Economics* 112, 375–405.

https://doi.org/10.1162/003355397555235

Direct link to paper

{% %}

Kahneman, Daniel & Ruth E. Wolman (1970) “Stroboscopic Motion: Effects of Duration and Interval,” *Perception and Psychophysics* 8, 161–164.

{% **Prospect theory not cited**; factors (poverty, gender, education) explaining inconsistencies in choice lists and so on; no clear results are found. %}

Kahsay, Haftom Bayray, Simone Piras, Laure Kuhfuss, Marco Setti, & Valentino Marini Govigli (2024) “Understanding Inconsistencies in Risk Attitude Elicitation Games: Evidence from Smallholder Farmers in Five African Countries,” *Journal of Behavioral and Experimental Economics* 113, 102307.

https://doi.org/10.1016/j.socec.2024.102307

{% %}

Kahneman, Daniel & Patricia Wright (1971) "Changes in Pupil Size and Rehearsal Strategies in a Short-Term Memory Task," *Quarterly Journal of Experimental Psychology* 23, 187–196.

{% Mentions many applications of CEU (Choquet expected utility). %}
Kaivanto, Kim (2000) "Endogenously Non-Additive Aggregate Probabilities: Syndicate Surrogate Functions and Composite Market Beliefs," Warwick.

{% Nicely describes neo-additive as linear-with-boundary-discontinuity. %}
Kaivanto, Kim (2011) "Optimal Cutoff Threshold Placement in Signal Detection Theory under Cumulative Prospect Theory," Warwick.

{% Signal detection theory ("is this email genuine or malignent") is reanalyzed using PT. Decentralized behavioral decisionmakers are biased toward underdetection, and system-level risk is consequently greater than in analyses predicated upon normative rationality. %}
Kaivanto, Kim (2014) "The Effect of Decentralized Behavioral Decision Making on System-Level Risk," *Risk Analysis* 34, 2121–2142.

{% Nicely points out that St. Petersburg paradox very crucially depends on RCLA, and on gamblers fallacy of people, after some tails, wrongly thinking that now heads must become more likely. %}
Kaivanto, Kim & Eike B. Kroll (2012) "Alternative Bias and Reduction in St. Petersburg Gambles: An Experimental Investigation," Lancaster University, Lancaster, UK.

{% %}
Kajii, Atsushi (1997) "On the Role of Options in Sunspot Equilibria," *Econometrica* 65, 977–986.

{% Consider forms of additivity between full-force and comonotonic additivity, and characterize various special cases of the Choquet integral. %}
Kajii, Atsushi, Hiroyuki Kojima, & Takashi Uic (2007) "Cominimum Additive Operators," *Journal of Mathematical Economics* 43, 218–230.

{% %}
Kajii, Atsushi & Stephen Morris (1997) "Common p-Belief: The General Case," *Games and Economic Behavior* 18, 73–82.

{% %}
Kalai, Ehud & Meir Smorodinsky (1975) "Other Solutions to Nash's Bargaining Problem," *Econometrica* 43, 513–518.

{% %}
Kalai, Ehud & David Schmeidler (1977) "Aggregation Procedure for Cardinal Preferences: A Formulation and Proof of Samuelson's Impossibility Conjecture," *Econometrica* 45, 431–438.

{% **revealed preference**; They consider choice functions that cannot be represented by one preference relation, but by a number r of preference relations. Present some numerical results, such as limiting and maxmin, on r. %}
Kalai, Gil, Ariel Rubinstein, & Ran Spiegler (2002) "Rationalizing Choice Functions by Multiple Rationales," *Econometrica* 70, 2481–2488.

{% **ranking economists** %}
Kalaitzidakis, Pantelis, Theofanis P. Mamuneas, & Thanasis Stengos (2003) "Rankings of Academic Journals and Institutions in Economics," *Journal of the European Economic Association* 1, 1346–1366.

{% **HYE** %}
Kalant, Norman. (1991) "Ionic versus Nonionic Contrast Media: A Burden or a Bargain?," *Can. Med. Assoc. J.* 144, 123–124.

{% **information aversion**; of people with possibly Huntington's disease, only 5% take the test! %}
Kalb, Claudia (2006) "Healt for Life; Peering into the Future," *Newsweek* December 11, 2006, 46–52.

{% Experiment plus desire to link individual and group behavior.

PT falsified: **risk seeking for symmetric fifty-fifty gambles**: they seem to find it. %}

Kameda, Tatsuya & James H. Davis (1990) "The Function of the Reference Point in Individual and Group Risk Decision Making," *Organizational Behavior and Human Decision Processes* 46, 55–76.

{% Imagine Bayesian B1 can choose which signal to be revealed to another Bayesian B2, wanting to manipulate the latter. If this desire is common knowledge, can B1 still manipulate? The paper answers affirmatively. The signal can make B2's preferred action, disfavorable to B1, more favorable in situations where it will be chosen anyhow, but make it more unfavorable in situations where this does change the choice. Concavity/convexity of utility also plays a role. I did not read the paper enough to see if meta-info considerations can play a role, with B2 guessing there may be signals making him go the other way but not revealed to him. %}

Kamenica, Emir & Matthew Gentzkow (2011) "Bayesian Persuasion," *American Economic Review* 101, 2590–2615.

{% They have a beautiful data set of Japanese insurance clients after the earthquake in Kobe 1995 and Tohoku 2001. Insurance is enhanced by prior own exposure to catastrophes, exposure by close people, whether the earth shaked so that one felt it even if not directly affected (§5.2), and other things. Well-known biases such as availability and representativeness are also found. Remarkably, there is also a gambler's fallacy. Neighboring regions of an earthquake area took less insurance (p. 132 end of 2nd para).

The findings of this paper are not very surprising; with the gambler's fallacy just described it feels like for every finding there is a fallacy fitting with it. But it is good to see things confirmed in a valuable data set.

P. 93 §3 cites underinsurance against catastrophes. %}

Kamiya, Shinichi & Noriyoshi Yanase (2019) "Learning from Extreme Catastrophes," *Journal of Risk and Uncertainty* 59, 85–124.

{% **information aversion**?? Games with incompete information, **value of information** %}

Kamien, Morton I., Yair Tauman, & Shmuel Zamir (1979) "On the Value of Information in a Strategic Conflict."

{% **foundations of probability** %}

Kamlah, Andreas (1983) "Probability as a Quasi-Theoretical Concept—J.V. Kries' Sophisticated Account after a Century," *Erkenntnis* 19, 239–251.

{% Reviewed in JMP 34, 336-363, by Harold P. Lehmann, extensively and nicely %}

Kanal, Laveen N. & John F. Lemmer (1986) "*Uncertainty in Artificial Intelligence; Machine Intelligence and Pattern Recognition*, Vol.4." North-Holland, Amsterdam.

{% %}

Kanal, Laveen N., Todd S. Levitt, & John F. Lemmer (1989) "*Uncertainty in Artificial Intelligence 3; Machine Intelligence and Pattern Recognition*, Vol.5." North-Holland, Amsterdam.

{% Differences in optimal income taxation if analyzed using prospect theory instead of EU. %}

Kanbur, Ravi, Jukka Pirttilä, & Matti Tuomala (2008) "Moral Hazard, Income Taxation and Prospect Theory," *Scandinavian Journal of Economics* 110, 321–337.

{% **decreasing ARA/increasing RRA**: seem to give thought experiment criticizing constant RRA. %}

Kandel, Shmuel & Robert F. Stambaugh (1991) "Asset Returns and Intertemporal Preferences," *Journal of Monetary Economics* 27, 39–71.

{% %}

Kaneko, Mamoru (1980) "An Extension of the Nash Bargaining Problem and the Nash Social Welfare Function," *Theory and Decision* 12, 135–148.

{% %}
Kaneko, Mamoru (1994) "Axiomatic Considerations of Nash Equilibrium."

{% I met Mamoru in the early 1980s, when he visited my supervisor Stef Tijs. Then for over 30 years I never heard from him, or vice versa. But then he invited me for a conference in Japan, in 2016. I then visited him and read a preliminary version of this paper. I told him that it was in the constructive spirit of my countryman Brouwer. He told me that he had in fact been much inspired by Brouwer. This paper takes utility values and probabilities as real numbers not as just given, but as to be constructed up to some precision. It then sees into behavioral implications, with indecisions up to some degree. It assumes, what I like much, finiteness of our observations including preferences. %}
Kaneko, Mamoru (2020) "Expected Utility Theory with Probability Grids and Preference Formation," *Economic Theory* 70, 723–764. https://doi.org/10.1007/s00199-019-01225-4

{% %}
Kaneko, Mamoru & Takashi Nagashima (1988) "Players' Deductions and Deductive Knowledge on Theorems," Hitotsubashi University, Kunitachi, Tokyo 186(?? of in Blacksburg?), E88-02-01.

{% **completeness criticisms**: seems to give that. %}
Kannai, Yakkar (1963) "Existence of a Utility in Infinite Dimensional Partially Ordered Spaces," *Israel Journal of Mathematics* 1, 229–234.

{% %}
Kannai, Yakkar (1977) "Concavifiability and Constructions of Concave Utility Functions," *Journal of Mathematical Economics* 4, 1–56.

{% %}
Kannai, Yakkar (1981) "Concave Utility Functions, Existence, Constructions and Cardinality." *In* Siegfried Schaible & William T. Ziemba (eds.) *Generalized Concavity in Optimization and Economics*, 543–611, Academic Press, New York.

{% Seems to be a well-known paper on total absence of information.

ordering of subsets; show that a betweenness axiom for average-utility representation and the additivity axiom (called monotonicity) for qualitative probability are incompatible on sets of 5 or more elements. %}

Kannai, Yakkar & Bezalel Peleg (1984) "A Note on the Extension of an Order on a Set to the Power Set," *Journal of Economic Theory* 32, 172–175.

{% **conservation of influence**: seems to open with:

"All of nature, as far as it is within the reach of his power, is subjected to the will of man, with the exception of other men and reasonable beings. From the point of view of reason, the things in nature can only be regarded as means to ends, but *man alone can himself be regarded as an end*. … Animals, as well [as unreasonable things], have no value in themselves, since they have no consciousness of their existence – man is the purpose of creation; nevertheless, he can also be used as a means by other reasonable beings. However, man is never merely a means; rather he is at the same time an end. For example: If a mason serves me as a means to building a house, I serve him, in turn, as a means to acquire money. … The world, as a system of ends, finally has to contain a purpose, and this is the reasonable being. If there existed no end, the means would serve no purpose and would have no value. — Man is an end. It is therefore contradictory that he should be a mere means. — If I am making a contract with a servant, he has to be an end as well, just as I am, and not merely a means." %}

Kant, Immanuel (1785/ 2002) "*Groundwork for the Metaphysics of Morals*." Translated into English by Allen Wood. Yale University Press, New Haven, CT.

{% **free will/determinism**: seems to have written that you have to act under the presupposition, even if illusion, of free will.

Seems to have written on free will being only our imagination:

"Daher ist Freiheit nur eine Idee der Vernunft,
deren objekive Realität in sich zweifelhaft ist, Natur aber ein Verstandesbegriff, der seine Realität an Beispielen der Erfahrung beweiset und notwendig beweisen muss."

Translation: ["Therefore freedom is only an idea of "Vernunft,"
whose intrinsic objective reality is questionable, nature however is a concept of "Verstand,"
which proves, and necessarily has to prove, its reality by examples of experience."] Here Vernunft and Verstand are two different terms for rationality with subtle differences, Verstand being more practically oriented. %}

Kant, Immanuel (1961) "*Grundlegung zur Metaphysik der Sitten*;" edn. of 1961. *Re*clam, Sittingen, Germany.

{% Distinguishes between extensive (kind of cardinal) and intensive (kind of ordinal) measurement. %}

Kant, Immanuel (1781) "*Kritik der Reinen Vernunft*." Johann Friedrich Hartknoch, Riga.

{% p. 28 seems to write: "I call it the law of the instrument, and it may be formulated as follows: Give a small boy a hammer, and he will find that everything he encounters needs pounding." He also seems to write: "It comes as no particular surprise to discover that a scientist formulates problems in a way which requires for their solution just those techniques in which he himself is especially skilled." (**ubiquity fallacy**) %}

Kaplan, Abraham (1964) "*The Conduct of Inquiry: Methodology for Behavioral Science.*" Chandler Publishing Co., San Francisco.

{% **foundations of probability**. %}

Kaplan, Mark (2010) "In Defense of Modest Probabilism," *Synthese* 176, 41–55.

{% %}

Kaplan, Robert M. (1993) "Quality of Life Assessment for Cost/Utility Studies in Cancer," *Cancer Treat. Rev.* 19 suppl A, 85–93.

{% **foundations of probability**; %}

Kaplan, Stan (1988) "Will the Real Probability Please Stand Up?," *Reliability Engineering and System Safety* 23, 285–292.

{% By measuring how much people are willing to pay for reducing mortality risk, the income elasticity of the value of a statistical life can be measured. Note here how utility is measured through probability of survival = 1 − mortality risk, very similar through the modeling of utility through the probability of gaining a prize (Roth & Malouf 1979). The income elasticity of statistical life must then also be 1 − power of utility of income; i.e., the RRA index of the utility function of income. Income elasticities of statistical lives typically found in the literature ranges around 0.5. The author now only refers to RRA indexes found in finance and macroeconomics, which are around 2, and considers the discrepancy a paradox. However, in individual choice experiments in laboratories, RRA indexes of 0.5 are typically found, and the paradox is resolved! %}

Kaplow, Louis (2005) "The Value of a Statistical Life and the Coefficient of Relative Risk Aversion," *Journal of Risk and Uncertainty* 31, 23–34.

{% **equity-versus-efficiency**: If criteria other than individual utility, such as equity, are considered, then sometimes some of individual utility must be sacrificed to equity. By reshifting and continuity this can lead to a situation where, for equity considerations, all individuals sacrifice some utility, which violates the Pareto principle defined in a narrow sense. %}

Kaplow, Louis & Steven Shavell (2001) "Any Non-Welfarist Method of Policy Assessment Violates the Pareto Principle," *Journal of Political Economy* 109, 281–286.

{% **equity-versus-efficiency** %}

Kaplow, Lowis & Steven Shavell (2002) "*Fairness versus Welfare*." Harvard University Press, Cambridge.

{% **risky utility u = transform of strength of preference v**: In §1 the authors adopt the assumption that intertemporal utility Z(.) is a composition W(U(.)), with U a risky vNM utility and W something like a welfare function. It is remiscent of the Dyer-Sarin risky-riskless utility difference, although the authors do not cite this strand of literature but work from scratch. The authors blame other authors who use different models, such as the cynical "in excellent company" on p. 126 middle. Then there follow many discussions of the chosen composition, again criticizing everyone who did it differently. %}

Kaplow, Louis & David Weisbach (2011) "Discount Rates, Social Judgments, Individuals' Risk Preferences, and Uncertainty," *Journal of Risk and Uncertainty* 42, 125–143.

{% %}

Kapteyn, Arie (1985) "Utility and Economics," *De Economist* 133, 1–20.

{% **questionnaire versus choice utility**

Abstract. Since the work of Pollak and Wales (1979), it is well known that demand data are insufficient to identify a household cost function. Hence, additional information is required. For that purpose I propose to employ direct measurement of feelings of well-being, elicited in surveys. In the paper I formally establish the connection between subjective measures and the cost function underlying the AID system. The subjective measures fully identify cost functions and the expenditure data do this partly. This makes it possible to test the null hypothesis that both types of data are consistent with one another; i.e., that they measure the same thing. I use two separate data sets to set up a test of this equivalence. The outcomes are somewhat mixed and indicate the need for further specification search. Finally, I discuss some implications of the outcomes. %}

Kapteyn, Arie (1994) "The Measurement of Household Cost Functions: Revealed Preference versus Subjective Measures," *Journal of Population Economics* 7, 333–350.

{% **dominance violation by pref. for increasing income**; Use panel data, so, no real incentives and hypothetical choice, to do an alternative to Barsky et al. (1997). Model with habit formation suggests more utility curvature than without (so, additive separability over time).

P. C147: under assumption of intertemporal separability, they find power (= 1 – relative-risk-aversion index) of about –0.94, and if they allow for violation of intertemporal separability then they get –3.8 (p. C150 Tables 3 and 4, where ρ = 1 – power and they give ln(ρ))

intertemporal separability criticized: p. C151: "The main finding of our empirical analysis may be the rejection of intertemporal additivity." %}

Kapteyn, Arie & Federica Teppa (2003) "Hypothetical Intertemporal Consumption Choices," *Economic Journal* 113, C140–C152.
https://doi.org/10.1111/1468-0297.00111

{% %}

Kapteyn, Arie & Tom J. Wansbeek (1982) "Empirical Evidence on Preference Formation," *Journal of Economic Psychology* 3, 137–154.

{% %}
Kapteyn, Arie & Tom J. Wansbeek (1985) "The Individual Welfare Function," *Journal of Economic Psychology* 6, 333–363.

{% **risky utility u = strength of preference v (or other riskless cardinal utility, often called value)** %}
Kapteyn, Arie & Tom J. Wansbeek (1985) "The Individual Welfare Function, A Rejoinder," *Journal of Economic Psychology* 6, 375–381.

{% %}
Kapteyn, Arie, Tom J. Wansbeek, & Jeannine Buyze (1980) "The Dynamics of Preference Formation," *Journal of Economic Behavior and Organization* 1, 123–157.

{% %}
Kareev, Yaakov (1992) "Not That Bad after All: Generation of Random Sequences," *Journal of Experimental Psychology: Human Perception and Performance* 18, 1189–1194.

{% **probability elicitation**: seems that they consider continous distributions %}
Kareev, Yaakov, Sharon Arnon, & Reut Horwitz-Zeliger (2002) "On the Misperception of Variability," *Journal of Experimental Psychology: General* 131, 287–297.

{% %}
Karlsson, Goran & Magnus Johannesson (1996) "The Decision Rules of Cost-Effectiveness Analysis," *PharmacoEconomics* 9, 113–120.

{% **inverse S;**
utility elicitation: different EU methods give different curves: he probably was the first to demonstrate it empirically. %}
Karmarkar, Uday S. (1974) "The Effect of Probabilities on the Subjective Evaluation of Lotteries," Working paper No. 698–74, MIT.

{% **utility elicitation: different EU methods give different curves**: P. 65 points out that utility curve, elicited under EU calculation, depends on probability used. (This was posed as a research question by Swalm 1966, p. 134 last para.) Karmarkar (1974) describes the experiment.

inverse S: underprocessing of information versus overprocessing of information (latter if it would not be inverse S but regular S) %}

Karmarkar, Uday S. (1978) "Subjectively Weighted Utility: A Descriptive Extension of the Expected Utility Model," *Organizational Behavior and Human Performance* 21, 61–72.

{% %}

Karmarkar, Uday S. (1979) "Subjectively Weighted Utility and the Allais Paradox," *Organizational Behavior and Human Performance* 24, 67–72.

{% **state-dependent utility** %}

Karni, Edi (1983) "Risk Aversion for State-Dependent Utility Functions: Measurement and Applications," *International Economic Review* 24, 637–647.

{% **state-dependent utility** %}

Karni, Edi (1985) "*Decision-Making under Uncertainty: The Case of State-Dependent Preferences*." Harvard University Press, Cambridge, MA.

{% **state-dependent utility** %}

Karni, Edi (1987) "Generalized Expected Utility Analysis of Risk Aversion with State-Dependent Preferences," *International Economic Review* 28, 229–240.

{% %}

Karni, Edi (1989) "Generalized Expected Utility Analysis of Multivariate Risk Aversion," *International Economic Review* 30, 297–305.

{% **state-dependent utility** %}

Karni, Edi (1992) "Subjective Probabilities and Utility with State-Dependent Preferences," *Journal of Risk and Uncertainty* 5, 107–125.

{% **state-dependent utility**; **utility depends on probability** %}
Karni, Edi (1992) "Utility Theory with Probability Dependent Outcome Valuation," *Journal of Economic Theory* 57, 111–124.

{% Does it for Anscombe-Aumann framework; **state-dependent utility** %}
Karni, Edi (1993) "A Definition of Subjective Probabilities with State-Dependent Preferences," *Econometrica* 61, 187–198.

{% **state-dependent utility**; does it for Savage. %}
Karni, Edi (1993) "Subjective Expected Utility with State-Dependent Preferences," *Journal of Economic Theory* 60, 428–438.

{% **state-dependent utility** %}
Karni, Edi (1996) "Probabilities and Beliefs," *Journal of Risk and Uncertainty* 13, 249–262.

{% **state-dependent utility**: Assumes in Harsanyi-style model that best and worst state of each agent have the same utility, and, thus, can compare utility units. The importance weights that can now be derived, should all be the same under impartiality. The probability, under the veil of ignorance, of being some future individual is not objectively given, but is to be inferred as subjective from the social planner's preferences. %}
Karni, Edi (1998) "Impartiality: Definition and Representation," *Econometrica* 66, 1405–1415.

{% Assumes bounded **state-dependent utility**. Utility is then normalized, it is assumed that the range of utility is the same across different states of nature. That is, extreme outcomes have state-independent utility. They can then be used to elicit probability. P. 482: "This definition of subjective probability involves a convention, namely, the normalization of the event-dependent utility functions … so that their least upper bounds and the largest lower bounds coincide." %}
Karni, Edi (1999) "Elicitation of Subjective Probabilities when Preferences Are State-Dependent," *International Economic Review* 40, 479–486.

{% **tradeoff method** is used for theoretical purposes, in variation of Karni, Schmeidler, & Vind. %}

Karni, Edi (2003) "On the Representation of Beliefs by Probabilities," *Journal of Risk and Uncertainty* 26, 17–38.

{% %}

Karni, Edi (2003) "Impartiality and Interpersonal Comparisons of Variations in Well-Being," *Social Choice and Welfare* 21, 95–111.

{% **criticisms of Savage's basic framework**: People usually follow Savage routinely in taking states-consequences-acts as he does, and don't seem to be aware that there is quite some arbitrariness in it, first, in how we define what as function of what mathematically, but second, to what extent things are independent from each other causally. I like Luce's work in the sense that he models these things in a provocatively different way. Karni also challenges these foundational aspects. The present paper makes things tangible because it does not just say things, but it formalizes and axiomatizes. The primary point of the paper is, therefore, for me that it brings new and different insights into the primitives of decision under uncertainty.

Given each action, there is a traditional framework with effects playing much the role of states of nature, not influenced by what the agent does (given the action chosen!). At the same time, there is place for influence of the agent on resolutions of uncertainty, and this is through the influence of actions on the effects. Accordingly, effects can also carry value, and not only be sources of uncertainty. This is clear by the general framework plus a specification where they "happen" not to carry value.) %}

Karni, Edi (2006) "Subjective Expected Utility Theory without States of the World," *Journal of Mathematical Economics* 42, 325–342.

{% %}

Karni, Edi (2007) "Foundations of Bayesian theory," *Journal of Economic Theory* 132, 167–188.

{% %}

Karni, Edi (2007) “Archimedean and Continuity,” *Mathematical Social Sciences* 53, 332–334.

{% Action-dependence and effect-dependence are used to avoid the use of states of nature. %}

Karni, Edi (2007) “A New Approach to Modeling Decision-Making under Uncertainty, *Economic Theory* 33, 225–242.

{% Karni’s action-dependent theory is used to analyze the principal-agent problem and the common prior assumption. %}

Karni, Edi (2008) “Agency Theory: Choice-Based Foundations of the Parametrized Distribution Formulation,” *Economic Theory* 36, 337–351.

{% %}

Karni Edi (2008) “Savage’s Subjective Expected Utility Model.” *In* Lawrence Blume & Steven N. Durlauf (eds.) *The New Palgrave: A Dictionary of Economics*. The MacMillan Press, London.
https://doi.org/10.1057/978-1-349-95121-5_2467-1

{% For an event E, the well-known matching probability p is defined through $100_E0 \sim 100_p0$. This was proposed for instance by Borel (1924). See p. 57 2nd para in its English translation “Apropos of a Treatise on Probability” in Henry E. Kyburg Jr. & Howard E. Smokler (1964, eds.) Studies in Subjective Probability, Wiley, New York (not Reprinted in 2nd, 1980, edn. of the book). The textbook Raiffa (1968) used it throughout as a central tool, as it has been used in 100s of papers before 2009. Karni’s paper proposes it again, and then proposes to use the very well-known Becker-DeGroot-Marschak method for eliciting this p. This is all that this paper does. Karni & Safra (1987) discussed the general BDM (Becker-DeGroot-Marschak) mechanism too from a theoretical perspective. §30.5 of Holt (2007) used BDM to elicit matching probabilities as recommended by this paper, and did experiments with it. %}

Karni, Edi (2009) “A Mechanism Design for Probability Elicitation,” *Econometrica* 77, 603–606.

{% Maxmin expected utility is applied to a principal-agent situation. %}
Karni, Edi (2009) "A Reformulation of the Maxmin Expected Utility Model with Application to Agency Theory," *Journal of Mathematical Economics* 45, 97–112.

{% The action-dependent model of the author is applied with medical interpretations. Interestingly, the model could be taken as axiomatization of willingness to pay for health. %}
Karni, Edi (2009) "A Theory of Medical Decision Making under Uncertainty," *Journal of Risk and Uncertainty* 39, 1–16.

{% His model has bets that are a sort of side payments. This makes it possible to measure and axiomatize all kinds of dependencies that cannot be so in classical models, such as act-dependent probabilities and dependence of decisions on information set. **tradeoff method**: used theoretically. %}
Karni, Edi (2011) "A Theory of Bayesian Decision Making with Action-Dependent Subjective Probabilities," *Economic Theory* 48, 125–146.

{% Assume transitivity and nontriviality throughout. Schmeidler (1971) showed, for connected topological spaces, that continuity (both for open and closed sets) implies completeness. Dubra (2011) & Galaabaatar (2010) showed similar results in the vNM EU context. This paper does so too, combining all the above, and showing that it matters much if and how one takes weak or strict preference as primitive. It also gives new results on indifference versus incomparability. %}
Karni, Edi (2011) "Continuity, Completeness and the Definition of Weak Preferences," *Mathematical Social Sciences* 62, 123–125.

{% %}
Karni, Edi (2011) "Subjective Probabilities on a State Space," *American Economic Journal: Microeconomics* 3, 172–185.

{% Generalizes his 2011 ET paper by incorporating effect-dependent risk attitudes that can also depend on their actions. **tradeoff method**: used theoretically. %}

Karni, Edi (2013) "Bayesian Decision Making with Action-Dependent Probabilities and Risk Attitudes," *Economic Theory* 53, 335–356.

{% Uses the Anscombe-Aumann framework, studying conditional incompletenesses, where familiar events have conditional completeness. Also considers sources of events, citing Chew & Sagi (2008). %}
Karni, Edi (2014) "Familiarity Breeds Completeness," *Economic Theory* 56, 109–124.

{% Subjects choose between bets with known and unknown probabilities. Extra is that they can choose for delays, i.e., for continued flexibility. Under some assumptions, this can be used to elicit 2nd order probabilities and sets of priors. %}
Karni, Edi (2020) "A Mechanism for the Elicitation of Second-Order Belief and Subjective Information Structure," *Economic Theory* 69, 217–232. https://doi.org/10.1007/s00199-018-1162-4

{% Outcomes are determined not only by acts but also by theories. A realized outcome of an act informs about theory. %}
Karni, Edi (2022) "A Theory-Based Decision Model," *Journal of Economic Theory* 201, 105444.

{% This paper opens with a discussion on the problematic nature of the completeness condition for preference. It then turns to Karni (2021) who proposed random choice to reflect incomplete preference, where it is random what the correct utility function is. This paper adds a proposal for eliciting the agent's private info on beliefs about that right utility. %}
Karni, Edi (2022) "Incomplete Risk Attitudes and Random Choice Behavior: An Elicitation Mechanism," *Theory and Decision* 92, 677–687. https://doi.org/10.1007/s11238-021-09829-w

{% This paper considers Schmeidler's CEU (Choquet expected utility), using the AA (Anscombe-Aumann) framework: in a first stage, a horse race takes place giving one winner, and condional on the winner, in the second stage one receives a

lottery, i.e., a probability distribution over prizes, say monetary prizes. Lotteries are evaluated by expected utility, and backward induction is used, i.e., every lottery is replaced by its certainty equivalent. The resulting gamble on the horse race is evaluated through its Choquet expected utility, i.e., the Choquet integral of outcome utilities invoking a capacity which is a nonadditive generalization of probability measures.

This paper considers the special case where the capacity is a nonlinear transformation w of an additive probability measure on the horse space, which I call subjective. The nonlinearity processing of the subjective 1st stage probabilities through w deviates from the linear weigthting of the objective probabilities in the second stage. This difference between uncertainty and risk is usually, for instance in my papers, interpreted as reflecting ambiguity attitude. This paper points out that it can be reinterpreted as a different RISK attitude for the subjective 1st-stage probabilities. In my terminology that would be something like a source-dependent risk attitude, although I do not like that term because it uses the term risk-attitude for something that is not risk.

uncertainty amplifies risk: the paper can be linked to this topic, although the interpretations of the author do not fit with it.

Claims in the paper such as in the abstract: "Consequently, the pattern of choice depicted by Ellsberg's experiments and … **is** an expression of decision makers' risk aversion." [bold enlargement added] are provocative and will draw attention but are, I think, overstatements. Mathematically isomorphic does not mean being identical.

The paper similarly argues that the ambiguity aversion of the smooth ambiguity model could be interpreted as extra risk aversion. %}

Karni, Edi (2024) "Ambiguity Aversion, Risk Aversion, and the Weight of Evidence," *Theory and Decision* 97, 595–611.
https://doi.org/10.1007/s11238-024-09995-7

{% **survey on nonEU** %}

Karni, Edi, Fabio Maccheroni, & Massimo Marinacci (2014) "Ambiguity and Nonexpected Utility." *In* Peyton H. Young & Shmuel Zamir (eds.) *Handbook of Game Theory with Economic Applications*, Vol. 4, 901–947, Elsevier, Amsterdam.

{% On what the title says. §2.1 describes Savage's (1954) contribution as the first big bang in decision under uncertainty.

§2.5, p. 229, describes Schmeidler's idea of using the Anscombe-Aumann (AA) framework (properly credited to Fishburn 1970 by the authors) for ambiguity as the second big bang in decision under uncertainty. The authors are very positive about the AA framework. I have often expressed more negative judgments: The AA framework was adopted to simplify the mathematical work, but at a nontrivial cost: expected utility for risk and a backward-induction type optimization over two stages or, equivalently, a separability of singleton ambiguous (horse-race) events, misleadingly called monotonicity, which is not appropriate for nonEU with ambiguous events.

P. 229: "Savage's most brilliant measuretheoretic approach was not so easily extended beyond its original domain and this was a main reason why so little happened in the field for decades after his 1954 masterpiece."

P. 230 argues for the plausibility of quasi-convexity of preference w.r.t. probabilistic mixing, i.e., Schmeidler's (1989) uncertainty aversion, which I again disagree with.

They list all Schmeidler's contributions to decision theory. %}

Karni, Edi, Fabio Maccheroni, & Massimo Marinacci (2022) "David Schmeidler's Contributions to Decision Theory," *Theory and Decision* 93, 219–235. https://doi.org/10.1007/s11238-022-09896-7

{% %}

Karni, Edi & Mark J. Machina (1987) "Multivariate Risk Aversion for Nonexpected Utility Preferences," Working paper no. 185, The Johns Hopkins University, Department of Political Economy.

{% %}

Karni, Edi & Philippe Mongin (1997) "On the Determination of Subjective Probability by Choices,"

{% End shows that for BDM (Becker-DeGroot-Marschak), for every nonEU there exists a lottery where BDM does not give right certainty equivalent if subject does **RCLA.** %}

Karni, Edi & Zvi Safra (1987) “Preference Reversal and the Observability of Preferences by Experimental Methods,” *Econometrica* 55, 675–685.

{% **dynamic consistency**; nicely described by Epstein (1992, p. 51); according to Karni & Schmeidler (1991, p. 407), they assume **RCLA** and forgone-branch independence (often called consequentialism) implicitly. %}

Karni, Edi & Zvi Safra (1989) “Dynamic Consistency, Revelations in Auctions and the Structure of Preferences,” *Review of Economic Studies* 56, 421–434.

{% **dynamic consistency** %}

Karni, Edi & Zvi Safra (1989) “Ascending Bid Auctions with Behaviorally Consistent Bidders,” *Annals of Operations Research* 19, 435–446.

{% **dynamic consistency**: **favors abandoning time consistency, so, favors sophisticated choice** (what they call behavioral consistency); Best ref. for defense sophisticated choice. %}

Karni, Edi & Zvi Safra (1990) “Behaviorally Consistent Optimal Stopping Rules,” *Journal of Economic Theory* 51, 391–402.

{% **inverse S** %}

Karni, Edi & Zvi Safra (1990) “Rank-Dependent Probabilities,” *Economic Journal* 100, 487–495.

{% **dynamic consistency**; introduction strongly suggests that they consider “behavioral consistency” (which is sophisticated behavior) to satisfy dynamic consistency. They use DC (dynamic consistency) in a weak sense. Behavioral consistency entails forgone-branch independence, time neutrality, weak DC, **RCLA**, and violates strong DC; i.e., DC à la Machina. %}

Karni, Edi & Zvi Safra (1994) “Unbounded Behaviorally Consistent Stopping Rules,” *Journal of Risk and Uncertainty* 9, 231–238.

{% %}

Karni, Edi & Zvi Safra (1995) “The Impossibility of Experimental Elicitation of Subjective Probabilities,” *Theory and Decision* 38, 313–320.

{% %}
Karni, Edi & Zvi Safra (1998) "The Hexagon Condition and Additive Representation for Two Dimensions: An Algebraic Approach," *Journal of Mathematical Psychology* 42, 393–399.

{% A theorem reminiscent of Karni, Schmeidler, & Vind (1983), state-dependent expected utility, with conceivable every probability distribution over the state space. %}
Karni, Edi & Zvi Safra (2000) "An Extension of a Theorem of von Neumann and Morgenstern with an Application to Social Choice Theory," *Journal of Mathematical Economics* 34, 315–327.

{% %}
Karni, Edi & Zvi Safra (2002) "Individual Sense of Justice: A Utility Representation," *Econometrica* 70, 263–284.

{% %}
Karni, Edi & Zvi Safra (2008) "Moral Sentiments and Social Choice," *Social Choice and Welfare* 30, 427–446.

{% Ω is a set of states of mnd ω, and for every ω, $\succcurlyeq_\omega$ is a preference relation. Acts are in the Anscombe-Aumann framework. Preferences are over menus; i.e., subsets of acts. An act induced by a menu assigns to each ω the best act from the menu accordint to ω. Acts induced by menus are evaluated by having a subjective probability on Ω and then take the probability-weighted average EU given each ω, where the EU is ω dependent. Preferences over hypothetical acts are involved where acts conditioned on different moods are compared, where the authors take them as hypothetical and not revealed-preference based. The model is related to many random-choice models and menu-models in the literature. The paper extends many results of Karni & Schmeidler (1980, working paper) and Karni (1985), linking those to modern models. %}

Karni, Edi & Zvi Safra (2016) “A Theory of Stochastic Choice under Uncertainty,” *Journal of Mathematical Economics* 63, 164–173.

{% Test preference for fairness if it concerns probabilistic fairness. %}

Karni, Edi, Tim Salmon, Barry Sopher (2008) “Individual Sense of Fairness: An Experimental Study,” *Experimental Economics* 11, 174–189.

{% **utility depends on probability** %}

Karni, Edi & Edward E. Schlee (1995) “Utility Theory with Probability-Dependent Outcome Valuations: Extensions and Applications,” *Journal of Risk and Uncertainty* 10, 127–142.

{% **SIIA/IIIA**; **revealed preference** %}

Karni, Edi & David Schmeidler (1976) “Independence of Nonfeasible Alternatives, and Independence of Nonoptimal Alternatives,” *Journal of Economic Theory* 12, 488–493.

{% %}

Karni, Edi & David Schmeidler (1990) “Fixed Preferences and Changing Tastes,” *American Economic Review, Papers and Proceedings* 80, 262–267.

{% **survey on nonEU** %}

Karni, Edi & David Schmeidler (1991) “Utility Theory with Uncertainty.” *In* Werner Hildenbrand & Hugo F. Sonnenschein (eds.) *Handbook of Mathematical Economics* 4, Ch. 33, 1763–1831, North-Holland, Amsterdam.

{% **dynamic consistency** %}

Karni, Edi & David Schmeidler (1991) “Atemporal Dynamic Consistency and Expected Utility Theory,” *Journal of Economic Theory* 54, 401–408.

{% Savage model, only there is a finite partition of S, and P4 holds only within each element of the partition. %}

Karni, Edi & David Schmeidler (1993) “On the Uniqueness of Subjective Probabilities,” *Economic Theory* 3, 267–277.

{% **state-dependent utility**

In Anscombe-Aumann framework, preferences over acts and state-prize lotteries, both maximizing vNM EU, and monotonicity are assumed. This is necessary and sufficient for state-dependent EU, with P unique up to states with trivial state-prize preferences. This is similar to Arrow (1951 pp. 431-432). %}

Karni, Edi & David Schmeidler (2016) "An Expected Utility Theory for State-Dependent Preferences," *Theory and Decision* 81, 467–478.
https://doi.org/10.1007/s11238-016-9545-0

{% **state-dependent utility** %}

Karni, Edi, David Schmeidler & Karl Vind (1983) "On State Dependent Preferences and Subjective Probabilities," *Econometrica* 51, 1021–1031.

{% **criticisms of Savage's basic framework**;
updating: discussing conditional probability and/or updating
Acording to the traditional Bayesian framework, every new observation is a subset of the universal state space, which shrinks and shrinks. In this paper, new observations enlarge the state space and open new possibilities not thought of before. Hence the nice title.

They give an axiomatization. They do not use the usual Savage framework where states and consequences are given as primitives, but take acts and consequences as primitives, and then all states are all maps from acts to consequences (à la Schmeidler & Wakker 1987). Thus, discovering new outcomes or new acts enlarges the state space. It can be taken to model unforeseen events or unawareness. They use the Anscombe-Aumann framework. An invariance axiom (awareness consistency) ensures that expanding the model does not affect the preferences already there. %}

Karni, Edi & Marie-Louise Vierø (2013) "Reverse Bayesianism: A Choice-Based Theory of Growing Awareness," *American Economic Review* 103, 2790–2810.

{% **updating: discussing conditional probability and/or updating**

Generalize their 2013 American Economic Review paper from EU to

probabilistic sophistication, while, in particular, maintaining the updating results. %}

Karni, Edi & Marie-Louise Vierø (2015) “Probabilistic Sophistication and Reverse Bayesianism,” *Journal of Risk and Uncertainty* 50, 189–208.

{% **updating: discussing conditional probability and/or updating**
Use the reverse Bayesianism approach and get preference-based utility of, for instance, unimaginable or even nonexisting outcomes. %}

Karni, Edi & Marie-Louise Vierø (2017) “Awareness of Unawareness: A Theory of Decision Making in the Face of Ignorance,” *Journal of Economic Theory* 168, 301–328.

{% **Harsanyi’s aggregation** %}

Karni, Edi & John A. Weymark (1996) “An Informationally Parsimonious Impartial Observer Theorem.”

{% **information aversion**: higher anxiety seems to give lower compliance with self-examination guidelines in woman with a family history of breast cancer. (**decision under stress**) %}

Kash, Kathryn M., Jimmy C. Holland, Marilyn S. Halper, & Daniel G. Miller (1992) “Psychological Distress and Surveillance Behaviors of Women with a Family History of Breast Cancer,” *Journal of the National Cancer Institute* 84, 24–30.

{% Characterization of random rank-dependent expected utility for finite datasets/ prizes. Find empirical evidence violating random expected utility, but fitting with random rank-dependent expected utility. %}

Kashaev, Neil & Victor H. Aguiar (2022) “Random Rank-Dependent Expected Utility,” *Games* 13(1).
https://doi.org/10.3390/g13010013

{% Test the sure-thing principle in the Ellsberg paradox. Find that framing affects choices, with saliency of common outcomes reducing violations of the sure-thing principle. The consider different dynamic framings (**dynamic consistency**). They

also asked subjects how they thought about it. They do not really discuss true preference. %}

Kashima, Yoshihisa & Patrick Maher (1995) "Framing of Decisions under Ambiguity," *Journal of Behavioral Decision Making* 8, 33–49.

{% %}

Kass, Robert E. & Adrian E. Rafferty (1995) "Bayesian Factors," *Journal of the American Statistical Association* 90, 773–795.

{% For loss aversion, Peeters & Czapinski (1990) and others discussed whether people really suffer more under losses than they are happy under gains, or whether this is not so but people still overweight losses, and tested it using introspective measurements. This paper does the same for discounting, whether people (think they) feel less in the future ("anhedonia"), or feel the same but still weigh the future less. The novelty is not in putting up this question, unlike the suggestion in the abstract, because the authors give many references, but it is in testing it. So, the authors conjecture that people underestimate future feelings. In other studies they have investigated the "impact bias," claiming that people overestimate future effects. Footnote 1 on p. 1534 explains that these are "fully consistent" because we may be overestimating future effects but, simply, be overestimating all present effects even more. Experiment 1b tries to demonstrate anhedonia by seeing if WTP in the fuure will be smaller than now. I wonder if WTP in the future is not also subject to anhedonia. In experiment 2a the authors show that not all subjects are completely driven by one bias, which however does not show that the bias would be completely absent. %}

Kassam, Karim S., Daniel T. Gilbert, Andrew Boston, & Timothy D. Wilson (2008) "Future Anhedonia and Time Discounting," *Journal of Experimental Social Psychology* 44, 1533–1537.

{% **Dutch book**; Consider a version of book making between regular book making and comonotonic book making, where comonotonicity is imposed on the acts of one side of the book but not the other. The condition is necessary and sufficient for Choquet expected utility with linear utility and a convex capacity. It is the

linear-in-payment analogue of the linear-in-probabilistic-mixing results of Wakker (1990, Journal of Economic Theory). %}

Kast, Robert & André Lapied (2003) "Comonotonic Book Making and Attitudes to Uncertainty," *Mathematical Social Sciences* 46, 1–7.

{% **dynamic consistency**; **updating: nonadditive measures**: Do what title says, for uncertainty (not risk). Do CEU (Choquet expected utility) with linear utility, DC (dynamic consistency) with violation of weak consequentialism (forgone-event independence), has updating of weighting functions. P. 32 bottom: one can consider discounted expectation or expected discounting. %}

Kast, Robert & André Lapied (2010) "Valuing Future Cash Flows with Non-Separable Discount Factors and Non-Additive Subjective Measures: Conditional Choquet Capacities on Time and on Uncertainty," *Theory and Decision* 69, 27–53.

{% **foundations of statistics**

The first sections pp. 177-181, present new ways to detect not only selection bias but also its size. Not of interest to me now. The rest of the paper I enjoyed much. Although I must have read 100 papers on this topic, as this annotated bibliography shows, this paper brings me many new insights. It properly distinguishes between the perspective of helping decision making, for which surprising results are most useful, and giving unbiased info, for which nonsurprising results are useful. P. 184 2nd para has a nice example, in my words: 100 tests, each of a different medicine, all equally clever. If one finds, surprisingly, that its medicine works, and the other 99 unsurprisingly that their medicine doesn't, then the former deserves pages in a top journal, and the other 99 don't. The surprising finding is most decision-relevant.

P. 184 middle: "there is a deep tension between relevance for decision-making and replicability in the design of publication rules."

P. 186 2nd para: "there is little reason to assume that this cutoff provides a good tradeoff between size and power": hits the nail on the head

The paper nicely distinguishes the single-decision maker perspective, in which case prior registration serves no purpose at all because of dynamic consistency, and strategic social aspects, for which prior registration may be

useful (p. 187 penultimate para). Kasy & Spies (2021) provide a mechanism design for the case.

P. 188: "if researchers have many choices (degrees of freedom) for their analysis—there are many forking paths—and if communication costs ar high (there is a lot of private information) [that is not entirely the same!], then pre-analysis plans can improve the welfare (statistical risk) of readers. If, on the other hand, researchers face a small number of choices and private information is limited, the reader might be better off without requiring a pre-analysis plan."

P. 188 3rd para: "publication decisions that do not depend on findings …. is required if our goal is validity of conventional inference. However, such independence is not necessarily desirable if our objective also includes other criteria, such as relevance and plausibility."

P. 188 penultimate para mentions journals for replications and null results.

P. 189 top: "Above, we have argued that aternative objectives—relevance for decision-makers, statistical validity, plausibility of published findings—can lead to conflicting recommendations for reforms of the publication system."

I reproduce virtually the whole p. 190 (of the conclusion):

"Let us conclude by taking a step back to consider what the debates around replicability and selective publication imply for the foundations of statistics. One of the main foundations of statistics is statistical decision theory. The activity of statistics as conceived by decision theory is a rather solitary affair. There is just the researcher and the data, and the researcher has to make some decision based on the data: estimate a parameter, test a hypothesis, and so on. This perspective can be extremely useful. It forces us to be explicit about our objective, the action space, and what prior information we wish to incorporate (for example, in terms of the statistical model chosen, or in terms of a Bayesian prior, or in terms of a set of parameters for which we wish to control worst-case risk). The decision-theory perspective makes explicit the tradeoffs involved in the choice of any statistical procedure.

But this decision-theory perspective also has severe limitations, as evidenced by the discussions around p-hacking, publication bias, and pre-analysis plans. It is hard to make sense of these discussions from the vantage point of decision theory. For instance, why don't we simply communicate all the data to the readers of research? If we took decision theory literally, that would be optimal. After all, communicating all the data avoids any issues of selection as well as any waste of information. In practice, as consumers of research, we of course do prefer to read summaries of findings ("X has a big effect on Y, when W holds"), rather than staring at large unprocessed datasets. There is a role for researchers who carefully construct such summaries for readers. But it is hard to make sense of such a role for researchers unless we think of statistics as communication and unless there is some constraint

on the attention or time or information-processing capacity of readers.

Relatedly, what is the point of pre-analysis plans? Their purpose is often discussed in terms of the "garden of forking paths" of specification searching. But taking the perspective of decision theory literally again, there is no obvious role for publicly committing to a pre-analysis plan in order to resolve this issue. Researchers might just communicate how they mapped data to statistics at the time of publication. To rationalize publicly registered pre-analysis plans, we again need to consider the social dimension of research; in ongoing work (Kasy and Spiess 2021) we do so through the lens of mechanism design."

The authors in some places seem to equate private info with costs of info, and never one, small, argument for publication decisions prior to results: that it is fairer to reward researchers. %}

Kasy, Maximilian (2021) "Of Forking Paths and Tied Hands: Selective Publication of Findings, and What Economists Should Do about It," *Journal of Economic Perspectives* 35, 175–192.
https://doi.org/10.1257/jep.35.3.175

{% Reviews and compares the performance of several optimization theories and several heuristics in several contexts, depending on information available and so on. Pleas for a mixed use of both approaches. %}

Katsikopoulos, Konstantinos V. (2011) "Psychological Heuristics for Making Inferences: Definition, Performance, and the Emerging Theory and Practice," *Decision Analysis* 8, 10–29.

{% %}

Katz, Leonard (1964) "Effects of Differential Monetary Gain and Loss on Sequential Two-Choice Behavior," *Journal of Experimental Psychology* 68, 245–249.

{% %}

Katzenstein, Herbert & William S. Sachs (1992) "*Direct Marketing*;" 2nd edn. New York: MacMillan.

{% %}

Katzner, Donald W. (1970) "*Static Demand Theory*." MacMillan, London.

{% %}

Kauder, Emil (1965) “*A History of Marginal Utility Theory*.” Princeton University Press, Princeton, NJ.

{% A review of health utility in breast cancer. Studies with direct utility measurement (18, 22%) still mostly use standard gamble (SG), followed by time tradeoff (TTO) and visual analog scale (VAS). But more studies (55, 69.6%) measure several attributes and then aggregate them as in multiattribute utility. 6 studies (7.6%) combine them. Of the direct ones. 7 (38.9%) searched for inconsistencies, to be coirrected. %}

Kaur, Manraj N., Jiajun Yan, Anne F. Klassen, Justin P. David, Dilshan Pieris, Manraj Sharma, Louise Bordeleau, & Feng Xie (2022) “A Systematic Literature Review of Health Utility Values in Breast Cancer,” *Medical Decision Making* 42, 704–719.

https://doi.org/10.1177/0272989X211065471

{% Necessary and sufficient condition for stochastic maximization of utility, being SARSP, strong axioms of revealed stochastic preference. %}

Kawaguchi, Kohei (2017) “Testing Rationality without Restricting Heterogeneity,” *Journal of Econometrics* 197, 153–171.

{% N = 25,000 subjects aged 18 to 79. Online survey; hypothetical. They measured what they call loss aversion through the following Samuelson-colleague-type question:

“Suppose that, if you invested 100,000 yen, you would either get a capital gain of 20,000 yen or a capital loss of 10,000 yen at a 50% probability. What would you do?” Here 100 Yen is about €1. 78.6% replied that they would not invest and 21.4% that they would. %}

Kawamura, Noriaki for Central Council for Financial Services Information (2016) “Financial Literacy Survey,” Public Relations Department, Bank of Japan; working paper.

{% This paper, and many others in this issue of this journal, devoted to use of probabilistic evidence in jurisdiction. %}

Kaye, David H. & Jonathan J. Koehler (1991) "Can Jurors Understand Probabilistic Evidence?," *Journal of the Royal Statistical Society* (Series A) 154, 75–81.

{% The authors discuss randomization in maxmin EU, e.g. (pp. 1160-1161) the Raiffa (1961) argument that can be taken to remove ambiguity if the randomization is conditioned on the horses but not at all remove ambiguity if ambiguity is conditioned on the randomization. They use the original Anscombe-Aumann framework with randomization both before and after the horse race. They axiomatize a double maxmin EU model. It is like maxmin EU, but there is not one set of priors, but there is a collection of sets of priors, and one also minimizes over this collection. The authors point out that their paper is close to Saito (2015).

The intro is characteristic of traditional ambiguity-literature thinking: Ambiguity aversion is suggested to be universal, is ascribed to Ellsberg even though Ellsberg himself emphasized that ambiguity aversion is not universal, and it is automatically assumed that ambiguity means that there must be a set of priors.

P. 1162 penultimate para: The authors assume that the probabilities used in Anscombe-Aumann need not be objective but can be subjective, to be revealed from preference. Problem is that these probabilities are used as inputs in the axioms, which is undesirable if they are subjective. %}

Ke, Shaowei & Qi Zhang (2020) "Randomization and Ambiguity Aversion," *Econometrica* 88, 1159–1195.

{% **free will/determinism**: Beginning nicely summarized different views. The author argues for being agnostic on it. %}

Kearns, Stephen (2015) "Free Will Agnosticism," *Nous* 49, 235–252.

{% **information aversion** %}

Keasy, Kevin (1984) "Regret Theory and Information: A Note," *Economic Journal* 94, 645–648.

{% N = 240 subjects. Did individual decisions under ambiguity, decisions after discussions, and group decisions. The interactions with others generated moves in the direction of ambiguity neutrality, which can be interpreted as moves towards

rationality.

Certainty equivalents were obtained for binary gambles, with degrees of ambiguity manipulated by providing probability intervals. The actual compositions were determined by randomly and uniformly drawing the probabilities from the intervals, which is the same as having the midpoint of the interval as objective probability. But subjects were not told this, and were only told that the true composition was "determined by chance" (p. 63). They used random incentive system for real payment.

P. 63 explains that they did not really control for suspicion other than tell subjects that the compositions of the ambiguous urns had really been determined by chance (which had not been specified further), and citing two references that it should be no problem.

P. 64 Table 3 gives the data with average CEs for all the Bayesian-probability (interval-midpoints) levels used: $p = 0.20$, 0.50, 0.80, with also some risky choices at $p = 0.35$ and $p = 0.65$. As the Δ size of the interval increases, so does ambiguity. Decreasing CEs as ambiguity increases (so, ambiguity aversion) happens mostly at $p = 0.5$, but maybe rather than looking at those absolutely we should look at them relatively to risk premium. For $p = 0.20$ it is close to ambiguity neutrality, more than for others, but things are not very clear or pronounced (**ambiguity seeking for unlikely**). Table 5 gives similar things with percentages of subjects/groups being ambiguity averse/seeking. %}

Keck, Steffen, Enrico Diecidue, & David V. Budescu (2014) "Group Decisions under Ambiguity: Convergence to Neutrality," *Journal of Economic Behavior and Organization* 103, 60–71.

{% **Z&Z**, **time preference**; classical reference to argue that discounting for costs should be the same as for benefits, the "Keeler-Cretin paradox" %}

Keeler, Emmett B. & Shan Cretin (1983) "Discounting of Life-Saving and Other Nonmonetary Effects," *Management Science* 29, 300–306.

{% **Z&Z** %}

Keeler, Emmett B., Daniel T. Morrow, & Joseph P. Newhouse (1977) "The Demand for Supplementary Health Insurance, or Do Deductibles Matter?," *Journal of Political Economy* 85, 789–801.

{% **Z&Z** %}
Keeler, Emmett B., Joseph P. Newhouse, & Charles E. Phelps (1977) "Deductibles and Demand for Medical Care Services: The Theory of a Consumer Facing a Variable Price Schedule under Uncertainty," *Econometrica* 45, 641–655.

{% Kimball showed that v is more prudent than u if the derivative v´ is a transform of u´ with positive second derivative (so, convex). This paper shows that v is more downside risk averse than u iff v itself is a transform of u itself that has positive third derivative. %}
Keenan, Donald C. & Arthur Snow (2009) "Greater Downside Risk Aversion in the Large," *Journal of Economic Theory* 144, 1092–1101.

{% $U'''/U' - (3/2)(U''/U')^2$, previously shown to be a good index of aversion to downside risk, has been known before in the maths literature as the Schwarzian derivative. It is discussed in this paper. %}
Keenan, Donald C. & Arthur Snow (2012) "The Schwarzian Derivative as a Ranking of Downside Risk Aversion," *Journal of Risk and Uncertainty* 44, 149–160.

{% Seems to have argued that failures of independence indicate poor structuring of the attributes. Parnell et al. (2013) review papers resulting from Keeney's book. %}
Keeney, Ralph L. (1992) "*Value-Focused Thinking.*" Harvard University Press, Cambridge, MA.

{% Argues that structuring is more important than the quantitative analysis (abstract). P. 195 argues that of 10,000 decisions, 10 can benefit from quantitative decision analysis as things are today. P. 196 writes that it should become 1000 out of 10,000: "The opportunity and challenge of the field of decision analysis is to have its concepts and ideas used on all of those 1,000 problems worth thinking about, rather than just 6 of the very complex ones that have an experienced decision analyst involved." The paper presents an

enthusiastic plea for decision analysis.

Keeney is most known for his 1976 textbook with Raiffa, explaining expected utility, utility independence axioms for multiattribute utility, and applied utility measurements. Expected utility is for decision under risk/uncertainty, a small part of our decisions and life. The quantitative techniques provided by it, and the multiattribute utility measurements, using simple choices to derive more complex ones, and they provide particular quantitative tradeoff techniques that are only of some use in very particular situations. Many researchers too much think, and suggest, that their particular work is relevant to too much in life. This paper went too far that way too (**ubiquity fallacy**). Although the author nicely clarifies that of 10,000 decisions in our life, most don't need decision analysis, he still too much puts the EU techniques forward as important. Again and again he overly quickly goes for his EU-multiattribute techniques (with probabilities to be assessed, for instance) as the one and only thing to do.

To illustrate my criticism, I give three citations:

(1) "To analyze alternatives, one typically requires a list of key uncertainties, assessments of probabilities for these uncertainties, a decision tree, value tradeoffs, and a quantified attitude toward risk [risk tolerance]. Subjective judgment is necessary to specify each of these." (p. 198 2nd column 3rd para)"

(2) "Decision analysis should guide all of our thinking about decisions." P. 200 3rd para

(3) "Decision analysis is useful for resolving all decisions worth thinking about." P. 201 2nd para

There are many other texts like the above ones. Had the author not worked on uncertainty all his life, but on intertemporal choice, then he would have written, instead of the above citation (1): "To analyze alternatives, one typically requires a list of future gains and losses, assessments of approximate times points of receipts of those gains and losses, a decision tree, value tradeoffs, and a quantified attitude toward discounting. Subjective judgment is necessary to specify each of these." Had the author worked in game theory, it would have been: "To analyze alternatives, one typically requires a list of key opponents, assessments of their strategies and interests, a game tree, noncredible threats, and a quantified utlity function for each opponent. Subjective judgment is necessary to specify each of these."

As the saying goes, give a small boy a hammer, and he will find that everything he encounters looks like a nail in need of pounding.

The broadenings in §7 help but stay too close to the techniques. %}

Keeney, Ralph L. (2004) “Making Better Decision Makers,” *Decision Analysis* 1, 193–204.

{% %}

Keeney, Ralph L. & Timothy L. McDaniels (1999) “Identifying and Structuring Values to Guide Integrated Resource Planning at BC Gas,” *Operations Research* 47, 651–662.

{% Apply some multiattribute utility techniques from Keeney & Raiffa (1976) to the case where attributes are different persons, to get a weighted average of individual utilities. %}

Keeney, Ralph L. & Robert F. Nau (2011) “A Theorem for Bayesian Group Decisions,” *Journal of Risk and Uncertainty* 43, 1–17.

{% **decreasing ARA/increasing RRA**??? check out

real incentives/hypothetical choice: §1.4.3, p. 18, discusses the necessity for decision analysis to use hypothetical choice, so as to clarify real choice.

substitution-derivation of EU: very concisely, on pp. 133-134, §4.1.1.

utility families parametric: Table 4.5, p. 173

risky utility u = transform of strength of preference v, latter doesn’t exist, because they let value function be ordinal; Digression in §4.4.1, p. 150, makes it very clear that they think so. They say very explicitly that vNM utility and economists’ utils are very different, adding on utils:

“which are never explicitly defined.”

real incentives/hypothetical choice: §1.4.3 explains that hypothetical choice is crucial in decision analysis.

§3.4.7: the midvalue splitting technique; does like **tradeoff method**, only, quite inefficiently, uses a different gauge each time to find for each pair a midpoint!?

§3.4.8: a hypothetical example of a hypothetical-choice utility measurement.

§4.9: example of hypothetical utility measurement.

§4.9.5, p. 199 middle (**risk averse for gains, risk seeking for losses**):

“Experience has indicated that, often in practice, the decision maker may seem to be risk averse in the entire range except for small negative amounts.” This section gives a (hypothetical) example of how reconciling inconsistencies improves the insights of the client.

§5.7: Jf attributes do not satisfy independence conditions, maybe we can redefine the attributes to re-obtain it.

§5.8.3 discusses cross-checks, concerning different shapes of multiattribute utility.

§6.5, p. 295. Theorem 6.4: Additive iff Fishburn's (1965 Eq. 5) marginal independence. (**restrictiveness of monotonicity/weak separability**).

dynamic consistency: Meyer, Richard F. (1976) "Preferences over Time." Ch. 9 in the book. P. 480 uses term "pairwise invariance" for Koopman's stationarity, restricted to tradeoffs between timepoint i and i+1, for each i.

Kirsten&I: §9.2.2 does discounted utility for finitely many timepoints, 9.2.3 extends to countably-infinite.

§10.2.1, p. 524: Arrow's impossibility theorem shows that you need interpersonal comparisons. (**Arrow's voting paradox ==> ordinality does not work**)

simple decision analysis cases using EU: §7.4 (p. 390 ff.) has no EU but only MAUT in their usual way. %}

Keeney, Ralph L. & Howard Raiffa (1976) "*Decisions with Multiple Objectives.*" Wiley, New York (2nd edn. 1993, Cambridge University Press, Cambridge).

{% **revealed preference** %}

Kehoe, Tomothy J. (1992) "Gross Substitutability and the Weak Axiom of Revealed Preference," *Journal of Mathematical Economics* 21, 37–50.

{% %}

Keisler, Jeffrey & Patrick S. Noonan (2012) "Communicating Analytic Results: A Tutorial for Decision Consultants," *Decision Analysis* 9, 274–292.

{% **probability communication**: at least, risk communication.

Investigate how numeracy is related to proper processing of info. (**cognitive ability related to risk/ambiguity aversion**). %}

Keller, Carmen, Christina Kreuzmair, Rebecca Leins-Hess, & Michael Siegrist (2014) "Numeric and Graphic Risk Information Processing of High and Low Numerates in the Intuitive and Deliberative Decision Modes: An Eye-Tracker Study," *Judgment and Decision Making* 9, 420–432.

{% **probability communication**; show that format of showing probabilities depends on way of presentation, interacting with numeracy. (**cognitive ability related to risk/ambiguity aversion**) %}
Keller, Carmen & Michael Siegrist (2009) "Effect of Risk Communication Formats on Risk Perception Depending on Numeracy," *Medical Decision Making* 29, 483–490.

{% %}
Keller, Kevin L. (2003) "*Strategic Brand Management: Building, Managing & Measuring Brand Equity*;" 2nd edn. Upper Saddle River, New Jersey: Prentice Hall.

{% P. 740 last para writes that if test of s.th.pr. uses transparent presentation, subjects may resort to cancellation, citing Kahneman & Tversky. This goes a bit in direction, but does not really say, that compliance with a principle in transparent formulation need not reflect true preference but may be just simple heuristic. %}
Keller, L. Robin (1985) "The Effects of Problem Representation on the Sure-Thing and Substitution Principles," *Management Science* 31, 738–751.

{% **risky utility u = transform of strength of preference v, latter doesn't exist**
violation of certainty effect: P 750, end of §4, 7 lines before §5, report unexpected violations of the certainty effect. %}
Keller, L. Robin (1985) "An Empirical Investigation of Relative Risk Aversion," *IEEE Transactions on systems, Man, and Cybernetics*, SMC-15, 475–482.

{% Tests **RCLA. %**}
Keller, L. Robin (1985) "Testing of the "Reduction of Compound Alternatives" Principle," *Omega* 13, 349–358.

{% **dynamic consistency** %}

Keller, L. Robin (1989) "The Role of Generalized Utility Theories in Descriptive, Prescriptive, and Normative Decision Analysis," *Information and Decision Technologies* 15, 259–271.

{% **dynamic consistency** %}

Keller, L. Robin (1992) "Properties of Utility Theories and Related Empirical Phenomena." *In* Ward Edwards (ed.) *Utility Theories: Measurement and Applications*, 3–23, Kluwer Academic Publishers, Dordrecht.

{% %}

Keller, L. Robin (2019) "Trends in Decision Analysis Research and Practice: Report on Ramsey Panel Presentation," with contributions by Vicki M. Bier, Simon French, Lawrence D. Phillips, Rakesh K. Sarin, Peter P. Wakker, & Robert L. Winkler, *Decision Analysis Today* 38, 22–27.

{% **dynamic consistency** %}

Keller, L. Robin & Craig W. Kirkwood (1999) "The Founding of INFORMS: A Decision Analysis Perspective," *Operations Research* 47, 16–28.

{% Group behavior enhanced ambiguity aversion. %}

Keller, L. Robin, R., Rakesh K. Sarin, & Jayavel Sounderpandian (2007) "An Examination of Ambiguity Aversion: Are Two Heads Better than One?," *Judgment and Decision Making* 2, 390–397.

{% %}

Keller, L. Robin, Rakesh K. Sarin, & Martin Weber (1986) "Empirical Investigation of Some Properties of the Perceived Riskiness of Gambles," *Organizational Behavior and Human Decision Processes* 38, 114–130.

{% %}

Keller, L. Robin, Uzi Segal, & Tan Wang (1993) "The Becker-DeGroot-Marschak Mechanism and Generalized Utility Theories: Theoretical Predictions and Empirical Observations," *Theory and Decision* 34, 83–97.

{% Use data set of Thaler (1981) and do data fitting. Nice didactical explanation of how data fitting works, with minimizing distance and maximum likelihood. They fit exponential discounting and 1-parameter hyperbolic family $1/(1+t)^{\gamma}$, and latter fits data better than exponential. Assume linear utility. %}

Keller, L. Robin & Elisabetta Strazzera (2002) "Examining Predictive Accuracy among Discounting Models," *Journal of Risk and Uncertainty* 24, 143–160.

{% **anonymity protection** %}

Keller, Wouter J., & Jelke C. Bethlehem (1987) "Disclosure Protection of Micro Data," *CBS Select* 4, 87–96; Staatsuitgeverij, The Hague. Appeared also in "*Proceedings of the Seminar on Openness and Protection of Privacy in the Information Society,*" Voorburg, 92–99.

{% %}

Kelley, John L., (1955) "*General Topology.*" Van Nostrand, London.

{% Seems to have proved, already way before Shapley (1971), that a convex capacity has a nonempty core. %}

Kelley, John L. (1959) "Measureson Boolean Algebras," *Pacific Journal of Mathematics* 9, 1165–1175.

{% p. 127 indicates that the authors use monadic testing, a common technique in marketing, where subjects are not asked to compare choice alternatives, but evaluate a choice alternative in isolation. This technique avoids contrast effects. This is what Tversky & Fox (1995) introduced for the Ellsberg paradox test of ambiguity aversion. %}

Kelly, Bridget, Clare Hughes, Kathy Chapman, Jimmy Chun-Yu Louie, Helen Dixon, Jennifer Crawford, Lesley King, Mike Daube, & Terry Slevin (2009) "Consumer Testing of the Acceptability and Effectiveness of Front-of-Pack Food Labelling Systems for the Australian Grocery Market," *Health Promotion International* 24, 120–129.

{% %}

Kellner, Christian (2015) “Tournaments as a Response to Ambiguity Aversion in Incentive Contracts,” *Journal of Economic Theory* 159, 627–655.

{% P. 272: Review some applications of ambiguity to game theory. Use maxmin EU model. Study equilibria for cheap talk theoretically. %}

Kellner, Christian & Mark T. le Quement (2017) “Modes of Ambiguous Communication,” *Games and Economic Behavior* 104, 271–292.

{% Introduced his well-known Kelly criterion, amounting to maximizing the logarithm of wealth. It usually implies primarily minimizing the probability of ruin (outcome 0). In a repeated growth process where wealth is changed multiplicatively, as with investing, round after round, with infinitely many rounds, *and where the strong law of large numbers (LLN) can be applied to these multiplicative changes*, the Kelly criterion gives the growth process that is optimal with probability 1. If the Kelly criterion deviates from expected value maximization (it is more risk averse), then which is more relevant depends on the stochastic nature of the process, which determines whether the LLN can be applied to additive or multiplicative changes. %}

Kelly, John L. (1956) “A New Interpretation of Information Rate,” *Bell System Technical Journal* 35, 917–926.

{% %}

Kelsey, David (1993) “Choice under Partial Uncertainty,” *International Economic Review* 34, 297–308.

{% §5.2: D**utch book** %}

Kelsey, David (1994) “Maxmin Expected Utility and Weight of Evidence,” *Oxford Economic Papers* 46, 425–444.

{% **Dutch book** %}

Kelsey, David (1995) “Dutch Book Arguments and Learning in a Non-Expected Utility Framework,” *International Economic Review* 36, 187–206.

{% **game theory as ambiguity**: In battle of the sexes with a 3rd option added for the column player, giving her certainty but too low to be part of Nash equilibrium, still many subjects choosev it. Ambiguity aversion can help explain this.

The column player chooses between three prospects: L gives 300 if opponent chooses B, 0 otherwise; M gives 100 if opponent chooses T, 0 otherwise; R gives a certain payoff of X (which is equal to 60, 120, 170, 200, 230, or 260). 30% of subjects chose R which gives the certain payoff of X = 60. The authors interpret this as ambiguity aversion, but risk aversion can interfere. %}

Kelsey, David & Sara le Roux (2015) "An Experimental Study on the Effect of Ambiguity in a Coordination Game," *Theory and Decision* 79, 667–688.

{% %}

Kelsey, David & Sara le Roux (2017) "Dragon Slaying with Ambiguity: Theory and Experiments," *Journal of Public Economic Theory* 19, 178–197.

{% Follow up on their earlier experiments, testing predictions by Eichberger & Kelsey (2002). They measure ambiguity attitudes in individual Ellsberg urns. They also consider choices in games where there is an action giving a sure outcome, but not part of a traditional Nash equilibrium. If subjects go for it, then they interpret it as ambiguity aversion. It could also be risk aversion, but they have a good argument against this in the conclusion on p. 403: "Future research on this area should be more careful to control for subjects' risk attitude. However, given the relatively small stakes, Expected Utility Theory would predict that subjects were approximately risk neutral. A similar argument does not apply to ambiguity. Choquet Expected Utility (CEU) orMaxmin Expected Utility (MEU) preferences have a kink. Consequently, ambiguity aversion may be seen even when the stakes are fairly small. Thus, it is not unreasonable to believe that most of the motivation for choosing the certain action is ambiguity aversion."

Abstract: They find more effect of ambiguity in the game than in individual choice. They also find context dependence of ambiguity attitudes, with ambiguity seeking (**ambiguity seeking**) in individual choice but ambiguity aversion in the game, which can be a kind of source dependence. P. 413 (in the Conclusion) writes: "In addition, we note that subjects' ambiguity attitudes appear to be context dependent: ambiguity loving in single-person decisions and ambiguity averse in games." I do not understand the claim of ambiguity loving in individual choice because §5.3, p.

398, reports 73% of subjects choosing in an ambiguity averse way in the standard three-color Ellsberg urn. Probably the slightly negative relation between ambiguity aversion in the game and in the Ellsberg urn (p. 395 last para & p. 396 top) made the authors write this. The ambiguity in the game, about opponent's choice, goes in the direction of natural uncertainty (**natural sources of ambiguity**).

P. 382 end of §3: Subjects liked to gamble on color blue because they like that color. Chinese students like to gamble on the color red. (**testing color symmetry in Ellsberg urn**: violated)

P. 388 ℓ. 3: "Risks are said to be ambiguous if the probabilities of possible outcomes are unknown and it is difficult or impossible to assign subjective probabilities to them."

P. 388 2nd para states the prediction of Eichberger & Kelsey (2002) confirmed here empirically: "In the case of strategic substitutes [competitive], increasing the level of ambiguity would shift the equilibrium strategies in an ex-post Pareto improving direction, whereas for strategic complements [cooperative], an increase in ambiguity would have the opposite effect."

P. 393 last para: for each subject, one randomly chosen game and one randomly chosen individual decision were implemented for real, giving some income effect.

P. 394: They let computers simulate Ellsberg urns. The composition was determined probabilistically, so that it in fact is 2nd order probability (**second-order probabilities to model ambiguity**). It is not clear to me if they informed subjects about this.

P. 395 last para & p. 396 top: Ambiguity aversion in different games was positively related. But it was even slightly negatively correlated with ambiguity aversion in the individual choices in the 3-color Ellsberg urn.

P. 403 last para: "It is our belief that subjects find it more ambiguous to make decisions against other people than against the random move of nature, over which everyone is equally powerless. This might even explain why people are more concerned with scenarios involving political turmoil or war—situations dependent on other people, but appear to discount the seriousness of possible natural disasters or climate change related catastrophes—which are beyond anyone's control." %}

Kelsey, David & Sara le Roux (2018) "Strategic Ambiguity and Decision-Making: An Experimental Study," *Theory and Decision* 84, 387–404.

{% %}

Kelsey, David & Shasikanta S. Nandeibam (1996) "On the Measurement of Uncertainty Aversion,"

{% **Dutch book** %}

Kelsey, David & Frank Milne (1997) "Induced Preferences, Dynamic Consistency and Dutch Books," *Economica* 64, 471–481.

{% %}

Kelsey, David & Frank Milne (1999) "Induced Preferences, Nonadditive Beliefs, and Multiple Priors," *International Economic Review* 40, 455–477.

{% %}

Kelsey, David & John Quiggin (1992) "Theories of Choice under Ignorance and Uncertainty," *Journal of Economic Surveys* 6, 133–153.

{% **ambiguity seeking for unlikely**: p. 529: write in beginning that unlikely uncertain events are overweighted, leading to optimism, but that they will assume universal pessimism nevertheless for reasons of tractability. %}

Kelsey, David & Willy Spanjers (2004) "Ambiguity in Partnerships," *Economic Journal* 114, 528–546.

{% Seems to have said or written:

> "I often say . . . that when you can measure what you are speaking about, and express it in numbers, you know something about it; but when you cannot measure it, when you cannot express it in numbers, your knowledge is of a meager and unsatisfactory kind; it may be the beginning of knowledge, but you have scarcely, in your thoughts, advanced to the stage of science, whatever the matter may be."

It is often referred to, briefly, as "science is measurement."

The Cowles Foundation took this as its motto in its first 20 years (1932-1952), writing it on every book and report. See Christ (1994).

Regular name was William Thomson, but was given the title Lord Kelvin. A famous physicist. %}

Kelvin, (Lord Kelvin) (1886) I have no concrete reference, seems to be May 1886.

{% **PT, applications**: PT gives some better explanations for paradoxes in transportation theories.

Take outcomes that are combinations of time and money. Do not consider tradeoffs between them, but just consider one pair x, 0, and –x, with $x \in \mathbb{R}_+^2$ assuming that for basic utility u we have u(–x) = –u(x), so that |U(–x)/U(x)| is loss aversion. They took x = (30 minutes, €5), and considered prospects with only outcomes x, 0, and –x. They use Ellsberg urns with 10 colors, where the urns have known or unknown compositions. The unknown urn was generated by a meta-lottery, so that in fact it was two-stage ambiguity. (**second-order probabilities to model ambiguity**). They derived probability weighting with a system similar to the preference ladders of Wu & Gonzalez (also in van Assen 1996), which gives a sequence of probabilities 0, p_1, …, $p_n < 1$ that are equally spaced in probability weighting, and then they did parametric fitting. I am not sure how the weight $w(p_n) < 1$ was determined. They used the Tversky & Kahneman (1992) and Prelec (1998) one-parameter weighting functions, which commit to inverse S.

Probability weighting more pronounced for ambiguity than for risk. (**uncertainty amplifies risk**). Ambiguity neutrality around $p = 1/3$. They find inverse S but used parametric families (one-parameter of T&K’92 and Prelec 1998) that have it. %}

Kemel, Emmanuel & Corina Paraschiv (2013) “Prospect Theory for joint Time and Money Consequences in Risk and Ambiguity,” *Transportation Research Part B: Methodological* 50, 81–95.
https://doi.org/10.1016/j.trb.2013.07.007

{% The authors measure CEs (certainty equivalents) using choice lists, for money and number of human lives, with losses also involved in mixed prospects, and fit prospect theory. Of course, must be hypothetical. For gains, probability weighting is the same for money and lives.

PT falsified; probability weighting depends on outcomes: For losses, probability weighting is less elevated for lives, suggesting more risk seeking there. They find bigger loss aversion for human lives, suggesting more risk aversion for mixed prospects. %}

Kemel, Emmanuel & Corina Paraschiv (2018) "Deciding about Human Lives: An Experimental Measure of Risk Attitudes under Prospect Theory," *Social Choice and Welfare* 51, 163–192.
https://doi.org/10.1007/s00355-018-1111-y

{% Measure certainty equivalents of 24 lotteries. Everything, deciding, resolution of uncertainty, takes place at present, only outcomes can occur at different timepoints, at present but also in one year. Prospect theory is used to fit data. There is less risk aversion for future outcomes. This is not due to utility, which is the same for those, but due to probability weighting, which is more elevated (source preference) for future payoffs. (**violation of risk/objective probability = one source**) %}

Pp. 332-333: Remarkably, the authors find that linear-exponential (CARA) utility first better than logpower (CRRA) (**decreasing ARA/increasing RRA**). %}

Kemel, Emmanuel & Corina Paraschiv (2023) "Risking the Future? Measuring Risk Attitudes towards Delayed Consequences," *Journal of Economic Behavior and Organization* 208, 325–344.

{% **real incentives/hypothetical choice**: find no difference in patterns, but less error for real incentives.

Fit PT to data of DFE, both for monetary outcomes and for time (waiting time in sense of time lost as with traffic delays). The authors confirm inverse S (§4.3.b) probability weighting (also for what is called the incomplete information condition, meaning that subjects are not informed about what the possible outcomes are), which is remarkable because in DFE people usually find the opposite. The authors do not discuss this point. (**DFE-DFD gap but no reversal**) Utility of time gains is almost linear, but is concave for money gains. Average probability weighting is more insensitive and more elevated for time than for money. It is interesting to see if at the individual level there are many differences between probability weighting. The authors report significant correlations between them, but this is a weak test of identity. They find more pessimism than is usual for risk (maybe explained by ambiguity aversion) and, hence, less overweighting of small probabilities than is usual with risk.

One difficulty I have with all DFE studies is that subjects may have prior beliefs at the beginning of the experiment, before starting the sampling, and the experiments have no control over that. Subjects will believe beforehand that high money gains have small probabilities, and negative money outcomes will not happen. For time outcomes they may have different prior beliefs. %}

Kemel, Emmanuel & Muriel Travers (2016) "Comparing Attitudes towards Time and Money in Experience-Based Decisions," *Theory and Decision* 80, 71–100.

{% **Dutch book** %}

Kemeny, John G. (1955) "Fair Bets and Inductive Probabilities," *Journal of Symbolic Logic* 20, 263–273.

{% Find very clear framing effects due to framing things as gains or losses, while clearly identical in terms of final outcomes. %}

Kern, Mary C. & Dolly Chugh (2009) "Bounded Ethicality: The Perils of Loss Framing," *Psychological Science* 20, 378–384.

{% %}

Kendall, Maurice G. & B. Babington Smith (1940) "On the Method of Paired Comparisons," *Biometrika* 31, 324–345.

{% %}

Keppe, Hans-Jürgen & Martin Weber (1990) "Stochastic Dominance and Incomplete Information on Probabilities," *European Journal of Operational Research* 43, 350–355.

{% **natural sources of ambiguity**

They find source preference for sources for which subjects are more competent. This work was inspired by Heath & Tversky (1991). They use matching subjective probabilities to measure belief in ambiguous events.

source preference directly tested: For the ambiguous events they measure both certainty equivalents and matching probabilities, and they do so for events

and their complements. They report results at the individual level, from which cases of source preference can be deducted. %}

Keppe, Hans-Jürgen & Martin Weber (1995) "Judged Knowledge and Ambiguity Aversion," *Theory and Decision* 39, 51–77. https://doi.org/10.1007/BF01078869

{% %}

Keren, Gideon B. (1984) "On the Importance of Identifying the Correct 'Problem Space'," *Cognition* 16, 121–128.

{% **probability elicitation**; **confirmatory bias** %}

Keren, Gideon B. (1988) "On the Ability of Monitoring Non-Veridical Perceptions and Uncertain Knowledge: Some Calibration Studies," *Acta Psychologica* 67, 95–119.

{% **probability elicitation**; **confirmatory bias** %}

Keren, Gideon B. (1991) "Calibration and Probability Judgments: Conceptual and Methodological Issues," *Acta Psychologica* 77, 217–273.

{% Most of the experiment uses hypothetical choice.

real incentives/hypothetical choice: §4.2 reports a test of the Ellsberg paradox where real and hypothetical payments gave the same results.

If the traditional 3-color Ellsberg questions are done with losses instead of gains, then there still is ambiguity aversion and it is almost equally strong as for gains (for gains, N = 75, 74.7% prefers unambiguous color, for losses, N = 59, 67.8% prefers unambiguous). For gambling on two colors (so, my subjective probability is 2/3), for gains, N = 60, 71.7% prefers unambiguous color, for losses, N = 64, 79.7%, prefers unambiguous to ambiguous. So, here is clear evidence against **ambiguity seeking for losses**.

Experiment 3 asked the subjects which event they considered more probable. They designated the unambiguous event as more probable. Remarkably, they even did so if the proportions were slightly favorable to the ambiguous urn. Pity it was always asked for the gain (or NOT-losing) event, so that subjects' answers may have confounded likelihood with amount of information.

Reducing ambiguity by providing (second-order probability) info reduces ambiguity aversion correspondingly.

reflection at individual level for ambiguity: paper gives no info because gain-loss was always between-subjects. %}

Keren, Gideon B. & Léonie E.M. Gerritsen (1999) "On the Robustness and Possible Accounts of Ambiguity Aversion," *Acta Psychologica* 103, 149–172.

{% %}

Keren, Gideon B. & Jeroen G.W. Raaijmakers (1988) "On Between-Subjects versus Within-Subjects Comparisons in Testing Utility Theory," *Organizational Behavior and Human Decision Processes* 41, 233–247.

{% **time preference**; if risk is introduced explicitly then immediacy effect greatly reduces, suggesting that the regular immediacy effect may be due to a kind of implicit risk. This can be taken as a violation of generalized stochastic dominance (**restrictiveness of monotonicity/weak separability**). %}

Keren, Gideon B. & Peter H.M.P. Roelofsma (1995) "Immediacy and Certainty in Intertemporal Choice," *Organizational Behavior and Human Decision Processes* 63, 287–297.
https://doi.org/10.1006/obhd.1995.1080

{% %}

Keren, Gideon B. & Karl H. Teigen (2001) "Why is p = .90 better than p = .70? Preference for Definitive Predictions by Lay Consumers of Probability Judgments," *Psychonomic Bulletin and Review* 8, 191–2002.

{% %}

Keren, Gideon B. & Willem A. Wagenaar (1987) "Violation of Utility Theory in Unique and Repeated Gambles," *Journal of Experimental Psychology: Learning, Memory, and Cognition* 13, 29–38.

{% %}

Keren, Gideon B. & Martijn C. Willemsen (2009) "Decision Anomalies, Experimenter Assumptions, and Participants' Comprehension: Revaluating the Uncertainty Effect," *Journal of Behavioral Decision Making* 22, 301–317.

{% **losses from prior endowment mechanism**: use this and discuss it on p. 651.

Asked people (some 105) to introspectively predict how bad they would feel when losing money in a prospect. Later, if people really lost, they were asked again. Afterwards they did not judge as bad as predicted. Seems that the first of two experiments manipulated the prospects, by letting either a final gain of $4 or a final loss of $4 result (p. 650 top) whereas the subjects thought it concerned sequence of truly random prospects.

The authors conclude that loss aversion is irrational: "To summarize, people believe that losses will have more impact than gains because they fail to anticipate how easily they will cope with losses. This may lead people to make decisions that maximize neither their wealth nor their happiness."

(p. 652, final sentence). A big conclusion from a simple experiment! %}

Kermer, Deborah A., Erin Driver-Linn, Timothy D. Wilson, & Daniel T. Gilbert (2006) "Loss Aversion Is an Affective Forecasting Error," *Psychological Science* 17, 649–653.
https://doi.org/10.1111/j.1467-9280.2006.01760.x

{%**game theory for nonexpected utility;** correlated equilibrium and two mixed strategy equilibria. %}

Keskin, Kerim (2016) "Equilibrium Notions for Agents with Cumulative Prospect Theory Preferences," *Decision Analysis* 13, 173–221.
https://doi.org/10.1287/deca.2016.0333

{% %}

Kerim Keskin (2016) "Inverse S-Shaped Probability Weighting Functions in First-Price Sealed-Bid Auctions," *Review of Economic Design* 20, 57–67.

{% %}

Keskin, Kerim (2018) "Cumulative Prospect Theory Preferences in Rent-Seeking Contests," *Mathematical Social Sciences* 96, 85–91.

{% The authors entirely failed to replicate an original finding by themselves. Nice that they report it and open it for methodological discussion. Their main explanation proposed is that it is because these studies are run in one session together with several others studies, and that the NUMBER of preeding studies matters, the more so as cognitive load is a relevant variable. I think that the NATURE of preceding studies matters more. %}

Kessler, Judd B. & Stephan Meier (2014) “Learning from (Failed) Replications: Cognitive Load Manipulations and Charitable Giving,” *Journal of Economic Behavior & Organization* 102, 10–13.

{% %}

Kets, Willemien & Alvaro Sandroni (2019) “A Belief-Based Theory of Homophily,” *Games and Economic Behavior* 115, 410–435.

{% %}

Kets, Willemien & Alvaro Sandroni (2017) “A Theory of Strategic Uncertainty and Cultural Diversity,” working paper.

{% The perception of numbers has concrete locations in the brain that depend on cultural background. %}

Keus, Inge M., Kathleen M. Jenks, & Wolf Schwarz (2005) “Psychophysiological Evidence that the SNARC Effect Has Its Functional Locus in a Response Selection Stage,” *Cognitive Brain Research* 24, 48–56.

{% Elementary introduction to axiomatics and decision-theories %}

Keuzenkamp, Hugo (1991) “Economen and Ons Verstand - Ronddolen in een Rusteloze Droom,” *Intermediair* 27–23, June 7, 51–57.

{% John Neville Keynes is the father of John Maynard Keynes.

P. 86: **conservation of influence; free will/determinism**: “The differentia of economic laws, as contrasted with purely physical laws, consists in the fact that the former imply voluntary human action.” Seems that he distinguished normative from positive economics. %}

Keynes, John Neville (1890) "*The Scope and Method of Political Economy.*" McMillan, London. (2nd edn. 1917.)

{% In Collected Works, Royal Economic Society XIV, p. 124, Keynes seems to have used the term Benthamite school for maximization of expectation.

P. 75 presents the known and unknown Ellsberg urns as illustration of unknown probabilities. Keynes argues for incomparability of some likelihoods, so, imprecise probability even at the ordinal level.

Keynes seems to write:

"The typical case, in which there may be a practical connection between weight and probable error, may be illustrated by the two cases following of balls drawn from an urn. In each case we require the probability of drawing a white ball; in the first case we know that the urn contains black and white balls in equal proportions; in the second case the proportion of each color is unknown, and each ball is as likely to be black as white. It is evident that in either case the probability of drawing a white ball is 1/2, but that the weight of the argument in favor of this conclusion is greater in the first case" (Keynes, 1921, p. 75) It reminds me of the deep point of Kahn & Sarin (1988), that we should not confuse outcome utility with process utility.

And Keynes seems to write, on p. 313:

"If two probabilities are equal in degree, ought we, in choosing our course of action, to prefer that one which is based on a greater body of evidence?"

(Craig Fox pointed out the combination of these two citations to me.) It may seem that Keynes is at an ε distance, with ε only trivially different from zero, from Ellsberg's discovery. But I disagree. First, the citation on p. 313 is for decisions in general. The urn is only an illustration of unknown probabilities without relation to decisions. Had Keynes thought for a split-second what the *decision* in the urn-case had been, he would of course have said immediately what we all know from Ellsberg. But Keynes did not bring decisions up there. Also, he did not notice the funny duality, that you prefer betting on an event as well as on its complement (source preference). Most importantly, he does not relate these urns vaguely to paradoxical behavior. He, of course, cannot show violation of the, then not yet existing, Savage axioms. He therefore preceded Ellsberg only to a little extent, and Ellsberg essentially deserves the novelty of his thought experiments.

The above citation, of p. 313, can be linked to the source method idea that the same probability can be weighted differently for different sources.

P. 309 discusses that in decisions you can't foresee the whole future.

P. 312, para 6, argues against context-independence

P. 348-349 of I think the 1973 edn.: He believes that degrees of belief are not measurable. Even if they are, expected utility may be inadequate. If we take "not measurable" as nonadditive then this suggestion entails the two-stage model; oh well. One should be careful not to impose one's favorite ideas on authors from the past. %}

Keynes, John Maynard (1921) "*A Treatise on Probability*." McMillan, London. 2nd edn. 1948.

{% **marginal utility is diminishing**, about consumption: p. 31:

"the marginal propensity to consume [is] weaker in wealthy community;" also on p. 120 and 349

P. 161-162 seems to write: "Most, probably, of our decisions to do something positive, the full consequences of which will be drawn out over many days to come, can only be taken as a result of animal spirits - of a spontaneous urge to action rather than inaction, and not as the outcome of weighted average of quantitative benefits multiplied by quantitative probabilities. Enterprise only pretends to itself to be mainly actuated by the statements in its own prospectus, however candid and sincere."

Seems to write on p. 161: [A] large proportion of our positive activities depend on spontaneous optimism rather than on a mathematical expectation, whether moral or hedonistic or economic. Most, probably, of our decisions to do something positive, the full consequences of which will be drawn out over many days to come, can only be taken as a result of animal spirits—of a spontaneous urge to action rather than inaction, and not as the outcome of a weighted average of quantitive benefits multiplied by quantitative probabilities.

P. 349:

"with the growth in wealth [comes] the diminishing marginal propensity to consume" %}

Keynes, John Maynard (1935) "*The General Theory of Employment, Interest, and Money*." Harvest/HBJ, San Diego, London, Recent edn.: 1964.

{% Pp. 212-215:

“… at any given time facts and expectations were assumed to be given in a definite and calculable form; and risks, of which, tho [though] admitted, not much notice was taken, was supposed to be capable of an exact actuarial computation. The calculus of probability … was supposed to be capable of reducing uncertainty to the same calculable status as that of certainty itself … Actually, however, we have, as a rule, only the vaguest idea … renders Wealth a peculiarly unsuitable subject for the methods of classical economic theory. … By “uncertain” knowledge, let me explain, I do not mean merely to distinguish what is known for certain from what is only probable. The game of roulette is not subject, in this sense, to uncertainty…. Even the weather is only moderately uncertain. The sense in which I am using the term is that in which the prospect of a European war is uncertain, or the price of copper and the rate of interest twenty years hence … About these matters there is no scientific basis on which to form any calculable probability whatever. We simply do not know. Nevertheless, the necessity for action and for decisions compels us as practical men to do our best to overlook this awkward fact and to behave exactly as we should if we had behind us a good Benthamite calculation of a series of prospective advantages and disadvantages, each multiplied by its appropriate probability, waiting to be summed. … it is subject to sudden and violent changes. … New facts and hopes will, without warning, take charge of human conduct. … All these pretty, polite techniques, made for a well-panelled Board Room and a nicely regulated market, are liable to collapse.” %}

Keynes, John Maynard (1937) “The General Theory of Employment,” *Quarterly Journal of Economics* 51, 209–223.

{% What the title says. Such criteria are usually less quantitative and more heuristic than in (axiomatic) decision theory. The analytical hierarchy process is most popular. %}

Khan, Ilyas, Liliane Pintelon, & Harry Martin (2022) “The Application of Multicriteria Decision Analysis Methods in Health Care: A Literature Review,” *Medical Decision Making* 42, 262–274.

{% This paper explains risk aversion for small stakes not by the loss aversion that Rabin (2000) suggested, but by imprecision in judgment and an implied randomness in choice. It develops a random perception model given which it would even be optimal and rational to have this small-stake risk aversion. The paper claims that its random model more efficiently accommodates phenomena such as risk aversion for small stakes, isolation effect, reflection effect, and random choice, than existing models. General (mis)perception of numbers plays a

big role in the model of this paper. Pp. 2003-2005, end of §4, shows how their error model can generate the Goldstein-Einhorn parametric family of probabiity weighting, in their Eq. 4.4.

P. 1982 argues a bit against my favored approach to analyze data: first use a deterministic model to derive estimates, and only then bring in statistics and error theory, and argues in favor of integrating deterministic theory and error theory from the beginning. %}

Khaw, Mel Win, Ziang Li, & Michael Woodford (2021) "Cognitive Imprecision and Small-Stakes Risk Aversion," *Review of Economic Studies* 88, 1979–2013. https://doi.org/10.1093/restud/rdaa044

{% %}

Khrennikov, Andrei, Irina Basieva, Ehtibar N. Dzhafarov, & Jeromy R. Busemeyer (2014) "Quantum Models for Psychological Measurement: An Unsolved Problem," *PLoS ONE* 9(10), e110909.

{% I tried to read this in 2017, but it requires too much prior knowledge of quantum mechanics to be understandable to me or my likes. %}

Khrennikov, Andrei Yu & Emmanuel Haven (2009) "Quantum Mechanics and Violations of the Sure-Thing Principle: The Use of Probability Interference and Other Concepts," *Journal of Mathematical Psychology* 53, 378–388.

{% %}

Khwaja, Ahmed, Dan Silverman, & Frank Sloan (2007) "Time Preference, Time Discounting, and Smoking Decisions," *Journal of Health Economics* 26, 927–941.

{% %}

Kiebert, Gwendoline M. (1995) "Choices in Oncilogy: Patients' Valuations of Treatment Outcomes in Terms of Quality and Length of Life." Ph.D. dissertation, Leiden University.

{% **updating: mistakes in using Bayes' formula**: %}

Kieren, Pascal & Martin Weber (2024) "Expectation Formation under Uninformative Signals," *Management Science*, forthcoming.
https://doi.org/10.1287/mnsc.2023.03367

{% For good health care, a procedure was recommended, of (1) defining the problem, (2) diagnosis of what is going on, (3) specifying the options, and then, interestingly, (4) individualization: Specify what is special of this individual patient. This step is explicitly required. Then it continues (5) tradeoffs and choice; (6) implementation. So, there should be both evidence-based and individualization. %}
Kievit, Job (2017) "Zorg en Kwaliteit: Van Individu naar Systeem, naar Beide." Goodbye speech, Leiden University.

{% **Z&Z**; Examines welfare effects of compulsory insurance versus free-market versus a mix of compulsory plus voluntary, a variation of Dahlby (1981), a paper that seems to be a classic. Assumes two risk types and two health benefits, community rating insurers and risk rating insurers. %}
Kifman, Mathias (2002) "Community Rating in Health Insurance and Different Benefit Packages," *Journal of Health Economics* 21, 719–737.

{% **revealed preference** %}
Kihlstrom, Richard E., Andreu Mas-Colell, & Hugo F. Sonnenschein (1976) "The Demand Theory of the Weak Axiom of Revealed Preference," *Econometrica* 44, 971–978.

{% They disseminated the strange claim that more risk averse comparison is possible only under the prior restriction of same ordering of riskless outcomes. Peters & Wakker (1987) show, for general outcomes (including commodity bundles as in K&M), that

MRA ⇔ [same ordering of sure outcomes & U more concave].

So, same ordering of riskless outcomes need not be presupposed because it simply is implied (modulo minimal outcomes). %}

Kihlstrom, Richard E. & Leonard J. Mirman (1974) "Risk Aversion with Many Commodities," *Journal of Economic Theory* 8, 361–388.
https://doi.org/10.1016/0022-0531(74)90091-X

{% **proper scoring rules**, seem to do proper scoring rules with competition involved. Wonder how this is related to Prelec (2004) Science. %}

Kilgour, D. Mark & Yigal Gerchak (2004) "Elicitation of Probabilities Using Competitive Scoring Rules," *Decision Analysis* 2, 108–113.

{% **natural sources of ambiguity;**

inverse S: they find it for risk, and more pronounced for uncertainty; latter also concerns: **uncertainty amplifies risk**

linear utility for small stakes: they assume linear utility.

real incentives: **random incentive system between-subjects** (they paid one choice for 1/5 of the subjects)

They use the two-stage model W(E) = w(P(E)) where P is judgded probability which may be nonadditive, and w is a probability weighting function that can depend on the source.

They say that the probability weighting function can depend on the source of uncertainty. It is an unfortunate terminology because the probability weighting function w(p) *is usually taken for risk* and then depends only on p under common terminology, and it is then logically impossible that it would depend on a source or whatever else other than p. If I may be allowed to write about own work, in the three-stage decomposition W(A) = w(φ(P(A))), proposed in Footnote 2 of Wakker (2004, *Psychological Review*, p. 239), φ (and not w) can depend on the source, and this is what may be happening here. In the source method of Abdellaoui et al. (2011) a composition w_S(P(A)) is considered with P additive and w_S depending on the souce, but w_S is not called probability transformation but source function.

They find that pessimism decreases for more familiar sources (competence effect).

Their idea to have risk (rather than ambiguity) attitude depend on source is so confusing that I usually avoid citing this paper, although otherwise it has many valuable ideas. This terminology is just too confusing. I was the AE editor handling this paper for MS, and did everything allowed within the boundaries for editors to make the authors change terminology, but did not succeed. Here is why I think this terminology is bad:

The concept of source dependent risk attitude works best when first explaining things to an uninitiated audience. They immediately understand the model, without having been exposed to new and difficult concepts such as ambiguity or uncertainty. But long-term this terminology is dead-end:

(1) The terminology deviates from common terminology. In the Ellsberg two-color, people call behavior for the known urn risk attitude. Behavior for the unknown urn they do not call risk attitude, but here ambiguity attitude comes in, deviating from risk attitude.

(2) If risk attitude becomes source dependent, then the concept becomes too general to be useful. There is some experimental evidence for source dependence of risk attitudes, so we should restrict to "emotion-neutral" risk. The evidence is not enough to pay the heavy price of giving up source-independence.

(3) The only definition of ambiguity attitude that I think can survive is

ambiguity attitude = uncertainty attitude - risk attitude

This definition is lost if risk attitude no more means one thing. If one calls behavior for Ellsberg unknown urn risk attitude, then I don't anymore see how to use the concept of ambiguity attitude. So, the concept of source-dependent risk attitude is impossible to coherently connect with other concepts. The difference between the unknown and the known Ellsberg urns is due to ambiguity attitude, and not due to changed risk attitude. %}

Kilka, Michael & Martin Weber (2001) "What Determines the Shape of the Probability Weighting Function under Uncertainty," *Management Science* 47, 1712–1726.
https://doi.org/10.1287/mnsc.47.12.1712.10239

{% **foundations of statistics** proposes as index a probability of replicating an effect. Has several references to discussions. Several discussions in December Issue of 2005. %}

Killeen, Peter R. (2005) "An Alternative to Null-Hypothesis Significance Tests," *Psychological Science* 16, 345–353.

{% **foundations of statistics**; reply to Wagenmakers & Grünwald (2006) %}
Killeen, Peter R. (2005) "The Problem with Bayes," *Psychological Science* 17, 643–644.

{% **DC = stationarity**: p. 603 bottom of 2nd column, and p. 604 1st column ℓ. 8.

This paper considers receipt of one nonzero outcome at some timepoint. It proposes not to use a multiplicative model to integrate utility and discounting, but an additive model (Eq. 6). Puts this forward as its central contribution (p. 605 directly following Eq. 6). Although it also argues at length that we should look at utilities of outcomes and not at outcomes and puts this also forward as a similarly central contribution (p. 606 last para of column 1).

One difficulty I have with the additive-multiplicative is that this form, in the absence of other nonzero outcomes, is purely ordinal and we can just apply the exponential function to get back the multiplicative form after all, after which the only point at which this model generalizes classical exponential discounting is that a power transformation of time is added. But it still is multiplicative then.

Another difficulty is that there is a timepoint at which the value of a positive outcome becomes 0. The author view this point from its sunny side, with a numerical example that $250 in 21 years from now should have value 0 (p. 605 middle of 2nd column). These insights are extremely new to anyone who has worked on intertemporal choice so far. P. 611 has another extremely interesting move: The author proposes to use his additive instead of multiplicative model also for risky choice, and sees sunny sides here too. The factual observation that he puts forward on p. 611, 2nd colum, 2nd para:
"Consumers do not multiply the payoff by its probability; they sum utility functions on magnitude and probability" of course provides strong evidence supporting his insight." So, then we get to deal with models where people have a strict preference for increasing an outcome obtained with 0 probability, but the author has his defense in place: "it is a mark of humanity that some individuals can always be found who will take that foolhardy gamble." (p. 611 2nd column 2nd para) So, again, extremely new insights, be it now for all working on risky choice.

I was surprised on p. 602 to find that the derivative of discounting (rather than utility) is taken to be Bernoulli's utility idea.

P. 604 top of 2nd column tells us, citing Luce, that power utility satisfies all empirical and theoretical desiderata for utility.

With this publication the top journal Psychological Review gives us many ideas that we would never have dreamed of otherwise. %}

Killeen, Peter R. (2009) "An Additive-Utility Model of Delay Discounting," *Psychological Review* 116, 602–619.

{% Table 2: Kahneman & Tversky (1979) is 2nd most cited paper in the economic literature between 1970 and 2005. Later, in Merigó, Rocafort, & Aznar-Alarcón (2016), it caught up and became the most-cited paper. %}

Kim, E. Han, Adair Morse, & Luigi Zingales (2006) "What Has Mattered to Economics since 1970," *Journal of Economic Perspectives* 20, 189–202.

{% **probability communication**: a thorough study showing that natural frequencies are better understood than (conditional) probabilities. %}

Kim, Soyun (2024) "Natural Frequencies Improve Public Understanding of Medical Test Results: An Experimental Study on Various Bayesian Inference Tasks with Multiple Scoring Methods and Non-Bayesian Reasoning Strategies," *Medical Decision Making* 44, 890–899.
https://doi.org/10.1177/0272989X241275191

{% **revealed preference** %}

Kim, Taesung (1987) "Intransitive Indifference and Revealed Preference," *Econometrica* 55, 95–115.

{% This paper gives the nicest axiomatization of expected utility for risk that I know.

We consider decision under risk with preferences over lotteries. This paper gives necessary and sufficient conditions for an arbitrary finite set of preferences (can be incomplete!) over simple lotteries to be representable by expected utility (EU), improving upon the nice Fishburn (1975, Theorem 3) and the very nice Border (1992 Theorem 2.4). It then uses continuity to extend to larger sets of preferences. For the essence, being the finite case with no continuity involved (finite outcome set and finitely many preferences), the condition says: for the preferences observed, $P^j \succcurlyeq Q^j$, j = 1 ,…, n, where the first is strict, one takes each with probability λ_j ($\lambda_1 > 1$) and then the probabilistic mixture $\sum_{j=1}^{n} \lambda_j Q^j$ should not be the same as $\sum_{j=1}^{n} \lambda_j P^j$. I add: restricting to rational probabilities one can use Scott's (1964) way to get rid of the λ weights and then it is: **conservation of influence**. I further add: such mixings of preferences commonly happen in the random incentive system, used in experimental economics.

Border (1992) adds nice discussions. Such as that Raiffa (1968) also used such "prior" mixing of preferences. I add: so did Raiffa (1961) when commenting on Ellsberg (1961). Border also discusses well that the case considered, finitely many preferences, is the best regarding observability. I agree much with the interpretations of observable choice given by Border. They are in the spirit of Marcel K. Richter, acknowledged by Kim (1996). Ket Richter, as Kim calls him, is the informal name for Marcel K. Richter that he preferred that his friends use. He also told me to use it in our memorable one-time meeting (dinner for two) of 1985 in Karlsruhe where I was the young author inspired by the experienced Ket, in particular on observability.

Kim's Theorem 3.1 generalizes the result that I explained above (finite case) to a compact outcome space (such as any closed bounded interval in $\mathbb{R}$ or any closed bounded Euclidean space) and countably additive probability measures on the Borel sigma-algebra. The topology of the compact X plays a role in the definition of the Borel sigma-algebra and then in countable additivity condition, which is a kind of continuity. It generalizes the above finite case, but makes the result inaccessible to non-mathematicians. Major drawback: it obfuscates the important point that it can do without any continuity, so that it can achieve perfect observability. This is also why I prefer Kim's axiomatization to the von Neumann-Morgenstern and Herstein-Milnor axiomatizations that use the famous and appealing independence condition (well, vNM should have; see Fishburn & Wakker 1996). The latter involve continuity/Archimedeanity, which adds observable restrictions to the other axioms that we do not know or understand well. See the many discussions in this annotated bblipography with the keyword "**criticizing the dangerous role of technical axioms such as continuity**." %}

Kim, Taesung (1996) "Revealed Preference Theory on the Choice of Lotteries," *Journal of Mathematical Economics* 26, 463–477. https://doi.org/10.1016/0304-4068(95)00755-5

{% **revealed preference** %}

Kim, Taesung & Marcel K. Richter (1986) "Nontransitive-Nontotal Consumer Theory," *Journal of Economic Theory* 38, 324–363.

{% **intuitive versus analytical decisions**; **reflective equilibrium**: **utility elicitation**; compares utility assessment methods, implemented on the computer, regarding acceptance by subjects if recommended choice is contrary to intuitive choice. Their "UF" program had an interactive resolution of inconsistencies built in. This worked well and clients had more confidence in this program than in programs that did not consider inconsistencies. Note that it is not clear, in case of inconsistency, which is better: Intuitive choice or analytic recommendation. P. 620 1st para takes program as better whenever its recommendations are more often accepted. %}

Kimbrough, Steven O. & Martin Weber (1994) "An Empirical Comparison of Utility Assessment Programs," *European Journal of Operational Research* 75, 617–633.

{% The authors examine intertemporal discounting, distinguising between the delay effect and the interval effect. Probably the former refers to discounting with the immediacy effect included and the latter without. But I did not read the paper long enough to be able to figure out what exactly the authors mean.

DC = stationarity: Several places suggest that the authors equate them (abstract, p. 88 $\ell\ell$. 3-5, p 88 footnote 1) but never clearly. Maybe (I do not know) their distinction between delay and interval refers to the distinction between stopwatch time and calendar time and then it would mean that they do distinguish. %}

Kinari, Yusuke, Fumio Ohtake, & Yoshiro Tsutsui (2009) "Time Discounting: Declining Impatience and Interval Effect," *Journal of Risk and Uncertainty* 39, 87–112.

{% Seems to be useful in showing that pointwise continuity implies countable additivity. %}

Kindler, Jürgen. (1983) "A Simple Proof of the Daniel-Stone Representation Theorem," *American Mathematical Monthly* 90, 396–397.

{% Nice verbal, but superficial, exposition of Bayesian Testing; nice annotated literature %}

King, Raymond O. & Terrence B. O'Keefe (1989) "Belief Revision from Hypothesis Testing," *Journal of Accounting Literature* 8, 1–24.

{% **real incentives/hypothetical choice, for time preferences**: used real incentives;

Seems to assume Mazur's discounting function, linear utility, dynamic inconsistency.

Experiment 1: fitting at individual level; 4 out of 24 subjects had discount functions with "unusual shape" and were neither exponential nor hyperbolic; 14% unusually shaped discount curves

Experiment 2: fitting at individual level; 1 out of 28 had increasing impatience; 3% unusually shaped discount curves

Experiment 3: fitting at individual level; 1 out of 20 had increasing impatience. %}

Kirby, Kris N. (1997) "Bidding on the Future: Evidence against Normative Discounting of Delayed Rewards," *Journal of Experimental Psychology: General* 126, 54–70.

{% **real incentives/hypothetical choice, for time preferences**: used RIS. Delays considered were some weeks. Results are as the title says, where additivity refers to intertemporal addition. So, the study both confirms intertemporal additivity and linearity of utility. %}

Kirby, Kris N. (2006) "The Present Values of Delayed Rewards are Approximately Additive," *Behavioural Processes* 72, 273–282.

{% **decreasing ARA/increasing RRA**: paper tests constant relative and constant absolute risk aversion (although the author does not know these terms or concepts) and finds them all violated, arguing that we have to search for different utility families.

Exp. 1 uses matching to infer indifferences, and (p. 465) uses BDM (Becker-DeGroot-Marschak), but nicely follows it up with a choice question to verify, although the latter was not really incentivized. Then he tests constant relative risk aversion, by testing whether or not in indifferences

(⅓:3x, ⅓: x, ⅓:0) ~ (⅓:2x, ⅓: y(x), ⅓:0)

y is a linear function of x or not, finding it falsified. He thus rejects power utility. The experiments all have groups of about N = 20. P. 466 3rd para: BDM is hard for subjects.

Experiment 2 uses choice lists. P. 466 5th para: Those take more time. Now uses indifferences $3x_{½}x \sim 2x_{½}y(x)$ to test constant relative risk aversion.

P. 466 penultimate para: strangely enough, does not allow for convex-utility answers.

Exp. 3 considers indifferences

(⅓:5x, ⅓: 3x, ⅓:x) ~ (⅓: 3.25x, ⅓: 2.75x, ⅓:y(x)) to test constant relative risk aversion, and

(⅓: (x+24), ⅓: (x+12), ⅓:x) ~ (⅓: (x+13.50), ⅓: (x+10.50), ⅓:y(x))

to test constant relative risk aversion. Again, strangely enough, he only allows for concave utility by only considering negative exponential utility.

Experiment 4 considers what I call logarithmic utility, ln(hx+1) with h the free parameter, for which he cites Rachlin (1992) but it dates back from long ago in economics. %}

Kirby, Kris N. (2011) “An Empirical Assessment of the Form of Utility Functions,” *Journal of Experimental Psychology: Learning, Memory and Cognition* 37, 461–476.

{% Seems that:

real incentives/hypothetical choice, for time preferences; more discounting for hypothetical than for real;

DC = stationarity;

Assume linear utility throughout. Mazur discounting. Kept delayed reward constant, varied delay, asked for reward today that yields indifference (matching). Repeated this for several delayed rewards. Delays were from 3 to 29 days. Rewards ranged from $14.75 to $28.50. Real rewards in experiment 1 through an auction (nice). Repeated the study in experiment 2 with hypothetical rewards. Find that hyperbolic discounting fits better than exponential discounting. Discount rates were lower for hypothetical rewards than for real ones. No evidence for reward-size-dependent discounting, so, no magnitude effect.

Fitting of data at individual level; "the most curious result of these experiments was the failure to find reliable decreases in discounting rates as delayed reward size increased." (The decrease was very small). %}

Kirby, Kris N. & Nino N. Marakovic (1995) "Modeling Myopic Decisions: Evidence for Hyperbolic Delay-Discounting with Subjects and Amounts," *Organizational Behavior and Human Decision Processes* 64, 22–30.

{% Seems that:

real incentives/hypothetical choice, for time preferences DC = stationarity; Claim that "most arguments against exponential discounting have tacitly assumed that the discounting rate parameter is independent of amount." Real rewards Choice between amount tonight and other amount after delay. Varied delay, amount tonight and amount after delay. Since it was "tonight" they did not start with $t = 0$ (= immediately). Choice task instead of matching. Delays ranged from 10 days to 75 days. Delayed rewards ranged from $30 to $85. Immediate rewards ranged from $15 to $83. Discount rate decreased as reward increased. %}

Kirby, Kris N., & Nino N. Maraković (1996) "Delay-Discounting Probabilistic Rewards: Rates Decrease as Amounts Increase," *Psychonomic Bulletin and Review* 3, 100–104.

{% Seems that:

real incentives/hypothetical choice, for time preferences

Delays are in days. Choice based task: Choice between smaller, immediate reward and larger, delayed reward. Rewards were below $100 and delays were below 186 days. Subjects had a 1 in 6 chance of receiving the reward of one of the choices. Authors use questionnaires for impulsiveness (nice!) and it turned out that the answers to the questionnaires were correlated with discount rates. Real rewards. Higher rewards were discounted less than small rewards. Heroin patients discounted more than the control group. Difficult to determine whether results could be explained by utility actually being convex or concave. %}

Kirby, Kris N., Nancy M. Petry, & Warren K. Bickel (1999) "Heroin Addicts Have Higher Discount Rates for Delayed Rewards than Non-Drug-Using Controls," *Journal of Experimental Psychology: General* 128, 78–87.

{% **real incentives/hypothetical choice, for time preferences**: seems to be. %}

Kirby, Kris N. & Mariana Santiesteban (2003) "Concave Utility, Transaction Costs, and Risk in Measuring Discounting of Delayed Rewards," *Journal of Experimental Psychology: Learning, Memory and Cognition* 29, 66–79.

{% Big study on decisions with and without time pressure. 1700 subjects from Sweden, Austria, US. Time pressure increases the reflection effect of PT. No effect on loss aversion, but little data on it; for it they assume that "risk aversion" is the same for gains and losses (p. 55), which I do not understand. More noise under time pressure. They elicit only one certainty equivalent under gains and one under losses, so that they cannot measure insensitivity.

cognitive ability related to risk/ambiguity aversion: All their results agree with time pressure increasing the role of system 1 (intuitive decision making) versus system 2 (deliberate/rational decision making). P. 57: "One interpretation of the current findings is that time pressure decreases System 2 processing compared to time delay and thus increases the reflection effect. Following this logic, and as pointed out by Kahneman (2011), the S-shaped value function of Prospect Theory may primarily be a result of System 1 processing."

P. 57 has the common sentence: "Our results are potentially important for real-world decision making since most everyday decisions entail some degree of risk." %}

Kirchler, Michael, David Andersson, Caroline Bonn, Magnus Johannesson, Erik Ø. Sørensen, Matthias Stefan, Gustav Tinghög, & Daniel Västfjäll (2017) "The Effect of Fast and Slow Decisions on Risk Taking," *Journal of Risk and Uncertainty* 54, 37–59.

{% %}

Kiresuk, Thomas J. & Robert E. Sherman (1968) "Goal Attainment Scaling: A General Method for Evaluating Comprehensive Community Mental Health Programs," *Community Mental Health Journal* 4, 443–453.

{% That we perceive things relative to status quo/neutral level of well-being (though it seems to relate more to a physical sense than otherwise). In reality we apprehend nothing for certain, but only as it changes according to the condition of our body and of the things that impinge upon or offer resistence to it. %}

Kirk, Geoffrey S. & John E. Raven (1957) "*The Pre-Socrates Philosophers*." P. 422, Cambridge University Press, Cambridge.

{% **ratio bias**: find it. Subjects find 1:20 less likely than 10:200.

Experiments show that people judge a probability n/7 to be smaller than 10n/100: the ratio bias.

The authors suggest that we have two different systems of probabilistic assessments. There is the rational one, making us be consciously aware of numerical probabilities that we can tell to other people. There is, however, also the experiental one, that makes us automatically act right in many situations but that we are not aware of and cannot express numerically. %}

Kirkpatrick, Lee A. & Seymour Epstein (1992) "Cognitive-Experiential Self-Theory and Subjective Probability: Further Evidence for Two Conceptual Systems," *Journal of Personality and Social Psychology* 63, 534–544.

{% %}

Kirkwood, Craig W. (1993) "An Algebraic Approach to Formulating and Solving Large Models for Sequential Decisions under Uncertainty," *Management Science* 39, 900–913.

{% %}

Kirkwood, Craig W. & Rakesh K. Sarin (1980) "Preference Conditions for Multiattribute Value Functions," *Operations Research* 28, 225–232.

{% Seems to argue against representative agent.

P. 119 seems to write: "… it is clear that the "representative" agent deserves a decent burial, as an approach to economics analysis that is not only primitive, but fundamentally erroneous."

%}

Kirman, Alan P. (1992) "Whom or What Does the Representative Individual Represent?," *Journal of Economic Perspectives* 6, 117–136.

{% **survey on nonEU** %}

Kischka, Peter & Clemens Puppe (1992) "Decisions under Risk and Uncertainty: A Survey of Recent Developments," *Methods and Models of Operations Research* 36, 125–147.

{% %}
Kitayama, Shinobu, Alana Conner Snibble, Hazel Rose Markus, & Tomoko Suzuki (2004) "Is there Any "Free" Choice," *Psychological Science* 15, 527–533.

{% %}
Klayman, Joshua (1995) "Varieties of Confirmation Bias," *Psychology of Learning* 32, 385–418.

{% Nice references to early literature on multiattribute value theory (is MAUT without risk involved). Develop interpretations and vocabulary to better communicate in qualitative terms than the standard analytical representation. %}
Klein, David A., Martin Weber, & Edward H. Shortliffe (1992) "A Framework for Computer-Based Explanation of Multiattribute Decisions in Expert Systems." *In*: Ambrose Goicoechea, Lucien Duckstein, & Stanley Zionts (eds.) *IX-th International Conference on Multiple Criteria Decision Making*, 159–171, Springer Verlag, Berlin.

{% %}
Klein, Gary A. (1993) "A Recognition-Primed Decision (RPD) Model of Rapid Decision Making." *In* Gary A. Klein (ed.), *Decision Making in Action: Models and Methods*, 138–147, Ablex Pub Norwood, NJ.

{% %}
Klein, Lawrence R. (1946) "Remarks on the Theory of Aggregation," *Econometrica* 14, 303–312.

{% %}
Kleindorfer, Paul R., Howard C. Kunreuther, & Paul J.H. Schoemaker (1993) "*Decision Sciences. An Integrative Perspective.*" Cambridge University Press, Cambridge.

{% **intuitive versus analytical decisions**; criticize Dawes, Faust, & Meehl (1989) for being too narrow. %}

Kleinmuntz, Benjamin, David Faust, Paul E. Meehl, & Robyn M. Dawes (1990) "Clinical and Actuarial Judgment," *Science* 247 (Jan. 12) 146–147.

{% Seems to argue on pp. 113-114 for a design of assessment where biases cancel each other out, something applied by Bleichrodt (2002). %}

Kleinmuntz, Don N. (1990) "Decomposition and the Control of Error in Decision Analytic Models." *In* Robin M. Hogarth (eds.) *Insights in Decision Making: A Tribute to Hillel J. Einhorn*, 107–126, University of Chicago Press, Chicago.

{% %}

Kleinmuntz, Don N. (1991) "Decision Making for Professional Decision Makers," *Psychological Science* 2, 135–141.

{% %}

Klement, Erich Peter & Dan Ralescu (1983) "Nonlinearity of the Fuzzy Integral," *Fuzzy Sets and Systems* 11, 309–315.

{% **dynamic consistency**; axiomatizes, in Anscombe-Aumann framework (so, EU for given probabilities in a second stage) with uncertainty aversion (quasi-concavity in posterior probability mixing à la Gilboa & Schmeidler, 1989), the Epstein & Wang 94 model for dynamic consistency; is intertemporal with payment at each timepoint and also a future opportunity set to reckon with at each timepoint. That leads to state dependence (I haven't studied it enough to understand in detail). He assumes equivalence of outcomes over different states, and points out that this restricts his model for regular state dependence but is reasonable in his model where state dependence results from the opportunity sets. In view of outcomes at each timepoint, intertemporal substitution is relevant. %}

Klibanoff, Peter (1995) "Dynamic Choice with Uncertainty Aversion," Northwestern University, Evanstone, IL.

{% Assumes Anscombe-Aumann setup. For two acts there does not exist a CEU (Choquet expected utility) model showing a violation of betweenness iff either one act dominates the other or they are comonotonic. %}

Klibanoff, Peter (2001) "Characterizing Uncertainty Aversion through Preference for Mixtures," *Social Choice and Welfare* 18, 289–301.

{% %}

Klibanoff, Peter (2001) "Stochastically Independent Randomization and Uncertainty Aversion," *Economic Theory* 18, 605–620.

{% **ambiguity attitude taken to be rational**: An accessible account of this model, describing its underlying assumptions, is in Marinacci (2015 §4). Kahneman & Tversky (1975 pp. 30-33) have the smooth model for ambiguity for two outcomes.

event/outcome driven ambiguity model: outcome driven.

source-dependent utility: the essence of their approach, although interpretations may differ.

The authors (KMM) consider a two-stage-expectation representation sometimes called rercursive EU as in Kreps & Porteus (1978), i.e.,

$EXP_{\Delta}[\varphi(EXP_S[U(f(s))d\pi])d\mu]$,

where

1. $EXP_S[\ldots]$ denotes expectation over S. S is a Savagean (1954) state space, f is an act, U is a usual utility function to be used in regular expected utility, and π is a subjective probability measure over S à la Savage.

2. KMM assume that there is ambiguity about what the proper π is. This is reflected by a second-order probability measure μ over the set Δ of all first-order probability measures π over S. This μ reflects subjective perception. Thus, this paper calls the last stage, to the right in the tree, first-order, and the first stage, to the left of the tree, second-order. Both this terminology, and the one with first and second interchanged, exist in the literature.

At each stage KMM assume EU but φ can be nonlinear and, hence, it is not EU overall. It means that they do commit to the backward-induction version of dynamic nonEU (formally stated in their Assumption 3, p. 1857), giving up RCLA.

They also assume that S has an Anscombe-Aumann-like decomposition (§2.1). In other words, they assume that objective probabilities are given in S about which there is no ambiguity, so that all π's considered (in the support of μ) agree there with those objective probabilities. They use these to derive U and, later, to define ambiguity.

A recursive EU-type two-stage model as above (for simplicity we follow the authors in not counting the Anscombe-Aumann part as an extra stage) has been considered before by Kreps & Porteus (1978), who interpreted it as an intertemporal model with a nonlinear φ modeling attitudes towards the *timing* of the resolution of risk. Reinterpreting such a two-stage Kreps-Porteus setup for ambiguity where the two stages reflect resolutions of uncertainty of a different level of ambiguity, was considered simultaneously and independently by Nau (2006) and Ergin & Gul (2009), and before by Neilson (1993, published 2010). Remarkably, also Kahneman & Tversky (1975 pp. 30-33). The Neilson (1993) reference I learned from KMM's citations. The authors cite Segal for the general use of 2^{nd}-order probabilities to model ambiguity (but without a recursive EU), but this has been done in many papers before 1990 (Gärdenfors 1979; Gärdenfors & Sahlin 1983; Kahneman & Tversky 1975 p. 30 ff.; Larson 1980; Yates & Zukowski 1976). As do the aforementioned studies, KMM assume that acts, called *second-order acts*, are available whose outcomes are contingent on the second-order uncertainty resolution; i.e., on which subjective probability measure $\pi \in \Delta$ on S applies. An example of such a second-order act is displayed some later.

The big difference of the present paper (KMM) with preceding ones is that KMM allow the two-stage decomposition to be endogenous. What I mean is that in preceding approaches each first-order probability distribution occurs conditionally on an exogenous explicitly defined 2nd-order event, referring to some physically defined event, such as a composition of an urn in the Ellsberg paradoxes. This greatly limits the applicability because such conditioning events are rarely available in practice. KMM drop the assumption of such conditioning events, and just directly let the subjective 2nd order distribution (denoted μ) apply to first-order subjective probability distributions over the Savagean state space S. So, KMM consider choices between bets (their second-order acts) such as:

EXAMPLE OF 2ND ORDER ACT.

> We are going to derive from your preferences what your subjective probability of rain tomorrow is. If we discover that you consider rain at least as likely as 0.45, you receive $\$10^6$. If we discover that you consider rain less likely than 0.45, then you receive \$0. Would you rather have that gamble or 200,000 dollar for sure?

Thus, KMM consider bets with payments contingent on endogenous aspects of preference. Such bets do exist in the special case where the events pertaining to π are exogenous and physically definable ("identifiable"), e.g. when referring to the unknown composition of an urn (then however the π's are only objective), or maybe to an unknown parameter in statistics. (These, however, while outcome-relevant, are usually not treated as observable in the sense that we can construct any bet on them. Bayesian statisticians who assume priors implicitly assume such bets to be available but are, I suspect, usually not well aware of the problematic observable status of bets on parameter-values.) Such cases are in the domain of Kreps & Porteus, Nau, and others, which includes all examples of this kind put forward in the KMM paper. The generalization added here of allowing the outcome-relevant events for second-order acts to also be endogenous greatly enhances the scope of applicability of the theory, but along with it brings in this observability problem, and tractability problems. It means they have as subjective decision parameter in their model the set of all probability distributions over the set of all probability distributions over Savage's state space S, which is a parameter of a very high cardinality (formalized by Basu & Echenique 2020), leaving the theory very very unspecified. KMM discuss the pros and cons of using the unobservable second-order acts on p. 1856.

With all events regarding π assumed observable etc. via second-order acts, KMM can separate ambiguity-beliefs (this is how μ above is interpreted) and ambiguity-attitudes (this is how φ above is interpreted).

KMM characterize concavity of φ as follows: They take utilities $U(f(s))$ as observable outcomes, which is plausible if we interpret them as standard gamble probabilities: $U(f(s)) = p$ can be taken as a M_pm lottery with M big outcome with $U(M) = 1$ and m small outcome with $U(m) = 0$. Then φ is concave if and only if every act f is less preferred than its μ-expectation U(f(s)). So, this is the usual definition of weak risk aversion. A difficulty of this condition is that the μ-expectation is not directly observable because μ is a subjective probability, only inferrable through elaborate elicitations of preferences over second-order act s (**derived concepts in pref. axioms**; that subjective probabilities are indeed subjective and cannot be direct inputs is argued for instance by Budescu & Wallsten (1987, p. 68). Strzalecki (2011 ECMA p. 61) will point this out. Things are doable from the observability perspective if there exists a subset of Δ with μ probability 0.5 because this is easy to infer from choice and using only this event is enough to characterize concavity of φ. It also implies that two persons can be compared regarding ambiguity aversion only if they have the same risk preferences.

A drawback that all the approaches mentioned, including Kreps & Porteus (1978), have and share with for instance Chew's (1983) weighted utility (sum $p_i f(x_i)U(x_i)/\text{sum} p_i f(x_i)$ for DUR) is that all extra mileage is obtained from a function φ that, like U, applies to outcomes (φ indirectly via utility U). Thus, not only the risk-attitude-like-EU behavior, but also the ambiguity attitude, is driven entirely by the outcome domain we are facing, and not by the uncertainty-domain we are facing. This is apparent from Corollary 3 (p. 1865) with ambiguity attitude described by the Pratt-Arrow measure of φ *at an outcome*, and Assumption 5.ii (p. 1869) with ambiguity attitude specified through the *interval of outcomes*.

The approach of this paper, like most others, cannot separate absence of ambiguity from ambiguity neutrality. Section 4 (pp. 1870-1872) is remarkable in having ambiguity defined through relating it to exogenous known probabilities—which I like. The definition of ambiguity is inextricably linked with ambiguity aversion or seeking. Likelihood sensitivity, with a symmetric capacity, is taken here as unambiguous (Proposition 5). It means that KMM only consider source preference and not source sensitivity. For example, the extreme case of likelihood insensitivity (source insensitivity), with weight 0 for empty event and weight 1 for universal event, and weight 0.5 for all other events, according to the authors' definition means that there be no ambiguity. This is not correct. (**Ambiguity = amb.av = source.pref, ignoring insensitivity**)

Note that an agent can be more ambiguity averse towards source_1 of events that towards $source_2$ in two ways: Either by either taking φ more concave, or by taking the endogenous two-stage decomposition more dispersed. In KMM's interpretation it should only be the second way. φ should be a stable within-person property independent of source. A person's ambiguity aversion should be independent of the source! I expect that most people applying KMM will not work this way, but will vary concavity of φ within a person as in Chew et al. (2008). For descriptive purposes, if we find ways to identify φ and μ from data, then it can become an empirical question.

P. 1859 end of §2, Corollary 1, states that on S the authors need not commit to EU, but could also handle nonEU models, where the authors consider Quiggin's RDU. In the more problematic second stage, where ambiguity is handled, the authors do need EU. For the axiomatization, however, EU on S is used.

I summarize what I consider to be drawbacks of the KMM approach in my comments to Epstein (2010, Econometrica). A detailed comparison on similarities and differences with recursive expected utility is at the beginning of my annotations at Denti Pomatto (2022).

biseparable utility violated %}

Klibanoff, Peter, Massimo Marinacci, & Sujoy Mukerji (2005) "A Smooth Model of Decision Making under Ambiguity," *Econometrica* 73, 1849–1892.

{% Give extension of their 2005 Econometrica paper to a sequential setting. At each timepoint there is a model to substitute certainty equivalents that works recursively, combining the utility of current consumption with that of the certainty equivalent next time through a discounted utility evaluation. They cite preference axiomatizations on discounted-utility evaluations with no need to write it out in their paper.

A big conceptual decision they took is that this is not a sequential setup of their model, but it is their model of a sequential setup. That is, the ambiguity is at the beginning and concerns the future path as a whole (consumption plans). They then do backward induction. But in their model it is reasonable that ambiguity disappears at future nodes because of more and more repeated observations, which they explain repeatedly (e.g. p. 937 §2.4; p. 952 ℓ. 8). They consider a model where there is a clear well-definable objective probability, the only thing being that this is unknown, and this becoming more and more known as more (frequentist!) info comes in over time, as is common in statistics (p. 937 writes “the true process”). In this sense the ambiguity considered here is not purely subjective but it is iid-type.

I was glad to see that p. 958 points out that the Epstein & Schneider (2003 JET) rectangle version of multiple priors was preceded by Sarin & Wakker (1998). %}

Klibanoff, Peter, Massimo Marinacci, & Sujoy Mukerji (2009) “Recursive Smooth Ambiguity Preferences,” *Journal of Economic Theory* 144, 930–976.

{% Discuss, within smooth models, some definitions of ambiguity by Epstein, Ghirardato et al., Nehring, and others. I see things differently in the sense that whether an event is ambiguous is better NOT taken as endogenous. We researchers decide beforehand, without having seen any preference, that it is the unknown urn that is ambiguous in the Ellsberg two-urn experiment. %}

Klibanoff, Peter Massimo Marinacci & Sujoy Mukerji (2011) “Definitions of Ambiguous Events and the Smooth Ambiguity Model,” *Economic Theory* 48, 399–424.

{% For my comments, see Epstein (2010). %}

Klibanoff, Peter, Massimo Marinacci, & Sujoy Mukerji (2012) “Notes and Comments On the Smooth Ambiguity Model: A Reply,” *Econometrica* 80, 1303–1321.

{% Consider the usual Anscombe-Aumann (Anscombe-Aumann) approach for ambiguity. Assume a countably infinite sequence of realizations of the state of nature that in a way are iid, and impose event symmetry which is like de Finett’s (1937) exchangeability. Their main axiom, Axiom 5 (p. 1951, event symmetry) requires, more precisely, that mixing an act with a cylinder-event-A-indicator function does not change preference value if a permutation is applied to A.

They get a kind of multiple prior representation. For every prior on the state space there is an EU representation. The representation then is a general overall aggregation of these EU representations.

What I find typical of multiple prir representations as opposed to two-stage representations is that a prior is in or out of the prior set and those in are treated similarly, as are those who are out, with for instance not one receiving higher weight than the other. (The latter happens in two-stage models.) This need not be the case for the general aggregator here, as it is not for the smooth model, which is why their model for me is more two-stage than multiple prior. The model is not like usual two-stage in that one cannot after every resolution of the 1st stage uncertainty plug in any continuation. Instead, there is only an act contingent on the state space, and the second-stage decomposition is endogenous with everything following conditional on a 1st stage resolution of uncertainty relating to that same act contingent on the state space, as in the smooth model. P. 1946 penultimate para assumes so much richness that they come close enough to the product-space richness of regular two-stage models to do the required maths.

They define a prior as nonnull (or relevant) if every of the open sets containing it is nonnull. One can restrict the set of priors aggregated by G to the set D of nonnull priors if one wants.

They formulate the usual Yaari (1969)-type condition of being more ambiguity averse. It implies that (I would then say can be applied only if) the risk attitude (vNM U in EU) must be the same and if nullness of priors (so, the above set D) is the same. They interpret this as meaning that the set D captures ambiguity, and G ambiguity aversion. This is plausible and a nice direction. Yet I see limitations. First, going only by priors being null or nonnull is crude. For instance, if two persons a priori do not think that any prior is impossible, then according to this definition they perceive the same ambiguity. But one of the two may be fairly sure about what the right prior is, and the other may be more diffuse, so that they perceive ambiguity differently. A second limitation is that the Anscombe-Aumann framework (through monotonicity on p. 1950) imposes an implausible separability on the ambiguous horse states (Wakker 2010 §10.7.1 and Machina 2014 Example 3), precluding many kinds of ambiguity attitudes. It would be more desirable to also compare ambiguity attitudes of agents who have different risk attitudes and different sets of D, using for instance techniques of Baillon, Driesen, & Wakker (2012), and it suggests to me that the Yaari-type condition is too restrictive, in the same way as I consider Yaari (1969) too restrictive for EU. That the condition in this paper restricts to the same set D then does not mean that D has nothing to do with ambiguity aversion, but that the definition is too limited.

I disagree with a text on p. 1955:

"Yaari's definition, under sufficient conditions on the utility function (e.g., differentiability), implies that SEU preferences can be ranked in terms of risk aversion only if they share a common subjective probability measure. Thus, changes in the subjective probability measure can neither increase nor decrease risk aversion. Analogously, our next result provides a sufficient condition so that, when Definition 3.4 is applied to Continuous Symmetric preferences, preferences may be ranked in terms of ambiguity aversion only if they share the same set of relevant measures. In this way, changes in relevant measures are shown to neither increase nor decrease ambiguity aversion."

That Yaari needs identical subjective probabilities is only a limitation of his definition. That a change in subjective probability then cannot lead to an increase or decrease in risk aversion reflects only that limitation, and is not because there'd be no increases or decreases. It is only because Yaari's condition is blind for such, i.e., doesn't give any info of any kind there on how much risk aversion or risk seeking there is. If a blind doctor cannot see a symptom then this does not prove that you are healthy. The same holds for what the authors do. The main result of this paper is no other than that for comparative ambiguity aversion results in the Yaari style one needs identical sets of priors (in the sense of "relevant measures"). This does not prove that they do not interact, but only that the authors' Yaari-style condition cannot detect it. %}

Klibanoff, Peter, Sujoy Mukerji, & Kyoungwon Seo (2014) "Perceived Ambiguity and Relevant Measures," *Econometrica* 82, 1945–1978.

{% They provide axiomatizations of the smooth model and α-maxmin. However, they use a very rich structure, where occurrences of the state space S can be repeated infinitely often, as in the relative frequency interpretation of probability, with symmetry imposed there. %}

Klibanoff, Peter, Sujoy Mukerji, Kyoungwon Seo, & Lorenzo Stanca (2022) "Foundations of Ambiguity Models under Symmetry: α-MEU and Smooth Ambiguity," *Journal of Economic Theory* 199, 105202.

{% **source-dependent utility**: A subjective version of Kreps & Porteus (1978). The authors assume a finite Savage state space. There are T timepoints, and at each timepoint one receives more info about the true state of nature. This can be modeled by T partitions of the state space, each later one getting more refined (a filtration). They assume recursive backward induction with certainty equivalent substitution. At each timepoint SEU holds within that stage. They consider all kinds of cases, such as a fixed filtration (which I find most interesting) or all filtrations. Can be the same SEU model at each stage, or entirely different, or same subjective probability μ all of them but different utilities (this is closest to Kreps & Porteus), or the same utilities also.

I regret that the authors at each stage have an Anscombe-Aumann framework, assumed to derive SEU there. This means there are not T+1 stages, but 2T+2, with at every timepoint first the event of the partition revealed but then also a lottery carried out. It also means that they still need objective probabilities as did Kreps & Porteus. %}

Klibanoff, Peter & Emre Ozdenoren (2007) “Subjective Recursive Expected Utility,” *Economic Theory* 30, 49–87.

{% They fit EU, RDU, and PT to data about call options in the S&P500 index, using representative agent, power utility (same power for gains and losses in PT), Prelec and T&K one-parmeter weighting functions, and loss aversion. PT fits best, and all empirical findings of PT are confirmed. Unfortunately, they do rank-dependent integration bottom-to-top, so, the wrong way, and the parametric families of T&K and Prelec therefore mean something different than is common in the literature. Thus, whereas in Prelec’s paper his one-parameter family predicts no probability weighting if the best of two outcomes receives probability 1/3, as these authors do it there is no probability weighting if the worst of two outcomes receives probability 1/3. For EU they cannot reject risk neutrality. %}

Kliger, Doron & Ori Levy (2009) “Theories of Choice under Risk: Insights from Financial Markets,” *Journal of Economic Behavior and Organization* 71, 330–346.

{% One of three papers in an issue on contingent evaluation. Gives survey on contingent valuations and stated preferences, starting with history of Exxon Valdez. Passive use value: your value of things existing without you using them.

P. 14: Jnduced value vs. homegrown value. %}

Kling, Catherine L.; Daniel J. Phaneuf, & Jinhua Zhao (2012) "From Exxon to BP: Has Some Number Become Better than No Number?," *Journal of Economic Perspectives* 26, 3–26.

{% For degree of ambiguity, they use Izhakian's average variance of probability.

second-order probabilities to model ambiguity: they generate ambiguity by letting the compositions of urns be decided probabilistically.

ambiguity seeking for unlikely: they find it.

updating under ambiguity with sampling: Subjects can sample from Ellsberg urns. It reduces not only degree of ambiguity but also aversion. As the authors point out, they do not use the concept of likelihood insensitivity. They do specify thresholds where ambiguity seeking turns into aversion, These thresholds seem to concern that for low degrees of ambiguity subjects prefer ambiguity to risk. A guess is that this is just because for the sources of low ambiguity they received much info and just liked that. %}

Klingebiel, Ronald & Feibai Zhu (2023) "Ambiguity Aversion and the Degree of Ambiguity," *Journal of Risk and Uncertainty* 67, 299–324. https://doi.org/10.1007/s11166-023-09410-6

{% Subjects judge prospects played once, five times, and fifty times. Confirm fallacies found before, such as overestimation of probability of loss. Also ask for risk perception (or verbal interpretation), and find that probability of loss determines it more than variance. %}

Klos, Alexander, Elke U. Weber, & Martin Weber (2005) "Investment Decisions and Time Horizon: Risk Perception and Risk Behavior in Repeated Gambles," *Management Science* 51, 1777–1790.

{% %}

KLST: Krantz, Luce, Suppes & Tversky (1971)

{% Point out that disparity between buyer's and seller's point of view is too big to be explained by income effect (whether or not buyer or seller was endowed a priori with lottery or sure amount of money possibly to be exchanged). %}

Knetsch, Jack L. & John A. Sinden (1984) “Willingness to Pay and Compensation Demanded: Experimental Evidence of an Unexpected Disparity in Measures of Value,” *Quarterly Journal of Economics* 99, 507–521.

{% %}

Knez, Peter, Vernon L. Smith, & Arlington W. Williams (1999) “Individual Rationality, Market Rationality, and Value Estimation,” *American Economic Review* 75, 397–402.

{% The monetary value of a statistical life is between $7.7 million and $8.3 million per year. They measure WTA and WTP through wage increases for extra risks. %}

Kniesner, Thomas J., W. Kip Viscusi, & James P. Ziliak (2014) “Willingness to Accept Equals Willingness to Pay for Labor Market Estimates of the Value of a Statistical Life,” *Journal of Risk and Uncertainty* 48, 187–205.

{% **foundations of probability**

P. 20 and 224 and further (especially p. 226) seem to explain that risk refers to objective probability

Ch. VIII opening page (p. 233 in version I saw): Risk is for “measurable” uncertainty; i.e., when there is a “group of instances.” So, risk concerns frequentist probability. Uncertainty concerns “unmeasurable uncertainty” which is also designated by “subjective probability” and it concerns the exercise of “judgment …. which … actually guide most of our conduct.”

If we interpret unmeasurable as nonadditive (which I think is not what Knight thought of; I think that additive subjective probability was called uncertainty by Knight), then the two-stage model is suggested, where first a probability judgment is formed that may well be nonadditive, next decisions are derived from it. %}

Knight, Frank H. (1921) “*Risk, Uncertainty, and Profit.*” Houghton Mifflin, New York.

{% **questionnaire versus choice utility**: argues for cardinal utility on basis of introspection and psychophysical measurement.

principle of complete ignorance: p. 234 seems to argue that probabilities are irrelevant for single events

P. 305 gives nice comparisons with physical notions such as mass and force, comparing utility with force.

P. 303 suggests measurability measured through tradeoffs with some other quantity that apparently is assumed linear in utility.

P. 304 suggests that introspection can reveal orderings of differences. %}

Knight, Frank H. (1944) "Realism and Relevance in the Theory of Demand," *Journal of Political Economy* 52, 289–318.

{% %}

Knutson, Brian, Scott Rick, G. Elliot Wimmer, E., Drazen Prelec, & George F. Loewenstein (2007) "Neural Predictors of Purchases," *Neuron* 53, 147–156.

{% %}

Knutson, Brian, G. Elliott Wimmer, Scott Rick, Nick G. Hollon, Drazen Prelec, & George F. Loewenstein (2008) "Neural Antecedents of the Endowment Effect," *Neuron* 58, 814–822.

{% %}

Köbberling, Veronika (2003) "Risk Attitude: Preference Models and Applications to Bargaining," Ph.D. dissertation, METEOR, Maastricht University, the Netherlands.

{% %}

Köbberling, Veronika (2003) "Comments on: Edi Karni and Zvi Safra (1998)," *Journal of Mathematical Psychology* 47, 370.

{% %}

Köbberling, Veronika (2004) Book Review of: Itzhak Gilboa & David Schmeidler (2001) A Theory of Case-Based Decisions, Cambridge University Press, Cambridge; *Economica* 71, 508–509.

{% **strength-of-preference representation** %}

Köbberling, Veronika (2006) "Preference Foundations for Difference Representations," *Economic Theory* 27, 375–391.
https://doi.org/10.1007/s00199-005-0598-5

{% **game theory for nonexpected utility** %}
Köbberling, Veronika & Hans J.M. Peters (2003) "The Effect of Decision Weights in Bargaining Problems," *Journal of Economic Theory* 110, 154–175.

{% note 1, p. 224 surveys the findings on convex versus concave utility for gains versus losses. %}
Köbberling, Veronika, Christiane Schwieren, & Peter P. Wakker (2007) "Prospect-Theory's Diminishing Sensitivity versus Economics' Intrinsic Utility of Money: How the Introduction of the Euro Can Be Used to Disentangle the Two Empirically," *Theory and Decision* 63, 205–231.
https://doi.org/10.1007/s11238-007-9040-8
Direct link to paper

{% **tradeoff method**; p. 408: e**ndogenous midpoints** %}
Köbberling, Veronika & Peter P. Wakker (2003) "Preference Foundations for Nonexpected Utility: A Generalized and Simplified Technique," *Mathematics of Operations Research* 28, 395–423.
https://doi.org/10.1287/moor.28.3.395.16390
Direct link to paper
Background paper, used in proofs

{% **tradeoff method** %}
Köbberling, Veronika & Peter P. Wakker (2004) "A Simple Tool for Qualitatively Testing, Quantitatively Measuring, and Normatively Justifying Savage's Subjective Expected Utility," *Journal of Risk and Uncertainty* 28, 135–145.
https://doi.org/10.1287/moor.28.3.395.16390
Direct link to paper

{% The exponential utility form recommended in this paper to fit loss aversion is found to fit data best by von Gaudecker, Hans-Martin, Arthur van Soest, & Erik Wengström (2011). %}

Köbberling, Veronika & Peter P. Wakker (2005) "An Index of Loss Aversion," *Journal of Economic Theory* 122, 119–131.

Selected as one of the 50 most influential papers published in *Journal of Economic Theory*. Reprinted in special issue:

Karl Shell, Tilman Borgers, & Alessandro Pavan (eds. 2020) "Articles Celebrating the 50th Anniversary of the Journal of Economic Theory," May 2020.

https://doi:10.1016/j.jet.2004.03.009

link to paper

Link to typo

(Link does not work for some computers. Then can:

go to Papers and comments; go to paper 05.2 there; see comments there.)

{% **ambiguity seeking for losses**: found

ambiguity seeking for unlikely: found

The original title was better: "Ambiguity Aversion is the Exception." Unfortunately, an insisting referee imposed her subjective opinion on the authors and demanded that they change the title into the much weaker version that it is now. The editor should have intervened and forbid the referee to do this, but unfortunately did not carry out his task here.

Confirm the fourfold pattern af ambiguity attitudes: Find perfect a(mbiguity-generated)-insensitivity with ambiguity seeking for unlikely gains and ambiguity aversion for moderate and likely gains, and ambiguity seeking for losses. They are probably the first to test ambiguity aversion for mixed prospects, and find neutrality there. So, the common loss aversion for risk is not amplified for ambiguity.

They measure ambiguity attitudes from direct choice between an ambiguous and nonambiguous option where an ambiguity-neutral person should be indifferent, and also from matching probabilities. Differences between gains, losses, mixed, high, and low probabilities are between-subjects. They use same implementations everywhere, giving very clean data.

P. 276, §6.2, points out that the smooth model can accommodate sign dependence, but not insensitivity. Multiple prior models as existing today cannot handle sign/reference dependence, but generalizations are straightforward. %}

Kocher, Martin G., Amrei Marie Lahno, & Stefan T. Trautmann (2018) "Ambiguity Aversion Is not Universal," *European Economic Review* 101, 268–283.

{% **decision under stress;**

losses from prior endowment mechanism: They do not do this, but use an interesting alternative, in Experiment 1, that can be called "losses from posterior endowment". Subjects are told that there are two parts, first A and then B. They are told that in A they may lose, and in B they may gain, without being told how much each is. In reality, the gain in Part B will always at least cover the loss in Part A. The endowment is not prior but posterior, so to say. No untrue things are told to subjects here, so, in this sense there is no deception. But subjects can come out saying:

"They may tell you that you may lose but in reality, don't worry."

Another small drawback is that there is an income effect of a weak kind. Part B was not relevant so, it does not matter there, but in Part A subjects know that more money is coming. Because they don't know how much, this income effect is really weak. Despite these two minor drawbacks, this is by far the best implementation of real incentives for losses that I ever saw, in fact the only one in the literature so far that I consider valid. Losses from prior endowment mechanism has drawbacks that are too big, with 1/3 of the subjects integrating the payments. So, this is an interesting new way to implement losses!

Study time pressure (TP) for choices under risk, for pure gains, pure losses, and mixed prospects (both gains and losses). TP does not affect risk aversion under gains, increases it (turning majority risk seeking into majority risk aversion) for losses, and has a mixed effect for mixed prospects: effect 1: when choosing between a nondegenerate pure-gain prospect and a mixed prospect, TP moves preference towards the pure-gain prospect. Effect 2: when choosing between a nondegenerate pure-loss prospect and a mixed prospect, TP moves preference towards the mixed prospect.

The authors claim that their finding on mixed prospects falsifies PT, but I disagree. It only falsifies PT-with-the-added-assumption-that-no-parameter-of-

PT-other-than-loss-aversion-will-be-affected-by-TP. (Then indeed Effect 1 implies increased loss aversion and Effect 2 implies decreased loss aversion. The latter claim is subtle and requires some thinking, but is correct; see Exercise 9.3.8 in my 2010 book.) However, there is too little evidence for the added assumption. For gains they find no change in risk aversion, but this is a null hypothesis accepted, which is weak evidence. Also, they only do particular tests of risk aversion, and not of insensitivity. For losses they do in fact find a change of risk attitude, falsifying the above added assumption. A more detailed investigation of the parameters of PT and their interactions, with possibly more detailed data, would be required before we can draw concrete conclusions about PT and its parameters under TP. The big picture of the results is increased insensitivity under TP, agreeing with PT.

As an aside, the EU-with-aspiration is not really a deviation from PT. It is an extreme degree of PT, with extreme insensitivity towards outcomes. Diecidue & Van de Ven show this in a mathematical sense, with the discontinuity of U at 0. This is a natural extension of the steepness of U at 0 that PT postulates.

Whereas PT is not violated by the data as I see it, EU-with-aspiration is in a way. It is violated by the change in attitude for losses, or at best has nothing to say on that.

In summary, I disagree with both of the following sentences in their conclusion "Our results show that typical nonexpected utility patterns as modeled by prospect theory may not provide an appropriate description of choice behavior if time pressure becomes important. We have shown that recently developed models of expected utility with an aspiration level (Diecidue & van de Ven 2008) may be a useful alternative in such situations."

Experiment 1 had some order effects, but Experiment 2 controlled for them and showed that they play no role.

They also study effects of providing info about expected values. This only had effect for the choices with mixed prospects, moving these choices towards expected value maximization. Besides the awareness explanation proposed by the authors in the last para of the paper, it may also be because for mixed prospects, with loss aversion coming in, preferences are volatile rather than conscious, making subjects more open to any kind of external influence. %}

Kocher, Martin G., Julius Pahlke, & Stefan T. Trautmann (2013) "Tempus Fugit: Time Pressure in Risky Decisions," *Management Science* 59, 2380–2391.

{% N = 379; RIS.

losses from prior endowment mechanism: Because losses were involved and as such were implemented, the subjects after carried out unrelated risky-choice tasks where they surely gained more than what was lost before. They got the reassurance that their net-gains would never be negative, but they did not get more info about those later choices. I don't know to what extent subjects thought that losses would just be recovered later, or questions later were chained in a way to make losses disappear so that one can ignore losses.

They analyze effects of self-selection in time pressure. In experiments on time pressure, experimenters often remove subjects who did not meet the time constraint, which obviously brings biases. This paper also analyzes the slowest subjects who did not meet the time constraint. Further, it relates to demographics. People who take more care without time pressure, suffer more from it. No very clear relations are found.

They consider decisions under risk. That is, choices between mixed and all-gain lotteries, where the mixed have higher EV, and between mixed and all-loss lotteries, where the all-loss have higher EV. EV maximization is taken as best. Heuristics will usually lead to preference for all-gain over mixed and of mixed over all-loss and, thus, to violations of EV.

cognitive ability related to risk/ambiguity aversion: They also measure cognitive ability using Raven's progressive matrices for cognitive ability (IQ) andintellectual efficiency (IE). Time pressure reduces EV maximization, and EV maximization is related with cognitive ability, but not strongly. It increases loss aversion and probability weighting. %}

Kocher, Martin G., David Schindler, & Stefan T. Trautmann (2019) "Risk, Time Pressure, and Selection Effects," *Experimental Economics* 22, 216–246. https://doi.org/10.1007/s10683-018-9576-1

{% %}

Kocher, Martin G. & Matthias Sutter (2006) "Time Is Money—Time Pressure, Incentives, and the Quality of Decision-Making," *Journal of Economic Behavior and Organization* 61, 375–392.

{% Gives statistics about returns on stocks during the past century. %}
Kocherlakota, Narayana R. (1996) “The Equity Premium: It’s still a Puzzle,” *Journal of Economic Literature* 34, 42–71.

{% Assumes both uncertainty and time. First aggregation is over time, but standard constant discounting. Next aggregation over uncertainty is through maxmin. The model is much the same as Anscombe-Aumann, only with temporal options and discounted utility instead of EU. Uncertainty aversion of Gilboa & Schmeidler now becomes preference for smoothing over events rather than over time. It is more involved because the extraneous weights of objective probabilities now are not available, but is achieved with intertemporal hedging (p. 241). Stationarity (p. 243) nicely becomes an analog of certainty independence. The paper provides a related result for the variational model. %}
Kochov, Asen (2015) “Time and No Lotteries: An Axiomatization of Maxmin Expected Utility,” *Econometrica* 83, 239–262.

{% Has time and uncertainty together. %}
Kochov, Asen (2015) “Stationary Cardinal Utility,” in preparation.

{% %}
Koçkesen, Levent & Efe A. Ok (2004) “Strategic Delegation by Unobservable Incentive Contracts,” *Review of Economic Studies* 71, 397–424.

{% %}
Kockesen, Levent, Efe A. Ok, & Rajiv Sethi (2000) “The Strategic Advantage of Negatively Interdependent Preferences,” *Journal of Economic Theory* 92, 274–299.

{% %}
Kóczy, László Á. & Alexandru Nichifor (2013) “The Intellectual Influence of Economic Journals: Quality versus Quantity,” *Economic Theory* 52, 863–884.

{% %}

Kodrzychki, Yolanda K. & Pingkang Yu (2006) "New Approaches to Ranking Economics Journals," *Contributions to Economic Analysis & Policy* 5, Article 24.

{% %}
Koehler, Derek J., Lyle A. Brenner, & Amos Tversky (1997) "The Enhancement Effect in Probability Judgment," *Journal of Behavioral Decision Making* 10, 293–313.

{% Nice illustration of ad hoc techniques used in law to deal with probabilities. %}
Koehler, Jonathan J. & Arienne P. Brint (2001) "Psychological Aspects of the Loss of Chance Doctrine,"

{% **(very) small probabilities**: small probabilities are overweighted if people can easily imagine an example, and underweighted otherwise, also if the imaginability-manipulation is clearly rationally irrelevant. %}
Koehler, Jonathan J. & Laura Macchi (2004) "Thinking about Low-Probability Events; An Exemplar-Cuing Theory," *Psychological Science* 15, 540–546.

{% %}
Koele, Pieter & Joop van der Pligt (1993) "*Beslissen en Oordeel.*" Boom, Amsterdam.

{% **ambiguity seeking for unlikely**: They confirm this. They also let subjects decide on behalf of others and then find the same. No significant differences with individual choices. Nice thing is that when determining matching probabilities (the authors use the term probability equivalent) for unlikely event they take a choice list that is symmetric for ambiguity neutrality (then p = 0.10; they took 0.10, 0.19, 0.04, 0.16, 0.07, and 0.13; see Table 1) so that there is no center-bias or regression to the mean.

I disagree with the sentence in the final para of the conclusion: "studies, we find that ambiguity attitudes depend strongly on the likelihood range considered." I think that ambiguity attitude is the same for low and moderate likelihoods: Always it is insensitivity. I would agree with the sentence of the authors if they had replaced the term "ambiguity attitudes" with the term "ambiguity aversion." %}

Koenig-Kersting, Christian & Stefan T. Trautmann (2016) “Ambiguity Attitudes in Decisions for Others,” *Economics Letters* 146, 126–129.

{% %}
Koerts, Johan & Erik de Leede (1973) “Statistical Inference and Subjective Probability,” *Statistica Neerlandica* 27, 139–161.

{% Quiggin says he claims that there must be fundamental uncertainty, because otherwise there could not be free will. %}
Koestler, Arthur (1965) “*The Roots of Coincidence.*” Picador, London.

{% **questionnaire for measuring risk aversion**: seem to propose questionnaire for risk-attitude. %}
Kogan, Nathan & Michael E. Wallach (1964) “*Risk-Taking: A Study in Cognition and Personality*.” Holt, Rinehart & Winston, New York.

{% %}
Kohlas, Jürg & Paul-André Monney (1994) “Theory of Evidence—A Survey of its Mathematical Foundations, Applications and Computational Aspects,” *ZOR - Mathematical Methods of Operations Research* 39, 35–68.

{% **dynamic consistency**; **normal/extensive form**; nice exposition of principles in refinements of the Nash equilibrium concepts. %}
Kohlberg, Elon (1990) “Refinement of Nash Equilibrium: The Main Ideas.” *In* Tatsuro Ichiishi, Abraham Neyman, Yair Tauman (eds.) *Game Theory and Applications*, 3–45, Academic Press, New York.

{% **normal/extensive form**; decision trees; **dynamic consistency**. Footnote 3 says: “We adhere to the classical point of view that the game under consideration fully describes the real situation—that any (pre)commitment possibilities, any repetitive aspect, any probabilities of error, or any possibility of jointly observing some random event, have already been modelled in the game tree.” Later, they nicely write that players are in cubicles where there is “not even a window” and, thus, nicely exclude observations of sunspots.

They argue for forward induction (and I agree) in the game where Harsani &

Selten (1988) argue for backward induction. Harper (1986, 1991) developed a logic with ratifiability to justify forward induction. Reviewed in Joyce & Gibbard (1998). %}

Kohlberg, Elon & Jean-François Mertens (1986) "On the Strategic Stability of Equilibria," *Econometrica* 54, 1003–1037.

{% **consistency** Observation in §2 (p. 108) shows that under some dynamic conditions, two-stage CEU (Choquet expected utility) must be SEU.

dynamic consistency. NonEU & dynamic principles by restricting domain of acts: C onsiders a two-stage structure with first-stage events $E_1,\ldots,E_n$ with $E_j = \{s_{j1},\ldots,s_{jn_j}\}$ and a ranking such that $s_{(j-1)n_{j-1}} \succcurlyeq s_{j1} \succcurlyeq \cdots \succcurlyeq s_{jn_j} \succcurlyeq s_{(j+1)}$, calling them nest-comonotonic. On this subset we have everything the same as SEU also if we reduce with CE (certainty equivalent) substitution. So, here different ways to evaluate dynamic prospects, and to update (Section 4), agree as they do under SEU. The author shows how restrictive backward induction is.

Then he imposes an axiom requiring that the CE substitution for each event E should be independent of the rank of E. It holds if and only if the weighting function W is an exponential transform of a probability measure (also implying probabilistic sophistication.) He assumes richness both for outcomes and for states.

Corollary 2 (p. 113) characterizes CEU with **state-dependent utility** as in Chew & Wakker (1996). Theorem 2 relates first- and second-stage exponential CEU by the Bayesian update rule for weighting functions. %}

Koida, Nobuo (2012) "Nest-Monotonic Two-stage Acts and Exponential Probability Capacities," *Economic Theory* 50, 99–124.

{% Analyze the role of benchmarks. Reminded me much of Lopes' SPA benchmarks: security, potential, aspiration. %}

Kolasinski, Adam, Xu Li, Mark Soliman, & Qian Xin (2023) "Ambiguity Aversion and Beating Benchmarks: Does it Create a Pattern?," *Management Science* 69, 7059–7078.
https://doi.org/10.1287/mnsc.2022.4609

{% Seems to have put forward representative income as analog for welfare of certainty equivalent for expected utility. The AKS (Atkinson-Kolm-Sen) index takes difference between average value and representative utility (which is risk premium and divides by absolute value of average utility. Similar indexes have been used ad hoc in risk theory to measure risk aversion, but their problem is that in the small they tend to 0, as if risk neutralilty. %}

Kolm, Serge-Christophe (1969) "The Optimal Production of Social Justice." *In* Julius Margolis & Henry Gutton (eds.) *Public Economics*, MacMillan, London.

{% **risky utility u = transform of strength of preference v**, haven't checked if latter doesn't exist. Seems to argue that. %}

Kolm, Serge-Christophe (1993) "The Impossibility of Utilitarianism." *In* Peter Koslowski & Yuichi Shionoya (eds.) *The Good and the Economical: Ethical Choices in Economics and Management,* 30–66, Springer, Berlin.

{% %}

Kolm, Serge-Christophe (1998) "Chance and Justice: Social Policies and the Harsanyi-Vickrey-Rawls Problem," *European Economic Review* 42, 1393–1416.

{% %}

Kolm, Serge-Christophe (2002) "*Modern Theories of Justice*." MIT Press, Cambridge, MA.

{% %}

Kolmogorov, Andrej N. (1930) "Sur la Notion de Moyenne," *Rendiconti della Academia Nazionale dei Lincei* 12, 388–391.

{% The "bible" where he lays down the current axiomatic foundations of probability theory. %}

Kolmogorov, Andrej N. (1933) "*Grundbegriffe der Warscheinlichkeitsrechnung.*" Springer, Berlin. Translated into English by Nathan Morrison (1950) "*Foundations of the Theory of Probability,*" Chelsea, New York. 2nd English edn. 1956.

{% The “bible” where he lays down the current axiomatic foundations of probability theory. %}

Kolmogorov, Andrej N. (1950) “*Foundations of the Theory of Probability*.” Chelsea, New York. 2nd English edn. 1956.

{% 2nd sentence writes: “Generally speaking there is no ground to believe that a random phenomenon should possess any definite probability.” Counters to the widespread view in ambiguity theory today 2022), that if not a single probability measure can be specified, it must be a set of priors, i.e., more than one. Why not less than on? %}

Kolmogorov, Andrej N. (1983) “On Logical Foundations of Probability Theory.” *In* Jurii V. Prokhorov & Kiyosi Itô (eds.) *Probability Theory and Mathematical Statistics* (Lecture Notes in Mathematics 1021), 1–5, Springer, Berlin.

{% %}

Kolmogorov, Andrej N: 4 Discussions of his work in The Annals of Statistics 18, (1990), pp. 987–1031.

{% Survey of diversification measures. %}

Koumou, Gilles Boevi (2020) “Diversification and Portfolio Theory: A Review,” *Financial Markets and Portfolio Management* 34, 267–312. https://doi.org/10.1007/s11408-020-00352-6

{% **ordering of subsets**: survey of comparative probability with many philosophical discussions. %}

Konek, Jason (2019) “Comparative Probabilities.” *In* Richard Pettigrew & Jonathan Weisberg (eds.) The Open Handbook of Formal Epistemology, 267–348, open access at https://jonathanweisberg.org/pdf/open-handbook-of-formal-epistemology.pdf

{% N = 185 incentivized lab and 2408 online nonincentivized. They find no difference (**real incentives/hypothetical choice**).

Trautmann & Wakker (2018) found weak certainty independence violated because of sign dependence. They found no violation for gains-only or losses-only. This paper tests certainty independence and weak certainty independence

and finds both violated in many contexts: gains-only, losses-only, nor driven by indifference, nor by monetary incentives, nor can they follow from a preference for randomization, which may be problematic in itself, fnding almost identical violation rates everywhere. It pleas for event-driven ambiguity models (**event/outcome driven ambiguity model: event driven; ambiguity seeking for unlikely**; **ambiguity seeking for losses**;) with insensitivity and sign-dependence. Prospect theory and source theory deliver exactly that!

The authors find no evidence for hedging against ambiguity, no color preference, and there is no suspicion (**suspicion under ambiguity**). %}

König-Kersting, Christian, Christopher Kops, & Stefan T. Trautmann (2023) "A Test of (Weak) Certainty Independence," *Journal of Economic Theory* 209, 105623. https://doi.org/10.1016/j.jet.2023.105623

{% For every interval there is an interval-dependent utility function such that lotteries are turned into certainty equivalents using EU with that utility function, where the range is the support. %}

Kontek, Krzysztof & Michal Lewandowski (2018) "Range-Dependent Utility," *Management Science* 64, 2812–2832. https://doi.org/10.1287/mnsc.2017.2744

{% **PT falsified**: A theory where people choose several reference points, and primarily go by the probability of exceeding those, fits data well. It is like Diecidue & van de Ven (2008) and Payne (2005) although they do not cite those. It is also like Lopes model, which is cited. However, the reference points are simply introduced here physically as thresholds above which the subjects gain points to participate in a bonus. Thus, they are just outcomes rather than psychological thresholds and in this sense the paper does not really show that thresholds lead to deviations from just maximizing outcomes. %}

Koop, Gregory K. & Joseph G. Johnson (2012) "The Use of Multiple Reference Points in Risky Decision Making," *Journal of Behavioral Decision Making* 25, 49–62 (2012).

{% **probability intervals** %}

Koopman, Bernard O. (1940) “The Bases of Probability,” *Bulletin of the American Mathematical Society* 46, 763–774.
Reprinted in Henry E. Kyburg Jr. & Howard E. Smokler (1964, eds.) *Studies in Subjective Probability,* Wiley, New York; 2nd edn. 1980, K Publishing Co., New York.

{% %}
Koopman, Bernard O. (1940) “The Axioms and Algebra of Intuitive Probability,” *Annals of Mathematics* 41, 269–292.

{% %}
Koopman, Bernard O. (1941) “Intuitive Probability and Sequences,” *Annals of Mathematics* 42, 169–187.

{% P. 140 seems to plead for introspection, though it may only be hypothetical choice as Savage also wanted. %}
Koopmans, Tjalling C. (1957) “The Construction of Economic Knowledge.”. *In Three Essays on the State of Economic Science* (Tjalling C. Koopmans, ed.) 127–166, McGraw-Hill Book Company, Ch. II.

{% P. 306: stationarity is independence of *calendar time.* Utility is bounded. %}
Koopmans, Tjalling C. (1960) “Stationary Ordinal Utility and Impatience,” *Econometrica* 28, 287–309.

{% **Kirsten&I**; %}
Koopmans, Tjalling C. (1972) “Representations of Preference Orderings with Independent Components of Consumption,” & “Representations of Preference Orderings over Time.” *In* Charles Bartlett McGuire & Roy Radner (eds.) *Decision and Organization*, 57–100, North-Holland, Amsterdam.

{% %}
Koopmans, Tjalling C., Peter A. Diamond & Richard E. Williamson (1964) “Stationary Utility and Time Perspective,” *Econometrica* 32, 82–100.

{% %}

Koopmanschap, Marc A., Frans F.H. Rutten, B. Martin van Ineveld, & Leona van Roijen (1997) "Reply to Johanneson's and Karlsson's Comment," *Journal of Health Economics* 16, 257–259.

{% Subjects choose between safe options and fifty-fifty risks for gains and losses, always at most one nonzero outcome. They also chose between immediate payment and delayed larger payent. They did so when having pain, and when not. For gains there was more risk seeking under pain, with no difference for losses. Pain increased impatience. %}

Koppel, Lina, David Andersson, India Morrison, Kinga Posadzy, Daniel Västfjäll, & Gustav Tinghög (2017) "The Effect of Acute Pain on Risky and Intertemporal Choice," *Experimental Economics* 20, 878–893.
https://doi.org/10.1007/s10683-017-9515-6

{% They test information aversion in a case of dilation in Ellsberg urns, and its relation to ambiguity aversion. An urn contains 21 balls, 5 numbered 1, 5 numbered 2, and 11 numbered 3 or 4 in unknown proportion. (So, the ambiguous are favored somewhat.) The odd-numbered balls with numbers 1 or 3, have a green color and the even-numbered, 2 or 4, a blue color. Subjects rather gamble on {3 or 4} than on 1 or 2}. However, if they first receive info about the color, so that, under color green, {3,4} becomes ambiguous, then they prefer to gamble on {1,2}, which under green coincides with {1}, than on {3,4}, which under green coincides with {3}. The color info "breaks a hedge," as the authors eloquently put it, against ambiguity. The hedge is close to Raiffa's (1961) deliberate randomization in Ellsberg's urn.

The above is not really a direct test of information aversion. The authors added such by letting subjects choose between gambling on {3,4} with or without olor info provided, where even the stakes were increased by 50 cents if color info was received. Still, 62% of subjects exhibited information aversion (**information aversion**). Information aversion is positively related to ambiguity aversion.

The authors also tested dynamic consistency by letting subjects specify conditional preferences before and after receipt of info. (**dynamic consistency**) They find no correlation between dynamic consistency and information aversion.

This is remarkable because, theoretically, information aversion is about the same as dynamic inconsistency.

A second experiment provided some robustness tests. One replaced the ambiguity in {3,4} regarding {3} versus {4} by two-stage probability, where the proportion of {3} versus {4} is determined probabilistically. This removed all ambiguity and was treated as risk. Although the authors do not cite Halevey (2007), this finding provides counterevidence against his claim that ambiguity is mostly perception of second-stage uncertainty plus violation of RCLA. The second experiment finds less information aversion (35%). Overall, it is 49%.

The concluding sentence: "Our results suggest that counseling on topics like health, financial literacy and others may have to be delivered in a way that takes into account what effect the information has on the subjectively perceived ambiguity in the situation." %}

Kops, Christopher & Illia Pasichnichenko (2023) "Testing Negative Value of Information and Ambiguity Aversion," *Journal of Economic Theory* 213, 105730.
https://doi.org/10.1016/j.jet.2023.105730

{% This paper investigates the Decision from Experience (DFE) versus Decision from Description (DFD) gap. It states and confirms the Relative Underweighting Hypothesis: There is a DFE-DFD gap (which is trivial), there is less pronounced inverse S for DFE, but it does not reverse into S-shape, but remains inverse S. (**DFE-DFD gap but no reversal**) This is contrary to the big selling point of DFE in its first papers. %}

Kopsacheilis, Orestis (2018) "The Role of Information Search and its Influence on Risk Preferences," *Theory and Decision* 84, 311–339.

{% **Compare different measurement methods**: compare two elicitation methods to calibrate prospect theory: Certainty equivalent measurements vs. choices between two binary lotteries. They thus in effect put the Mccord & de Neufville's (1986) idea to a test. They also compare two methods of statistical analysis: maximum likelihood vs. Bayesian hierarchical.

It should be understood here that comparing different elicitation methods is much more difficult that comparing different theories. The reason is that different theories can be tested on the same data set. One needs to collect only one data set, and then can compare 20 different theories, and 20 different parametric implementations of each theories, readily. With few exceptions, every different elicitation method and every different implementation thereof requires different stimuli and a different data set. Thus, this paper has only two horses participating, and then needs to collect two data sets for it. Another problem is that, because different measurements involve different stimuli, comparisons are hard. Different stimuli can involve different difficulties and biases, and in return be more or less informative, the latter domain-dependent. The authors, indeed, find that CE measurements better predict CE choices, and binary-lottery choice measurements better predict the corresponding choices. So, what to conclude?

As for statistical analysis, the Bayesian hierarchy method does better simply because it uses more information, letting choices of one person be informative about another person's choices. Yet maximum likelihood remains of interest because in many applications we apply theories at the individual level, for only one patient or only one company, and then need to know the performance of maximum likelihood. %}

Kopsacheilis, Orestis, Dennie van Dolder, & Jörg Weber (2019) "A Horse Race between Elicitation Methods of Prospect Theory," working paper presented at SPUDM 2019.

{% Generalizes Savage (1954) to algebras of events. Furthermore, to mosaics of events. Also does it with probabilistic sophistication. He has a finely ranged probability, meaning that for each $\varepsilon > 0$ there is a partition with all events having smaller probability. %}

Kopylov, Igor (2007) "Subjective Probabilities on "Small" Domains," *Journal of Economic Theory* 133, 236–265.

{% **EU+a*sup+b*inf**: In Anscombe-Aumann framework has direct choice, but also choice maintained after any deferral, as two primitives. It leads to a multiple prior model where choice after any deferral relates to unanimous preference for all priors, and immediate choice goes by a sort of ε α maxmin model, taking ε times infimum + (1–ε) times EU. It is a subclass of ε-contamination. The set of priors is derived endogenously here. The same model with this set exogenous is in

Kopylov (2016).

Section 2.5 is on complete ignorance (**principle of complete ignorance**). %}

Kopylov, Igor (2009) "Choice Deferral and Ambiguity Aversion," *Theoretical Economics* 4, 199–225.

{% Representation à la Dekel, Lipman, & Rustichini (2009, RESTUD) over menus that can capture temptation and so on. %}

Kopylov, Igor (2009) "Finite Additive Utility Representations for Preferences over Menus," *Journal of Economic Theory* 144, 354–374.

{% Extends probabilistic sophistication to infinite and unbounded distributions, so that normal distributions and so on can be handled, mainly by using Arrow's monotone continuity. %}

Kopylov, Igor (2010) "Unbounded Probabilistic Sophistication," *Mathematical Social Sciences* 60, 113–118.

{% Uses techniques (truncation continuity) from my 93 MOR paper, with a countable additivity axiom added. This way it can achieve useful simplifications. Also, very importantly, this paper is the **FIRST** to axiomatize **CONSTANT DISCOUNTING FOR CONTINUOUS TIME.** As often as this functional has been used, no one had ever axiomatized it yet. There are close results by Grodal and Vind, and by Harvey & Østerdal, but they did not really have it, and Kopylov is the first.

The paper follows Savage (1954) in having a rich state space (elements can also be timepoints), so that the outcome space can be general, e.g., finite. It uses Arrow' monotone continuity instead of P6/P7, giving countable additivity, but the event space is only an algebra and need not be a σ-algebra. P. 869 discusses the case of the universal σ-algebra, but by Banach & Kuratowski (1929) and Ulam (1930) this cannot be (there is no countably additive atomless P on it). The author also assumes pointwise monotonicity. %}

Kopylov, Igor (2010) "Simple Axioms for Countably Additive Subjective Probability," *Journal of Mathematical Economics* 46, 867–876.

{% **preference for flexibility**: Gul & Pesendorfer's (2001) menu framework. Example: paying for not going to the gym. Avoiding tasks for fear of negative self evaluation. Has a utility component that reflects emotional costs and benefits of perfectionism. %}

Kopylov, Igor (2012) "Perfectionism and Choice," *Econometrica* 80, 1819–1843.

{% **one-dimensional utility**: States continuity conditions that are suited for simple proofs and extensions of domains while preserving the continuity. Seems to provide the simplest derivation of general one-dimensional utility. %}

Kopylov, Igor (2016) "Canonical Utility Functions and Continuous Preference Extensions," *Journal of Mathematical Economics* 67, 32–37.

{% Considers maxmin EU with set Δ of priors exogenously given. Good arguments can be given for using Δ as exogenous. And, as often done, the Anscombe-Aumann framework is used. Model is convex combination of EU and maxmin EU: $(1-\varepsilon)EU_p + \varepsilon \inf_{q \in \Delta} EU_q$ for a subjective probability measure p. So, a special case of neo-additive (**EU+a*sup+b*inf**). §1.3 shows that the model can be rewritten as maxmin EU with ε contamination multiple priors. The set of priors is derived endogenously here. The same model with this set endogenous is in Kopylov (2009).

A monotonicity condition over Δ ensures that p is in Δ. The security level of each act is the EU minimized over Δ. For acts with same security level, vNM independence holds, so that then EU governs. The preference value of an act depends on both the EU mentioned and the security level, leading to the convex combination. Given the linearity present in the Anscombe-Aumann framework, the convex combination results. Note that Jaffray (1994 §3.4.3) also characterizes α maxmin with Δ exogenously given.

The paper also considers updating with a weakening of dynamic consistency (**dynamic consistency**; **updating under ambiguity**). %}

Kopylov, Igor (2016) "Subjective Probability, Confidence, and Bayesian Updating," *Economic Theory* 62, 635–658.

{% Keeps all axioms of Gilboa & Schmeidler (1989) except transitivity. Then the set of multiple priors can depend on the partitions of the state spacce generated by the available acts, based on partitional transitivity. The paper is motivated by Fox & Tversky's (1995) comparative ignorance. Theorem 4 adds betweennessn in a way to get partition-dependent SEU. %}

Kopylov, Igor (2021) "Multiple Priors and Comparative Ignorance," *Journal of Economic Theory* 191, 105–132.

{% %}

Korchin, Sheldon J. (1976) "*Modern Clinical Psychology.*" Harper & Row Inc., New York.

{% %}

Korhonen, Pekka, Herbert Mowkowitz, & Jyrki Wallenius (1992) "Multiple Criteria Decision Support—A Review," *European Journal of Operational Research* 63, 361–375.

{% **Dutch book**: they test this in fact (although not referring to uncertainty and only to multicriteria choice, using hypothetical choice, having 144 students choose between pairs of credit points and grade points for the coming academic year. %}

Korhonen, Pekka J., Kari Silvennoinen, Jyrki Wallenius, & Anssi Öörni (2012) "Can a Linear Value Function Explain Choices? An Experimental Study," *European Journal of Operational Research* 219, 360–367.

{% **updating: testing Bayes' formula** %}

Koriat, Asher (2008) "Alleviating Inflation of Conditional Predictions," *Organizational Behavior and Human Decision Processes* 106, 61–76.

{% Present the judgment aggregation paradox: Imagine three judges on three issues. If we apply the majority rule but first aggregate over issues, a different result can come than if we first aggregate over judged. %}

Kornhauser, Lewis A. & Lawrence G. Sager (1986) "Unpacking the Court," *Yale Law Journal*, 96, 82–117.

{% Written from legal perspective, but with very detailed discussion and review of endowment effect. %}
Korobkin, Russell (2003) "The Endowment Effect and Legal Analysis," *Northwestern University Law Review* 97, 1227–1293.

{% Cites many papers advancing book arguments against thirders and halvers in sleeping beauty. %}
Korzukhin, Theodore (2021) "A Dutch Book for CDT Thirders," *Synthese* 198, 11925–11941.
https://doi.org/10.1007/s11229-020-02841-7

{% Explains lattices and Möbius inverses from general mathematics. %}
Koshevoy, Gleb A. (1998) "Distributive Lattices and Products of Capacities," *Journal of Mathematical Analysis and Applications* 219, 427–441.

{% **game theory for nonexpected utility** %}
Koskievic, Jean-Max (1997) "Bargaining and Rank Dependent Utility Model,"

{% **value of information**: Takes emotions of fear for negative information as part of the utility function. Thus, aversion to information can arise. But it can't be anything and, for instance, it will never make a person go to a bad doctor instead of a good doctor. %}
Köszegi, Botond (2003) "Health Anxiety and Patient Behavior," *Journal of Health Economics* 22, 1073–1084.

{% Surveys behavioral ideas, such as loss aversion, in contract theory and mechanism design. %}
Köszegi, Botond (2014) "Behavioral Contract Theory," *Journal of Economic Literature* 52, 1075–1118.

{% Biggest contribution of this paper is to give background to what the reference point is, and doing so in a tractable and implementable manner. Big question in prospect theory is what the reference point is. This paper, as explained p. 1136 end, gives an answer, using common economic-model inputs (besides the gain-

loss function μ and interpretations of utility as introspective rather than revealed-preference measurable).

u(c|r) is utility of outcome c if reference outcome is r. The authors consider U(F|G) with F and G prospects (probability distributions over outcomes), F being the prospect received, and G being the reference prospect. (**conservation of influence**: would be nice to reconsider it from that perspective). So, not only the object received but also the reference point can be random, as in Sugden (2003). G need not be status quo but is EXPECTED prospect. (Here expected could be a natural-language term, but it also is taken as a formal expectation integrating out over a probability distribution over decision situations, where apparently an expectation is the operation to be used but this is only applied to the second-stage probabilities. I will ignore this extra stage in what follows.) If a person decides to choose some F from an available set, then F will also become the expectation, and U(F|F) is the evaluation to be considered. Choosing from an available set then amounts to maximizing the function F --> U(F|F) which, in this interpretation, could be taken as just a consumption utility function of F with no reference dependence involved. Caveat is that F must be a personal equilibrium (PE) in the sense that U(F´|F) should not exceed U(F|F) for the available F´. The best such, maximizing F --> U(F|F), is the preferred personal equilibrium (PPE). F|F is a PE if sufficiently strong assumptions of loss aversion are made, favoring the reference point enough relative to other points. A strange thing is that in all evaluations U(F|G) the authors assume F and G stochastically independent, also if F is G. It means that what is known as disappointment (under regret you compare with other things that could have happened had you acted differently; under disappointment you compare with other things that could have happened had nature, coincidence, acted differently) plays a big role in this model. It is also remarkable that in optimizing F --> U(F|F) (rather than staying put in the first PE one runs into), the reference point is apparently something to choose so as to optimize, and utilities of different reference points are compared to each other. The function U(F|F), with stochastic independence of the one F from the other F, is like the one of Delquié & Cillo (2006). Traditional models only have choices GIVEN a reference point, and endogeneity of a reference point then means no more than that we infer from choices what the reference point is but still without assuming that the reference point was an actual thing to choose.

I next give details about U. The authors propose that utility U(c) consists of two components, first a consumption utility, second a gain-loss component (I would prefer to interpret it as a more general perception component that also captures diminishing sensitivity etc., similar to Sugden's (2003, JET) gain-loss interpretation which in fact also captures more general psychological perceptions), and get $U(c) = m(c) + n(c|r)$, where $n(c|r) = \mu\big(m(c) - m(r)\big)$. They take U as sum of m and n, and not as composition where U(c) would be $u\big(\varphi(c)\big)$ with φ a (mis)perception which would be my preferred way to model. The sum suggests that psychological perception be an additional source (error possibly) of utility, besides consumption, rather than an intervening misperception. This point is essential when they impose the assumptions of prospect theory on the utility-difference transformation μ.

They propose that the reference point is the expectation of future consumption. If this expectation is related to the decision yet to be taken (rather than a decision made before, in the past), then an implicit definition results. Equilibria are formulated for when this can happen consistently. In the case of multiple equilibria, the one with highest utility is selected, which, if not taken as if, would suggest that the consumer is actively choosing between different reference points to take. Traditionally, reference points are not objects of choice, but aspects determining choice.

The authors derive predictions about more or less willingness to buy depending on whether one had long time to get accustomed to new situation with adaptation of reference point. They also get some self-fulfilling results where a consumer wants to buy iff he expects to buy.

They in fact take multidimensional commodity bundles with, for simplicity, additively separable utility (with a common discussion that separability is justified under proper consequentialistic definition of components)

$U(c) = U(c_1,\ldots,c_n) = U_1(c_1) + \cdots + U_n(c_n)$ with each $U_k(c) = m_k(c) + n_k(c|r)$.

For the underlying consequentialism assumption the nicest discussion that I know is in Broome (1991). For the plausibility of this decomposition, separability of the components is crucial, because consumers have to really perceive them separately so as to take reference points for each separately.

Sometimes they take μ linear outside of 0, so that all it does is generate a kink at the reference point. They explicitly assume that nonrevealed-preference based introspective or psychological inputs are used to determine various components of utility. This interpretation is desirable to justify comparisons between (U(F|G) and U(F´|G´) with G different than G', as happening in this paper, because it is hard to give revealed-preference foundations to it. U(F|G) is decreasing in G so that if we were completely free to choose G we would simply choose G extremely low to attain infinite happiness.

Whether status quo is different from what is expected is partly terminological. One could argue that status quo by definition incorporates what one then expects.

We all know from everyday experience that we sometimes manipulate our expectations, e.g. lowering them to avoid disappointment. This looks like choosing the reference point. It is, however, a minor marginal effect to change our utilities just a little bit. It can only justify a small part of utility. Making yourself more happy by choosing a different reference point is no more than an illusion. Loss aversion, on the other hand, can more than double our perception of utility. Hence, these two don't sit together well if treated as the same component as done in this paper.

biseparable utility: the most popular special case, with μ piecewise linear, is biseparable utility, and even RDU (Masatlioglu & Raymond 2016). %}

Köszegi, Botond & Matthew Rabin (2006) "A Model of Reference-Dependent Preferences," *Quarterly Journal of Economics* 121, 1133–1165.

{% Use their 2006 QJE model to predict risk attitudes after small or big gains or losses, being expected or being surprises. %}

Köszegi, Botond & Matthew Rabin (2007) "Reference-Dependent Risk Attitudes," *American Economic Review* 97, 1047–1073.

{% Dynamic model on plans for future consumption. Meant to be rational. Loss aversion over changes in beliefs. Reference point endogenously resulting from sophisticated optimization as in their other papers. So, one doesn't improve utility by choosing better alternatives, but by changing one's perception. A classical modeling would be that one chooses between pairs (F,G), with G a choice object rather than a reference point.

P. 912 Eq. 1: instant utility is sum of reference-dependent classical consumption utility and gain-loss utility derived from changes in belief about future outcomes.

P. 913 2/3: money in prospect theory is news about future consumption.

Pp. 913-914: belief-comparisons go through quantile-comparisons.

P. 914: loss aversion consists of two parts: (1) Kink of utility at 0 (their A4); (2) U´(-x) > U´(x) for all x > 0 (their A2).

Their (A3) has U convex for losses and concave for gains. But they will often assume utility linear for gains and losses.

P. 930: they write that their model crucially depends on what people believe, which makes it hard to test. %}

Köszegi, Botond & Matthew Rabin (2009) "Reference-Dependent Consumption Plans," *American Economic Review* 99, 909–936.

{% %}

Kothiyal, Amit (2012) "Subjective Probability and Ambiguity." Ph.D. dissertation, Erasmus School of Economics, Erasmus University Rotterdam, the Netherlands.

{% **proper scoring rules %}**

Kothiyal, Amit, Vitalie Spinu, & Peter P. Wakker (2011) "Comonotonic Proper Scoring Rules to Measure Ambiguity and Subjective Beliefs," *Journal of Multi-Criteria Decision Analysis* 17, 101–113.
https://doi.org/10.1002/mcda.454
Direct link to paper

{% **finite additivity** %}

Kothiyal, Amit, Vitalie Spinu, & Peter P. Wakker (2011) "Prospect Theory for Continuous Distributions: A Preference Foundation," *Journal of Risk and Uncertainty* 42, 195–210.
https://doi.org/10.1007/s11166-011-9118-0
Direct link to paper

{% %}

Kothiyal, Amit, Vitalie Spinu, & Peter P. Wakker (2014) “Average Utility Maximization: A Preference Foundation,” *Operations Research* 62, 207–218. http://dx.doi.org/10.1287/opre.2013.1230
Direct link to paper

{% Shows that prospect theory with the source method better fits/predicts data than other popular ambiguity models. It thus corrects an analysis by Hey, Lotito, & Maffioletti (JRU, 2010). %}

Kothiyal, Amit, Vitalie Spinu, & Peter P. Wakker (2014) “An Experimental Test of Prospect Theory for Predicting Choice under Ambiguity,” *Journal of Risk and Uncertainty* 48, 1–17.
http://dx.doi.org/10.1007/s11166-014-9185-0
Direct link to paper

{% The authors interviewed 910 entrepreneurs, 397 managers, and 981 employees, which is an impressive sample, online. They measured risk attitude w.r.t. gain-lotteries, mixed lotteries, and ambiguity aversion w.r.t. ambiguous (Ellsberg urns) gambles. Ambiguity attitudes do not differ, and neither risk aversion for gains, between the groups. But they do for mixed gambles, suggesting that entrepreneurs are less loss averse than the others. In their terminology, the authors equate risk aversion with risk aversion for gains, and take loss aversion as distinct from risk aversion, a terminology differring from mine. %}

Koudstaal, Martin, Randolph Sloof, & Mirjam van Praag (2016) “Risk, Uncertainty, and Entrepreneurship: Evidence from a Lab-in-the-Field Experiment,” *Management Science* 62, 2897–2915.
http://dx.doi.org/10.1287/mnsc.2015.2249

{% **updating under ambiguity**:
Updating of set of priors, partial Bayesian. (1) utilizes an event-dependent threshold to determine whether a prior is likely enough; (2) applies Bayes’ rule to the sufficiently likely priors. %}

Kovach, Matthew (2024) “Ambiguity and Partial Bayesian Updating,” *Economic Theory* 78, 155–180.

https://doi.org/10.1007/s00199-023-01528-7

{% **coalescing**: Demonstrate complexity aversion (w.r.t. number of stages and branches and degree of ambiguity). Suggest that complexity aversion generates ambiguity aversion. %}

Kovarik, Jaromir, Dan Levin & Tao Wang (2016) "Ellsberg Paradox: Ambiguity and Complexity Aversions Compared," *Journal of Risk and Uncertainty* 52, 47–64. https://doi.org/10.1007/s11166-016-9232-0

{% Propose a new way to estimate prospect theory. %}

Kpegli, Yao Thibaut, Brice Corgnet, & Adam Zylbersztejn (2020) "All at Once! A Comprehensive and Tractable Semi-Parametric Method to Elicit Prospect Theory Components," working paper.

{% %}

Krabbe, Paul F.M. (1998) "The Valuation of Health Outcomes," Ph.D. dissertation, Erasmus Uiversity, Rotterdam, the Netherlands.

{% **time preference**. In a nicely simple setup they show that the value of a health state depends on what came before or after, so, there is a sequence effect.

intertemporal separability criticized: sequence effects %}

Krabbe, Paul F.M. & Gouke J. Bonsel (1998) "Sequence Effects, Health Profiles, and the QALY Model: In Search of Realistic Modeling," *Medical Decision Making* 18, 178–186.

{% **ordering of subsets**: Show that the five necessary conditions for representability by a finitely additive probability measure of an ordering of subsets are also sufficient if the state space has 4 or fewer elements. If 5 or more, then no more, and counterexamples exist. With 5 states we still always have almost representability, but with 6 or more also that can go wrong. They give necessary and sufficient conditions for finite state spaces, amounting to the duality conditions for solving linear inequalities.

Their result in fact shows that for only two consequences and no more than 4 states of nature, Savage's (1954) axioms (with the richness condition P6

removed) are necessary and sufficient for SEU. (De Finetti's additivity axiom is the sure-thing principle if there are only two outcomes.) %}
Kraft, Charles H., John W. Pratt, & Teddy Seidenberg (1959) "Intuitive Probability on Finite Sets," *Annals of Mathematical Statistics* 30, 408–419.

{% **second-order probabilities to model ambiguity**
A choice made can alter subjective beliefs/tastes, with regret coming in, implying Schmeidler's (1989) quasi-convexity interpreted as uncertainty aversion. %}
Krähmer, Daniel & Rebecca Stone (2013) "Anticipated Regret as an Explanation of Uncertainty Aversion," *Economic Theory* 52, 709–728.

{% Door Anne Stiggelbout besproken op 18 nov. 1992
that discounting of money should be as strong as for health states. %}
Krahn, Murray. & Amiram Gafni (1993) "Discounting in the Economic Evaluation of Health Care Interventions," *Medical Care* 31, 403–418.

{% %}
Krahnen, Jan-Pieter & Martin Weber (1999) "Does Information Aggregation Depend on Market Structure?," *Zeitschrift für Wirtschafts- und Sozialwissenschaften* 119, 1–22.

{% %}
Krahnen, Jan-Pieter & Martin Weber (1999) "Generally Accepted Rating Principles: A Primer."

{% Introduced the two-envelope paradox, in a version with two neckties. %}
Kraitchik Maurice B. (1953) "*Mathematical Recreations*." Dover, New York, NY.

{% %}
Krantz, David H. (1975) "Color Measurement and Color Theory. I. Representation Theorem for Grassman Structures," *Journal of Mathematical Psychology* 12, 283–303.

{% Tries to characterize belief functions. %}

Krantz, David H. (1982) “Foundations of the Theory of Evidence.” Paper presented at the Society for Mathematical Psychology, Princeton, NJ.

{% P. 7 seems to exclude preferential choice research from this survey of mathematical psychology, writing pessimistically “there is no lack of technically excellent papers in this area … they give no sense of any real accumulation of knowledge. … what are the established laws of preferential choice behavior?” (p. 7). %}

Krantz, David H., Richard C. Atkinson, R. Duncan Luce, & Patrick Suppes (1974) “*Contemporary Developments in Mathematical Psychology*.” W. H. Freeman, San Francisco.

{% %}

Krantz, David H. & Laura K. Briggs (1990) “Judgments of Frequency and Evidence Strength,” Dept. of Psychology, Columbia University, New York.

{% Online lectures on this book by its authors in 1981 are here: https://www.youtube.com/playlist?list=PLrKlhVqlZwK6UcJ7K-XpaLmWoGehnXLAX

A good concise description of the essence of this book is Narens & Luce (1986). If you study this book, then you will be 100 years ahead of your field. The first chapter explains how measurement starts with counting, and how standard sequences capture this. It gives a geneal technique for getting cardinal measurement in ordinal preference models. I was lucky to be exposed to this technique at young age. In my young years I wrote many papers using this technique, using the term tradeoff. Unfortunately, I co-found the right way to market it, using merely indifferences, only in Köbberling & Wakker (2004 JRU), mathematically matured in the follow-up paper Köbberling & Wakker (2003). The present, 2013, generation (I write this para in 2013) working on ambiguity and uncertainty has forgotten this technique of Krantz et al. (1971) and, hence, mostly uses the unsatisfactory Anscombe-Aumann (1963) model to get cardinality. The present 2013 generation does not have the insights of the previous generation that by coincidence had some exceptionally deep mathematicians, being Krantz et al. (1971). Unfortunately, Luce in his return to decision theory in the 1990s had lost his technique, and used the unsatisfactory

joint receipt to get cardinality.

standard-sequence invariance; Fig. 1 in §1.2 (p. 18) depicts the construction of standard sequences.

restricting representations to subsets: p. 276

Pointed out to me by Han Bleichrodt (in Nov. 2003): §6.3.4, p. 266, 3rd and 4th para claim, without any justification, that a local version of triple cancellation implies a global one. In the algebraic approach, no such results are available in the literature though.

Ttm. 4.2: **strength-of-preference representation**.

Kirsten&I: Ch. 6, with finitely many timepoints;

criticisms of Savage's basic framework: §8.2.1 explains Luce's views on the primitives of decision under uncertainty, deviating from Savage (1954).

criticizing the dangerous role of technical axioms such as continuity: §9.1 has the good discussion of the dangerous empirical status of technical axioms such as continuity and solvability, often overlooked. In the presence of other axioms, they do have empirical content but it may not be clear what that content is. See also §6.6 of Pfanzagl (1968), and Schmeidler (1971).

cancellation axioms: Theorem 9.2.1 (p. 430) gives necessary and sufficient conditions for additive representation of finitely many preferences (can be incomplete on any subset of a product set) through cancellation axioms. Unfortunately, the authors use an irreflexivity condition for an extended relation and it takes some time to see that this is equivalent to imposing all cancellation axioms.

§10.9.2 distinguishes between fundamental and derived measurement:

"As we use the term, an attribute is called *fundamental* if its measurement does not depend on the measurement of anything else. … If, as is usual, one places derived in opposition to fundamental, …" Most of the section discusses how other authors used the terms, and some confusions.

SELECTION OF MATERIAL FOR STUDENTS

For students of preference axiomatizations of decision theory, here is a selection of material from the book that is useful to read. The general techniques of this book allow for appealing and mathematically general theorems because they show how to obtain cardinality efficiently. The techniques of this book are mostly based on Hölder's lemma, which is more efficient than the mixture-set techniques of the Anscombe-Aumann framework. This knowledge has been lost by present (2013) generations, which is why nowadays (1990-2023) in decision under uncertainty (ambiguity) the Anscombe-Aumann framework is usually used, to my regret.

Preface: read

Ch. 1 on general measurement procedures: study

Ch. 2 on first derivations of numerical representations: study except:
§2.2.7 (rings) read once. Its ring structure is useful for SEU and discounted utility where, besides an addition operation, also a multiplication operation plays a role.

Ch. 3 on measurement with an operation: study except:
§3.2.2 (periodic case): skip
§3.4 (measurement when operation is incomplete) gives the really powerful mathematical tools from which much in this book is derived. It can however be skipped if only the gist of the book is to be learnt.
§3.6: skim
§3.7 (essential maxima): skip
§3.10.1: skim
§3.10.2: important
§3.12: c onditional connectedness: skip
§3.14 intro: read
§3.14.1 (riskiness): skip

Ch. 4: useful but can be skipped if only the gist of the book is to be learnt.
If you study it, can skip §4.6 (cross-modality), 4.10 (absolute difference), and 4.12 (strongly conditional indifference structures).

Ch. 5: useful but can be skipped if only the gist of the book is to be learnt.
If you study it:
§5.4.1 (QM-algebra) is useful for the study of ambiguity because the set of

unambiguous events will not be an algebra, but can be a QM algebra.
§5.6 (conditional qual. prob): can skim
§5.8 (stochastic independence as a primitive): can skip

Ch. 6: most important chapter
§6.5.1: skip
§6.5.5 important for nonEU that imposes the EU axioms on subspaces.
§6.7: skim
§6.9: bisymmetry is a way to turn additive representations into SEU and discounted utility, alternatively to my tradeoff technique.
§6.11 (many components): most important section in book.

Ch. 7 on polynomial measurement: nice but can skim

Ch. 8 on risk/uncertainty: skip because outdated

Ch. 9 on finite sets: study
§9.1-9.2: important
§9.4 (applications): skip
§9.5: polynomial: skip

Ch. 10 on dimensional laws: skip
--- %}

Krantz, David H., R. Duncan Luce, Patrick Suppes, & Amos Tversky (1971) "*Foundations of Measurement, Vol. I (Additive and Polynomial Representations)*." Academic Press, New York. (2nd edn. 2007, Dover Publications, New York.)

{% %}

Krantz, David H. & Geoffrey F. Miller (1990) "Judgments of Likelihood Evidence," Dept. of Psychology, Columbia University, New York.

{% Figure 3, distributive cancellation, is a special case of triple cancellation. If, with gauge (a,.,.) versus (b,.,.), you compare a tradeoff on only the 2nd coordinate with

a tradeoff on only the 3rd coordinate, then this should remain if the gauge on the first coordinate is replaced by a gauge (c,.,.) versus (d,.,.). It is in fact symmetric in the three coordinates.

Fig. 4 shows that Gorman's (1968) result was not known among mathematical psychologists. %}

Krantz, David H. & Amos Tversky (1971) "Conjoint-Measurement Analysis of Composition Rules in Psychology," *Psychological Review* 78, 151–169.

{% P. 13 introduces the beautiful and important concept of **relative curvature** for subjective dimensions; i.e., one scale is more curved than another. Unfortunately, it does not pay much attention to it. To define it, let δ denote a distance (or difference) function, and there are scale 1 and scale 2, with elements x_1,y_1, z_1, and x_2,y_2, z_2, respectively. If $\delta(x_1,y_1) = \delta(x_2,y_2)$ and $\delta(y_1,z_1) = \delta(y_2,z_2)$ but $\delta(x_1,z_1) \geq \delta(x_2,z_2)$ then the second scale is more curved than the first. A bit more general: if $\delta(x_1,y_1) \leq \delta(x_2,y_2)$ and $\delta(y_1,z_1) \leq \delta(y_2,z_2)$ but $\delta(x_1,z_1) \geq \delta(x_2,z_2)$ then the second scale is more curved than the first. Note that here we are not comparing different functions on the same domain, as in tyical Pratt-Arrow results, but we compare the same distance function δ (could also be different) on different subdomains. (**measure of similarity)** %}

Krantz, David H. & Amos Tversky (1975) "Similarity of Rectangles: An Analysis of Subjective Dimensions," *Journal of Mathematical Psychology* 12, 4–34.

{% **preference for flexibility** %}

Kraus, Alan & Jacob Sagi (2006) "Inter-Temporal Preference for Flexibility and Risky Choice?," *Journal of Mathematical Economics* 42, 698–709.

{% %}

Kraus, Alan & Jacob Sagi (2006) "Asset Pricing with Unforeseen Contingencies?," *Journal of Financial Economics* 82, 417–453.

{% May explain if Aristotel had some sort of concept of utility. The author had many papers on Bentham, utility, etc. %}

Kraus, Oskar (1903) "Die Aristotelische Werttheorie in Ihrer Beziehungen zu den Lehren der Modernen Psychologenschule," *Zeitschrift für die Gesamte Staatswissenschaften* 61, 573–592.

{% **real incentives/hypothetical choice**: seem to consider how actual behavior can be predicted from (hypothetical!) attitude questions. %}

Kraus, Stephen J. (1995) "Attitudes and the Prediction of Behavior: A Meta-Analysis of the Empirical Literature," *Personality and Social Psychology Bulletin* 21, 58–75.

{% **PT falsified; probability weighting depends on outcomes** %}

Krawczyk, Michal W. (2015) "Probability Weighting in Different Domains: The Role of Affect, Fungibility, and Stakes," *Journal of Economic Psychology* 51, 1–15.

{% Study insurance for low-probability large-loss events. (**(very) small probabilities**) Discuss that many people do NOT insure here. Mimic it in the lab with subjects getting money and risking to loose it. Social comparison effects are less robust. People underweight others' information. %}

Krawczyk, Michal W., Stefan T. Trautmann, & Gijs van de Kuilen (2017) "Catastrophic Risk: Social Influences on Insurance Decisions," *Theory and Decision* 82, 309–326.

{% **Best core theory depends on error theory**: they find it for prospect theory.

They study identifiability/collinearity but only if one parameter concerns the error theory and the other the core theory. As remedies they study: Redefining the subjective parameters of the core theory or changing the error theory. P. 21 2nd para mentions an important third remedy not analyzed: To change the stimuli used to measure the model. Some stimuli will be better to separate parameters than others.

P. 20 "General Discussion" is in fact just a summary.

P. 20 penultimate para opens with "Moreover, the problem of interdependent parameters is not restricted to computational models of cognition." This is trivial because it is a general problem of statistics, occurring in all empirical disciplines. %}

Krefeld-Schwalb, Antonia, Thorsten Pachur, & Benjamin Scheibehenne (2022) "Structural Parameter Interdependencies in Computational Models of Cognition," *Psychological Review* 129, 33–339. https://doi.org/10.1037/rev0000285

{% **risky utility u = transform of strength of preference v**, haven't checked if latter doesn't exist. %}

Krelle, Wilhelm E. (1968) "*Präferenz- und Entscheidungstheorie.*" Mohr, Tübingen.

{% **risky utility u = transform of strength of preference v**, haven't checked if latter doesn't exist. %}

Krelle, Wilhelm E. (1984) "Remarks to Professor Allais' Contributions to the Theory of Expected Utility and Related Subjects." *In* Ole Hagen & Fred Wenstop (eds.) *Progress in Utility and Risk Theory*, 173–180, Reidel, Dordrecht.

{% Acceptance of small risky gambles and scores on math tests is associated with inventory accumulation among Kenyan shopkeepers. The authors argue that loss aversion plays a big role here. %}

Kremer, Michael, Jean Lee, Jonathan Robinson, & Olga Rostapshova (2013) "Behavioral Biases and Firm Behavior: Evidence from Kenyan Retail Shops," *American Economic Review, Papers and Proceedings* 103, 362–368.

{% %}

Kreps, David M. (1977) "Decision Problems with Expected Utility Criteria, I: Upper and Lower Convergent Utility," *Mathematics of Operations Research* 2, 45–53.

{% **preference for flexibility** %}

Kreps, David M. (1979) "A Representation Theorem for Preference for Flexibility," *Econometrica* 47, 565–577.

{% Kreps 1988 Eqs. 4.4 and 7.13 argues that state-dependent expected utility is like additive decomposability.

Does he use "Axiom 0" as name for DUR assumption? P. 101 mentions that Anscombe-Aumann's enrichment is OK normatively if person can imagine, but descriptively is highly problematic (in case of coming as auxiliary structure.

P. 120:

"Savage's theory, which is the crowning glory of choice theory, …"

P. 127, beginning of Ch. 9: "This is actually part of his theory of choice under uncertainty, which is, as much as anything, the crowning achievement of single-person decision theory." %}

Kreps, David M. (1988) "*Notes on the Theory of Choice.*" Westview Press, Boulder, Colorado.

{% %}

Kreps, David M. (1990) "*A Course in Microeconomic Theory.*" Princeton University Press, Princeton, NJ.

{% **small worlds**? %}

Kreps, David M. (1992) "Static Choice in the Presence of Unforeseen Contingencies." *In* Partha Dasgupta, David Gale, Oliver Hart, & Eric S. Maskin (eds.) *Economic Analysis of Market and Games: Essays in Honor of Frank Hahn*, MIT Press, Cambridge, MA.

{% **source-dependent utility**: the first paper to have this clearly.

dynamic consistency (DC); p. 189, following Axiom 2.1, states version of context-independence;

Paper does dynamic decision under risk, with consumption at each timepoint; Axiom 3.11 ("Temporal consistency") is what is nowadays (after Halevy 2015) called time consistency, maybe with forgone-branch independence included I am not sure; Theorem 2 on p. 195 then shows the way I always look at the models of Luce/Segal: Given DC, you can consider only prior choice. It is nicely repeated in words following Corollary 2 on p. 196; Axiom 6.1 resembles forgone-branch independence (often called consequentialism) but also requires independence of past consumption which is far less innocuous than real forgone-branch independence.

They assume EU at every single-stage but give up the **RCLA** assumption and, thus, permit nonindifference to the timing of the resolution of uncertainty.

A simplified version can be found in §2 of Grant, Kajii, & Polak (1998, JET)

"Intrinsic Preference for Information," in §1 of Ahlbrecht & Weber (1997, Theory and Decision), and in Ch. 20 of Gollier (2001). According to Grant et al., Kreps & Porteus (1978) were the first to introduce preference for early resolution of uncertainty. The basic model is, for two-stage gambles:

$\sum_{j=1}^{n} p_j VU^{-1}(EU(z_j))$ where: $EU(z_j)$ is expected utility under some utility function U applied to a second-stage lottery z_j. V is a transformation function serving as a vNM utility function in the first stage. Whereas U only captures risk attitude, V also captures attitude towards the timing of the resolution of uncertainty. VU^{-1} is convex iff early resolution is always preferred to late. %}

Kreps, David M. & Evan L. Porteus (1978) "Temporal Resolution of Uncertainty and Dynamic Choice Theory," *Econometrica* 46, 185–200. https://doi.org/10.2307/1913656

{% **dynamic consistency: favors abandoning RCLA when time is physical.** %}

Kreps, David M. & Evan L. Porteus (1979) "Dynamic Choice Theory and Dynamic Programming," *Econometrica* 47, 91–100.

{% **consequentialism/pragmatism**: putting everything relevant in consequences makes model intractable;

P. 82 seems to argue for nonindifference towards the timing of the resolution of uncertainty. %}

Kreps, David M. & Evan L. Porteus (1979) "Temporal von Neumann-Morgenstern and Induced Preferences," *Journal of Economic Theory* 20, 81–109.

{% %}

Kreps, David & Joel Sobel (1994) "Signalling." *In* Robert J. Aumann & Sergiu Hart (eds.) *Handbook of Game Theory, Volume II*, 849–867. Elsevier, Amsterdam.

{% %}

Kreps, David M. & Robert Wilson (1982) "Sequential Equilibria," *Econometrica* 50, 863–894.

{% As pointed out by Fishburn, this paper was the first to introduce the skew-symmetric bilinear utility theory of Fishburn. %}

Kreweras, Germain (1961) "Sur une Possibilité de Rationaliser les Intransitivités," *La Décision*, Colloques Internationaux CNRS, 27–32.

{% %}

Kriegler, Elmar, Jim W. Hall, Hermann Held, Richard Dawson, and & Joachim Schellnhuber (2009) "Imprecise Probability Assessment of Tipping Points in the Climate System," *Proceedings of the National Academy of Sciences* 106, 5041–5046.

{% %}

Krijnen, Job M. T., Gülden Ülkümen, Jonathan E. Bogard, & Craig R. Fox (2022) "Lay Theories of Financial Well-Being Predict Political and Policy Message Preferences," *Journal of Personality and Social Psychology: Personality Processes and Individual Differences* 122, 310–336. https://doi.org/10.1037/pspp0000392

{% %}

Krischer, Jeffrey P. (1980) "An Annotated Bibliography of Decision Analytic Applications to Health Care," *Operations Research* 28, 97–113.

{% An earlier study reported that asking people in the beginning of a questionnaire to be truthful works better than at the end. This study reports in detail that it fails to replicate.

The paper considers the kind of honesty test where people throw a die, report which number k ($1 \le k \le 6$) came up, and then receive $k. However, no one else can see whether they reported truthfully. Statistically, too many report high numbers. One cannot prove dishonesty at the individual level, but one can prove statistically at the group level. I always have difficulties here. The rewarding system rewards dishonest people and punishes honest people, and if anything is to be called immoral I would say it is the rewarding system. If a subject, fully knowing the design, throws a low number and then reports the low number I

would not call that honest but rather stupid. So, I think that they are not studying honesty but stupidity. %}

Kristal, Ariella S., Ashley V. Whillans, Max H. Bazerman, Francesca Gino, Lisa L. Shu, Nina Mazar, & Dan Ariely (2019) "Signing at the Beginning versus at the End Does not Decrease Dishonesty," *Proceedings of the National Academy of Sciences* 117:13, 7103–7107.

{% **equity-versus-efficiency**: seems to be on it. %}

Kritikos, Alexander & Friedel Bolle (2001) "Distributional Concerns: Equity- or Efficiency-Oriented?," *Economics Letters* 73, 333–338.

{% **foundations of statistics**; **foundations of probability**
Nice books on history and discussions of probability %}

Krüger, Lorenz, Lorraine J. Daston, & Michael Heidelberg (1987, eds.) "*The Probabilistic Revolution*, Vol. 1: Ideas in History," MIT Press, Cambridge, MA.

{% **foundations of statistics**; **foundations of probability**
Nice books on history and discussions of probability %}

Krüger, Lorenz, Gerd Gigerenzer, & Mary S. Morgan (1987, eds.) "*The Probabilistic Revolution*, Vol. 2: Ideas in the Sciences," MIT Press, Cambridge, MA.

{% %}

Krueger, Norris F. & Peter R. Dickson (1994) "How Believing in Ourselves Increases Risk Taking: Perceived Self-Efficacy and Opportunity Recognition," *Decision Sciences* 25, 385–400.

{% The Kruger-Dunning effect: That people of low skill think they are good whereas people of high skill know their limitations, has happens for instance in finance where laypeople think they can predict the market. %}

Kruger, Justin & David Dunning (1999) "Unskilled and Unaware of It: How Difficulties in Recognizing One's Own Incompetence Lead to Inflated Self-Assessments," *Journal of Personality and Social Psychology* 77, 1121–1134.
https://doi.org/10.1037/0022-3514.77.6.1121

{% %}
Krugman, Paul (1998) “Two Cheers for Formalism,” *Economic Journal* 108, 1829–1836.

{% **utility elicitation**; shows that patients have difficulty in relating to probabilities. %}
Krumins, Peter E., Stephan D. Fihn, & Daniel L. Kent (1988) “Symptom Severity and Patients’ Values in the Decision to Perform a Transurethral Resection of the Prostate,” *Medical Decision Making* 8, 1–8.

{% **foundations of statistics**: A warm plea for Bayesian statistics. Giving nice numerical examples, graphs, and useful software. §1 nicely illustrates the ad hoc (but no better alternative) things that Bayesians can do once they arrived at the posterior distribution. My sympathy is with the likelihood principle, that the likelihood function (= Bayes factors) summarizes the relevant info in the data, and that from there on further things have to be added such as prior distribution and ad hoc things such as described in this §1. P. 577 1st column last para describes ROPE (region of practical equivalence) as a region around 0 taken as negligibly different from 0, where an effect size of 0.1 is qualified as small. It is ad hoc but there is nothing better.

Unfortunately, theoretical backgrounds, while available in the literature, are often lacking in this paper. For many known problems, the author does not cite literature or uses standard terminology, but develops a private terminology. For instance, that p-values depend on sampling “intentions” is the author’s way of writing about violations of the likelihood principle, a term that is never mentioned.

The paper throughout presents richness of info as a pro, e.g. the richness of reporting the whole posterior distribution versus a binary “reject/no-reject” of NHST. P. 587 penultimate para: “Therefore we should use the analysis method that provides the richest information possible regarding the answer we seek. And that method is Bayesian estimation.” By reductio ad absurdem, the richest info, just giving the whole data set with every data point, would then be best to do. This is not so. There should also be tractability and direct relevance for decisions: statistics should present useful *summaries* of data.

The presentation of null hypothesis significance testing (NHST) is overly simplistic:

P. 573, bottom of 1st column, claims that NHST cannot accept (in the sense of arguing for) the null hypothesis. But NHST can do things, such as power analysis and reformulating the null as alternative.

The paper often suggests that NHST can only do t-tests, and cannot handle other distributions. Relatedly,

The paper often suggests that NHST cannot handle outliers.

P. 577 middle of 1st column describes the well-known problem of statistical significance that has no economic/psychological significance. The author uses a strong versus weak theory terminology for this point.

For Bayes factors the author throughout uses the terms model and prior for what I think are parameter value and distribution over observables conditional on parameter.

P. 577 2nd column 1st para criticizes Bayes factor for being sensitive to choice of alternative, but this holds the same for ROPE.

The paper often writes about credible values but never defines them-at least I did not see it. I guess it means putting up a threshold and taking all parameters whose posterior is above the threshold.

The author often claims that one has to correct for multiple testing also if those tests concern unrelated and independent tests of different things, and complains about having to do extra tests ("I have to conduct an additional NHST F test"). %}

Kruschke, John K. (2013) "Bayesian Estimation Supersedes the *t* Test," *Journal of Experimental Psychology: General* 142, 573–603.

{% %}

Krusell, Per P. & Anthony A. Smith (2003) "Consumption-Savings Decisions with Quasi-Geometric Discounting, *Econometrica* 71, 365–375.

{% **risky utility u = transform of strength of preference v**; **concave utility for gains, convex utility for losses**: Fig. 1 has some results for 12 subjects, but it is not clear, e.g. regarding reference level 0.5 and the use or not of mixed gambles. %}

Krzysztofowicz, Roman (1983) “Strength of Preferences and Risk Attitude in Utility Measurement,” *Organizational Behavior and Human Performance* 31, 88–113.

{% Studies a model by Hagen that combines linearly expectation and variance and skewness. %}

Krzysztofowicz, Roman (1994) “Filtering Risk Effect in Standard-Gamble Utility Measurement.” *In* Maurice Allais & Ole Hagen (eds.) “Cardinalism; A Fundamental Approach,” 233–248, Kluwer Academic Publishers, Dordrecht.

{% Studies, both empirically and axiomatically, lotteries with only one nonzero outcome, assumes strength of preferences over these lotteries given, and then derives weighting functions and value functions.

inverse S: §5.2 finds support for inverse S weighting function and EU for nonextreme probabilities. (**EU+a*sup+b*inf**)

risky utility u = strength of preference v (or other riskless cardinal utility, often called value): §4.2.5 discusses idea of transformation between value function v and risky utility function u and says that transformation idea does not seem to be correct.

P. 253: Influence formulation for str. of pr. %}

Krzysztofowicz, Roman (1994) “Generic Utility Theory: Explanatory Model, Behavioral Hypotheses, Empirical Evidence.” *In* Maurice Allais & Ole Hagen (eds.) “Cardinalism; A Fundamental Approach,” 249–288, Kluwer Academic Publishers, Dordrecht.

{% %}

Krzysztofowicz, Roman & Lucien Duckstein (1980) “Assessment Errors in Multiattribute Utility Functions,” *Organizational Behavior and Human Performance* 26, 326–348.

{% **risky utility u = strength of preference v (or other riskless cardinal utility, often called value)**: state this very explicitly in second paragraph of their paper! So, don’t want risky u to be transform of riskless v!

decreasing ARA/increasing RRA & **utility elicitation**: power family did somewhat better than exponential, much better than logarithmic or linear

utility measurement: c**orrect for probability distortion**. They use the term "risk function of probability" instead of probability weighting. %}

Krzysztofowicz, Roman & John B. Koch (1989) "Estimation of Cardinal Utility Based on a Nonlinear Theory," *Annals of Operations Research* 19, 181–204.

{% Seems to have **risk averse for gains, risk seeking for losses** %}

Kuhl, Julius (1978) "Standard Setting and Risk Preference: An Elaboration of the Theory of Achievement Motivation and an Empirical Test," *Psychological Review* 85, 239–248.

{% **foundations of statistics**: argue that Neyman's sampling theory supports an argument for the intermediate approach in the frequentism vs. Bayesianism debate. %}

Kubiak, Adam P. & Paweł Kawalec (2022) "Prior Information in Frequentist Research Designs: The Case of Neyman's Sampling Theory," *Journal for General Philosophy of Science* 53, 381–402.
https://doi.org/10.1007/s10838-022-09600-x

{% %}

Kübler, Dorothea & Georg Weizsäcker (2006) "Limited Depth of Reasoning and Failure of Cascade Formation in the Laboratory," *Review of Economic Studies* 71, 425–441.

{% Consider choices from budget sets over two periods, depending on prices and initial wealth, assuming the classical time-separable EU. Give conditions on preferences/utility under which utilities, beliefs, and discounting are identifiable. A sufficient condition is if some indirect marginal utilities are linearly independent. This holds often, but not for instance if utility is linear/exponential (CARA). Local data often suffices. %}

Kübler, Felix & Herakles Polemarchakis (2017) "The Identification of Beliefs from Asset Demand," *Econometrica* 85, 1219–1238.

{% **revealed preference**: Consider a finite state space $\{s_1,\ldots,s_n\}$, acts, and preferences over those. However, the state space is also endowed with objective probabilities ($p_1,\ldots,p_n$). They assume ($p_1,\ldots,p_n$) variable, getting a rich domain. Give necessary and sufficient conditions for expected utility maximization for a finite set of choices. %}

Kübler, Felix, Larry Selden, & Xiao Wei (2014) "Asset Demand Based Tests of Expected Utility Maximization," *American Economic Review* 104, 3459–3480.

{% **tradeoff method**.; **revealed preference**

Assume Savage model but with finite state space. Assume that objective probabilities of the states are given. Then axioms such as my tradeoff consistency can be used to give SEU. Only, this SEU model may use subjective probabilities different than the objective ones. They propose an axiom to then give identity of probabilites, generalizing Werner's (2005) risk aversion: There must exist a sure outcome such that in its neighborhood all acts with EV equal to that outcome are either all more preferred or all less preferred (if U´´ < 0 there). The case of always U´´ = 0 with linear utility also works. Their analysis does need sufficient differentiability of U.

They consider two richer domains: The probabilities of the states can vary, but preferences are only between acts with the same probabilities involved. Then tradeoff consistency can ensure the same utility function for different probabilities. And then, yet more general: Prefs can be between acts with different probabilities involved. Such prefs can be matched through certainty equivalents and transitivity. %}

Kübler, Felix, Larry Selden, & Xiao Wei (2017) "What Are Asset Demand Tests of Expected Utility Really Testing?," *Economic Journal* 127, 784–808.

{% **inverse S (= likelihood insensitivity) related to emotions**: In risky choice, fearful subjects are more risk averse than angry subjects. If the uncertainty concerns the move of the other in a coordination game, then the effect is opposite. So, this is a kind of source dependence. %}

Kugler, Tamar, Terry Connolly, & Lisa D. Ordóñez (2012) "Emotion, Decision, and Risk: Betting on Gambles versus Betting on People," *Journal of Behavioral Decision Making* 25, 123–134.

{% **risk averse for gains, risk seeking for losses**: Meta-analysis of 136 empirical studies of framing. Framing means that a problem can be formulated in two logically equivalent ways, one suggesting gain outcomes and the other losses. Then, it also means that the gain formulation gives most risk aversion, and the loss formulation gives most risk seeking (p. 29). Seems that this study does not investigate that, but instead whether there is less risk aversion for losses than for gains (unidirectional test). The former, bidirectional, seems to be examined by Kühberger, Schulte-Mecklenbeck, & Perner (1999).

Takes statistics of the papers considered, carry out statistical analyses over them, and find 72% of studies confirming framing (p. 35), if I understand right. Strongest effect if study has risky versus riskless options, not risky versus risky, if framing is by variable reference point, not salience of outcomes, and, amazingly, in within-subject designs and not between-subjects.

Another survey of framing is Levin, Schneider, & Gaeth (1998). %}

Kühberger, Anton (1998) "The Influence of Framing on Risky Decisions: A Meta-Analysis," *Organizational Behavior and Human Decision Processes* 75, 23–55.

{% Hypothetical choice with framing effects in Asian disease (now in 2024 I find this term politically incorrect) in choice, rating, and ranking. Framing does more to evaluation of riskless options than of risky options. %}

Kühberger, Anton & Patricia Gradl (2013) "Choice, Rating, and Ranking: Framing Effects with Different Response Modes," *Journal of Behavioral Decision Making* 26, 109–117.

{% **suspicion under ambiguity**: seem to find that people behave under ambiguity as if they play against a better-informed opponent. %}

Kühberger, Anton & Josef Perner (2003) "The Role of Competition and Knowledge in the Ellsberg Task," *Journal of Behavioral Decision Making* 16, 181–191.

{% Meta-analysis of Asian-disease (now in 2024 I find this term politically incorrect) like studies. **risk averse for gains, risk seeking for losses**: Is found. Pp. 216-217: more risk aversion for gains than risk seeking for losses.

P. 217: **risk seeking for small-probability gains**: not found, only weak risk aversion.

P. 217: risk aversion for small-probability losses: neither found, only weak risk seeking.

Pp. 225-226: **losses from prior endowment mechanism**, argues that subjects may integrate the prior endowment, and then invokes the house-money effect, to explain the risk seeking found.

decreasing ARA/increasing RRA: may have that; I should check. %}

Kühberger, Anton, Michael Schulte-Mecklenbeck, & Josef Perner (1999) "The Effects of Framing, Reflection, Probability, and Payoff on Risk Preference in Choice Tasks," *Organizational Behavior and Human Decision Processes* 78, 204–231.
https://doi.org/10.1006/obhd.1999.2830

{% **real incentives/hypothetical choice**: Point out that differences between real and hypothetical choice may be because hypothetical is with high payoffs and real is with low. In general are positive for hypothetical choice. Seem to find no difference between real and hypothetical choice.

decreasing ARA/increasing RRA: may have that; I should check. %}

Kühberger, Anton, Michael Schulte-Mecklenbeck, & Josef Perner (2002) "Framing Decisions: Hypothetical and Real," *Organizational Behavior and Human Decision Processes* 89, 1162–1176.

{% Discuss framing effects such as in Asian disease (now in 2024 I find this term politically incorrect). P. 316, very correctly, points out that the problem is not well done by Tversky & Kahneman (1981) because, when saying that 200 people die, they don't say what happens to the rest. Give several references to others who pointed this out. They compare prospect theory to their preferred fuzzy-trace theory. Here is a typical example of how the latter goes (p. 318). If saving 200 for sure: "some will be saved."

If saving either 600 (p = 1/3) or none: Some will be saved or none will be saved. And, awel, then the former is preferred. So, this is how fuzzy trace theory works more or less. %}

Kühberger, Anton & Carmen Tanner (2010) "Risky Choice Framing: Task versions and a Comparison of Prospect Theory and Fuzzy-Trace Theory," *Journal of Behavioral Decision Making* 23, 314–329.

{% **normal/extensive form** %}

Kuhn, Harold W. (1953) "Extensive Games and the Problem of Information." *In* Harold W. Kuhn & Albert W. Tucker (eds.) *Contributions to the Theory of Games* I, 193–216, Princeton University Press, Princeton NJ.

{% **cancellation axioms**; Gives nice didactical presentation of solving linear equations, and consistency of those; recommended to me by Aldo Rustichini. Scott (1964) showed how one can derive additively decomposable representations theorems from this result. %}

Kuhn, Harold W. (1956) "Solvability and Consistency for Linear Equations and Inequalities," *American Mathematical Monthly* 63, 217–232.

{% Discusses, for one thing, the mass action interpretation of game theory that Nash wrote in his Ph.D. thesis but did not publish, in the contribution by Weibull and elsewhere. %}

Kuhn, Harold W., John C. Harsanyi, Reinhard Selten, Jörgen W. Weibull, Eric van Damme, John F. Nash Jr., & Peter Hammerstein (1996) "The Work of John Nash in Game Theory: Nobel Seminar, December 8, 1994," *Journal of Economic Theory* 69, 153–185.

{% all hypothetical; **ambiguity seeking for losses**: finds that for negatively framed decisions, ambiguity seeking was more common. For positive framing, ambiguity seeking is more common.

reflection at individual level for ambiguity: Although Experiment 1 has within-individual data, it is not reported regarding this. (What is called within-subject analysis is ANOVA still testing group averages.) Experiment 2 is only probability estimations and, again, reports only group averages. %}

Kuhn, Kristine M. (1997) "Communicating Uncertainty: Framing Effects on Responses to Vague Probabilities," *Organizational Behavior and Human Decision Processes* 71, 55–83.

{% %}

Kuhn, Kristine M. & David V. Budescu (1996) "The Relative Importance of Probabilities, Outcomes, and Vagueness in Hazard Risk Decisions," *Organizational Behavior and Human Decision Processes* 68, 301–317.

{% **Dutch book**: extends de Finetti's book making result to general logical structures. %}

Kühr, Jan & Daniele Mundici (2007) "De Finetti Theorem & Borel States in [0, 1]-Valued Algebraic Logic," *International Journal of Approximate Reasoning* 46, 605–616.

{% **one-dimensional utility** %}

Kukushkin, Nikolai S. (2003) "Acyclicity of Monotonic Endomorphisms,"

{% %}

Kun He (1990) "An Ancillarity Paradox in the Estimation of Multinomial Probabilities," *Journal of the American Statistical Association* 85, 824–828.

{% Children with good grades at high school do better in universities. %}

Kuncel, Nathan R. & Sarah A. Hezlett (2007) "Standardized Tests Predict Graduate Students' Success," *Science* 315, 23 February 2007, no. 5815, pp. 1080–1081.

{% %}

Kunreuther, Howard C. et al. (1978) "*Disaster Insurance Protection: Public Policy Lessons*." Wiley, New York.

{% **crowding-out**: raising tax-rebates failed to increase support for siting nuclear repository in Nevada. %}

Kunreuther, Howard C. & Douglas Easterling (1990) "Are Risk-benefit Tradeoffs Possible in Siting Hazardous Facilities?," *American Economic Review* 80, 252–256.

{% %}

Kunreuther, Howard C. & M.V. Raieev Gowda (1990) "*Integrating Insurance and Risk Management for Hazardous Wastes.*" Kluwer Academic Publishers, Dordrecht.

{% Seems to discuss ambiguity premium. %}

Kunreuther, Howard C. & Robin M. Hogarth (1992) "How Does Ambiguity Affect Insurance Decisions? ." *In* Georges Dionne (ed.) "C*ontributions to Insurance Economics*," 307–324, Kluwer, Dordrecht.

{% Application of ambiguity theory;

Summarize a series of studies by Kunreuther et al., showing that professional actuaries charge higher prices under ambiguity than under known probabilities; this will of course be partially due to asymmetric information and avoidance of winner's curse. The latter is mentioned on p. 38 of Hogarth & Kunreuther (1992). %}

Kunreuther, Howard C., Robin M. Hogarth, & Jacqueline Meszaros (1993) "Insurer Ambiguity and Market Failure," *Journal of Risk and Uncertainty* 7, 71–81.

{% %}

Kunreuther, Howard C., Jacqueline Meszaros, Robin M. Hogarth, & Mark Spranca (1995) "Ambiguity and Underwriter Decision Processes," *Journal of Economic Behavior and Organization* 26, 337–352.

{% **(very) small probabilities**: p. 105 cites evidence that people may overestimate, but also ignore, small probabilities;

inverse S: Studies 1 and 2 show that people are unresponsive to changes in the order of magnitude of a low probability. Study 3 puts such different probabilities side by side and then people are responsive to them. So, it is not for motivational reasons, but for cognitive reasons. (**cognitive ability related to likelihood insensitivity (= inverse S)**) %}

Kunreuther, Howard C., Nathan Novemsky, & Daniel Kahneman (2001) "Making Low Probabilities Useful," *Journal of Risk and Uncertainty* 23, 103–120.

{% **(very) small probabilities**

risk seeking for small-probability gains: Nice example that small probabilities are often ignored. Give bounded-rationality arguments: for very small probability, even if the catastrophe is large, it is not worth the time to think and have transaction costs about. %}

Kunreuther, Howard C. & Mark Pauly (2003) "Neglecting Disaster: Why Don't People Insure against Large Losses," *Journal of Risk and Uncertainty* 28, 5–21.

{% %}

Kunreuther, Howard C., Mark V. Pauly, & Stacey McMorrow (2013) "*Insurance and Behavioral Economics: Improving Decisions in the Most Misunderstood Industry*." Cambridge University Press, Cambridge UK.

{% **questionnaire versus choice utility**: Suggest that questionnaires may be useful even though economists do not want them. Did telephone surveys on people throughout the US facing risks of floods. Also did experimental lottery choices in the lab. Unfortunately, do not report the data. P. 67, 2nd and 3rd paras, find, remarkably, that people want insurance for "relatively high" probability risks, not for small risks. Don't say what "relatively high" means. %}

Kunreuther, Howard C. & Paul Slovic (1978) "Economics, Psychology and Protective Behavior," *American Economic Review* 68, 64–69.

{% %}

Kupperman, Miriam, Stephen C. Shiboski, David H. Feeny, Eric P. Elkin, & A Eugene Washington (1997) "Can Preference Scores for Discrete States be Used to Derive Preference Scores for an Entire Path of Events? An Application to Prenatal Diagnosis," *Medical Decision Making* 42, 42–55.

{%

One thing they point out (as in Dasgupta & Maskin 2005): An aggregate of exponential discounters will be a hyperbolic discounter. Thus, if all individuals in society are constant discounters, then the representative agent is hyperbolic. It can als be aggregation within an individual, who is uncertain which exponential discounting to take. %}

Kurth-Nelson, Zeb, & A. David Redish (2009) "Temporal-Difference Reinforcement Learning with Distributed Representations," *PLoS ONE* 4(10), e7362. http://dx.doi.org/10.1371/journal.pone.0007362

{% **paternalism/Humean-view-of-preference**: He proposes to take a representative sample into the lab, and from them get unbiased estimates. Contrary to what has sometimes been suggested, Kurz does not propose to estimate biases quantitatively so as to correct for them I think.

P. 333 makes the assumption that under hypothetical choice, subjects have no reason to lie: "Assumption 2. In the absence of any reward or loss due to the revelation of true preferences, individuals have the intrinsic desire to tell the truth and thus be prepared to reveal their true demands." %}

Kurz, Mordecai (1974) "Experimental Approach to the Determination of the Demand for Public Goods," *Journal of Public Economics* 3, 329–348.

{% P. 1487 calls prospect theory the leading psychological descriptive theory of "decision making" without there specifying risk. (**Prospect theory/Rank-Dependent Utility most popular for risk**)

This paper uses the term precautionary decision as equivalent to insurance decision, deviating from economic terminology where it means reducing but not entirely removing bad probabilities.

In rank-dependent theories, including PT, one can use two dual ways of using the probability weighting function in the preference functional (top-down or bottom-up), and this paper left me confused on what they do. What is high one way, is low the other way, and what reflects optimism one way, reflects pessimism the other way. (Inverse S is not really affected by it.) In the early days of RDU, bottom-up was most common, but nowadays (1990-2023) top-down is the almost universally agreed upon convention. For PT of Tversky & Kahneman (1992), top-down for gains and bottom-up for losses is the common way. This paper uses PT but, unfortunately, does not specify which way of integration it uses. P. 1491 penultimate para of 1st column claims that the δ parameter of probability weighting represents attractiveness of a lottery, without specifying if this is for gains or losses. The weighting function is given in Eq. 1, p. 1491, and it is the Goldstein-Einhorn (1987) family (they cite Gonzalez & Wu 1999). The authors interpret the parameter δ, the index of elevation, as attractiveness (2nd para below Eq. 1). However, under common PT, for losses, it is the opposite, unattractiveness. And insurance is about losses (although this paper considers both gains and losses). This left me confused. On p. 1501, 2nd column, end of 3rd para, the authors write that overweighting of probabilities means risk aversion for losses, suggesting that they did use the common way of integration. My comments below will, therefore, assume the common way of integration.

It has often been observed that framing a risky choice as an insurance decision increases risk aversion. (**insurance frame increases risk aversion**) The authors mention this on p. 1488. For probability weighting for losses under PT this will increase pessimism; i.e., it will increase the weighting function and the intersection point with the diagonal. This paper confirms this finding in a number of experiments. (**PT falsified; probability weighting depends on outcomes**) The authors take this as evidence against PT. But I find it so much one of the many known framing effects affecting every theory, that I would not interpret it that way.

A general phenomenon with experiments is that subjects often replace the info given by the experimenter with their own experiences. If the experimenter says “assume that this has probability 1” they may reason: “the experimenter may say so, but I think it is different” and they go by their own ideas. This may explain why subjects in this experiment were not only affected by the probabilities given by the experimenters, but also by accessibility. P. 1497 1st column penultimate para writes:

It was not clear to me what accessibility means in this paper, and to what extent it is anything beyond probability/frequency, although it apparently is assumed to happen only with insurance events and not with just probability-gambles. P. 1495 2nd column will give high-frequency events as an example of accessible events.

P. 1495 text from 1st to 2nd column: “When evaluating risks for insurance, people do not usually use statistical evidence about the probability of risky events. Instead, people may commonly rely on inferences based on what they remember hearing or observing about a particular risk (Hertwig, Pachur, & Kurzenha¨user, 2005; Slovic, Fischhoff, & Lichtenstein, 1979; Tversky & Kahneman, 1973).”

P. 1497: “in the low-frequency insurance risk condition, we attached the highest probability levels to those risks judged as less frequent in the norming procedure” Such hypothetical things may be hard to imagine for subjects, and they may rather substitute their own ideas. For such kinds of questions, real incentives are useful. This paper did everything hypothetical, asking subjects over 100s of hypothetical choices.

They did data-fitting on many choices from which CEs (certainty equivalents) were derived using power utility and the Goldstein & Einhorn family (for which they refer to Gonzalez & Wu 1999). They usually confirm **inverse S**. %}

Kusev, Petko, Paul van Schaik, Peter Ayton, John Dent, & Nick Chater (2009) “Exaggerated Risk: Prospect Theory and Probability Weighting In Risky Choice,” *Journal of Experimental Psychology: Learning, Memory, and Cognition* 35, 1487–1505.

{% In studies on coherent risk measures, he is usually credited for introducing the assumption of decision under risk (state space is endowed with probability measure, and acts’ preference value depends solely on the probability distribution they generate over outcomes), called law invariance. %}

Kusuoka, Shigeo (2001) “On Law Invariant Coherent Risk Measures,” *Advances in Mathematical Economics* 3, 83–95.

{% Discusses the use of objective randomization to elicit ambiguity, and brings in Wald’s theorem at the level of strategies, which requires heavy assumptions. %}

Kuzmics, Christoph (2017) “Abraham Wald’s Complete Class Theorem and Knightian Uncertainty,” *Games and Economic Behavior* 104, 666–673.

{% **criticism of monotonicity in Anscombe-Aumann (1963) for ambiguity**: they find some violations in an experiment. But they do not criticize it, but rather suggest that it is normatively appealing.

P. @ Footnote 5 writes: “One can, in fact, regard ambiguity aversion as a preference for randomization”, which entirely builds on the Anscombe-Aumann (AA) framework and, for instance, Schmeidler’s (1989) definition of ambiguity aversion—which Wakker (2010 §11.6) qualified as a historical mistake.

Subjects are given info about the choice situation and randomization, through a video. In common descriptive terminology, that info changes preferences. However, the authors are interested in a more normative interpretation of preference, where lacks of understanding are not to be part of it. Such normative “underlying” preferences are not affected by such info, but only become better

observable. They thus say that not subjects' preferences, but their understanding of the situation, is affected, and that this may show that classical revealed preference experiments do not measure real preferences but only misunderstandings. Every researcher agrees that an experiment where stimuli are described in a language that the subject does not know, do not measure preferences but only basic mis(not)-understanding. Which misunderstandings one assumes to be incorporated into preference and which not, is a matter of taste and application-relevance. Psychologists such as Kahneman and Tversky incorporate more misunderstandings in their concept of preference than experimental economists such as Plott. The authors of this paper incorporate fewer misunderstandings in preference than commonly done in empirical studies.

If I understand right, if the Raiffa randomization precedes the ambiguous Ellsberg urn color draw, then according to the plausible backward induction, ambiguity aversion remains, and this they find, even that it increases after the informative video. If the Raiffa randomization comes after the ambiguous Ellsberg urn color draw, then according to the plausible backward induction, the usual finding of preference for the unambiguous color is in fact just a violation of AA monotonicity, and this is reduced after the informative video. The authors take this finding as indicating that subjects find ambiguity aversion and monotonicity normative, where normative is taken in Gilboa's sense of sticking with under full comprehension. I did not check out how they provided info in their video, and to what extent it only gives better understanding and to what extent it is "just" suggesting preference. %}

Kuzmics, Christoph, Brian W. Rogers, & Xiannong Zhang (2024) "Randomization Advise and Ambiguity Aversion," *Journal of Risk and Uncertainty* 69, 85–104. https://doi.org/10.1007/s11166-024-09436-4

{% Hein used this work in Copenhagen. %}

Kyburg, Henry E., Jr. (1970) "*Probability and Inductive Logic.*" MacMillan, London.

{% **foundations of probability**; **foundations of statistics**; %}

Kyburg, Henry E., Jr. (1983) "*Epistemology and Inference.*" University of Minnesota Press, Minneapolis, MN.

{% **updating under ambiguity**; about convex sets of probability distributions as in maxmin EU. %}

Kyburg, Henry E., Jr. (1987) "Bayesian and Non-Bayesian Evidential Updating," *Artificial Intelligence* 31, 271–293.

{% **updating under ambiguity** %}

Kyburg, Henry E., Jr. (1988) "Addendum to Bayesian and Non-Bayesian Evidential Updating," *Artificial Intelligence* 36, 265–266.

{% **updating under ambiguity**; **foundations of probability** %}

Kyburg, Henry E., Jr. (1990) "Uncertainty and the Conditioning of Beliefs." *In* George M. von Furstenberg (ed.) *Acting under Uncertainty: Multidisciplinary Conceptions*, 77–94, Kluwer Academic Publishers, Dordrecht.

{% Discusses discussions between Keynes and Ramsey. Advocates a frequentist interpretation of probability. %}

Kyburg Jr, Henry E. (2003) "Are there Degrees of Belief?," *Journal of Applied Logic* 1, 139–149.

{% **Dutch book**, pp. 3-22
foundations of probability; **foundations of statistics**; %}

Kyburg, Henry E., Jr. & Howard E. Smokler (1964, eds.) *Studies in Subjective Probability*. Wiley, New York. (2nd edn. 1980, Krieger Publishing Co., New York.)

{% Show how rational expectations implies time inconsistency, underlining the value of policy maker's credible commitment to a policy rule. Nobel prize 2004. Remarkable is that, contrary to Strotz (1957), the time inconsistency need not be due to nonconstant discounting, but can occur if the policymakers share the public's objectives, are not myopic, and understand the structure of the economy perfectly. The time inconsistency is due to strategic aspects. %}

Kydland, Finn E. & Edward C. Prescott (1977) "Rules rather than Discretion: The Inconsistency of Optimal Plans," *Journal of Political Economy* 85, 473–491.

{% %}

Kydland, Finn & Edward Prescott (1982) "Time to Build and Aggregate Fluctuations," *Econometrica* 50, 1345–1370.

{% **PT, applications** %}

Kyle, Albert S., Hui Ou-Yang, & Wei Xiong (2006) Prospect Theory and Liquidation Decisions, *Journal of Economic Theory* 129, 273–288.

{% **probability elicitation**: Reviews the biases and heuristics works by Kahneman & Tversky and others, and works on probability elicitation. Does not consider prospect theory. Says statisticians should pay more attention to this literature, but doesn't do much more than reviewing the literature. %}

Kynn, Mary (2008) "The 'Heuristics and Biases' Bias in Expert Elicitation," *Journal of the Royal Statistical Society: Series A (Statistics in Society)* 171, 1–26.

{% The author redoes the Wu, Zhang, & Abdellaoui (2005) study, testing CPT (I prefer to call it PT) against OPT with a probability tradeoff idea, but for losses (WZA did gains). He does not really do OPT for strictly positive or negative prospects, but the separate-probability transformation version (separable prospect theory), which he still calls OPT (**SPT instead of OPT**). His Eq. 1 on p. 541 cites Fennema & Wakker 97 for it, but the latter only considered mixed prospects and not loss-zero prospects as this paper does. Thus, Eq. 1 is not really OPT if $p_3 = 0$ (as for instance in the left-hand side of Eq. 4). But, as with Wu, Zhang, & Abdellaoui (2005), for the tests done here it does not matter. The paper rejects OPT if sure outcomes are involved. Otherwise OPT and CPT are accepted. So, this provides evidence supporting CPT more. Wu, Zhang, & Abdellaoui (2005) supported OPT some more. No real incentives but flat payment. %}

L'Haridon, Olivier (2009) "Behavior in the Loss Domain: An Experiment Using the Probability Trade-Off Consistency Condition," *Journal of Economic Psychology* 30, 540–551.
https://doi.org/10.1016/j.joep.2009.03.007

{% %}

L'Haridon, Olivier (2018); website to illustrate probability weighting functions: https://olivierlHaridon.shinyapps.io/probability_weighting_functions/

{% %}
L'Haridon, Olivier, Ryan Oprea, Rafael Polania, & Ferdinand M. Vieider (2023) "Cognitive Foundations of Ambiguity Atttitudes," working paper.

{% %}
l'Haridon, Olivier & Corina Paraschiv (2009) "Point de Référence et Aversion aux Pertes: Quel Intérêt pour les Gestionnaires?," *Gérer et Comprendre* 97, 60–69.

{% %}
l'Haridon, Olivier & Corina Paraschiv (2009) "Choix Individuel et Décision Fondée sur l'Expérience: Une Étude Expérimentale," *Revue Economique* 60, 949–978.

{% %}
l'Haridon, Olivier & Laetitia Placido (2008) "An Allais Paradox for Generalized Expected Utility Theories?," *Economics Bulletin* 4, 1–6.

{% They test the most important paradox of Machina (2009), being the reflection example. They confirm what is so natural, being that $f_6 > f_5$ because f_6 has one outcome, 4, resulting with known probability ½, whereas f_5 has all outcomes ambiguous. For exactly the same reason, ambiguity averse people will have $f_7 > f_8$. Strange that Machina did not want to commit to these predictions. A follow-up question could be to test for strength of preference, so as to exclude indifferences. %}
l'Haridon, Olivier & Laetitia Placido (2010) "Betting on Machina's Reflection Example: An Experiment on Ambiguity," *Theory and Decision* 69, 375–393. https://doi.org/10.1007/s11238-008-9128-9

{% This paper presents an impressive data set on risk attitudes of people, well, students (N = 2939), from many (30) countries, turning it into the most authoritative empirical measurement of risk attitudes presently available. It can be taken as representative for the world population. In particular, it can serve as

the central reference for representative parameters of prospect theory. It adds cultural comparisons. A nice finding is that, whereas risk attitudes are problematic for predictions at the between-individual level, they work well for predictions at the between-country level. Poor countries are more risk seeking. Individual characteristics do not predict well at the individual level, but macroeconomic indicators explain between-country variation.

The authors measured certainty equivalents of two-outcome lotteries.

The paper confirms reference dependence.

The authors confirm inverse S probability weighting, with risk seeking for unlikely gains and risk aversion for likely gains, and this reflected for losses, confirming the fourfold pattern.

The authors find that gender, body length, and cognitive ability (**cognitive ability related to risk/ambiguity aversion**; **cognitive ability related to likelihood insensitivity (= inverse S)**; p. 202) correlate with insensitivity and not with aversion. Women are more insensitive both for gains and for losses, are more pessimistic for gains, and have more noise (§5.4, p. 201 bottom).

I regret that the authors use a concept of likelihood dependence. In my interpretation, risk attitude is not likelihood dependent, although risk aversion is. In my interpretation, there is insensitivity, and this is likelihood independent. Insensitivity is the right concept and risk aversion is not, the same way as green and blue are right concepts of color and grue and bleen are not, to cite a well-known example from philosophy.

P. 187 3rd para discusses the related paper Rieger, Wang, & Hens (2015). That paper gave a breakthrough in providing worldwide data but had a number of problems, properly described by l'Haridon & Vieider, because of which its results cannot yet be used.

P. 189 top pleas for **linear utility for small stakes**. They use the Prelec 2-parameter family.

The sample is not representative for all human beings because it is only students. The pro of doing so is that the population is homogeneous here so that other comparisons are more convincing. %}

l'Haridon, Olivier & Ferdinand Vieider (2019) "All over the Map: A Worldwide Comparison of Risk Preferences," *Quantitative Economics* 10, 185–215.

https://doi.org/10.3982/QE898

{% **suspicion under ambiguity**: The authors could not control for this, as they discuss in detail, and I agree that they had to do without. But here, unlike some other studies, I think it did affect data and increased ambiguity aversion. They cite Dimmock, Kouwenberg, Mitchell, & Peijnenburg (2016, Journal of Financial Economics) who convincingly argued that they need not control for suspicion, and some studies that found no effect. However, this depends much on the study. For Dimmock et al., subjects were clients of a big organization that much worked with them in the past and future and, therefore, could be trusted. Here subjects one time interact with experimenters from other countries and have much more reason to suspect.

The paper considers 3000 students across 30 countries and measures their ambiguity attitudes, using Ellsberg urns. It considers urns with 8 colors, and a-neutral probabilities 1/8, 2/8, 3/8, 5/8, 6/8, 7/8, with one nonzero outcome that can be a gain or a loss. The authors measure CEs of ambiguous and risky prospects, and take their normalized differences as index of ambiguity aversion. Normalization is by dividing by difference between extreme outcomes. In general, this normalization has the drawback that for small stakes it tends to reduce deviations from linearity and neutrality (because utility usually is between CRRA and CARA). In this study, the difference between extreme outcomes, the denominator, was always 20 (once 15) and, hence, did not affect within-study comparisons. I prefer matching probabilities, and elaborate some on the difference between the two.

BEGINNING OF INTERMEZZO

COMPARING MATCHING PROBABILITIES AND NORMALIZED CE DIFFERENCES

I assume the source method, where the ambiguous event E has a-neutral probability p, and consider only gains. I first assume linear utility, which for moderate amounts as considered here ($20, $0) is reasonable. I take normalized stakes 1 and 0. By w_S I denote the source function, and by w the probability weighting function for the source of known probabilities (risk). Then the normalized CE is the CE, and $CE(1_E0) = w_S(p)$ and $CE(1_p0) = w(p)$. The event-dependent index of ambiguity aversion of the authors is

$w_S(p) - w(p)$. (*)

Given that the matching probability is $w^{-1}(w_S(p))$, matching probabilities instead consider the difference

$w^{-1}(w_S(p)) - p$. (**)

If I may be allowed to take (**) as gold standard, following Dimmock, Kouwenberg, & Wakker (2016 Theorem 3.1), then the authors' (*) has brought in the transformation w. It means, roughly, that w´ interferes. It means that (*) amplifies differences where w´ is steep, which is near the extremes (where differences are large anyhow), so that (*) amplifies ambiguity aversion near certainty. If near impossibility there is ambiguity seeking, as there usually is, then it is amplified and (*) is amplifying insensitivity. In this study it is a bit ambiguity aversion near impossibility, so that (*) is again amplifying ambiguity aversion. In the middle region, differences, which are small anyhow, are reduced.

If we assume nonlinear utility, then this also interferes in (*). For example, concavity of utility will reduce the two CEs, but this will not affect their difference much. The normalization by dividing by the difference of the two extreme outcomes, as written before, reduces the indexes for small stakes somewhat.

END OF INTERMEZZO

No surprise that I disagree with the authors' arguments in favor of their index. Their index depends on utility. They argue that, if ambiguity attitude depends on utility, then that is an advantage. One reason I disagree is that dependence on utility does not mean good dependence on utility. The above intermezzo has given analytical details. Another has to do with the authors' claim: "Thus if utility is different between risk and uncertainty but decision weights are not, *the matching probabilities will not detect ambiguity attitudes*, but our ambiguity premia will." [italics added here] The italicized part is not correct. That matching probabilities and indexes derived from those do not depend on outcomes or utilities, is derived *under the assumption that utility is the same for risk and uncertainty*. If that assumption is relaxed, as in the smooth model, then matching probabilities and indexes derived from them do become utility dependent.—Which need not yet mean utility dependent in a good manner. That is yet another question.—

Genetic diversity measures the genetic diversity in a country.

ambiguity seeking for losses & **ambiguity seeking for unlikely**: The authors find strong ambiguity aversion for likely gains and unlikely losses. Insensitivity often means ambiguity seeking for unlikely gains and likely losses. This paper does find reduced ambiguity aversion for unlikely gains and likely losses, but no ambiguity seeking. This may be because this experiment could not control for suspicion, leading to increased ambiguity aversion throughout. Searching this annotated bibliography for the keyword **suspicion under ambiguity** shows that ambiguity aversion for unlikely gains happens almost only if there was no control for suspicion.

At the individual level, they can explain almost nothing of the variance, even less than for risk attitudes, in the data. As the authors write: "[it] could be due either to systematic noise in the responses of some individuals, or to ambiguity attitudes constituting an idiosyncratic trait that is orthogonal to observable characteristics." At the country level (which averages over individuals, so has more reliability) things are much better, and more of variance can be explained.

They also write: "We do not mean to conclude from our results that ambiguity aversion is not an empirically meaningful concept. The use of abstract urns and the comparison of extreme situations of completely known and completely unknown probabilities, however, seem to induce high levels of inconsistencies in responses, which may well result from the salient and artificially induced absence of information from one of the urns (Frisch and Baron, 1988; Fox and Tversky, 1995). These issues may then be further exacerbated by measurement problems, which are also wel known in the risk preference literature. One solution for applied empirical researchers may then be to recur to more natural sources of uncertainty (Abdellaoui et al., 2011; Baillon, Huang, Selim and Wakker, 2016b)."

natural sources of ambiguity: The authors plea for studying those in the concluding text of the paper: "Our conclusions about measuring ambiguity attitudes are rather negative. We do not want to say with this that ambiguity does not matter. The point is rather that processes resembling ambiguity are quite artificial, and may thus have limited real world applications. There furthermore appear to be severe measurement problems. Ambiguity may well matter where it occurs naturally in the real wold—see for instance Kunreuther, Meszaros, Hogarth and Spranca (1995) for evidence that the presence of ambiguity about the precise probabilities underlying a process affects the pricing decisions of insurance underwriters. The way forward may then be to investigate naturally occurring uncertainty, rather than artificial ambiguity that is rare in the real world. This will mean focusing on natural sources of uncertainty, as some studies have already done (Abdellaoui et al., 2011; Baillon, Bleichrodt, Keskin, l'Haridon and Li, 2016a). Baillon et al. (2016b) proposed a method for the nonparametric measurement of ambiguity attitudes and showed that it exhibits high levels of measurement reliability. This may also mean moving away from a comparison point of risk, which can hardly ever be found in

reality, and towards varying degrees of ambiguity underlying outcome-generating processes. Time will tell whether such approaches will indeed perform better in terms of the external validity of experimentally measured preferences.” %}

l’Haridon, Olivier, Ferdinand Vieider, Diego Aycinena, Augustinus Bandur, Alexis Belianin, Lubomir Cingl, Amit Kothiyal, & Peter Martinsson (2018) “Off the Charts: Massive Unexplained Heterogeneity in a Global Study of Ambiguity Attitudes,” *Review of Economics and Statistics* 100, 664–677. https://doi.org/10.1162/rest_a_00724

{% **proper scoring rules**
Make the, reasonable, assumption of linear utility for moderate stakes. Then use quadratic proper scoring rules to measure decision weights. Loss aversion is incorporated in these decision weights. Thus, comparing them at 0 with other outcomes gives loss aversion. In an experiment, the authors find no loss aversion and neither its opposite, gain seeking. They do find probability weighting and ambiguity nonneutrality. %}

L’Haridon, Olivier, Craig S. Webb, & Horst Zank (2021) “An Effective and Simple Tool for Measuring Loss Aversion,” working paper.

{% **ambiguity seeking for losses** %}

La-Ornual, Dolchai (2010) “Individual Decision Making under Ambiguity,” Ph.D. dissertation, INSEAD, Fontainebleau, France.

{% MAUT for CEU (Choquet expected utility). Argues for attribute-wise sign-dependence, rather than overall. %}

Labreuche, Christophe & Michel Grabisch (2003) “The Choquet Integral for the Aggregation of Interval Scales in Multicriteria Decision Making,” *Fuzzy Sets and Systems* 137, 11–26.

{% %}

Labreuche, Christophe & Michel Grabisch (2006) “Generalized Choquet-Like Aggregation Functions for Handling Bipolar Scales,” *European Journal of Operational Research* 172, 931–955.

{% They investigate that patients evaluate their position higher than nonpatients who evaluate it hypothetically. They show that it cannot be (just) explained by different endpoints/scalings, because it also occurs in relative evaluations. %}

Lacey, Heather P., Angela Fagerlin, George F. Loewenstein, Dylan M. Smith, Jason Riis & Peter A. Ubel (2009) "Are They Really That Happy? Exploring Scale Recalibration in Estimates of Well-Being," *Health Psychology* 27, 669–675.

{% Emotional sensitivity to probabilities (ESP) impacts people's perception of risks, increasing commission bias. %}

Lacey Heather P., Steven C. Lacey, Prerna Dayal, Caroline Forest, & Dana Blasi (2023) "Context Matters: Emotional Sensitivity to Probabilities and the Bias for Action in Cancer Treatment Decisions," *Medical Decision Making* 43, 417–429. https://doi.org/10.1177/0272989X231161341

{% Formulate a variation of EU where both regret and disappointment are incorporated, and show how particular assumptions on the form of utility lead to empirical predictions such as the Allais paradox. %}

Laciana, Carlos E. & Elke U. Weber (2008) "Correcting Expected Utility for Comparisons between Alternative Outcomes: A Unified Parameterization of Regret and Disappointment," *Journal of Risk and Uncertainty* 36, 1–17.

{% **foundations of statistics**: a textbook in statistics that is completely in the Bayesian de Finetti spirit, using many geometric explanations. %}

Lad, Frank (1996) "*Operational Subjective Statistical Methods. (A Mathematical, Philosophical, and Historical Introduction.*" Wiley, New York.

{% If uncertainty is resolved in the future, then subjects are more risk seeking. %}

Ladouceur, Robert & Marie Mayrand (1987) "The Level of Involvement and the Timing of Betting in Roulette," *Journal of Psychology: Interdisciplinary and Applied* 121, 169–176.

{% **real incentives/hypothetical choice**: 30 subjects did some 4 hypothetical risky choices, and 32 did it real, having all questions played for real (so, income effect …). The real choices gave more risk aversion. No results are given on whether

subjects are risk averse or risk seeking. They used the choice list to measure probability equivalents. They do not explain well how exactly they implemented the real incentives ("they would actually play their chosen risk levels for the amounts of money in the items" on p. 829 is not clear to me). %}

Lafferty, Terence & Kenneth L. Higbee (1974) "Realism and Risk Taking," *Psychological Repor*ts 34, 827–829.

{% P. 24 suggests that decreasing absolute risk aversion is common. %}

Laffont, Jean-Jacques (1993) "*The Economics of Uncertainty and Information.*" MIT Press, Cambridge, MA.

{% **real incentives/hypothetical choice, for time preferences**: Investigate it, and find no difference between real and hypothetical choice. 6 students for many weeks had to choose daily either to get something like $0.50 immediately or $1 some days/weeks later (in real incentives maximal delay considered was 1 month, see p. 178 1st column penultimate para). To avoid saving and so on they could not keep the money but had to spend it immediately upon receipt on candies, so as to enforce consuming and avoid saving. This is in itself a nice idea.

Explicitly do not do RIS, but pay all choices. They avoid income effects in the sense that subjects can never get more than one consumption-set per day. They want subjects to first have experienced the options before choosing themselves, so, subjects first got some delayed or nondelayed options just like that. Each subject first did hypothetical choice and when that treatment was over did real incentives treatment.

Although there is a nice basis, there are several problems. One thing is that subjects can resort to outside options. They can buy the candies outside the experiment. So, if they prefer it now then they can still choose the delayed option but buy immediately after in the store.

Problem is that I think that they do not measure so much discounting, which for days or weeks should be very weak, but they rather measure attitudes toward hunger. Big drawback is that subjects who chose the delayed reward had to come back to the lab later just to get the delayed reward which, given the small stake per case, is huge transaction costs. The discussion, top of p. 185, does not account for this properly, suggesting subjects had to come to the lab anyhow. This is not

true. Subjects for future options had to come especially to the lab for getting them and then would get no other choice or anything (p. 179).

For real incentives the starting choice of the bisectionprocedure was the indifference value found with hypothetical (p. 178 end), introducing a strong framing/bias to have real the same as hypothetical. %}

Lagorio, Carla H. & Gregory J. Madden (2005) "Delay Discounting of Real and Hypothetical Rewards: III. Steady-State Assessments, Forced-Choice Trials, and All Real Rewards," *Behavioural Processes* 69, 173–187.

{% %}

Lahdelmaa, Risto & Pekka Salminen (2009) "Prospect Theory and Stochastic Multicriteria Acceptability Analysis (SMAA)," *Omega* 37, 961–971.

{% When a lottery is allocated to a peer, 15% of subjects change their choice in the direction of the peer. When the peer chose a lottery rather than getting it allocated, 30% of subjects change choice towards peer. Then imitation also plays a role. The change came about most when the lottery for the peer was riskless. This suggests, as explained p. 76 end of 2nd para, that people may more easily imitating each other in taking insurance than to purchase stocks. %}

Lahno, Amrei M. & Marta Serra-Garcia (2015) "Peer Effects in Risk Taking: Envy or Conformity?," *Journal of Risk and Uncertainty* 50, 73–95.

{% **dynamic consistency**; **DC = stationarity**: first sentence of abstract opens up with this;

Golden egg: A goose that lays golden eggs, is very useful in the long run, but it is difficult, if not impossible, to realize these benefits immediately. Many illiquid assets are like that.

Develops a golden eggs model for a consumer who discounts hyperbolically and can do some form of precommitment. Economic implications and equilibria are derived.

This paper popularized the quasi-hyperbolic discounting introduced by Phelps & Pollak (1968). %}

Laibson, David I. (1997) "Golden Eggs and Hyperbolic Discounting," *Quarterly Journal of Economics* 112, 443–477.

{% **small worlds** %}

Laibson, David I. (1998) "Life-Cycle Consumption and Hyperbolic Discount Functions," *European Economic Review* 42, 861–871.

{% First part of paper describes Amos' work. Second part of §4 and §5 describe authors' viewpoints on future.

P. 8: "Folk wisdom holds that "Prospect theory," with 1703 cites as of 1996, is the most-cited paper ever published in *Econometrica*." This is indeed a rumour that has been around for many years, so, it was not introduced by Laibson & Zeckhauser (1998) and they do describe something going on in the field. Kim, Morse, & Zingales (2006, Table 2) had the paper as the second-most cited in all of Economics (and also in Econometrica). Merigó, Rocafort, & Aznar-Alarcón (2016) Table 2 and p. 402 had it indeed as the most-cited paper in business and economics.

P. 8: "He showed that nonrational behavior can be identified and predicted, and that it has important implications for real world economics." (**Prospect theory/Rank-Dependent Utility most popular for risk**)

P. 14 says that extreme underweighting of high probabilities makes insurance attractive. It rather is extreme overweighting of low probabilities (of losses), in cumulative prospect theory.

paternalism/Humean-view-of-preference: p. 20, on Amos: "and did not challenge the central normative judgments of the profession."

P. 21:

"Amos Tversky pioneered the archeology of cognition."

I remember from conversations with Amos that he indeed studied things from the cognitive perspective. He wanted to trace down the biases in human brains similarly to the cognitive illusions.

real incentives/hypothetical choice: §4.1 explains that real incentives are not so important for Amos.

§4.5 points out that there is little field data validation of Amos' ideas, but cites some.

§4.6 and other places explain that Amos did not, or little, commit to normative viewpoints. My annotations on Tversky (1975), Kahneman & Tversky (1979),

Tversky & Kahneman (1981), and other papers show that he did consider EU to be normative. My personal communication with him confirmed it. Kahneman (2011 p. 314) also confirms it. %}

Laibson, David I. & Richard J. Zeckhauser (1998) “Amos Tversky and the Ascent of Behavioral Economics,” *Journal of Risk and Uncertainty* 16, 7–47. https://doi.org/10.1023/A:1007717224343

{% %}

Lajeri, Fatma & Lars Tyge Nielsen (2000) “Parametric Characterizations of Risk Aversion and Prudence,” *Economic Theory* 15, 469–476.

{% %}

Lakatos, Imre (1970) “Falsification and the Methodology of Scientific Research Programmes.” *In* Imre Lakatos & Alan Musgrave (eds.) *Criticism and the Growth of Knowledge*, Cambridge University Press, Cambridge.

{% **adaptive utility elicitation**: adaptive PE %}

Lalonde, Lyne, Ann E. Clarke, Lawrence Joseph, Stephen A. Grover, & Canadian Collaborative Cardiac Assessment Group (1999) “Conventional and Chained Standard Gamble in the Assessment of Coronary Heart Disease Prevention and Treatment,” *Medical Decision Making* 19, 149–156.

{% An interesting explanation of why people underinsurance for small-probability high-consequence catastrophes is that they feel ambiguity (or just extra risk and risk aversion?) about the actual reimbursement, and then ambiguity aversion comes in. This paper investigates it and finds partial support. %}

Lambregts, Timo R., Paul van Bruggen, & Han Bleichrodt (2021) “Insurance Decisions under Nonperformance Risk and Ambiguity,” *Journal of Risk and Uncertainty* 63, 229–253. https://doi.org/10.1007/s11166-021-09364-7

{% %}

Lamers, Leida M., Peep F.M. Stalmeier, Paul F.M. Krabbe, & Jan J.V. Busschbach (2006) "Inconsistencies in TTO and VAS Values for EQ-5D Health States," *Medical Decision Making* 26, 173–181.

{% Discuss that with risky intertemporal choice, one can first aggregate over risk (taking each single timepoint as separable, so, weak separability w.r.t. timepoints) or first over time (taking each probability-generating event as separable). They find that the second fits best. This is plausible, because separability is more plausible for differet events, which are disjoint, than for different timepoints, which coexist. %}

Lampe, Immanuel & Matthias Weber (2020) "Intertemporal Prospect Theory." Lecture presented at D-TEA, 18 June, 2020.

{% Seem to propose what in fact amounts to Chew's weighted utility formula for decision under risk. That is, the average of a set of stimuli x_1, ..., x_n is sum $w(x_j)s(x_j)$ /sum $w(x_j)$ for functions w and s. P. 1 second column next-to-last paragraph seems to describe a nonnormalized sum $w(x_j)s(x_j)$. P. 5 second column third paragraph last sentence also suggests it a bit. There are no formulas and it is nowhere very clear. %}

Lampel, Anita K. & Norman H. Anderson (1968) "Combining Visual and Verbal Information in an Impression-Formation Task," *Journal of Personality and Social Psychology* 9, 1–6.

{% Poster presented at SPUDM Stockholm 2005. They present the classical Ellsberg paradox, but frame the options in a matrix with four states of nature (Red known & Black unknown, etc.) as four columns in a matrix. (**ambiguity seeking**) In this format, the paradox disappears and people are ambiguity neutral! %}

Lan, Cherng-Horng & Nigel Harvey (2005) "How Would Savage Frame Ellsberg's Two-Color Problem?,"

{% **Kirsten&I**; Characterizes something like discounted utility for continuous time but, like Fishburn & Rubinstein (1982), with only one consumption at one timepoint.

DC = stationarity; Axiom P6 is nice version of **dynamic consistency**, and axiom P. 10 a nice version of stationarity. %}

Lancaster, Kelvin J. (1963) "An Axiomatic Theory of Consumer Time Preference," *International Economic Review* 4, 221–231.

{% Recommended to be by Hahneman in Aug. 2000. The paper adds an extra layer to commodities, something like features of those. (For example, my example: not commodities are what it is really about, but the shelter or health improvement that they give us.)

Gives background to complementarity/substitutability. %}

Lancaster, Kelvin J. (1966) "A New Approach to Consumer Theory," *Journal of Political Economy* 74, 132–157.

{% **paternalism/Humean-view-of-preference**: Gives long list of reasons for not deleting responses deemed irrational (and not one reason for deleting them). They can be summarized as: It is wrong for those responses that are not irrational so that they were misdeemed. It is like writing a long list of reasons for why a null hypothesis can be rejected incorrectly, ending up with the recommendation to never reject a null hypothesis. The authors ascribe empirical meaning to continuity, and claim that most modern research is on preferences and that preferences is not choice but introspection (so, contrary to most, they do not equate preference with binary choice in most of their text). Sometimes seem to follow the unfortunate convention of equation rationality with transitivity and completeness, an unfortunate convention common in revealed preference theory. Give recommendations such as "As a general guide, researchers should consider carefully how they design DCEs [discrete choice experiments]." (p. 807 bottom) and "one should design the largest design possible … given constraints such as research budgets as well as more subjective constraints regarding number of attributes and complexity" (p. 808 top). P. 799 qualifies a self-reference as "pioneering." %}

Lancsar, Emily & Jordan Louviere (2006) "Deleting 'Irrational' Responses from Discrete Choice Experiments: A Case of Investigating or Imposing Preferences?," *Health Economics* 15, 797–811.

{% Seems that they propose 0.61 as threshold for substantial correlation. %}

Landis, J. Richard & Gary G. Koch (1977) "The Measurement of Observer Agreement for Categorical Data," *Biometrics* 33, 159–174.

{% **principle of complete ignorance**: axioms for preferences over intervals, interpretable as complete ignorance. %}
Landes, Jürgen (2014) "Min–Max Decision Rules for Choice under Complete Uncertainty: Axiomatic Characterizations for Preferences over Utility Intervals," *International Journal of Approximate Reasoning* 55, 1301–1317.

{% %}
Landsberger, Michael & Isaac Meilijson (1990) "A Tale of Two Tailes: An Alternative Characterization of Comparative Risk," *Journal of Risk and Uncertainty* 3, 65–82.

{% %}
Landsberger, Michael & Isaac Meilijson (1990) "Lotteries, Insurance, and Star-Shaped Utility Functions," *Journal of Economic Theory* 52, 1–17.

{% %}
Landsberger, Michael & Isaac Meilijson (1990) "Demand for Risky Financial Assets: A Portfolio Analysis," *Journal of Economic Theory* 50, 204–213.

{% %}
Landsberger, Michael & Isaac Meilijson (1994) "Co-Monotone Allocations, Bickel-Lehmann Dispersion and the Arrow-Pratt Measure of Risk Aversion," *Annals of Operations Research* 52, 97–106.
https://doi.org/10.1007/BF02033185

{% **foundations of statistics**: paper argues that probability is better learned using experiments than using maths. %}
Lane, Andrew (2009) "Experimental Probability in Elementary School," *Teaching Statistics* 31, 34–36.

{% Argues in fact for violation of **RCLA**! He argues for the following difference. Imagine T is a sufficient statistic. First assume that in a first stage a value t of T is generated. In a second stage, conditional upon that value t of T, a corresponding value x of the observed statistic X is observed corresponding with T (so, in T's inverse of t). Note that the second-stage probability distribution is independent of the parameter θ. In this two-stage process, Hill finds sufficiency convincing. In general, when the two stages are collapsed together, he does not find it convincing! %}

Lane, David A. (1984) "Discussion" in Berger, James O. & Robert L. Wolpert (1984) "*The Likelihood Principle: A Review, Generalizations and Statistical Implications.*" Lecture Notes, Monograph Series, Volume 6, Institute of Mathematical Statistics, Hayward, California; 2nd edn. 1988; pp. 175–181.

{% **crowding-out**: Ch. 19 seems to survey the crowding out effect as studied by psychologists. %}

Lane, Robert E. (1991) "*The Market Experience.*" Cambridge University Press, New York.

{% The paper takes beliefs as tangents to indifference curves, i.e., accepted odds for bets at infinitesimal stakes, which, for instance, under RDU means that decision weights are taken as beliefs. This explains why the author finds that people prefer investing in an ambiguous option to not investing if and only if there is a belief giving a positive EV. P. 1256 defines ambiguity premium in monetary terms, using the beliefs as input.

Table 1 lists theories with 1st order ambiguity aversion (kinks is explained to be a proxy). Being maxmin EU, RDU with convex weighting function, constraint preferences, variational preferences, confidence preferences, and uncertainty-averse preferences. I add: α maxmin & biseparable. Second-order are: smooth, multiplier, variational, confidence, and uncertainty averse. So, confidence, and uncertainty averse can be both. %}

Lang, Matthias (2017) "First-Order and Second-Order Ambiguity Aversion," *Management Science* 63, 1254–1269.
https://doi.org/10.1287/mnsc.2016.2443

{% Lotteries for charitable purposes work better than voluntary gifts; paper pays special attention to risk attitudes of potential donateurs, and the heterogeneity of those risk attitudes, and that this may sometimes imply that multiple-outcome lotteries work better than single-outcome lotteries and have some predictions confirmed in an experiment. They use EU to analyze throughout and do not mention nonEU. %}

Lange, Andreas, John A. List, & Michael K. Price (2007) "Using Lotteries to Finance Public Goods: Theory and Experimental Evidence," *International Economic Review* 48, 901–927.

{% %}

Lange, Andreas & Anmol Ratan (2010) "Multi-Dimensional Reference-Dependent Preferences in Sealed-Bid Auctions – How (Most) Laboratory Experiments Differ from the Field," *Games and Economic Behavior* 68, 634–645.

{% **strength-of-preference representation**; Points out that comparability of strength of preference determines utility up to level and unit; i.e., utility is "measurable" in the terminology of those days. Refers to Frisch (1926) for a formal analysis. Gives reference to many who overlooked this point. Argues that observable choice gives only ordinal utility and that that is all needed for equilibrium. For strength of preference, psychological introspection is needed. Says that the latter is needed for a theory of "human welfare" but does not explain the latter. Seems to be mathematically sloppy, corrected by Alt (1936). %}

Lange, Oskar (1934) "The Determinateness of the Utility Functions," *Review of Economic Studies* 1, 218–224.

{% **conservation of influence**: Through illusion of control. We treat chance events as if they involve skill and therefore as if we have control over them. %}

Langer, Ellen J. (1975) "The Illusion of Control," *Journal of Personality and Social Psychology* 32, 311–328.

{% We treat chance events as if they involve skill and therefore as if we have control over them. %}

Langer, Ellen J. (1977) "The Psychology of Chance," *Journal of Social Theory and Behavior* 7, 185–207.

{% Usually, separate evaluation of a number of lotteries comes out lower than their joint evaluation (so, of their convolution), because in the second case many losses are neutralized by gains so that the loss aversion effects are less strong. There do exist special lotteries such that the separate evaluation of two of them comes out higher than the joint evaluation. This is pointed out in this paper, and implications are discussed. They suggest (e.g. p. 730 ℓ. 2) that subjects, in complex decisions, may simply go by the probability of attaining some target, e.g. they may minimize the probability of losing. %}

Langer, Thomas & Martin Weber (2001) "Prospect Theory, Mental Accounting, and Differences in Aggregated and Segregated Evaluation of Lottery Portfolios," *Management Science* 47, 716–733.

{% Measure preferences when there is risk and time. Use Nishimura, Ok, & Quah's (2017) method to test fit with utility functions that increase with a given preorder. Find intertemporal correlation aversion. %}

Lanier, Joshua, Bin Miao, John K.-H. Quah, & Songfa Zhong (2024) "Intertemporal Consumption with Risk: A Revealed Preference Analysis," *Review of Economics and Statistics* 106, 1319–1333.
https://doi.org/10.1162/rest_a_01220

{% The author axiomatizes what I would call regret theory, varying upon preceding work by Fishburn. However, nowadays (2018-2023) this is often described as "continuous" salience theory and this way it can get into QJE. Very unfortunately, QJE publishes proofs only in online appendixes, meaning that maths published in this journal is unreliable. For a good view on this point, see Spiegler (2023).

For regret theory, when choosing between two lotteries, one has to specify the joint distribution. Thus, the choice domain considered in this paper is pairs of lotteries with the joint distribution specified. This is mostly done by specifying an underlying state space *endowed with an objective probability measure*. This paper does not want to do that to avoid, as the author writes, issues of ambiguity about an unknown probability distribution. However, this is no issue at all because one assumes the probability measure on the state space to be given, known, and objective. In Footnote 5 he criticizes state spaces for the requirement of nonatomicity (needed to induce all probabilities), but his assumption of all simple probability distributions available is only more demanding. One can, for instance, take state space [0,1] endowed with the Lebesgue measure (uniform distribution) and it is rich enough to induce all pairs of simple lotteries with any joint distribution. The mathematically-sounding question can be turned into practically-sounding question by asking how all those pairs of lotteries with joint distributions have been generated. %}

Lanzani, Giacomo (2022) “Correlation Made Simple: Applications to Salience and Regret Theory,” *Quarterly Journal of Economics* 137, 959–987. https://doi.org/10.1093/qje/qjab041

{% P. 46 suggests a bit that Jevons introduced outcomes in terms of final wealth, and that Bentham had them as changes w.r.t. reference point. The authors use different terminologies than I am used to, and I should not make the mistake of reading modern ideas into old (Bentham) writings, and it isn’t 100%. The authors write that Jevons turned preferences into “exogenous” and unchanging, and that with Bentham it was “endogenous” and “changing” depending on preceding pains, pleasures (and, hence, decisions which explains the endogenekity). In their formal model later they also bring in time explicitly to capture the changes. This “changing” is a broad term that could mean anything. Yet I think that they really mean changing only in the sense of reference dependence.

P. 46: “Consequently, the agent’s preference order will be viewed as depending on his initial situation, and on asymmetric sensitivity to gains and losses, relative to this situation (§2). Bentham clearly expressed this idea when he argued that ‘the pleasure of gaining is not equal to the evil of losing’ (1785-6: 331).”

Pp. 47-48 acknowledges that there is no direct evidence for “endogenous” (what I call reference dependence) preference in Bentham, but that indirect evidence is conclusive.

P. 50 acknowledges the value of the ordinal revolution (this is my

interpretation): "founding economic calculus on the basis of a given utility function was already a difficult task, which required nearly a century after Jevons to be achieved; but the enterprise would surely have been bound to fail with a utility function submitted to continuous changes."

P. 52: "it opens the path to the possibility that a same final situation of alternative trajectories is associated with different levels of utility."

Pp. 66-67: "the juncture between the positive and the normative aspects of the principle of utility."

paternalism/Humean-view-of-preference: §5 argues that Bentham advocated paternalism where biases (mistakes in felicific calculus) are to be corrected and reduced. %}

Lapidus, André & Nathalie Sigot (2000) "Individual Utility in a Context of Asymmetric Sensitivity to Pleasure and Pain: An Interpretation of Bentham's Felicific Calculus," *European Journal of the History of Economic Thought* 7, 45–78.

{% **updating: nonadditive measures**: a correction of Zimper (2011). %}

Lapied, André & Pascal Toquebeuf (2013) "A Note on "Re-Examining the Law of Iterated Expectations for Choquet Decision Makers," *Theory and Decision* 74, 439–445.

{% **conservation of influence**: Aristotle said that, for an object to move, there must be some one/thing moving it, which in turn must be moved by something else, which … The first to move something was then a nonmover, so, that must have been God. Anyway, there was sort of purpose/intention driving nature. Laplace came with what was later called Laplace's demon: Nature is governed by laws, rules, patterns, eqauations. That makes it predictable (determinism). It is not purpose. It is a clockwork universe.

Pr. of insufficient reason; seems to have stated the gambler's fallacy somewhere (Peter Ayton). Was he the first?

p. xvii in reprint in Oeuvres completes de Laplace, Voi. 7, Gauthier-Villars, Paris, 1886 seems to state the rule of succession (name given later by Venn 1888): If on n trials we see m successes, then the next trial has success probability

(m+1)/(n+2). (The rule I have used privately lifelong.). It is a special case of using beta priors, and of Carnap's induction rule. %}

Laplace, Pierre Simon de (1796) "*Essai Philosophique sur les Probabilités.*" Paris. (5th edn. 1825). Translated into English as "A Philosophical Essay on Probabilities," Dover Publications, New York, 1951.

{% p. 402 in reprint in Oeuvres completes de Laplace, Voi. 7, Gauthier-Villars, Paris, 1886 seems to state the rule of succession (name given later by Venn (1888): if on n trials we see m successes, then the next trial has success probability (m+1)/(n+2). (The rule I've used privately lifelong.) %}

Laplace, Pierre Simon de (1812) "*Théorie Analytique des Probabilités*." Courcier, Paris, 2nd edn., 1814; 3rd edn., 1820.

{% Paper says that Bernoulli's theory and prospect theory (here the paper is just plainly wrong) do not permit individual differences in risk attitude, are called "universal theories" for that reason, and are contrasted with individual-difference theories, which incorporates EU, Lopes' theory, and Atkinsons theory (latter turns out to consider events under control of the subject) %}

Larrick, Richard P. (1993) "Motivational Factors in Decision Theories: The Role of Self-Protection," *Psychological Bulletin* 113, 440–450.

{% In the 1980s and 1990s there were papers on expert aggregation studying that one does not just take the average of expert opinions, but one determines qualities of the experts and then takes weighted averages and/or removes low-quality experts. But then there came papers showing that just taking averages works surprisingly well, as a sort of paradox. However, this paper is not on that.

This paper is purely empirical, letting subjects (students) do expert aggregation, and seeing whatever they do. That is, it is the typical psychological way of studying things. They find that subjects greatly misunderstand the pros of taking averages of expert opinions. Of course, this result depends much on the subjects taken, and students will not be representative of other people. Students here were INSEAD MBA students, some or all taking statistics courses. They in particular compare the average of the judgments with the judgment of the average expert, where the latter is usually inferior. Unfortunately, I could not find out from the paper what “average expert” means. Other people told me it is the average of the absolute value of the deviation. So, then this paper is based on the principle that the average of absolute values exceeds the absolute value of the average; i.e., absolue value is a convex function. %}

Larrick, Richard P. & Jack B. Soll (2006) “Intuitions about Combining Opinions: Misappreciation of the Averaging Principle,” *Management Science* 52, 111–127.

{% Change in Miles-per-Gallon from 12 to 14 has a larger impact on fuel reduction than from 28 to 40. This has a bit to do with well-known mistake to take 1/X linear instead of convex in X. For example, driving half the way with speed 100 h and half way with speed 300/h is slower than driving 200/h all the way, but many take it to go equally fast. This is vaguely related to: **ratio-difference principle. %}**

Larrick, Richard P. & Jack B. Soll (2008) “The MPG Illusion,” *Science* 20, 1592–1594.

{% Seem to show that gains and losses are psychologically distinct. %}

Larsen, Jeff T., A. Peter McGraw, Barbara A. Mellers, & John T. Cacioppo (2004) “The Agony of Victory and the Thrill of Defeat: Mixed Emotional Reactions to Disappointing Wins and Relieving Losses,” *Psychological Science* 15, 325–330.

{% scheurkalender etc. van Bert en mij %}

Larson, Gary

{% **second-order probabilities to model ambiguity**; presented 2nd order probabilities to subjects, with 20 possible compositions of 100 balls, where the 2nd order distribution was too complex to be reduced. Subjects preferred small variance of 2nd order distributions to big variances under same expectation, violating RCLA. %}

Larson, James R., Jr. (1980) “Exploring the External Validity of a Subjectively Weighted Utility Model of Decision Making,” *Organizational Behavior and Human Performance* 26, 293–304.

{% The whole issue of the journal is dedicated to infinity. %}

Larvor, Brendan P., Benedikt Löwe, & Dirk Schlimm (2015) "History and Philosophy of Infinity," *Synthese* 192, 2339–2344.

{% %}
Laskey, Katheryn B. & Paul E. Lehner (1988) "Belief Maintenance: An Integrated Approach to Uncertainty Management," *Proceedings of the 7th National Conference on AI* (AAAI-88) Minneapolis.

{% **error theory for risky choice** %}
Laskey, Katheryn B. & Gregory W. Fischer (1987) "Estimating Utility Functions in the Presence of Response Error," *Management Science* 33, 965–980.

{% Although the title does not express it, this paper provides specialized results for finance models. %}
Lassance, Nathan, Alberto Martín-Utrera, & Majeed Simaan (2024) "The Risk of Expected Utility Under Parameter Uncertainty," *Management Science* 70, 7644–7663.
https://doi.org/10.1287/mnsc.2023.00178

{% **intuitive versus analytical decisions**; Give alternative explanation for Dijksterhuis et al. (2006) finding. %}
Lassiter, G. Daniel, Matthew J. Lindberg, Claudia González-Vallejo, Francis S. Bellezza, & Nathaniel D. Phillips (2009) "The Deliberation-without-Attention Effect: Evidence for an Artifactual Interpretation," *Psychological Science* 20, 671–675.

{% Footnote 12 says that Bernoulli (1738) is generally credited for being the first to use utility. Argues that maximization of expectation of geometric mean; i.e., Bernoulli's logarithmic utility, is a useful approach.
P. 147 middle of second column points out that the classical expected value criterion left no space for individual variation, so, no subjectivity involved. %}
Latané, Henry A. (1959) "Criteria for Choice among Risky Ventures," *Journal of Political Economy* 67, 144–155.

{% **inverse S**; use the two-parameter extension of Karmarkar, as Goldstein & Einhorn (1987) also did before them, and find inverse S for both gains and, as it seems, losses.

real incentives: they did hypothetical choice. %}

Lattimore, Pamela M., Joanna R. Baker, & Ann D. Witte (1992) "The Influence of Probability on Risky Choice," *Journal of Economic Behavior and Organization* 17, 377–400.

{% First paper on program Decision Maker %}

Lau, Joseph, Jerome P. Kassirer, & Stephen G. Pauker (1983) "Decision Maker 3.0: Improved Decision Analysis by Personal Computer," *Medical Decision Making* 3, 39–43.

{% %}

Lau, Sie Ting, Lilian Ng, & Bohui Zhang (2010) "The World Price of Home Bias," *Journal of Financial Economics* 97, 191–217.

{% **PT, applications**, loss aversion; **utility concave near ruin** & **risk averse for gains, risk seeking for losses**: consider losses, and find most risk seeking if no ruin, risk aversion if ruin comes in. %}

Laughhunn, Dan J., John W. Payne, & Roy L. Crum (1980) "Managerial Risk Preferences for Below-Target Returns," *Management Science* 26, 1238–1249.

{% **statistics for C/E** %}

Laupacis, Andreas, David H. Feeny, Alan S. Detsky, & Peter X. Tugwell (1992) "How Attractive Does a New Technology Have to Be to Warrant Adoption and Utilisation? Tentative Guidelines for Using Clinical and Economic Evaluations," *Canadian Medical Association Journal* 146, 473–481.

{% Subjects choose between gaining on the unknown Ellsberg urn (50-50 in normative sense) and gaining with probability p, for varying p. So, this is finding matching probability using choice list for the 50-50 Ellsberg urn. The unknown urn is of course chosen less as p increases. Average switch is before p = .50, in agreement with the commonly found ambiguity aversion for .50-.50 Ellsberg

urns.

It is also obvious that most preferences will switch around the normative threshold; i.e., around p = .50. Contrary to the authors' claim, this does not mean that people are more sensitive near .50 than elsewhere in a general sense.

reflection at individual level for risk: p. 117: no relation

reflection at individual level for ambiguity: p. 117: no relation: "Thus there is sufficient reason to argue that loss trials and gain trials tap different processes."

correlation risk & ambiguity attitude: p. 117: ambiguity aversion is positively related to risk aversion for losses, and is not significantly related to risk attitude for gains. %}

Lauriola, Marco & Irwin P. Levin (2001) "Relating Individual Differences in Attitude toward Ambiguity to Risky Choices," *Journal of Behavioral Decision Making* 14, 107–122.

{% Apparently do only hypothetical choice.

Ambiguous urn always is 2-color, but they also vary the total number of balls in the urn, and find that this does something even if normatively it shouldn't. Measure matching probabilities. Claim as novelty that they derive it from bisection, rather than from matching as did Kahn & Sarin (1988).

correlation risk & ambiguity attitude: Find positive relation between ambiguity attitude and risk aversion. Do so by first experiment to measure ambiguity aversion, then taking the very extremely ambiguity averse and the very extremely ambiguity seeking separately (extreme-group design), and comparing their risk attitudes to find significant differences in the latter. This method does not show much of how strong the attitudes are related, only that they are. The second measurement was deliberately done two months later only. The intermediates are control group. The potential selection bias and nonrepresentativeness is discussed on p. 132 middle of 2nd column, referring to social psychology for this technique. %}

Lauriola, Marco, Irwin P. Levin, & Stephanie S. Hart (2007) "Common and Distinct Factors in Decision Making under Ambiguity and Risk: A Psychometric Study of Individual Differences," *Organizational Behavior and Human Decision Processes* 104, 130–149.

{% **random incentive system**. Points out that she does not test the isolation effect because no single-choice situation is involved. She tests a Davis & Holt (1993) conjecture (see there).

Treatment 1: pay one randomly selected choice from 10 choices made (the random incentive system)

Treatment 2: pay all 10 choices made.

Treatment 3: pay one randomly selected choice from 10 choices made (the random incentive system but with payments increased).

Treatments 1 and 2 give the same result, suggesting no income effect here. Treatments 1 and 3 give different results, with treatment 3 more risk aversion.

I think that this finding entails that no income effect occurred, and (**decreasing ARA/increasing RRA**) that there was increasing RRA. It does not directly test the Davis-Holt conjecture because for that it should have scaled the payments down and not up. %}

Laury, Susan K. (2005) "Pay One or Pay All: Random Selection of One Choice for Payment."

{% **real incentives/hypothetical choice**: use high real incentives ($100 etc.) for some of the subjects (all students).

losses from prior endowment mechanism: they do this. For the high payments, they first let subject do another game theory experiment where they made very much money.

equate risk aversion with concave utility under nonEU: p. 406: very unfortunately, the authors do not call concave utility what it is (concave utility), but what it is not: risk aversion. The usual concept of risk aversion (preference for EV over prospect) apparently is also called risk aversion.

concave utility for gains, convex utility for losses: Find it for hypothetical choice. For real choice they rather find risk aversion and concave utility for both gains and losses.

reflection at individual level for risk: P. 419, for hypothetical low outcomes finds reflection, with risk aversion (in their terminology) for gains usually going together with risk seeking for losses and risk seeking for gains mostly going together with risk aversion for losses. For real incentives, however, it is very opposite. Risk aversion for gains has majority risk aversion for losses, and risk seeking for gains has majority risk seeking for losses.

P. 422: For hypothetical high payment and, even more for real high payment, there is also violation of reflection at the individual level. The econometric analysis later gives no results at the individual level.

An attempt to defend reflection against the finding of this paper can be that when implementing **losses from prior endowment mechanism**, subjects integrate the payments especially if they are high. From that perspective, I could hope to convince the authors to change their conclusion into: for losses better do hypothetical? (☺) %}

Laury, Susan K. & Charles A. Holt (2008) "Further Reflections on Prospect Theory." *In* James C. Cox & Glenn W. Harrison (eds.) *Risk Aversion in Experiments,* (Experimental Economics, Volume 12) 405–440, JAI Press, Greenwich, CT.

{% **real incentives/hypothetical choice, for time preferences;**

This paper pays subjects in probability of gaining a prize. The authors assume EU and then (well, + backward induction) this amounts to linear (risky!) utility, as pointed out by Roth & Malouf (1979), Cedric Smith (1961), and many others. They assume (implicitly, as did Andersen et al. 2008), that EU utility for risk also is utility for intertemporal discounting, and then use this to estimate discounting while reckoning with that utility curvature.

real incentives/hypothetical choice, explicitly ignoring hypothetical: p. 182 ℓ. –9 writes that the authors only cite experiments with real incentives, and in this sense the priority claims of this paper are unreliable.

P. 183 writes, on their method:

"we propose and test a new method."

In an email of 13 Feb., 2011, I pointed out to the authors that Takeuchi (2011) had used this method for measuring discounting before. So, the authors now cite him om p. 182 last para: "Takeuchi (2011) uses an alternative procedure to estimate discount rates that is theoretically invariant to utility curvature …"

The authors consider correcting for probability weighting, but it does not do much. One reason can be that they use the T&K'92 family, which has mostly the inverse S component, whereas here the pessimism component is more relevant. Another reason can be that discounting and probability weighting have much collinearity.

P. 190, end of §2.1: because the authors use real incentives, the longest time period they can consider is 12 weeks. (**real incentives/hypothetical choice, for time preferences**) %}

Laury, Susan K., Melayne Morgan McInnes, & J. Todd Swarthout (2012) "Avoiding the Curves: Direct Elicitation of Time Preferences," *Journal of Risk and Uncertainty* 44, 181–217.

{% %}

Lauwers, Luc (1997) "Infinite Utility: Insisting on Strong Monotonicity," *AustralAsian Journal of Philosophy* 75, 222–233.
https://doi.org/10.1080/00048409712347831

{% Considers countably infinite income streams (x_1,x_2,…). A medial limit is linear and assigns average whenever defined, and otherwise something between liminf and limsup of average. The main result, Theorem 2, shows that a linear functional (amounting to linear utility) defined on bounded sequences in $\mathbb{R}^{\mathbb{N}}$ that satisfies supnorm continuity and a weak stationarity condition is a medial limit if and only if it satisfies a version of anonymity (w.r.t. bounded permutations), and a discount rule iff it satisfies strong Pareto (strictly improving any outcome strictly improves the sequence). %}

Lauwers, Luc (1998) "Intertemporal Objective Functions: Strong Pareto versus Anonymity," *Mathematical Social Sciences* 35, 37–55.

{% %}

Lauwers, Luc (2012) "Intergenerational Equity, Efficiency, and Constructability," *Economic Theory* 49, 227–242.
https://doi.org/10.1007/s00199-011-0603-0

{% **value of information**; **normal/extensive form** %}

LaValle, Irving H. (1968) "On Cash Equivalents and Information Evaluation in Decisions under Uncertainty, Part I: Basic Theory, Part II: Incremental Information Decisions, Part III: Exchanging Partition-J for Partition-K

Information," *Journal of the American Statistical Association* 63, 252–276, 277–284, 285–290.

{% **simple decision analysis cases using EU**: §1.5 (pp. 6-12) has many nice examples, revisited later (fig. 2.16, Example 4.4). Example 4.3.1 (p. 165) and §4.7 (p. 179) have more. %}

LaValle, Irving H. (1978) "*Fundamentals of Decision Analysis.*" Holt, Rinehart, Winston, New York.

{% **value of information**; **normal/extensive form** %}

LaValle, Irving H. (1980) "On Value and Strategic Role of Information in Semi-Normalized Decisions," *Operations Research* 28, 129–138.

{% **small worlds**; **dynamic consistency**; assumes that acts, conditional upon any event, can be ordered in a way independent of anything else. Mainly this assumption implies independence (compare p. 123, fourth paragraph). (**restrictiveness of monotonicity/weak separability**) %}

LaValle, Irving H. (1992) "Small Worlds and Sure Things: Consequentialism by the Back Door." *In* Ward Edwards (ed.) *Utility Theories: Measurement and Applications*, 109–136, Kluwer Academic Publishers, Dordrecht.

{% **normal/extensive form** %}

LaValle, Irving H. & Peter C. Fishburn (1987) "Equivalent Decision Trees and Their Associated Strategy Sets," *Theory and Decision* 23, 37–63.

{% %}

LaValle, Irving H. & Peter C. Fishburn (1991) "Lexicographic State-Dependent Subjective Expected Utility," *Journal of Risk and Uncertainty* 4, 251–269.

{% %}

Lavalle, Irving H. & Peter C. Fishburn (1992) "State-Independent Subjective Expected Lexicographic Utility," *Journal of Risk and Uncertainty* 5, 217–240.

{% %}

LaValle, Irving H. & Peter C. Fishburn (1996) “On the Varieties of Matrix Probabilities in Nonarchimedean Decision Theory,” *Journal of Mathematical Economics* 25, 33–54.

{% **dynamic consistency**: f**avors abandoning time consistency, so, favors sophisticated choice**; assumes the other conditions implicitly. It appears from their analysis of violation of independence that they consider sophisticated choice as self-evident; The strategic analysis assumes choice prior to the resolution of uncertainty (at least, if in the third paragraph of p. 383 “evaluate his or her position prior to the occurrence or nonoccurrence of uncertainty” can be identified with prior choice, which the subsequent text indeed suggests; if not then the paper is ambiguous), and does Alias (b) ⇒ (c). So, (1) ⇒ (a) (forgone-branch independence; often called consequentialism), (a) ⇒ (b) (part of DC), and (c) ⇒ (1) (**RCLA**) are assumed implicitly. %}

LaValle, Irving H. & Kenneth R. Wapman (1986) “Rolling Back Trees Requires the Independence Axiom,” *Management Science* 32, 382–385.

{% **value of information**; Value of informatie for Choquet Expected Utility %}

LaValle, Irving H. & Yongsheng Xu (1990) “Information Evaluation under Nonadditive Expected Utility,” *Journal of RIsk and Uncertainty* 3, 261–275.

{% **ubiquity fallacy**: He seems to have said/written: “Life is a chemical process.” %}

Lavoisier, Antoine

{% %}

Law, John (1705) “Money and Trade Considered, with a Proposal for Supplying the Nation with Money.” *In* Antoine E. Murphy (ed. 1997) *Monetary Theory*, Vol. 5. Routledge, London.

{% Historical discussions of the roots of the risk-uncertainty distinction %}

Lawson, Tony (1985) “Uncertainty and Economic Analysis,” *Economic Journal* 95, 909–927.

{% r**eal incentives/hypothetical choice, for time preferences**: seems to be on it %}

Lawyer, Steven R., Frederick R. Schoepflin, Ryan Green, & Charles Jenks (2011) "Discounting of Hypothetical and Potentially Real Outcomes in Nicotine-Dependent and Nondependent Samples," *Experimental and Clinical Psychopharmacology* 19, 263–274. https://doi.org/10.1037/a0024141

{% Outcomes are minutes of sexual activity, hypothetical that is. They find usual patterns of hyperbolic discounting. %}

Lawyer, Steven R., Sonja A. Williams, Tereza Prihodova, Jason D. Rollins, & Anita C. Lester (2010) "Probability and Delay Discounting of Hypothetical Sexual Outcomes," *Behavioural Processes* 84, 687–692.

{% %}

Layard, Richard (2005) "*Happiness, Lessons from a New Science*." Penguin, London.

{% %}

Lazaro, Angelina, Ramon Barberan, & Encarnacion Rubio (2002) "The Discounted Utility Model and Social Preferences: Some Alternative Formulations to Conventional Discounting," *Journal of Economic Psychology* 23, 317–337.

{% %}

Lazimy, Rafael (1986) "Solving Multiple Criteria Problems by Interactive Decomposition," *Mathematical Programming* 35, 334–361.

{% %}

Lazzarini, Sergio G., Regina Madalozzo, Rinaldo Artes, & José de Oliveira Siqueira (2005) "Measuring Trust: An Experiment in Brazil," *Brazilian Journal of Applied Economics* 9, 153–169.

{% Critical discussion of Savage (1954), still calling his theorem beautiful.

P. 142 has a nice text on probabilities through analogies with benchmark random mechanisms, with is similar to matching probabilities although there is no subjective twist:

“Since the classical theory is essentially mathematical and clearly not normative it is rather unconcerned about how one interprets the probability measures P_θ. The easiest interpretation is probably that certain experiments such as tossing a coin, drawing a ball out of a bag, spinning a roulette wheel, etc., have in common a number of features which are fairly reasonably described by probability measures. To elaborate a theory or a model of a physical phenomenon in the form of probability measures is then simply to argue by analogy with the properties of the standard ‘random’ experiments.” %}

Le Cam, Lucien (1977) “A Note on Metastatistics or ‘An Essay toward Stating a Problem in the Doctrine of Chances’,” *Synthese* 36, 133–160.

{% Ch. 1.6, p. 11-15 %}

Le Cam, Lucien (1986) “*Asymptotic Methods in Statistical Decision Theory*.” Springer, Berlin.

{% **utility of gambling** %}

Le Menestrel, Marc (2001) “A Process Approach to the Utility of Gambling,” *Theory and Decision* 50, 249–262.

{% %}

Le Menestrel, Marc & Bertrand Lemaire (2004) “Biased Extensive Measurement: The Homogeneous Case,” *Journal of Mathematical Psychology* 48, 9–14.

{% Subjects receive private and social signal, risky or ambiguous. They are found to learn from social information, not significantly affected by ambiguity. (**ambiguous outcomes vs. ambiguous probabilities**: here outcomes are ambiguous.) %}

le Roux, Sara & Fabian Bopp (2025) “Social Learning under Ambiguity—An Experimental Study,” *Journal of Behavioral and Experimental Economics* 114, 102323.
https://doi.org/10.1016/j.socec.2024.102323

{% Recursive utility à la Koopmans. Generalize earlier results on recursive utility regarding unbounded utility and some results of additive separability still holding in their non-separable model. %}

Le Van, Cuong & Yiannis Vailakis (2005) “Recursive Utility and Optimal Growth with Bounded or Unbounded Returns,” *Journal of Economic Theory* 123, 187–209.

{% %}
Leaf, Alexander (1989) “Cost Effectiveness as a Criterion for Medicare Coverage,” *New England Journal of Medicine* 321, 898–900.

{% **foundations of statistics** %}
Lecoutre, Bruno & Jacques Poitevineau (2010) “The Significance Test Controversy and the Bayesian Alternative.” In *StatProb: The Encyclopedia*, free online, Sponsored by Statistics and Probability SocietiesPublisher: Springer

{% Seem to have tested risk attitudes for money and for time (I guess not life duration but waiting time. And not waiting time in sense of delayed payment where discounting would come in, but waiting time in sense of time lost, as with traffic for instance. Probably hypothetical choice. Seems more risk seeking for monetary losses than for time losses. (**risk averse for gains, risk seeking for losses.**) %}
Leclerc, France, Bernd H. Schmitt, & Laurette Dube (1995) “Waiting Time and Decision Making: Is Time like Money?,” *Journal of Consumer Research* 110–119.

{% **foundations of probability**: according to Miettinen (2001), this is a seminal paper arguing for the use of probabilities and Bayes formula in epidemiology. %}
Ledley, Robert S. & Lee B. Lusted (1959) “Reasoning Foundations of Medical Diagnosis,” *Science* 130, 9–21.

{% %}
Ledyard, John O. (1971) “A Pseudo-Metric Space of Probability Measures and the Existence of Measurable Utility,” *Annals of Mathematical Statistics* 42, 794–798.

{% Does experiments with several choices, studying the effects of prior outcomes on later choices. **decreasing ARA/increasing RRA**: if repeated payments of every choice, then decreasing absolute risk aversion.

random incentive system: Finds it confirmed, where it removes income effects as occurring with repeated payment. Nice study! %}

Lee, Jinkwon (2008) "The Effect of the Background Risk in a Simple Chance Improving Decision Model," *Journal of Risk and Uncertainty* 36, 19–41.

{% **measure of similarity** %}

Lee, Michael D. (2001) "Determining the Dimensionality of Multidimensional Scaling Models for Cognitive Modeling," *Journal of Mathematical Psychology* 45, 149–166.

{% **probability elicitation**; good background for work of Daniëlle Timmermans; explains Lens model. %}

Lee, Ju-Whei & J. Frank Yates (1992) "How Quantity Judgment Changes as the Number of Cues Increases: An Analytical Framework and Review," *Psychological Bulletin* 112, 363–377.

{% **inverse S:** p. 61 seems to support that. %}

Lee, Wayne (1971) "*Decision Theory and Human Behavior*." Wiley, New York.

{% Argues that probabilities can be used in legal applications, law and jurisdiction. %}

Lee-Stronach, Chad (2024) "Just Probabilities," *Nous* 58, 948–972. https://doi.org/10.1111/nous.12486

{% %}

Leeds, Stephen (1990) "Discussion: Levi's Decision Theory," *Philosophy of Science* 57, 158–168.

{% %}

Lefebvre, Mathieu & Ferdinand M. Vieider (2013) "Reining in Excessive Risk-Taking by Executives: The Effect of Accountability," *Theory and Decision* 75, 497–517.

{% %}

Lefebvre, Mathieu & Ferdinand M. Vieider (2014) "Risk Taking of Executives under Different Incentive Contracts: Experimental Evidence," *Journal of Economic Behavior and Organization* 97, 27–36.

{% **ratio bias**: find that it easily disappears with good incentives, avoidance of contrast effects, and other things. %}

Lefebvre, Mathieu, Ferdinand M. Vieider, & Marie Claire Villeval (2011) "The Ratio Bias Phenomenon: Fact or Artifact?," *Theory and Decision* 71, 615–641.

{% %}

Lefoll, Jean, Jean M. Guiot, & Alain Chateauneuf (1988) "Allais' Model vs. Expected Utility: Some Preliminary Empirical Results," paper presented at Foundations of Utility and Risk theory IV conference at Budapest, June 6–10, 1988.

{% Utilty of agent is known but (possibly nonadditive) belief is not. Two experts guess the belief of the agent. Definitions of better guesses are given and analyzed. %}

Lefort, Jean-Philippe (2009) "Guessing the Beliefs," *Journal of Mathematical Economics* 45, 846–853.

{% Side-issue: existence of God %}

Lefton, Brian (1990) "Is God an Abstract Object?," *Nous* 24, 581–598.

{% %}

Légaré, France, Annette M. O'Connor, Ian D. Graham., Georges A. Wells, & Stéphane Tremblay (2006) "Impact of the Ottawa Decision Support Framework on the Agreement and the Difference between Patients' and Physicians' Decisional Conflict," *Medical Decision Making* 26, 373–390.

{% Dollar-cost Averaging: Invest 5% of your money every month. Not optimal from the prespective of classical theories. Neither from the perspective of prospect theory and loss aversion, as this paper analyzes and tests on data. So, it is a negative finding. %}

Leggio, Karyl B. & Donald Lien (2001) “Does Loss Aversion Explain Dollar-Cost Averaging?,” *Financial Services Review* 10, 117–127.

{% **foundations of statistics** %}

Lehmann, Erich L. (1950) “Some Principles of the Theory of Testing Hypotheses.” *In* Omar F. Hamouda & J.C. Robin Rowley (1997, eds.) “*Statistical Foundations for Econometrics.*” Edward Elgar, Cheltenham.

{% **foundations of statistics** %}

Lehman, Erich L. (1958) “Significance Level and Power.” *In* Omar F. Hamouda & J.C. Robin Rowley (1997, eds.) “*Statistical Foundations for Econometrics.*” Edward Elgar, Cheltenham.

{% %}

Lehmann, Erich L. (1986) “*Testing Statistical Hypotheses.*” Wiley, New York.

{% %}

Lehmann, Erich L. (1990) “Model Specification: The Views of Fisher and Neyman, and Later Developments,” *Statistical Science* 5, 160–168.

{% **foundations of statistics** %}

Lehmann, Erich L. (1993) “The Fisher, Neyman-Pearson Theories of Testing Hypotheses: One Theory or Two?,” *Journal of the American Statistical Association* 88, 1242–1249.

{% **Dutch book** %}

Lehman, R. Sherman (1955) “On Confirmation and Rational Betting,” *Journal of Symbolic Logic* 20, 251–262.

{% A forecaster and an inspector play a game, observing one by one realizations x_1, x_2, …of a distribution. Whatever the checking rule used by the inspector, the forecaster can manipulate. Manipulation means that he makes a forecast after observing $x_1,\dots,x_n$ for each n, not using any prior knowledge and using only $x_1,\dots,x_n$, such that he is perfectly calibrated in the sense that asymptotically every

relative frequency in his predictions match the true relative frequencies. The idea is that the infinite sequence $x_1,\ldots,x_n$ contains enough info, if observed long enough, to get that done, without needing prior knowledge. %}

Lehrer, Ehud (2001) "Any Inspection is Manipulable," *Econometrica* 69, 1333–1347.

{% **updating: nonadditive measures**; nice idea to do updating under nonadditive measures analogous to conditional expectations theory. Anomalies can still occur. Can be excluded in a somewhat ad hoc way by excluding them by restricting set of sub-sigma-algebra-measurable functions accordingly.

In traditional additive probability theory, E(f|A), the conditional expectation of a rv f given a sigma-field A is the "averaging out" of f over A. It is the function g that is A measurable and, given that, minimizes expectation of quadratic difference with f. Conditional expectation of rv is the primitive concept to think of. Conditional probability of event B given event C is derived concept, as follows: (1) Take 1_B as rv and $\{C,C^c\}$ as sigma-algebra. You can see only through $\{C,C^c\}$. Conditional probability of B is then what you see of 1_B in event C. In general, it can be proved that E(f|A) has the same expectation as f, in fact it has that over every A event. Also, on every A event it does not exceed max or min f.

Lehrer considers extension of these concepts to nonadditive measures. The starting idea is to, again, let E(f|A) minimize quadratic difference with f.

First problem: Unfortunately, that does not have nice properties such as having same expectation as f, or not exceed max or min of f. So, one restricts attention to the subclass of functions, measurable w.r.t. C, which do have the desired properties, and only over those one minimizes expectation of quadratic difference.

Second problem: The solution need not be unique. Lehrer proposes refinements. %}

Lehrer, Ehud (2005) "Updating Non-Additive Probabilities—A Geometric Approach," *Games and Economic Behavior* 50, 42–57.

{% Takes a variation of the Choquet integral that is always concave. It agrees if the weighting function is convex, but is a concave functional that in a way is closest if the weighting function is not convex. That is, for a prospect X and a weighting function v, min{f(X)} is taken over all concave and homogeneous functions f that dominate w for all indicator functions. A preference axiomatization is given. The same definition can be used if w is not defined for all subsets. %}

Lehrer, Ehud (2009) "A New Integral for Capacities," *Economic Theory* 39, 157–176.

{% Characterizes a subfamily of maxmin EU, with only finitely many priors. The value of an ambiguous act is the supremum of dominated unambiguous acts, which is very pessimistic. An act is fat-free if reducing any outcome strictly worsens the act. In the other case, if there is fat, then an EU minimizing prior can be found making the relevant outcome-event null. Strong fat-free maintains fat-free under mixing with a nonminimal outcome. If two acts have fat, there can be synergy under mixing, and this is a nice way of interpreting things. The model is the decision model corresponding with the functional of Lehrer (2009). The paper applies its model to NE in game theory. %}

Lehrer, Ehud (2012) "Partially Specified Probabilities: Decisions and Games," *American Economic Journal: Microecnomics* 4, 70–100.

{% Every simple act can be written as a weighted sum of indicator functions SUM$\alpha_j 1_{E_j}$, where the E_js may be nested and so on. The model of this paper ("event-separable representation") assumes existence of a nonadditive weighting function v, and a subjective choice of one of the many possible decompositions SUM$\alpha_j 1_{E_j}$ for each act, after which it is evaluated by a separate-event weighting SUM$\alpha_j v(E_j)$ (like separable prospect theory but with events instead of probabilities). It assumes that acts $\alpha 1_E$ with only one nonzero outcome are always evaluated by $\alpha v(E)$. If acts are subjectively similar (same events involved) they provide no hedge against each other and satisfy independence preference conditions. RDU is the special case where the events E_j are nested. %}

Lehrer, Ehud & Roee Teper (2015) "Subjective Independence and Concave Expected Utility," *Journal of Economic Theory* 158, 33–53.

{% Realist interpretation of utility: It is concrete, an object or quality of mental state etc. Instrumental interpretation of utility: only theoretical concept. %}

Lehtinen, Aki (2001) "The Interpretation of Utility Theory,"

{% Keynes distinguished the balance of evidence and the weight, arguing that the latter can matter, and it underlies the modern ambiguity theories. This paper seems to argue that that weight of evidence indeed plays a role, but only when it comes to the dynamic point of updating. (**updating under ambiguity**) This is surely my opinion. Weight of evidence plays no role in static decisions, but in updating. The term "stability" seems to refer to this idea. %}

Leitgeb, Hannes (2014) "The Stability Theory of Belief," *Philosophical Review* 123, 131–171.

{% P. 67 2nd column $\ell\ell$. 1-3 does the typical overselling of DFE of suggesting that everything in life that has no known probabilities must be DFE: "had no alternative but to make *decisions from experience*" (italics from original).

Do DFD (decision from description) versus DFE (decision from experience) for both monetary and medical outcomes. As the authors properly explain, the latter have to be hypothetical, and then for avoiding confounded comparisons the former are also better done hypothetically, which is what they did. As Figure 3 illustrates, they find, remarkably, more optimism for DFE than for DFD, but also somewhat more, rather than less, inverse S. Strongest finding is way more inverse S fror medical than for money. (**DFE-DFD gap but no reversal?**) %}

Lejarraga, Tomás, Thorsten Pachur, Renato Frey & Ralph Hertwig (2016) "Decisions from Experience: From Monetary to Medical Gambles," *Journal of Behavioral Decision Making* 29, 67–77.

{% **questionnaire for measuring risk aversion**: not really that, but nice alternative: People can each time decide to blow a balloon up one more or not. If they do, 1 cent is added to their gains, but each time there is a chance the balloon explodes and then all gains are lost. Probability of explosion is something like j/128 at jth trial. Pretty idea! %}

Lejuez, Carl W., Jennifer P. Read, Christopher W. Kahler, Jerry B. Richards, Susan E. Ramsey, Gregory L. Stuart, David R. Strong, & Richard A. Brown (2002) "Evaluation of a Behavioral Measure of Risk Taking: The Balloon Analogue Risk Task (BART)," *Journal of Experimental Psychology: Applied* 8, 75–84.

https://doi.org/10.1037//1076-898X.8.2.75

{% %}

Leland, Jonathan W. (1994) "Generalized Similarity Judgments: An Alternative Explanation for Choice Anomalies," *Journal of Risk and Uncertainty* 9, 151–172.

{% **measure of similarity;** Seems to show that violations of stochastic dominance can be found in experiments only if the dominance relation is not transparent. %}

Leland, Jonathan W. (1998) "Similarity Judgments in Choice under Uncertainty: A Reinterpretation of the Prediction of Regret Theory," *Management Science* 44, 659–672.

{% The author argues that violations of independence may be less important than thought, the reason given being that in matrix representation it is less violated (one can debate if the latter is due to true preference or due to heuristic). It then presents regret theory and Rubinstein-type similarity arguments, each in one page, as alternative points to pursue. The paper is nicely written, but the content is thin (just reiterating that independence is less violated in matrix format, and regret and similarity) and not new. %}

Leland, Jonathan W. (2010) "The Hunt for a Descriptive Theory of Choice under Risk—A View from the Road not Taken," *Journal of Socio-Economics* 39, 568–577.

{% Uses Dempster-Shafer belief functions, having a separation between uncertainty and imprecision. Uncertainty seems to be qualitative and concern noise, and imprecision seems to be in imperfect discrimination of measurement instrument. %}

Lelandais, Benoît, Isabelle Gardin, Laurent Mouchard, Pierre Vera, & Su Ruan (2013) "Dealing with Uncertainty and Imprecision in Image Segmentation Using Belief Function Theory," *International Journal of Approximate Reasoning* 55, 376–387.

{% %}

Lemmer, John F. & Laveen N. Kanal (1988) "*Uncertainty in Artificial Intelligence 2; Machine Intelligence and Pattern Recognition*, Vol.5." North-Holland, Amsterdam.

{% Using simulations, shows that a joint estimation of risk preference and technology, something that seems to be common in agricultural risk studies, does not work well. Last sentence of intro: "by allowing researchers to discard doomed-to-fail estimation projects at an early stage." %}

Lence, Sergio H. (2009) "Joint Estimation of Risk Preferences and Technology: Flexible Utility or Futlity?," *American Journal of Agricultural Economics* 91, 581–598.

{% On choice lists: Measure indifference values in two different ways: (a) ping-pong; (b) "titration." In each, consider PE (if I remember well, they call it SG) questions where people must give the probability p making them indifferent between, for instance, being blind and (perfect health)$_p$(death). In the titration method people are offered a decreasing sequence of probabilities p = 1, p = 0.99, … of "offers" of risks that they are willing to accept, until the point where they are no longer willing to accept the offer. That point is their indifference point. The ping-pong method "offered" risks 0.01, 0.99, 0.02, 0.98, 0.10, 0.90, 0.80, 0.20, 0.70, 0.30, 0.60, 0.40, 0.50. But surprisingly, the titration method gave higher results. %}

Lenert, Leslie A., Daniel J. Cher, Mary K. Goldstein, Merlynn R. Bergen, & Alan M. Garber (1998) "The Effect of Search Procedures on Utility Elicitations," *Medical Decision Making* 18, 76–83.

{% 39% of the subjects ordered health states differently in pairwise choice than in the PE. This is a violation of generalized stochastic dominance (i.e., with respect to a subjective underlying preference) and entails: **restrictiveness of monotonicity/weak separability** %}

Lenert, Leslie A., Sydney Morss, Mary K. Goldstein, Merlynn R. Bergen, William O. Faustman, & Alan M. Garber (1997) "Measurement of the Validity of Utility Elicitations Performed by Computerized Interview," *Medical Care* 35, 915–920.

{% %}
Lenert, Leslie A., Cathy D. Sherbourne, & Valerie F. Reyna (2001) "Utility Elicitation Using Single-Item Questions Compared with a Computerized Interview," *Medical Decision Making* 21, 97–104.

{% P. 779 refers to Gold et al. (1996) for the, I think unjustified, claim (where preference weights means utilities): "In addition, clinically obtained preference weights are ill-suited for use in CEAs of public health interventions designed to inform resource allocation in populations, where it is community, rather than patient preferences, that are relevant." %}
Lenert, Leslie A. & Roy M. Soetikno (1997) "Automated Computer Interviews to Elicit Utilities: Potential Applications in the Treatment of Deep Venous Trombosis," *Journal of the American Medical Informatics Association* 4, 49–56.

{% Using probability equivalents they measure utilities of health states according to the classical elicitation assumption (i.e., EU calculations). They find that people in poor health state judge states more positive on average than people in good health state. Interpret this finding as evidence in favor of prospect theory. Do not use prospect theory to calculate utilities from probability equivalent questions, but only EU. %}
Lenert, Leslie A., Jonathan R. Treadwell, & Carolyn E. Schwartz, (1999) "Associations between Health Status and Utilities Implications for Policy," *Medical Care* 37, 479–489.

{% **foundations of statistics** %}
Lenhard, Johannes (2006) "Models and Statistical Inference: The Controversy between Fisher and Neyman–Pearson," *British Journal for the Philosophy of Science* 57, 69–91.

{% %}
Lensberg, Terje (1987) "Stability and Collective Rationality," *Econometrica* 55, 935–961.

{% Generalizes Hardy, Littlewood, & Polya (1934, Observation 88 in §3.7.). A function f on a convex subset of a vector space is concave as soon as for each α,β

in its domain there exists $0 < \lambda < 1$ with $f(\lambda\alpha + (1-\lambda)\beta) \geq \lambda f(\alpha) + (1-\lambda)f(\beta)$, where λ may depend on α,β, and f is radially lower semicontinuous. The paper cites textbooks on convex functions. %}

Leonetti, Paolo (2018) "A Characterization of Convex Functions," *American Mathematical Monthly* 125, 842–844. https://doi.org/10.1080/00029890.2018.1507205

{% **loss aversion: erroneously thinking it is reflection**: Happens on p. 406. The authors present the Asian disease problem (now in 2024 I find this term politically incorrect), explained by convex utility for losses as they properly point out (let us ignore probability weighting). Then they describe loss aversion as utility steeper for losses. Then they say that loss aversion is the desire to avoid a sure loss. They probably think that loss aversion enhances risk seeking in a choice between a sure loss $-\beta$ and a risky prospect $\alpha_p(-\gamma)$, which is incorrect because loss aversion here enhances risk aversion, i.e., preference for the sure loss (Wakker 2011 Exercise 9.3.8). Then they seem to think that the risk seeking enhanced by loss aversion (which can only affect mixed prospects) explains the Asian disease. Thus, they conclude their reasoning: "In other words, the idely accepted prospect theory explains uncertainty-seeking ehavior as the result of loss aversion." %}

Leonhardt, James M., L. Robin Keller, & Cornelia Pechmann (2011) "Avoiding the Risk of Responsibility by Seeking Uncertainty: Responsibility Aversion and Preference for Indirect Agency when Choosing for Others," *Journal of Consumer Psychology* 21, 405–413.

{% Seems to have defined money illusion as a violation of the homogeneity postulate of demand. %}

Leontief, Wassily W. (1936) "The Fundamental Assumptions of Mr. Keynes' Monetary Theory of Unemployment," *Quarterly Journal of Economics* 5, 192–197.

{% Theorem II, essentially, already has Gorman's (1968) result, only heavily using differentiability. The result is replicated in Proposition IV of his 1947 paper in Econometrica.

It seems that Gorman at first did not want to write his paper because he said it had all been known, was a folk theorem, and others had to convince him to write his paper still. %}
Leontief, Wassily W. (1947) "A Note on the Interrelation of Subsets of Independent Variables of a Continuous Function with Continuous First Derivatives," *Bulletin of the American Mathematical Society* 53, 343–350.

{% Comments: see his other 1947 paper. %}
Leontief, Wassily W. (1947) "Introduction to a Theory of the Internal Structure of Functional Relationships," *Econometrica* 51, 361–373.

{% **information aversion**: People who had given a blood sample could be informed if they were carriers of one of two genetic mutations that indicate susceptibility to breast cancer. Almost half (169/396) declined. %}
Lerman, Caryn, Chanita Hughes, Stephen J. Lemon, David Main, Carrie L. Snyder, Carolyn Durham, Steven A. Narod, & Henry T. Lynch (1998) "What You Don't Know Can Hurt You: Adverse Psychological Effects in Members of BRCA1-Linked and BRCA2-Linked Families Who Decline Genetic Testing," *Journal of Clinical Oncology* 16, 1650–1654.

{% This paper is a criticism of Rabin (2000, Econometrica). Rabin assumed that many people reject a fifty-fifty gamble +11, –10. The author calculates what the gamble would be if repeated 365 times independently. He points out that many accept such a gamble. He seems to conclude, and I do not understand, that the latter would imply that many will also accept the one-shot gamble. He derives from his conclusion that Rabin's argument is based solely on questionnaires and experiments, and that real-world is different from the former. %}
LeRoy, Stephen F. (2003) "Expected Utility: A Defense," *Economics Bulletin* 7, 1–3.

{% %}
LeRoy, Stephen F. & Richard D. Porter (1981) "The Present-Value Relation: Tests Based on Implied Variance Bounds," *Econometrica* 49, 555–574.

{% Risk versus Uncertainty; historical comments. Argue that, for Knight, the case of subjective nonobjective additive probability was uncertainty and not risk. Also that Knight's writing is confused. (**criticizing Knight (1921) for low quality**) %}

LeRoy, Stephen F. & Larry D. Singell, Jr. (1987) "Knight on Risk and Uncertainty," *Journal of Political Economy* 2, 398–406.

{% **tradeoff method**: §8.6 uses it to characterize SEU. %}

LeRoy, Stephen F. & Jan Werner (2000) "*Principles of Financial Economics.*" Cambridge University Press, New York.

{% Seem to compare najority rule with one delegate and two delegates of groups, but to find no differences in ambiguity attitudes. %}

Levati, M. Vittoria, Stefan Napel, & Ivan Soraperra (2017) "Collective Choices under Ambiguity," *Group Decision and Negotiation* 26, 133–149. https://doi.org/10.1007/s10726-016-9488-4

{% P. 409 criticizes Bayesianism not only for choosing exact probability, but also for choosing exact utility (up to level and unit), and wants to have not only a set of priors but also of utilities. Wants to allow for indeterminate choice. His decision theory violates independence of irrelevant alternatives (pp. 415 ff.).

E-admissability of a prospect: There exists a P in the set of possible P's and a U in the set of possible U's such that the prospect is optimal for this P and U. I, by the way, do not find this a convincing criterion. Couldn't one take a prospect that is never first but always a good second? %}

Levi, Isaac (1974) "On Indeterminate Probabilities," *Journal of Philosophy* 71, 391–418.

{% Elaborates on his 1974 theory.

Discusses **second-order probabilities**; seems to write: epistemic utility: evaluate utility independent of probabilities;

Pp. 441-442 discusses Rasmussen report on nuclear safety.

Credal probability: Evaluate probabilities independently of utility: I checked on May 24 '96 but it was not clearly there. %}

Levi, Isaac (1980) "*The Enterprise of Knowledge*." MIT Press, Cambridge, MA.

{% Ch. 4 seems to be on **free will/determinism.**
Seems to have written on p. 121: "One must be committed, whether one knows it or not, to a definite credal probability function even though neither inducive logic nor the relevant contextual features furnish any reason for adopting that function rather than another." %}
Levi, Isaac (1986) "*Hard Choices: Decision Making under Unresolved Conflict.*" Cambridge University Press, New York.

{% **dynamic consistency**; discursive writing. P. 94/95 is typical of the style of the author: "If Hammond is right, this position is untenable. Ordering and independence are indivisible. I think that Hammond is wrong." Says that nothing in Savage prevents the Jeffrey interpretation, that probabilities can be assigned to future actions to some extent. %}
Levi, Isaac (1991) "Consequentialism and Sequential Choice." *In* Michael Bacharach & Susan Hurley (eds.) *Foundations of Decision Theory*, 92–122, Basil-Blackwell, Oxford.

{% **updating: testing Bayes' formula**: Apply updating models to common-value Dutch auctions. Non-probabilistic reasoning (NPR) refers to further info besides the probability update. %}
Levin, Dan, James Peck, & Asen Ivanov (2016) "Separating Bayesian Updating from Non-Probabilistic Reasoning: An Experimental Investigation," *American Economic Journal: Microeconomics* 8, 39–60.

{% **real incentives/hypothetical choice**: subjects had to rate how likely it was that they would choose risk gambles (??), both hypothetically and real. %}
Levin, Irwin P., Daniel P. Chapman, & Richard D. Johnson (1988) "Confidence in Judgments Based on Incomplete Information: An Investigation Using Hypothetical and Real Gambles," *Journal of Behavioral Decision Making* 1, 29–41.

{% Children and some adults could do risky choices (which each really paid, in some prizes) between sure prize or fifty-fifty gambles to get two prizes. Same for

losses. Each choice was really paid (so, repeated payments).

risk seeking for symmetric fifty-fifty gambles: they find more risk seeking than risk aversion for gains, and even more risk seeking for losses. (Also for 0.2 probability gambles.) %}

Levin, Irwin P. & Stephanie S. Hart (2003) "Risk Preferences in Young Children: Early Evidence of Individual Differences in Reaction to Potential Gains and Losses," *Journal of Behavioral Decision Making* 16, 397–413.

{% This paper reviews (and interprets) studies of framing and loss aversion, as alternative to the review by Kuhberg (1998) that they cite much. This paper received many citations. For me nonpychologist it was hard to relate to it. I am interested in two different aspects of loss aversion (of, say, size 2), which may explain loss aversion:

(1) At a loss that in physical units is as big as a corresponding gain, the suffering when experiencing the loss is twice as big as the happiness when experiencing the gain.

(2) For a loss that in suffering is as big as the joy is of a corresponding gain, it still weights twice as much in decisions because the agent pays more attention to losses.

Under (1) loss aversion is part of utility, under (2) it is not. In (2) one can distinguish between this happening deliberately, with the agent thinking that it is rational to pay more attention to losses than to gains, and this happening psychologically, not as a deliberate act but automatically perceptionally and probably not rationally.

It was not easy for me nonpsychologist to understand whether the distinctions the authors make relate to the above distinction or not.

The authors distinguish three frame types of loss aversion, being risky framing, attribute framing, and goal framing.

The second, attribute, is when people are asked for straight introspective evaluations without these being related to decisions. "How much do you like beef 75% lean" versus "How much do you beef 25% fat?" and subjects indicate their likings on a scale. Subjects like more the 75% lean formulation, which is not surprising as the authors point out somewhere (p. 159). For one thing, it has the same ambiguity-problem as the well-known Asian disease problem (75% nonfat does not mean the other 25% has to be fat). (Now in 2024 I find this term Asian disease politically incorrect.) The authors feel it necessary, p. 159 4th para, to make explicit that the above judgment does not involve risk.

The third, goal framing, is, if I understand right, decision problems where one option is doing nothing. Breast self-examination is done more with negative info (not doing has decreased chance of finding tumor) than with positive (doing so has increased chance of finding tumor), p. 168 2nd para.

For the first, risky framing, the authors do point out at some stage that loss aversion can and has been used also for decisions if tradeoffs do not concern getting some more with 60% probability versus some less with 40% probability but also getting some more on one attribute at the cost of getting some less on another. They do point out this is like goal framing (p. 180 top). The useful summary p. 181 2nd para also suggests so. But then why risky framing is considered a different category escapes me.

Then 2nd framing of evaluation without relation to decision interests me economist less anyhow.

The paper often writes in a boasting manner, praising itself (p. 177 bottom, p. 179 penultimate para “unique,” p. 181 penultimate para; p. 182 last para “The discovery of the distinguishing features ..”)

P. 150 $\ell\ell$. 3-8 is funny for economists. When the authors want to show how diverse the areas are where loss aversion has appeared, they mention 7 subdisciplines of psychology and then one other discipline: business. Later for decisions also medical (and clinical!) decisions are mentioned, and bargaining, and some more, but, sorry for economics, it did not make it to the list. %}

Levin, Irwin P., Sandra L. Schneider, & Gary J. Gaeth (1998) “All Frames Are not Created Equal: A Typology and Critical Analysis of Framing Effects,” *Organizational Behavior and Human Decision Processes* 76, 149–188.

{% **restricting representations to subsets**: Mainly one-dimensional representations without particular aggregation properties. Some results are on utilitarianism, $U_1(x_1) + \ldots + U_n(x_n)$ where, however, the U_j’s are used as directly observable inputs so that it is more de Finetti-type additive representations $p_1x_1 + \ldots + p_nx_n$. %}

Levin, Vladimir L. (2010) "On Social Welfare Functionals: Representation Theorems and Equivalence Classes," *Mathematical Social Sciences* 59, 299–305.

{% %}

Levine, Frederic J. & Lester Luborsky (1981) "The Core Confictual Relationship Theme Method: A Demonstration of Reliable Clinical Inferences by the Method of Mismatched Cases." *In* Saul Tuttmen, Carol Kaye, & Muriel Zimmerman (eds.) *Object and Self: A Developmental Approach*. International Universities Press; New York.

{% After Math.Psy-meeting 1992 the author mailed this paper, and earlier, papers, to me. May have something to do with tradeoff consistency, and with additive representations on subsets. %}

Levine, Michael V. (1982) "Fundamental Measurement of the Difficulty of Test Items," *Journal of Mathematical Psychology* 25, 243–268.

{% Games with incompete information, **value of information** %}

Levine, Pierre & Jean-Pierre Ponssard (1977) "The Value of Information in Some NonZero Sum Games," *International Journal of Game Theory* 6, 221–229.

{% %}

Levinger, George & David J. Schneider (1969) "Test of the 'Risk is a Value' Hypothesis," *Journal of Personality and Social Psychology* 11, 165–169.

{% Uses a huge data set. Bookmakers for sports are better at predicting outcomes of games, and there do not seem to be people performing systematically better than bookmakers. They deliberately set odds against known biases (and deviating from equilibrating supply and demand), such as biased in favor of favorite but against home team; someone knowing this can benefit from it. Here bookmakers can typically do what thousands of people have found out they cannot do on the stock market! %}

Levitt, Steven D. (2004) "Why Are Gambling Markets Organised so Differently from Financial Markets?," *Economic Journal* 114, 223–246.

{% %}

Levitt, Steven D. (2005) "*Freakonomics*." Penguin, London

{% P. 347 abstract opens with: "We can think of no question more fundamental to experimental economics than understanding whether, and under what circumstances, laboratory results generalize to naturally occurring environments."

Such a sentence is typical of researchers putting their own field forward as the most important field there is. %}

Levitt, Steven D. & John A. List (2007) "Viewpoint: On the Generalizability of Lab Behaviour to the Field," *Canadian Journal of Economics* 40, 347–370.

{% A nice survey of the main experiments in social choice, and complications for external validity of lab experiments on them (e.g., see Table 1 p. 155).

Some details that I see a bit different are: The authors suggest that external validity is no problem in the natural sciences. I conjecture that it is a bigger problem in natural sciences than in the social sciences.

The authors use the term generalizability in too narrow a sense, being only for generalizability of lab findings to outside world. (p. 153).

The authors only consider moral costs for subjects, but there will be other costs such as effort or loss of self-confidence.

The formula ("model") on p. 157 serves no purpose. %}

Levitt, Steven D. & John A. List (2007) "What Do Laboratory Experiments Measuring Social Preferences Reveal about the Real World?," *Journal of Economic Perspectives* 21, 153–174.

{% **value-induced beliefs**: reported probabilities are not used to describe beliefs, but to justify decisions taken, in a medical context. %}

Levy, Andrea G. & John C. Hershey (2006) "Distorting the Probability of Treatment Success to Justify Treatment Decisions," *Organizational Behavior and Human Decision Processes* 101, 52–58.

{% stochastic dominance survey %}

Levy, Haim (1992) "Stochastic Dominance and Expected Utility: Survey and Analysis," *Management Science* 38, 555–593.

{% **real incentives/hypothetical choice**: actual payment was done at the end after dividing by 1,000

decreasing ARA/increasing RRA: accept decreasing absolute risk aversion (DARA) but find no increasing RRA (IRRA), says it's decreasing or at best constant.

SPT instead of OPT: no explicit formulas are given of theories, but most clear from p. 763 2nd para.

Sixty-two subjects had to play 10 rounds of investing, experimental amounts in order of $30,000, actual payment was done at the end after dividing by 1,000. If their game-asset became negative during the game, they had to stop and pay (ruin). That setup made the subjects conservative, indeed none ended in ruin. The latter may explain the DRRA found: Those with little money become very risk averse so as to avoid ruin, those with much money were lucky and, thus, are encouraged to risk more. This holds the more so as only the game-rewards, not the actual richness of the subjects, played a role.

Results on absolute risk aversion and RRA were derived from intermediate choices (time series) and, thus, assume the isolation effect. However, the isolation effect is not easy to defend here because the subjects clearly are aware of the dynamic repeated setup, the more so as they get a sum total in the end. %}

Levy, Haim (1994) "Absolute and Relative Risk Aversion: An Experimental Study," *Journal of Risk and Uncertainty* 8, 289–307.

{% Finds violations of stochastic dominance, but more because of randomness than systematic. Thus, explains it as bounded rationality rather than probability weighting. Puts it forward as argument against original prospect theory of Kahneman & Tversky (1979) (in all tasks; e.g., p. 765, end of §2.1; also p. 767, 769, 771) and in favor of new Tversky & Kahneman (1992) prospect theory and rank dependence. %}

Levy, Haim (2008) "First Degree Stochastic Dominance Violations: Decision Weights and Bounded Rationality," *Economic Journal* 118, 759–774. https://doi.org/10.1111/j.1468-0297.2008.02141.x

{% Link to comment on multi-publication by Levy & Levy %}

Levy, Haim & Moshe Levy (2002) "Arrow-Pratt Risk Aversion, Risk Premium and Decision Weights," *Journal of Risk and Uncertainty* 25, 265–290.

{% Link to comment on multi-publication by Levy & Levy
Wakker (2003 Management Science) strongly criticized this paper. %}
Levy, Haim & Moshe Levy (2002) "Experimental Test of Prospect Theory Value Function: A Stochastic Dominance Approach," *Organizational Behavior and Human Decision Processes* 89, 1058–1081.

{% Nice idea to assume that people in their instantaneous decisions go by PT value function, but after some time adapt and then their vNM utility function takes 2over. They have the two-argument function depending on current wealth and change of that. There are, unfortunately, inaccuracies in the analysis. %}
Levy, Haim & Zvi Wiener (1996) "Prospect Theory and Utility Theory: Temporary and Permanent Attitude toward Risk," Hebrew University.

{% **correlation risk & ambiguity attitude**: Experiment 1 investigates it but finds no relation. But, as the authors point out, their sample is small (N = 22). %}
Levy, Ifat, Jason Snell, Amy J. Nelson, Aldo Rustichini, & Paul Glimcher (2010) "Neural Representation of Subjective Value under Risk and Ambiguity," *Journal of Neurophysiology* 103, 1036–1047.

{% %}
Levy, Matthew R. & Joshua Tasoff (2020) "Exponential-Growth Bias in Experimental Consumption Decisions," *Economica* 87, 52–80.

{% Link to comment on multi-publication by Levy & Levy
Wakker (2003 Management Science) strongly criticized this paper. %}
Levy, Moshe & Haim Levy (2001) "Testing for Risk Aversion: A Stochastic Dominance Approach," *Economics Letters* 71, 233–240.

{% Link to comment on multi-publication by Levy & Levy
Wakker (2003 Management Science) strongly criticized this paper. %}

Levy, Moshe & Haim Levy (2002) "Prospect Theory: Much Ado about Nothing," *Management Science* 48, 1334–1349. https://doi.org/10.1287/mnsc.48.10.1334.276

{% **three-doors problem**; Baumann (2005) argued that not switching need not be irrational. %}

Levy, Ken (2007) "Baumann on the Monty Hall Problem and Single-Case Probabilities," *Synthese* 158, 139–151.

{% Do Holt & Laury (2002) experiment. Consistency is better in simultaneous (rather than sequential) choice and increasing or random rather than decreasing order, and much higher for 10 times higher payments and after experience. Risk aversion is higher in sequential, and in decreasing & random than in increasing.

Sequential decisions give more inconsistencies than simultanous, as did decreasing rather than increasing or random orders. %}

Lévy-Garboua, Louis, Hela Maafi, David Masclet, & Antoine Terracol (2012) "Risk Aversion and Framing Effects," *Experimental Economics* 15, 128–144. https://doi.org/10.1007/s10683-011-9293-5

{% Several people have argued that with common utility functions the income effect in the WTP/WTA discrepancy is too small to explain it. This paper shows that with extreme utility functions it can be. For instance, if we take logarithmic utility and let it tend to minus infinity at a status quo, then extreme things can happen. The paper also comments on Rabin's (2000) calibration paradox, siding with Rubinstein's (2006) view that it can be solved by taking utility of income rather than utility of final wealth. In Wakker (2010) "*Prospect Theory: For Risk and Ambiguity*." Cambridge University Press, Cambridge, UK, §8.6, I criticize this view: Utility of income is not a small variation of EU, but is the same as reference dependence of prospect theory and is a major breakaway. Whereas EU is the hallmark of rationality, reference dependence is utterly irrational. %}

Lewandowski, Michal (2014) "Buying and Selling Price for Risky Lotteries and Expected Utility Theory with Gambling Wealth," *Journal of Risk and Uncertainty* 48, 253–283. https://doi.org/10.1007/s11166-014-9191-2

{% P. 291: Violations of EU due to violations of monotonicity, transitivity, or event splitting, are not incorporated in theory because they are considered mistakes. %}
Lewandowski, Michal (2017) "Prospect Theory versus Expected Utility Theory: Assumptions, Predictions, Intuition and Modelling of Risk Attitudes," *Central European Journal of Economic Modelling and Econometrics* 9, 275–321.
https://doi.org/10.24425/cejeme.2017.122213

{% %}
Lewandowski, Michal (2018) "Complementary Symmetry in Cumulative Prospect Theory with Random Reference," *Journal of Mathematical Psychology* 82, 52–55.
https://doi.org/10.1016/j.jmp.2017.11.004

{% Generalizes complementary symmetry to uncertainty and multiple outcomes, and tests it in an experiment to check out various reference dependence models. %}
Lewandowski, Michał & Łukasz Woźny (2022) "On Reference Dependence and Complementary Symmetry," *Journal of Mathematical Psychology* 108, 102653.
https://doi.org/10.1016/j.jmp.2022.102653

{% Presentation of identification problem for econometricians.

P. 836: "from observable data. Roughly, identification asks, if we knew the population that data are drawn from, would θ be known? And if not, what could be learned about θ."

"For θ to be identified, alternative values of θ must imply different distributions of the observable data"

"More generally, identification failures complicate statistical analyses of models, so recognizing lack of identification, and searching for restrictions that suffice to attain identification, are fundamentally important problems in econometric modeling."

p. 842, top of 2nd column gives definition of identifiability: "We're now ready to define identification. The parameter θ is defined to be point identified (often just called identified) if there do not exist any pairs of possible values θ and $\tilde{\theta}$ that are different but observationally equivalent." %}
Lewbel, Arthur (2019) "The identification Zoo: Meanings of Identification in Econometrics," *Journal of Economic Literature* 57, 835–903.

https://doi.org/10.1257/jel.20181361

{% %}
Lewbel, Arthur & William Perraudin (1995) "A Theorem of Portfolio Separation with General Preferences," *Journal of Economic Theory* 65, 624–626.

{% The author, with an economic background although the style suggests more of psychology and sociology, wrote this before receiving Ph.D, and developed own ideas on ordinal revolution and history. Although I disagree with several (such as difference between ordinalism and behaviorism), the paper gave me many new insights and I enjoyed it.

Argues that ordinalism does not work because, first, it does not get good data (I agree) and, second, it ignores sociological (institutional) effects (not my focus of research).

P. 1294 §B: I don't think there was an attack by psychologists on marginal utility. The attack was initiated by the other side.

conservation of influence: pp. 1298-1304 is nice on the role of introspection ("verstehen") and teleology in economics, and ordinalism as an attempt to get rid of that and turn economics into a mechanic science, with nice citations of Weber. P. 1299 footnote 7 defines teleology discussed jointly with psychological hedonism, which is close to utilitarianism.

Pp. 1301-1302 has nice text by Veblen on teleological nature of utility rendering it unscientific.

P. 1304: Behaviorism was movement away from teleology, to turn sychology into a mechanical science like physics. (Also p. 1308 for ordinalism in economics.)

P. 1305: psychological hedonism took utility as primitive, and it was not observable.

She lets force (and energy similar, but mostly force) from physics (not a primitive concept but only derived from movements of bodies) have a role similar to utility.

P. 1309, as so many, misunderstands Pareto (1901). Pareto writes: "Let others concern themselves with the *nature*, with the *essence* of value. I am interested only in seeing whether I can discover which regularities are presented by prices (1901, p. 204)." So, Pareto does not say there is anyhing wrong in inspecting value and essence, only that he now does not do so. However, Lewin will take him to say the former (which he did not say).

P. 1310 announces difference between ordinalism and behaviorism but only discusses revealed preference of Samuelson which is a nice contribution but in which I see no difference.

P. 1312: “Cardinal utility was more than a particular theoretical concept; it symbolized verstehen.”

P. 1313: according to Knight, we cannot dispense with motives as we can dismiss with force in physics because there is more error in measuring.

P. 1315 and elsewhere (p.; 1317): “It was simply not empirically possible to base preference theory on behavior alone.”

P. 1315 refers to several economic studies in the 1930s trying to measure utility empirically, such as Thurstone (1931). %}

Lewin, Shira B. (1996) “Economics and Psychology: Lessons for Our Own Day from the Early Twenthieth Century,” *Journal of Economic Literature* 34, 1293–1323.

{% Seems to find violations of **RCLA. %**}

Lewis, Barry L. & Jan Bell (1985) “Decisions Involving Sequential Events: Replications and Extensions,” *Journal of Accounting Research* 23, 228–239.

{% **discounting normative**: seems to argue against discounting. %}

Lewis, Clarence I. (1946) “*An Analysis of Knowledge and Valuation*.” Open Court, La Salle.

{% %}

Lewis, Charles & Gideon Keren (1999) “On the Difficulties Underlying Bayesian Reasoning: A Comment on Gigerenzer and Hoffrage,” *Psychological Review* 106, 411–416.

{% **updating: discussing conditional probability and/or updating**
principle of complete ignorance: seems to discuss this view that events that happen or not, cannot be assigned probabilities. %}

Lewis, David (1980) "A Subjectivist's Guide to Objective Chance." *In* Richard C. Jeffrey (ed.) *Studies in Inductive Logic and Probability*, Vol. II, 263–293, University of California Press, Berkeley.
Reprinted (with added postcripts) in David Lewis (1986) *Philosophical Papers: Volume II*, 83–132, Oxford University Press, New York.

{% **updating: discussing conditional probability and/or updating** %}
Lewis, David (1986) "Probabilities of Conditionals and Conditional Probabilities II," *Philosophical Review* XCV, 581–589.

{% Seems to believe in multiverses. For every random process, and every of its possible outcomes, there is a possible world where this really happens (happened/will-happen). %}
Lewis, David (1986) "*On the Plurality of Worlds*." Blackwell, Oxford.

{% %}
Lewis, David (1987) "Causal Decision Theory." *In* Peter Gärdenfors & Nils-Eric Sahlin (eds.) *Decision, Probability, and Utility*, 377–405, Cambridge University Press, Cambridge.

{% Much literature documenting the home bias. %}
Lewis, Karen (1999) "Trying to Explain Home Bias in Equities and Consumption," *Journal of Economic Literature* 37, 571–608.

{% About friendship of Kahneman & Tversky. %}
Lewis, Michael (2016) "*The Undoing Project: A Friendship That Changed Our Minds*." W. W. Norton & Company, New York.

{% **foundations of quantum mechanics** %}
Lewis, Peter J. (2006) "Conspiracy Theories of Quantum Mechanics," *British Journal for the Philosophy of Science* 57, 359–381.

{% **natural sources of ambiguity;**
Contributions: (1) First comprehensive measurement of ambiguity attitude,

including insensitivity, in the developing world (p. 242 3rd para); (2) Introduces an important new source of ambiguity: linguistic ambiguity; (3) Studies wealth effects on ambiguity with big income difference (factor 10) but more similarities and fewer differences between the subjects otherwise than in other studies, made possible because of a typical local difference between mountain- and city inhabitants (pp. 241-242 & p. 258 bottom); (4) contributes to literature showing importance of a(mbiguity-generated) insensitivity, capturing more variance than ambiguity aversion.

Within the rural group the poor are more ambiguity averse and a-insensitive (p. 251 2nd para). Within the urban group, the rich are more insensitive, maybe because they are so rich that they can be lazy. For the poor group, higher irrationality (my interpretation) of the poor group can add to poverty trap. (p. 241 4/5). Between group, rural are more ambiguity averse and a-insensitive (p. 242 3rd para).

P. 242: "a-insensitivity captures to what extent people understand the ambiguous decision situation from a cognitive perspective." P. 258 middle reiterates it.

P. 242 last para: "the clear classification of a-insensitivity as irrational … it is easier for people to learn about their cognitive mistakes than the emotional ones."

P. 243 middle: "But this symmetry [as in Ellsberg urn] does not hold in general for natural ambiguity sources." P. 249 last line reports asymmetry found in data.

P. 243: Subjects (high school age 17) were given phrases in foreign languages of which three possible meanings were given (one correct), and sudents had to gamble money depending on the correct meaning. Every sentence was taken as a different source of uncertainty (p. 243).

P. 244: difference between subjective (= a-neutral) probability and matching probability can be taken as an ambiguity premium.

P. 246: RIS was used where each subject played one randomly chosen choice for real.

P. 248/249: correlation between multiple switching and score on Fredricks' cognitive reflection.

P. 249, on subjective probabilities in source method:

"capture subjects' subjective beliefs (although distorted by their ambiguity attitudes)"

P. 256: rich urbans were **ambiguity seeking**.

P. 257: discusses policy implications of insensitivity, not in the cliché way as in most papers, but nicely. %}

Li, Chen (2017) "Are the Poor Worse at Dealing with Ambiguity? Ambiguity Attitude of Urban and Rural Chinese Adolescents," *Journal of Risk and Uncertainty* 54, 239–268.
https://doi.org/10.1007/s11166-017-9262-2

{% %}

Li, Chen & Peter P. Wakker (2024) "A Simple and General Axiomatization of Average Utility Maximization for Infinite Streams," *Journal of Economic Theory* 216, 105795.
https://doi.org/10.1016/j.jet.2024.105795

Direct link to paper

{% **paternalism/Humean-view-of-preference** %}

Li, Chen, Zhihua Li, & Peter P. Wakker (2014) "If Nudge Cannot Be Applied: A Litmus Test of the Readers' Stance on Paternalism," *Theory and Decision* 76, 297–315.
http://dx.doi.org/10.1007/s11238-013-9375-2
Direct link to paper

{% %}

Li, Chen & Ning Liu (2021) "What to Tell? Wise Communication and Wise Crowd," *Theory and Decision* 90, 279–299.
https://doi.org/10.1007/s11238-020-09784-y

{% %}

Li, Chen, Kirsten I.M. Rohde, & Peter P. Wakker (2023) "The Deceptive Beauty of Monotonicity, and the Million-Dollar Question: Row-First or Column-First Aggregation?," working paper.
https://personal.eur.nl/Wakker/pdf/deu.pdf

{% **cognitive ability related to likelihood insensitivity (= inverse S)**:

They ("we") find that ambiguity aversion reduces trust, and a(mbiguity

generated) insensitivity reduces the willingness to act upon beliefs.
Eq. 3.3 shows how the belief hedge method not only gives ambiguity indexes if a-neutral probabilities are unknown, but also enables one to actually find these probabilities. (**inverse S negatively related to prevention**) %}

Li, Chen, Uyanga Turmunkh, & Peter P. Wakker (2019) "Trust as a Decision under Ambiguity," *Experimental Economics* 22, 51–75.
https://doi.org/10.1007/s10683-018-9582-3
Direct link to paper

{% %}

Li, Chen, Uyanga Turmunkh, & Peter P. Wakker (2020) "Social and Strategic Ambiguity versus Betrayal Aversion," *Games and Economic Behavior* 123, 272–287.
https://doi.org/10.1016/j.geb.2020.07.007
Direct link to paper

{% **ordering of subsets**: This paper examines choices between subsets of a finite set X whose elements are called alternatives. It considers a model where, for a subset A c X, first a subset A' c A is chosen, the subset that receives attention. Because of inattention, the omitted alternatives were not considered. Next, A' is evaluated by the sum of the utilities of its elements. Utilities are nonnegative. If there is no inattention, then the model concerns an additive-measure representation of subsets, whose characterization has long been known, following from the theorem of the alternative for instance. For a set A, the set A' can be found by A' ~ A. Here idempotence is assumed. That is, for A' then all elements receive attention. So, inattention does not pile up. Then after that, it becomes as standard with no attention. %}

Li, Dayang (2024) "Additive Representation under Idempotent Attention," *Theory and Decision* 97, 563–583.
https://doi.org/10.1007/s11238-024-09986-8

{% %}

Li, Hao & Wing Suen (2004) "Delegating Decisions to Experts," *Journal of Political Economy* 112, 311–355.

{% **dynamic consistence**: This paper considers decision under uncertainty as with Savage (1954), although the outcome set is a convex subset of a vector space so that the Ansombe-Aumann structure is available. The paper assumes constant-act independence, building on the linearity of the Anscombe-Aumann structure.

The paper assumes static a priori preferences together with preferences conditioned on events E, for all E. The first part specifies a recursive model, the separability condition that is equivalent to it, and consequentialism & dynamic consistency, again, equivalent. Thus, it deviates from SEU only by violating reduction/event collapsing, i.e., the uncertainty analog of reduction of compound lotteries (p. 1079).

The second part of the paper considers certainty equivalent substitutions and ambiguity attitudes. It only considers aversion to ambiguity, and that ambiguities conditional on different events can be used to hedge against each other. One could also imagine that ambiguity conditional on one event reinforces the effects of ambiguity conditional on another event, but this is assumed not to happen. Then, replacing a conditional act by a "neutral" certainty equivalent (nicely called ironing out) can only be bad because it, first, can only reduce the hedging effects and, hence, increase ambiguity perception and, by ambiguity aversion, decrease preference. This condition is called event complementarity. The condition can be reinterpreted as aversion to receiving partial info (**information aversion**). Partial info can only reduce ambiguity hedging. The conditions are shown to hold under some ambiguity models.

The aversion to certainty equivalent substitution is similar to that in cautious utility by Cerreia-Vioglio, Dillenberger, & Ortoleva (2015). Both conditions go purely for pessimism and aversion. The author refers to this related condition on p. 1072 citing Dillenberg (2010) who introduced it.

Kops & Pasichnichenko (2023) presented an empirical test of this model. %}

Li, Jian (2020) "Preferences for Partial Information and Ambiguity," *Theoretical Economics* 15, 1059–1094.
https://doi.org/10.3982/TE2851

{% **inverse S:** Find pessimism instead of inverse S. This can, however, be explained by a confound. They asked, in Russian roulette, for the WTP and happiness for

removing one bullet, with j bullets ($1 \leq j \leq 6$) present. Subjects did not just answer what the increase in happiness was as the authors assume, but what the happiness in the final situation is. %}

Li, Li-Bo, Shu-Hong He, Shu Li, Jie-Hong Xu, & Li-Lin Rao (2009) "A Closer Look at the Russian Roulette Problem: A Re-Examination of the Nonlinearity of the Prospect Theory's Decision Weight π," *International Journal of Approximate Reasoning* 50, 515–520.

{% The index of riskiness of a lottery (only mixed) is the level of absolute risk aversion making the lottery equivalent to 0. The author gives easy upper and lower bounds, he considers sums of lotteries that, unlike with Aumann, can also be not-independent, extends it to general (also nonmixed) lotteries relative to also nonzero prices, and he gives multiplicative analogs of the preceding additive results. The latter can be used to characterize decreasing or increasing relative risk aversion. %}

Li, Minqiang (2014) "On Aumann and Serrano's Economic Index of Risk," *Economic Theory* 55, 415–437.

{% A strategy is obviously dominant if its worst outcome possible is better than the best outcome possible under deviations. (Like the intuitive criterion for equilibrium refinements.) It is nice for mechanisms to have obvious dominance, because then it is easier to understand for subjects. In an ascending clock auction, the dominant strategy at each timepoint obviously dominates deviations. This is not so when choosing a bid in a second-pice sealed-bid auction. %}

Li, Shengwu (2017) "Obviously Strategy-Proof Mechanisms," *American Economic Review* 107, 3257–3287.
https://doi.org/10.1257/aer.20160425

{% Finds that if common outcome transparent, then not always cancellation. %}

Li, Shu (1994) "What is the Role of Transparency in Cancellation?," *Organizational Behavior and Human Decision Processes* 60, 353–366.

{% Says there is no preference reversal because (suggesting: “what nobody ever was aware of yet”) it is simply two different preference relations; %}

Li, Shu (1994) “Is there a Problem with Preference Reversals?,” *Psychological Reports* 74, 675–679.

{% too small amounts sometimes, ignoring curvature of utility, ad hoc cancellation-editing, etc. %}

Li, Shu (1995) “Is there a Decision Weight π?,” *Journal of Economic Behavior and Organization* 27, 453–463.

{% Studies situations where a principal receives sequential reports from agents. The agent may pretend to change mind more or less than appropriate to suggest more expertise, and the principal may desire to solicit sequential or one-time reporting depending on circumstances. %}

Li, Wei (2007) “Changing One’s Mind when the Facts Change: Incentives of Experts and the Design of Reporting Protocols,” *Review of Economic Studies* 74, 1175–1194.

{% Shows how prospect theory can accommodate a large number of financial phenomena.

loss aversion: erroneously thinking it is reflection: not that confusion, but relatedly, the authors use the term diminishing sensitivity for what better be called reflection. %}

Li, Yan & LiyanYang (2013) “Prospect Theory, the Disposition Effect, and Asset Prices,” *Journal of Financial Economics* 107, 715–739.

{% **Newcomb’s problem**: they argue that the original problem lacks causal information. %}

Li, Zhanglyu & Frank Zenker (2021) “Newcomb’s Problem Isn’t a Choice Dilemma,” *Synthese* 199, 5125–5143.
https://doi.org/10.1007/s11229-020-03018-y

{% **PT, applications**; Seem to review 10 empirical studies in transportation, finding that PT improves understanding.

P. 97, opening sentence: "Prospect Theory (PT) is regarded as a leading behavioural paradigm to understand decision-making under risk." (**PT/RDU most popular**) %}

Li, Zheng & David A. Hensher (2011) "Prospect Theoretic Contributions in Understanding Traveller Behaviour: A Review and Some Comments," *Transport Reviews* 31, 97–115.

{% Reinvestigate preference reversals as in Tversky & Kahneman (1990), and find, to the contrary, that much can be explained by intransitivities. %}

Li, Zhihua & Graham Loomes (2022) "Revisiting the Diagnosis of Intertemporal Preference Reversals," *Journal of Risk and Uncertainty* 64, 19–41. https://doi.org/10.1007/s11166-022-09369-w

{% Players play a coordination game. For instance, they rank three metals, copper (E_1), gold (E_2), iron (E_3) in places 1-3. A player is matched with a random opponent. If they ranked the same metal first, they receive £20, and otherwise nothing.

Next they must assess percentages of subjects with E_i for all i, and then E_{ij} (= $E_i \cup E_j$) ($i \neq j$), that is probabilities, through probability equivalents, i.e., matching probabilities are measured (using BDM (Becker-DeGroot-Marschak)). The singleton matching probabilities add to more than 1 (would be 1 under Bayesianism; **ambiguity seeking for unlikely**), the composite to less than 2 (would be 2 under Bayesianism). This agrees with the common fourfold pattern of ambiguity attitude, although the overweighting of singletons is greater than usual. They do and find the same for seven other triples, flowers, etc. They also measure other things, such as certainty equivalents, but do not use those in the analysis. %}

Li, Zihua, Graham Loomes, & Ganna Pogrebna (2017) "Attitudes to Uncertainty in a Strategic Setting," *Economic Journal* 127, 809–826.

{% %}

Li, Zhihua, Julia Müller, Peter P. Wakker, & Tong V. Wang (2018) "The Rich Domain of Ambiguity Explored," *Management Science* 64, 3227–3240.
https://doi.org/10.1287/mnsc.2017.2777
Direct link to paper

{% %}

Li, Zhihua, Kirsten I.M. Rohde, & Peter P. Wakker (2017) "Improving One's Choices by Putting Oneself in Others' Shoes—An Experimental Analysis," *Journal of Risk and Uncertainty* 54, 1–13.
https://doi.org/10.1007/s11166-017-9253-3
Direct link to paper

{% The paper has three topics:

(1) Choice of reference points. The paper provides a clean design to identify choices of reference points, both exogenous (by changing the fixed option in the choice list) and endogenous, confirmed in the results.

(2) Role of reference points in choice lists.

(3) Time preference. This paper properly measures discounting and utility. It allows for two nonzero outcomes, which is needed to identify discounting and utility. The novelty is, again, that this paper is the first to properly reckon with reference dependence.

More impatience if present-oriented fixed option than if future-oriented. %}

Li, Zhihua & Songfa Zhong (2023) "Reference Dependence in Intertemporal Preference," *Management Science* 69, 475–490.
https://doi.org/10.1287/mnsc.2022.4348

{% First consider the standard Savage model, with acts mapping states to outcomes. Imagine the agent chose an act f. She next is not informed about the true state of nature s, but only about the outcome f(s) received. So, then she only knows that $f^{-1}(f(s))$ happened, and she can update subjective probabilities accordingly. (In the version of this paper of Nov. 11 2019, the latter assumption is made implicitly.) This paper considers, one step more complex here, the Anscombe-Aumann (AA) framework where an act maps every state to a probability distribution over outcomes. (I maintain this term here instead of the term prize commonly used in the AA framework, or the term consequence used by Savage.) Given an act, every outcome induces a likelihood function on the state space. Thus, if a subject is informed only about the outcome received, she can update using that likelihood function.

This paper considers a model where preferences are represented by the sum of subjective expected utility and a rather general function of the value of info provided by the likelihood function. So, the info has additional value, possibly for future unmodeled decisions or something intrinsic (although I find that word close to being a dirty word in decision theory). Information aversion (seeking) is defined in a way making it equivalent to concavity (convexity) of the info-value function. Information seeking holds if and only if there is a hidden act representation (like a future unmodeled decision).

In the axiomatization, there is a special role for sets of acts that provide the same info about states. Preferences within them are governed by standard expected utility. %}

Liang, Yucheng (2019) "Information-Dependent Expected Utility," working paper.

{% **updating under ambiguity**; The paper considers unknown probability where the true probability either is high, p_h, or low, p_l. Subjects receive info and the paper considers updating. Special here is that there may be uncertainty about the correctness of the info received. It finds that people exhibit both pessimism and insensitivity, the latter by underreacting. The underreaction is more pronounced for good news than for bad news. The attitudes towards uncertainty itself and towards belief updating are uncorrelated. The paper considers the various proposals for updating in the literature. Pessimism and insensitivity are stronger for genuine ambiguity than for compound uncertainty. Full Bayesian updating with pessimism and insensitivity best explains the data. %}

Liang, Yucheng (2022) "Learning from Unknown Information Sources," working paper.

{% Cooperative game theory, with many references %}

Liao, Stephen, Tanying Wu, Raymond Lau, & Itadong Zhang (2011) "Coalition Formation Based on Marginal Contributions and the Markov Process,"

{% Seems to show that every finite, vector-valued, non-atomic, countably additive measure is closed and convex. %}

Liapunov, Aleksandr Mikhailovich (1940) "Sur les Fonctions-Vecteurs Complètement Additives," *Izvestiya Akademii Nauk SSSR* 5, 465–478.

{% Reviews evidence that people, unassisted, lack the ability to behave as Bayesian statisticians. %}

Libby, Robert (1981) "*Accounting and Human Information Processing: Theory and Applications*." Prentice-Hall, Englewood Cliffs, NJ.

{% **risk averse for gains, risk seeking for losses & utility concave near ruin**: Risk aversion near ruin: pp. 285-286 suggest that the probability of ruin plays a special role, also middle of p. 287, a point reiterated extensively on pp. 288-289. %}

Libby, Robert & Peter C. Fishburn (1977) "Behavioral Models of Risk Taking in Business Decisions: A Survey and Evaluation," *Journal of Accounting Research* 15, 272–292.

{% Cognitive ability is related to probability judgments. (**cognitive ability related to risk/ambiguity aversion**)

The authors consider several numeracy/intelligence tests, and relate them to each other with factor analyses and relate them also to disjunction and conjuction and ratio-bias fallacies in probability judgement. The natural finding is that more intelligence leads to fewer biases. The authors point out that there hasn´t yet been much theory on the cognitive abilities relevant here, and contribute to that, giving more refined results. They identify some factors of intelligence and their effect on biases. %}

Liberali, Jordana M., Valerie F. Reyna, Sarah Furlan, Lilian M. Stein, & Seth T. Pardo (2012) "Individual Differences in Numeracy and Cognitive Reflection, with Implications for Biases and Fallacies in Probability Judgment," *Journal of Behavioral Decision Making* 25, 361–381.

{5 **probability elicitation** %}

Liberman, Varda & Amos Tversky (1993) “On the Evaluation of Probability Judgments: Calibration, Resolution, and Monotonicity,” *Psychological Bulletin* 114, 162–173.

{% **free will/determinism**: Famous experiment on free will. Asked subjects to move right hand at moment chosen themselves. Had to indicate exact point of decision. However, EEG-registered brain activities prepared the movement earlier, prior to, the indicated time of decision. So, consciousness seems to come after decision in brains. This study initiated many similar studies.

The conclusion about free will was contested by the Dutch psychologist Herman Kolk. He cited William James’ (1890) ideomotor theory and his famous example of getting up without a conscious decision to that effect: There are impulses pro and impulses con. Subjects are asked to push a button, giving impulses pro doing it, but are also asked not to do it immediately, which are impulses con ion the beginning. If may be the disappearance of the impulses con that generate the push of button, without there having been some decision pro. Such a quasi-decision is only stated later by the subject so as to ex post justify for himself or others what happened. %}

Libet, Benjamin, Curtis A. Gleason, Elwood W. Wright & Dennis K. Pearl (1983) “Time of Conscious Intention to Act in Relation to Onset of Cerebral Activities (Readiness-Potential): The Unconscious Initiation of A Freely Voluntary Act,” *Brain* 106, 623–642.

{% **ordering of subsets** %}

Licalzi, Marco (1998) “Variations on the Measure Representation Approach,” *Journal of Mathematical Economics* 29, 255–269.

{% **utility families parametric**; investigate the Pearson parametric family, proposed to fit probability distributions, for the purpose of a parametric utility family. One parameter, m, is the reference point, and then the family can be concave or convex below it, also above it, and can have any of four combinations. It extends the HARA family. For some parameters the maximum support is bounded. §6 briefly discusses the use for probability weighting. %}

LiCalzi, Marco & Annamaria Sorato (2006) "The Pearson System of Utility Functions," *European Journal of Operational Research* 172, 560–573.

{% Show that, for expert aggregation, averaging quantiles usually works better than averaging probability estimates. %}

Lichtendahl, Kenneth C. Jr., Yael Grushka-Cockayne, & Robert L. Winkler (2013) "Is It Better to Average Probabilities or Quantiles?," *Management Science* 59, 1594–1611.
http://dx.doi.org/10.1287/mnsc.1120.1667

{% **probability elicitation**: survey of calibration; **survey on belief measurement** %}

Lichtenstein, Sarah, Baruch Fischhoff, & Lawrence D. Phillips (1977) "Calibration of Probabilities: The State of the Art." *In* Helmut Jungermann & Gerard de Zeeuw (eds.) *Decision Making and Change in Human Affairs*. Reidel, Dordrecht.

{% **probability elicitation**: survey of calibration; find widespread overconfidence; a follow-up is in McClelland & Bolger (1994) %}

Lichtenstein, Sarah, Baruch Fischhoff, & Lawrence D. Phillips (1982) "Calibration of Probabilities: The State of the Art to 1980." *In* Daniel Kahneman, Paul Slovic, & Amos Tversky (eds.) *Judgment under Uncertainty: Heuristics and Biases*, Cambridge University Press, Cambridge.

{% original reference;

P. 53 last para of first column: They did debriefings. Of 11 subjects, 6 quickly restored consistency, 3 only after insistance with money-pump arguments, and 2 not at all.

P. 556, last para, argues that subjects' inconsistent choices need not be irrational because consistent decision strategies are costly to implement, citing Tversky (1969) for this view. %}

Lichtenstein, Sarah & Paul Slovic (1971) "Reversals of Preference between Bids and Choices in Gambling Decisions," *Journal of Experimental Psychology* 89, 46–55.

{% gamblers in Las Vegas; using real stakes %}

Lichtenstein, Sarah & Paul Slovic (1973) "Response-Induced Reversals of Preferences in Gambling: An Extended Replication in Las Vegas," *Journal of Experimental Psychology* 101, 16–20.

{% **inverse S:** Jn !judgments of frequencies!, people exhibit inverse S. %}

Lichtenstein, Sarah, Paul Slovic, Baruch Fischhoff, Mark Layman, & Barbara Combs (1978) "Judged Frequency of Lethal Events," *Journal of Experimental Psychology: Human Learning and Memory* 4, 551–578.

{% Use graphs to represent strengths of preferences, with the length of an arrow indicating strength of preference. %}

Lidouh, Karim, Yves De Smet, & Minh Tuan Huynh (2009) "Circular Representations of a Valued Preference Matrix," Université Libre de Bruxelles.

{% They study and review many "collapse-to-the-mean" results. That is, law-invariant functionals that, because of some extra conditions, can be nothing other than expected value. %}

Liebrich, Felix-Benedikt & Cosimo Munari (2022) "Law-Invariant Functionals That Collapse to the Mean: Beyond Convexity," *Mathematics and Financial Economics* 16, 447–480. https://doi.org/10.1007/s11579-022-00313-9

{% Measure prospect theory for African cattle farmers. %}

Liebenhem, Sabine & Hermann Waibel (2014) "Simultaneous Estimation of Risk and Time Preferences among Small-Scale Cattle Farmers in West Africa," *American Journal of Agricultural Economics* 96, 1420–1438.

{% Find that duration neglect disappears when episodes are represented using graphs, rather than memory. Frankly, this is not surprising. %}

Liersch, Michael J. & Craig R.M. McKenzie (2009) "Duration Neglect by Numbers—And Its Elimination by Graphs," *Organizational Behavior and Human Decision Processes* 108, 303–314.

{% **inverse S:** Moderately experienced poker players estimate probability of winning, given their cards, quite well, although they overestimate some probabilities below 0.7 and underestimate them above. This may be mere regression to the mean. %}
Liley, James & Tim Rakow (2010) "Probability Estimation in Poker: A Qualified Success for Unaided Judgment," *Journal of Behavioral Decision Making* 23, 496–526.

{% **cognitive ability related to risk/ambiguity aversion**: A review and meta-analysis of the relation. Weak negative relation between risk aversion and cognitive ability for gains. No relation for losses or for mixed prospects. No gender difference. %}
Lilleholt, Lau (2019) "Cognitive Ability and Risk Aversion: A Systematic Review and Meta Analysis," *Judgment and Decision Making* 14, 234–279.

{% Study + references on correcting intransitivities. %}
Linares, Pedro (2009) "Are Inconsistent Decisions Better? An Experiment with Pairwise Comparisons," *European Journal of Operational Research* 193, 492–498.

{% Only reasonable way to determine social rate of discounting is by eliciting **time preference** of individuals. Gives examples where people do different trades with different discountings in different domains. People save at some interest rate but at the same time pay with credit cards with higher rates of interest. This is not only due to transaction costs but also due to of a kind of mental accounting, e.g. to control certain kinds of spending differently than others. Thus, in particular, people need not be affected much by the market interest rate. %}
Lind, Robert C. (1990) "Reassessing the Government's Discount Rate Policy in the Light of New Theory and Data in a World Economy with a High Degree of Capital Mobility," *Journal of Environmental Economics and Management* 18, S8–S28.

{% If two persons are altruistic then that may generate inefficiencies, such as me deliberately consuming more the first period knowing that my partner (and me) out of altruistic reasons will share in the second period, and my altruism being present but smaller than my selfishness. %}

Lindbeck, Assar & Jörgen Weibull (1988) "Altruism and Time Consistency: The Economics of Fait Accompli," *Journal of Political Economy* 96, 1165–1182.

{% Measure risk aversion, simply via # times of preference for smaller variance, whilst it is specified what fixed outcome a nonanonymous opponent gets. The latter was an opponent before in a Bertrand game (where both choose price and the lowest price gets the whole market, so very competitive). When the opponent's outcome is above the lottery outcomes, there is (just) more risk aversion than when not. If the opponent's outcome serves as a reference point, this finding goes against the less risk aversion for losses that prospect theory posits. I am interested in speculations on the emotions that the prior Bertrand game may have generated to explain this.

losses give more/less noise: P. 51 speculates that, because utility is steeper for losses, there will be fewer errors for losses. Although early studies suggested more errors for losses, several studies by Eldad Yechiam, e.g. Yechiam, Retzer, Telpaz, & Hochman (2015) confirmed fewer errors, showing that with losses involved subjects pay more attention.

§2.2 cites the circle test for measuring other-regarding attitude. You choose a point on a circle with center (0,0) and radius 1, say. Then the first coordinate is your payment, and the second is your opponent's. At your maximally selfish point, (1,0), the exchange rate is ∞. The direction of your point shows your degfree of selfishness. Pretty! %}

Linde, Jona & Joep Sonnemans (2012) "Social Comparison and Risky Choices," *Journal of Risk and Uncertainty* 44, 45–72.

{% %}

Lindenstrauss, Joram (1966) "A Short Proof of Lyapunov's Convexity Theorem," *Journal of Mathematics and Mechanics* 15, 971–972.

{% P. 1: "But above all he was a revolutionary, in the sense of Kuhn (1970), a man who replaced the accepted paradigm of inference by another, without, at first, realising what he had done."

Pp. 1-2: a distance space is embeddable in Euclidean space iff every four points are.

P. 6 ℓ. 3, on Savage (1954): "the last part was a failure"

Pp. 7 & 9 explain that Savage came to understand the likelihood principle only quite after 1954.

P. 9 emphasizes the importance of using economic decision theory to provide a rationality basis for statistical inference, citing Savage on it.

P. 10 is on the optimal stopping rule discussions.

P. 11 2nd para explains why the influential Edwards, Lindman, & Savage (1963) was not more influential than it was.

P. 19 end of penultimate para mentions that Fisher both advocated in criticized sufficiency. %}

Lindley, Dennis V. (1980) "L.J. Savage—His Work in Probability and Statistics," *Annals of Statistics* 8, 1–24.

{% %}

Lindley, Dennis V. (1982) "Scoring Rules and the Inevitability of Probability," *International Statistical Review*, 1–26.

{% **coherentism**: §10.13, last line of third-to-last para expresses, unfortunately, the view that the only criterion for rationality is preference coherence. I criticize this view by comparing with a logician claiming that the only mistake an astronomer can make is violating the rules of logic, in my review of this book in Wakker (1986). %}

Lindley, Dennis V. (1985) "*Making Decisions*" 2nd edn. Wiley, New York.

{% **foundations of statistics**; usual story, starting from Wald; usual discussants. %}

Lindley, Dennis V. (1990) "The 1988 Wald Memorial Lectures: The Present Position in Bayesian Statistics," *Statistical Science* 5, 44–89.

{% On upper/lower probability: "One is that it is not necessary to increase complexity by including two numbers, upper and lower probability, in place of a single probability." A similar point is in Camerer & Weber (1992, p. 346). %}

Lindley, Dennis L. (1996) “Discussion of Walley (1996),” *Journal of the Royal Statistical Society B* 58, 47–48.

{% **probability elicitation**; on how to correct inconsistencies in probability judgments, either through improving internal consistency or through external source. %}

Lindley, Dennis V., Amos Tversky, & Rex V. Brown (1979) “On the Reconciliation of Probability Assessments,” *Journal of the Royal Statistical Society* A 142, 146–180.

{% According to Seidl (2002) the first discoverer of preference reversals. %}

Lindman, Harold R. (1965) “The Measurement of Utilities and Probabilities.” Ph.D. dissertation, University of Michigan.

{% According to Seidl (2002) the first discoverer of preference reversals through his 1965 Ph.D. disseration, so, preceding Lichtenstein & Slovic (1968, 1971) %}

Lindman, Harold R. (1971) “Inconsistent Preferences among Gambles,” *Journal of Experimental Psychology* 89, 390–397.

{% %}

Lindman, Harold R. & James Lyons (1978) “Stimulus Complexity and Choice Inconsistency among Gambles,” *Organizational Behavior and Human Decision Processes* 21, 146–159.

{% Shows that if we take expected utility but have initial wealth and income as separate arguments in deviation from final wealth, then we have preference reversals. Can be taken to support my opinion that EU of income is a big breakaway from classical models. A model accommodating preference reversals isn’t anywhere near a classical rational model. %}

Lindsay, Luke (2013) “The Arguments of Utility: Preference Reversals in Expected Utility of Income Models,” *Journal of Risk and Uncertainty* 46, 175–189.

{% They experiment with risky decisions only affecting oneself but with a fixed social context. They don’t use full-fledged decision models with risk, social, inequality, and everything there, but they present partial formulas enough to make qualitative predictions, such as dependence on rank but also dependence on distance to reference point, and they test those. %}

Lindskog, Annika, Peter Martinsson, & Haileselassie Medhin (2022) "Risk-Taking and Others: Does the Social Reference Point Matter?," *Journal of Risk and Uncertainty* 64, 287–307.
https://doi.org/10.1007/s11166-022-09376-x

{% **foundations of statistics**; discussion in Amsterdam with Molenaar and de Leeuw %}

Linssen, H. Nico (1984) "Fiduciële Statistiek," *Kwantitatieve Methoden* 13, 31–41.

{% %}

Linville, Patricia W. & Gregory W. Fischer (1991) "Preferences for Separating or Combining Events," *Journal of Personality and Social Psychology* 60, 5–23.

{% Refers to Hintikka (1975) for the term "impossible possible worlds" as state of the world that is subjectively possible but for omniscient perfect logician would not be possible, e.g. that 10,000 digit of square-root of 2 is 1 (which it is not if I understood the text right). %}

Lipman, Barton L. (1999) "Decision Theory without Logical Omniscience: Toward an Axiomatic Framework for Bounded Rationality," *Review of Economic Studies* 66, 339–361.

{% The paper cites several surveys on discount measurements, including meta-analyses, of Amlung et al. (2019), Frederick et al. (2002), Percoco & Nijkamp (2009), Cohen et al. (2020), and Matousek, Havranek, & Irsova (2022). This paper kind of updates but its focus is different, as its title says: on measuring methods. A valuable feature is that it connects economic literature with the vast health literature, and also with the psychological literature.

P.151, Table 2, nicely gives (almost) all discount functions used in the literature. I think the current (in 2024) literature overemphasizes decreasing impatience, and there should be more attention for increasing impatience. Unfortunately, this paper pays no attention to the latter. %}

Lipman, Stefan A. & Arthur E. Attema (2024) "A Systematic Review of Unique Methods for Measuring Discount Rates," *Journal of Risk and Uncertainty* 69, 145–189.
https://doi.org/10.1007/s11166-024-09439-1

{% Nudge originated as a subtle way of improving decisions by reckoning with descriptive insights while avoiding (strong) paternalism. (Nowadays, 2020, the term has inflated and is often used more broadly.) In many situations, this is not possible and we must be paternalistic. E.g., if forbidding by law that adolescents use heroine. Thus, Bleichrodt, Pinto, & Wakker (2001) proposed to use prospect theory (PT) to improve utility measurement. More precisely, they took expected utility (EU) is normative theory and PT as descriptive theory. PT's deviations from EU then are taken as irrational biases, to be corrected. Thus, recommended decisions can deviate from expressed subjects'/patients' preferences. This sounds paternalistic, but if one does not do this one can almost never improve others' decisions. (Raiffa 1961: "we don't have to teach what comes naturally"). It is called the corrective approach. This paper follows that approach and discusses many applications and practical implications.

This paper does not consider much the measurement of utility of life duration/discounting. It focuses on the measurement of quality of life of health states, also called utility of health states or, sometimes, weight of health states. Box 1 on p. 817 explains the TTO and SG measurements of quality of life. In general, whenever a bias has a particular effect, then the corrective procedure for it, serving to neutralize, will impose the opposite effect. And, in general, given the scaling U(death) = 0, U(perfect health) = 1, the more concave utility is, i.e., the more risk averse we make it, the higher utility values for intermediate health states. Thus, loss aversion and the, mostly pessimistic, probability weighting increase risk aversion. The corrective approach then increases risk seeking and decreases quality of life estimations. Same things when correcting for loss aversion in TTO. A bit of a different story regarding normative/descriptive is correcting TTO for concave utility of life duration but, anyway, it leads to increases in quality of life estimates. Because most of these corrections lead to more convex utility, they lead to higher evaluations of getting back perfect health (the "perfect heath gap").

This paper uses the term loss aversion differently than I and Bleichrodt, Pinto, & Wakker (2001) do. I use it only for framing effects that, by definition, are irrational. Rational part are put into utility, more precisely, “basic utility.” This is by definition, and terminological. This paper does not do so and also uses the term loss aversion for components that may be rational.

P. 818 top: criticism of parametric fitting.

P. 819 end of 1st column: compression is not an explanation, but a restatement of the perfect health gap.

P. 819 top of 2nd column: compression need not explain consistency because the different measurements can get compressed at different levels.

P. 820 2nd para: never in my life, so, never in Diecidue & Wakker (2001), did I call a deviation from EU such as probability weighting rational. %}

Lipman, Stefan A., Werner B.F. Brouwer, & Arthur E. Attema (2019) “The Corrective Approach: Policy Implications of Recent Developments in QALY Measurement Based on Prospect Theory,” *Value in Health* 22, 816–821. http://dx.doi.org/10.1016/j.jval.2019.01.013

{% Compared TTO measurements with SG measurements. For discrepancies, subjects (students) were asked to choose which they found more plausible. It was mostly TTO that was more plausible. %}

Lipman, Stefan A., Werner B. F. Brouwer, & Arthur E. Attema (2020) “What Is It Going to Be, TTO or SG? A Direct Test of the Validity of Health State Valuation,” *Health Economics Letter* 29, 1457–1481. https://doi.org/10.1002/hec.4131

{% %}

Lippman, Steven A. (1975) “On Dynamic Programming with Unbounded Rewards,” *Management Science* 21, 1225–1233.

{% A follow-up on Pratt & Zeckhauser (1987), on Samuelson’s colleague example. %}

Lippman, Steven A. & John W. Mamer (1988) “When Many Wrongs Make a Right: An Asymptotic Analysis of Risk Aversion and Additive Risks,” *Probability in the Engineering and Informational Sciences* 2, 115–127.

{% **Z&Z** %}
Lippman, Steven A. & John C. McCall (1981) "The Economics of Uncertainty: Selected Topics and Probabilistic Methods." *In* Kenneth J. Arrow & Michael D. Intriligator (eds.) *Handbook of Mathematical Economics* I, Ch. 5, 211–284, North-Holland, Amsterdam.

{% Discounted utility model doesn't always truly represent prefs and, hence, recommends "scenario" analysis (global EU evaluation) %}
Lipscomb, Joseph (1989) "Time Preference for Health in Cost-Effectiveness Analysis," *Medical Care* 27, S233–S253.

{% %}
Lismont, Luc & Philippe Mongin (1994) "On the Logic of Common Belief and Common Knowledge," *Theory and Decision* 37, 75–106.

{% %}
Lismont, Luc & Philippe Mongin (1995) "Belief Closure: A Semantics of Common Knowledge for Modal Propositional Logic," *Mathematical Social Sciences* 30, 127–153.

{% **free will/determinism**: Distinguishes between physical and agential possible. The latter is broader. %}
List, Christian (2014) "Free Will, Determinism, and the Possibility of Doing Otherwise," *Nous* 48, 156–178.

{% **free will/determinism**: seems to argue as follows: Even if weather is determined by many elementary particles that all behave deterministically, this phenomenon is not deterministic at the macro level, at least in our psychological perception. Thus, there is space for free will at such macro levels. I am not sure if the author thinks that the macro events are in principle fully determined by the micro phenomena but it is just too complex for us to understand, which is not really deviating from reductionism, or if he thinks that there are macro phenomena that really in no way are determined by the micro-phenomena. Or, to what extent free

will is only (mis)perception in a deterministic world, and to what extent it really needs indeterminism. %}

List, Christian (2019) “*Why Free Will is Real.*” Harvard University Press, Cambridge, MA.

{% %}

List, Christian & Clemens Puppe (2009) “Judgment Aggregation: A Survey.” *In* Paul Anand, Prastanta Pattanaik, & Clemens Puppe (eds.), *Handbook of Rational and Social Choice*, Ch. 19, Oxford University Press, Oxford.

{% Shows preference reversal for people buying sportscard. Nice thing is that these were real people really buying those cards. The author argues that, because his data do not consider risky choices, there are also problems with the classical decision paradigm outside of nonexpected utility.

His interpretations of the findings are on p. 1641:

“these findings should lend new insights into nonexpected utility resolutions to paradoxes of choice.”

“a reevaluation of the fundamental building blocks of utility theory is necessary.” “Overall, these empirical results should have practical significance for economic theorists, empirical researchers, policy makers, and the growing body of scientific research that uses experimental methods.” %}

List, John A. (2002) “Preference Reversals of a Different Kind: The “More Is Less” Phenomenon,” *American Economic Review* 92, 1636–1643.

{% Inexperienced subjects in the market place exhibit loss aversion (endowment effect) as prospect theory has it. If subjects acquire experience, the effect attenuates. They then also exhibit less loss aversion in different tasks, i.e., transference of behavior. %}

List, John A. (2004) “Neoclassical Theory versus Prospect Theory: Evidence from the Marketplace,” *Econometrica* 72, 615–625.

{% A pretty experiment disentangling prosocial behavior, reciprocal behavior, reputation building, and field versus lab. %}

List, John A. (2006) "The Behaviorist Meets the Market: Measuring Social Preferences and Reputation Effects in Actual Transactions," *Journal of Political Economy* 114, 1–37.

{% **concave utility for gains, convex utility for losses**: tests Hicksian compensating surplus and finds that inexperienced agents exhibit diminishing sensitivity and, thus, convex utility for losses as predicted by prospect theory and contrary to classical theories, but for experienced agents it is the other way around. He does this using real-market data. %}
List, John A. (2006) "Using Hicksian Surplus Measures to Examine Consistency of Individual Preferences: Evidence from a Field Experiment," *Scandinavian Journal of Economics* 108, 115–134.

{% **real incentives/hypothetical choice** %}
List, John A. & Craig A. Gallet (2001) "What Experimental Protocol Influence Disparaties between Actual and Hypothetical States Values? Evidence from a Meta-Analysis," *Experimental and Resource Economics* 20, 241–254.

{% **losses from prior endowment mechanism**: this is what they do. Do the traditional **probability triangle** with CEOs and students. Find deviations from EU primarily for small probabilities, as is common. They argue that small probabilities at catastrophes are important in policy decisions (**(very) small probabilities**), and that cost-benefit analyses are virtually always based on EU. So, what they are finding implies that people are willing to pay much more for avoiding such risks than commonly thought.

The implementation of high losses in the experiment is \$100 for CEOs and \$10 for students. To be sure that these can be qualified as considerable losses they asked the subjects, who confirmed (p. 116 1st column ℓ. 4), so, they are solid on this point. %}
List, John A. & Charles F. Mason (2011) "Are CEOs Expected Utility Maximizers?," *Journal of Econometrics* 162, 114–123.

{% A phantasy-story: Jn 300 years from now, when people use only computers to write and no one uses pens or pencils anymore, someone will rediscover pencils, and everyone will find it a large improvement over computers.

This paper reminds me of the phantasy-story. In experiments in the past, indifference-switching values were elicited through binary choices in paper-and-pencil questions. Later, computers were used and things became more sophisticated. This paper considers, as if new, the return to paper-and-pencil questions. %}

Littenberg, Benjamin, Steven Partilo, Anita Licata, & Michael W. Kattan (2003) "Paper Standard Gamble: The Reliability of a Paper Questionnaire to Assess Utility," *Medical Decision Making* 23, 480–488.

{% P. 49 (citation from Sen):

"The new [Samuelson's revealed preference] formulation is scientifically more respectable [since] if an individual's behavior is consistent, then it must be possible to explain the behavior without reference to anything other than behavior" %}

Little, Ian M.D. (1949) "A Reformulation of the Theory of Consumer's Behaviour," *Oxford Economic Papers* 1, 90–99.

{% %}

Little, Ian M.D. (1985) "Robert Cooter and Peter Rappoport, 'Were the Ordinalists Wrong about Welfare Economics?': A Comment," *Journal of Economic Literature* 23, 1186–1188.

{% %}

Little, John D.C. (2015) "Obituary John F. Nash Jr.," *International Transactions in Operational Research* 22, 1117–1118.
https://doi.org/10.1111/itor.12203

{% Uses nonaddtive measures to model subjective beliefs. Normative perspective, and mathematical. Similar to Schmeidler (1989), but developed independently, with no cross references. Has many citations. %}

Liu, Boading (2015) "*Uncertainty Theory*." Springer, Berlin.

{% Measures prospect theory for Chinese cotton farmers. %}

Liu, Elaine M. (2013) "Time to Change What to Sow: Risk Preferences and Technology Adoption Decisions of Cotton Farmers in China," *The Review of Economics and Statistics* 95, 1386–1403.

{% Provide representation and applications of law-invariant convex risk functionals. %}

Liu, Fangda, Jun Cai, Christiane Lemieux, & Ruodu Wang (2020) "Convex Risk Functionals: Representation and Applications," *Insurance, Mathematics and Economics* 90, 66–79. https://doi.org/10.1016/j.insmatheco.2019.10.007

{% People are less ambiguity averse when choosing the better of two options than when rejecting the worst of two options. The author discusses this finding extensively. %}

Liu, Hsin-Hsien (2011) "Task Formats and Ambiguity Aversion," *Journal of Behavioral Decision Making* 24, 315–330.

{% Prevention-focused people (focusing on cons) are more ambiguity averse than promotion-focused people. %}

Liu, Hsin-Hsien (2011) "Impact of Regulatory Focus on Ambiguity Aversion," *Journal of Behavioral Decision Making* 24, 412–430.

{% **updating under ambiguity with sampling**; P. 278 shows that the Samuelson colleague example does not violate EU if not the single rejection is imposed in all situations.

All choices hypothetical …

Do choice under risk and ambiguity (Ellsberg urn and market choice with 40-80% success chance indicated). Do single choice and repeated (twice). In repeated choice less ambiguity aversion. This is the simple finding of this paper. A plausible and even normative explanation, not mentioned by the authors, is that for repeated ambiguous choice one can learn about (unknown) probabilities in later choices from the first choice. In the Ellsberg experiment subjects were told that on each choice the computer anew determined the composition of the unknown urn, but we can then still learn about the computer from repeated

choice.

The authors put up loss aversion as explanation. I do understand that for repeated choice sometimes the probability of a loss is smaller than for single choice, but not why that reduces ambiguity aversion. %}

Liu, Hsin-Hsien & Andrew M. Colman (2009) "Ambiguity Aversion in the Long Run: Repeated Decisions under Risk and Uncertainty," *Journal of Economic Psychology* 30, 263–516.

{% Whereas for moderate-outcome events with nonlow frequencies probabilities are known, for rare events of extreme magnitudes (p. 132 1/3) they are not (**(very) small probabilities**). Hence, adding additional ambiguity aversion and ambiguity-premium (the paper calls it uncertainty premium) can help explain asset prices. So it does. Especially for options out of the money, which are very sensitive to rare events (unlike equity for instance, see p. 146), this works well. The effect is independent of risk aversion (they assume EU for given probabilities and, hence, risk aversion = concave utility). For instance, Eq. 27 (p. 143) displayes the additional component in the equity premium. They explain that recursive utility cannot do it because it should be only for rare events and recursive utility does it for all events. For example, p. 135: "In particular, the rare-event premium component, which is linked directly to rare-event uncertainty in our setting, cannot be generated by the recursive utility." Reiterated on p. 139

P. 135 footnote 8: "We show that recursive utility cannot resolve the smile puzzle. … In effect, it does not have the additional coefficient to control the market price of rare events separately from the market price of diffuse shocks."

ambiguity seeking for unlikely: The paper does not show that, but it does show that ambiguity attitude is different for events of different likelihoods. It also supports **event/outcome driven ambiguity model: event driven**.)

P. 137 footnote 11: impossible events get weight 0. (As in neo-additive models.)

Helps explain equity premium puzzle and volatility smile (or smirk, which is a skewed version; see p. 150).

P. 152: Points out that their model can only work because they add a new dimension: "since we add a new dimension to the problem: rare events and uncertainty aversion only toward rare events." This is nice support for likelihood insensitivity, and

against universal ambiguity aversion.

P. 155: "these restrictions do become important as we apply the model to a range of securities with varying sensitivity to rare events." %}

Liu, Jun, Jun Pan, & Tan Wang (2005) "An Equilibrium Model of Rare-Event Premia and Its Implication for Option Smirks," *Review of Financial Studies* 18, 131–164.

{% Variation of the Luce-Fishburn axiomatization, using joint receipt. %}

Liu, Liping (2003) "A Note on Luce-Fishburn Axiomatization of Rank-Dependent Utility," *Journal of Risk and Uncertainty* 28, 55–71.

{% Redefines downside risk increase as a change preferred by all agents with decreasing absolute risk aversion. Provides an alternative definition in terms of more prudent, improving a Keenan & Snow definition, e.g. in being transitive. All is under EU. %}

Liu, Liqun & Jack Meyer (2012) "Decreasing Absolute Risk Aversion, Prudence and Increased Downside Risk Aversion," *Journal of Risk and Uncertainty* 44, 243–260.

{% A variation of the Pratt-Arrow measure or risk aversion where the denominator is the derivative of U at some prespecified point. Ross (1981) is central. %}

Liu, Liqun & Jack Meyer (2013) "Normalized Measures of Concavity and Ross's Strongly More Risk Averse Order," *Journal of Risk and Uncertainty* 47, 185–198.

{% Generalize Machina & Neilson (1987) by considering rates of substitution between different orders of riskiness. %}

Liu, Liqun & Jack Meyer (2013) "Substituting one Risk Increase for Another: A Method for Measuring Risk Aversion," *Journal of Economic Theory* 148, 2706–2718.

{% This paper examines transformations T transforming probability distributions into other probability distributions. Shape transformation results from what economists would call utility transformation of outcomes. Probability transformation results from transforming the distribution function, which is what

economists call rank-dependent probability weighting. Such T transformations provide a nice unified framework to capture many things under one umbrella.

Theorem 1 shows that, under some regularity assumptions, a transformation is commutative with a shape transformation if and only if it is rank-dependent probability weighting transformation. That is, whether you first transform outcomes into their utilities, and then transform the distribution, or you first transform the distribution and then transform the outcomes into their utilities, does not matter. While a mathematical result, it nicely supports the natural nature of rank dependence, where transforming the outcomes and transforming the probabilities are sort of orthogonal operations. Further properties, such as convexity, are studied. %}

Liu, Peng, Alexander Schied, & Ruodu Wang (2021) "Distributional Transforms, Probability Distortions, and Their Applications," *Mathematics of Operations Research* 46, 1490–1512.
https://doi.org/10.1287/moor.2020.1090

{% Increasing a future payoff's ambiguity from a precise value (e.g., $150) to a range (e.g., $140–$160) can increase appeal. This is called the future ambiguity effect. %}

Liu, Yuanyuan, Timothy B. Heath, & Ayse Onculer (2020) "The Future Ambiguity Effect: How Narrow Payoff Ranges Increase Future Payoff Appeal," *Management Science* 66, 3754–3770.
https://doi.org/10.1287/mnsc.2019.3375

{% **ambiguity seeking for unlikely**: pp. 81-82: -"To sum up, we propose that time has a differential influence on high probability and low-probability prospects. Specifically, for high probabilities, time will reduce ambiguity aversion by increasing the reliance of cognitive processing. For low probabilities, the influence of time is trivial because of the predominance of cognitive processing for small probabilities." They use experimenter-specified probability intervals to generate probabilities (through urns with upper and lower bounds on compositions specified), taking, as usual, arithmetic midpoint as ambiguity neutrality.

Study 1: choices were hypothetical, with introspective strengths of preferences.

Study 2: Matching probabilities were determined. The authors use the term ambiguity-probability trade-off task. The authors use biseparable utility, calling it α-maxmin, and use α as index of ambiguity aversion. Here RIS was used where 1 subject played for real, with one future payment possibly one year later.

Study 3 is most interesting. A control group is like study 2 (although hypothetical). But one other group before answering the immediate questions is primed cognitively by being asked five calculation questions, and another group before answering the future-decision questions is primed affectively by first answering five affect-questions ("if …, what do you feel?"). The cognitively primed indeed become more ambiguity neutral (rational!?) and the affectively primed opposite. %}

Liu, Yuanyuan & Ayse Öncüler (2017) "Ambiguity Attitudes over Time," *Journal of Behavioral Decision Making* 30, 80–88.
https://doi.org/10.1002/bdm.1922

{% %}

Liu, Zhiwei, Xinxi Song, & Nicholas C. Yannelis (2020) "Randomization under Ambiguity: Efficiency and Incentive Compatibility," *Journal of Mathematical Economics* 90, 1–11.

{% **anonymity protection** %}

Ljungqvist, Lars (1993) "A Unified Approach to Measures of Privacy in Randomized Response Models: A Utilitarian Perspective," *Journal of the American Statistical Association* 88, 97–103.

{% Gul's (1991) disappointment aversion model extended to subjective probabilities with probabilistic sophistication. %}

Lleras, Juan Sebastián, Evan Piermont, & Richard Svoboda (2019) "Asymmetric Gain–Loss Reference Dependence and Attitudes toward Uncertainty," *Economic Theory* 68, 669–699.

{% **Adaptive utility elicitation**: find that adaptive utility measurements give higher values. %}

Llewellyn-Thomas, Hilary A., Rena Arsinoff, Mary Bell, Jack Ivan Williams, & C. David Naylor (2002) "Healthy-Year Equivalents in Major Joint Replacement," *International Journal of Technology Assessment in Health Care* 18, 467–484.

{% **adaptive utility elicitation**: find that adaptive utility measurements give higher values. %}

Llewellyn-Thomas, Hilary A., Heather J. Sutherland, Robert Tibshirani, Antonio Ciampi, James E. Till, & Norman F. Boyd (1982) "The Measurement of Patients' Values in Medicine," *Medical Decision Making* 2, 449–462.

{% **utility elicitation** %}

Llewellyn-Thomas, Hilary A., Heather J. Sutherland, Robert Tibshirani, Antonio Ciampi, James E. Till, & Norman F. Boyd (1984) "Describing Health States, - Methodologic Issues in Obtaining Values for Health States," *Medical Care* 22, 543–552.

{% Aangeraden door Lia als bekijkend verband tussen anticipated en experienced utility. %}

Llewellyn-Thomas, Hilary A., Heather J. Sutherland, Antonio Ciampi, Jamshid Etezadi-Amoli, Norman F. Boyd & James E. Till (1984) "The Assessment of Values in Laryngeal Cancer: Reliability of Measurement Methods," *J. Chron Disease* 37, 283–291.

{% %}

Llewellyn-Thomas, Hilary A., Elaine C. Thiel, & R.M. Clark (1989) "Patients versus Surrogates: Whose Opinion Counts on Ethics Review Panels?," *Clinical Research* 37, 501–505.

{% referaat van Sylvia op 3 feb. 97. Paper suggests use of reference point idea of prospect theory but does not get into reference point-dependence. %}

Llewellyn-Thomas, Hilary A., Elaine C. Thiel, & M. June McGreal (1992) "Cancer Patients' Evaluations of Their Current Health States," *Medical Decision Making* 12, 115–122.

{% Seem to find that groups are more ambiguity averse. %}
Lloyd, Alex & Anna K. Döring (2019) "When Do Peers Influence Adolescent Males' Risk Taking? Examining Decision Making under Conditions of Risk and Ambiguity," *Journal of Behavioral Decision Making* 32, 613–626.

{% %}
Lo, Kin Chung (1995) "Nash Equilibrium without Mutual Knowledge of Rationality," Dept. of Economics, University of Toronto, Canada.

{% **equilibrium under nonEU**; p. 447 takes null event in the "conservative" Savage sense. %}
Lo, Kin Chung (1996) "Equilibrium in Beliefs under Uncertainty," *Journal of Economic Theory* 71, 443–484.

{% %}
Lo, Kin Chung (1996) "Weighted and Quadratic Models of Choice under Uncertainty," *Economics Letters* 50, 381–386.

{% **PT, applications**: nonadditive measures, overbidding %}
Lo, Kin Chung (1998) "Sealed Bid Auctions with Uncertainty Averse Bidders," *Economic Theory* 12, 1–20.

{% **equilibrium under nonEU**; **game theory for nonexpected utility**; à la Gilboa & Schmeidler (1989), Anscombe-Aumann framework with set of priors; takes null event in Savage sense; i.e., conservative. Strict monotonicity in event E means event E is nonnull everywhere. Shows that null-invariance holds in the maxmin EU model if and only if all possible prior probabilities have same support. Does Anscombe-Aumann mixing after, not before, in definition of quasi-concave;
Uncertainty aversion in extensive games can lead to Pareto improvement. %}
Lo, Kin Chung (1999) "Extensive Form Games with Uncertainty Averse Players," *Games and Economic Behavior* 28, 256–270.

{% **game theory for nonexpected utility** %}

Lo, Kin Chung (2000) "Epistemic Conditions for Agreement and Stochastic Independence of ε-Contaminated Beliefs," *Mathematical Social Sciences* 39, 207–234.

{% Shows that in the Savage model a single choice from a set of available actions can reveal violation of SEU only through violation of dominance (preference ordering on outcomes pregiven I assume). (A similar result fails for DUR, e.g. if the chosen act f is a probabilistic mixture of g and h, both of which are dominated by some other acts g´ and h´.) The result is reminiscent of Wald (1950). %}
Lo, Kin Chung (2000) "Rationalizability and the Savage Axioms," *Economic Theory* 15, 727–733.

{% **game theory for nonexpected utility**; considers maxmin EU in game theory. %}
Lo, Kin Chung (2007) "Sharing Beliefs about Actions," *Mathematical Social Sciences* 53, 123–133.

{% %}
Lobel, Jules & George F. Loewenstein (2005) "Emote control: The Substitution of Symbol for Substance in Foreign Policy and International Law," *Chicago Kent Law Review* 80, 1045–1090.

{% %}
Lobo, Miguel Sousa & Dai Yao (2010) "Human Judgement is Heavy Tailed: Empirical Evidence and Implications for the Aggregation of Estimates and Forecasts," INSEAD, Fontainebleau, France.

{% r**eal incentives/hypothetical choice, for time preferences**: seems to be on it %}
Löckenhoff, Corinna E., Joshua L. Rutt, Gregory R. Samanez-Larkin, Ted O'Donoghue, Valerie F. Reyna, & Barbara Ganzel (2016) "Dread Sensitivity in Decisions about Real and Imagined Electrical Shocks Does not Vary by Age," *Psychology and Aging* 31, 890–901.
https://doi.org/10.1037/pag0000136

{% Elaborates on all standard sufficiency implications concerning risk aversion and the like for RDU. %}

Loehman, Edna (1994) "Rank Dependent Expected Utility: Stochastic Dominance, Risk Preference, and Certainty Equivalence," *Journal of Mathematical Psychology* 38, 159–197.

{% An individual nonparametric estimation of RDU, PT, and other things is presented, based on pairwise choices between gambles, for N = 21 subjects. No real incentives were used. The way of getting nonparametric fittings resembles the method of Gonzalez & Wu (1999). That is, outcomes 300, 200, 150, 100, 50, 0, −50, −100, −200 are considered and the utilities of these outcomes are treated as parameters to be estimated. Similarly, probabilities .10, .25, .50, .75, .90 are taken and their weighting function values (possibly different for gains than losses) are treated as parameters to be estimated. P. 293 brings up the interpretation as parametric fitting of piecewise linear functions. Note that the Gonzalez & Wu paper had been around long before publication, with Gonzalez presenting it in a Mathematical Psychology conference of '92.

The numerical algorithm, explained on p. 293, is iterative, again similar to Gonzalez & Wu (1999). First w(.5) = .5 is taken and then from a number of .5 prob gamble prefs ("Set I") utility is estimated. Next these utilities are taken as given and from other gamble-prefs ("set II") the weights of the probabilities considered are estimated. The resulting weight of probability .5, which is usually different from .5, is used to re-estimate the utilities based on set-I-prefs. These are used to recalculate the weighting function, until the process converges. At each step, the solution closest to linear is chosen.

The gambles have either one nonzero outcome or one positive and one negative outcome. Here:

PT: original (1979) prospect theory, which is in fact PT with reflection in the domain considered. **SPT instead of OPT**: happens in Eq. 1

EURDP: what I call RDU.

SDM: on this domain it is in fact PT, generalizing OPT by allowing for different weighting of gains and losses. (It is taken from Currim & Sarin 1989.) It performs poorly.

The most pronounced effect in the data is, remarkably, never noted or discussed in the paper! It is loss aversion. That is, the slope of utility is big just below zero and then strongly drops when passing through zero. This effect can be seen in Tables 4 and 5 in the slope-of-utility tables, given for eight "smooth" subjects chosen out of a total of N = 21.

concave utility for gains, convex utility for losses: The paper finds concave utility for losses, in deviation from the commonly found convex utility. This finding may be explained because losses are framed as insurance questions which is known to enhance risk aversion (see keyword **insurance frame increases risk aversion**). The paper finds concave utility for small gains which may result from loss aversion. The paper finds convex utility for large gains (100-300 I guess) which is harder to explain. (Maybe a numerical effect of overmodeling loss aversion, so coming up with overly small slopes just after zero?)

inverse S: P. 289 says that insurance was accepted mostly for small-prob-high-losses. P. 295 finds inverse S for RDU which is the special case of PT where weighting for gains is dual to weighting for losses (loss aversion is captured in curvature of utility). P. 296 bottom mentions the results for PT (called SDM) briefly with no clear pattern.

P. 299, in the Conclusion, writes that there is clearly predictive power between RDU and OPT, but does not say how. The only thing I find is on p. 293 where, of 25 subjects, RDU fits two subjects more than OPT.

P. 299 last line: "Thus, the assumption that subjective probabilities sum to one has a strong effect on subjective probability estimates." %}

Loehman, Edna (1998) "Testing Risk Aversion and Nonexpected Utility Theories," *Journal of Economic Behavior and Organization* 33, 285–302. https://doi.org/10.1016/S0167-2681(97)00097-8

{% **time preference; decreasing/increasing impatience**: Finds counter-evidence against the commonly assumed decreasing impatience and/or present effect, explaining it by the value of anticipation and savoring. Seems to find negative discounting for losses. %}

Loewenstein, George F. (1987) "Anticipation and the Value of Delayed Consumption," *Economic Journal* 97, 666–684.

{% %}
Loewenstein, George F. (1988) "Frames of Mind in Intertemporal Choice," *Management Science* 34, 200–214.

{% P. 31, bottom: argues that economists should pay more attention to psychological aspects of **time preference**. %}
Loewenstein, George F. (1992) "The Fall and Rise of Psychological Explanations in the Economics of Intertemporal Choice." *In* George F. Loewenstein & John Elster (1992) *Choice over Time*, 3–34, Russell Sage Foundation, New York.

{% **real incentives/hypothetical choice**: §5 argues that real monetary incentives are not very important, because ten incentives other than monetary are more important (status, being best, other emotions).

Paper discussed behavioral economics versus experimental economics. The author sometimes gets carried away with his enthusiasm for behavioral economics and against experimental economics. Such as footnote 2 (p.F31): "Because context cannot be eliminated, experiments should never be used for the purpose of measuring individual propensities. … Some EE's [experimental economists] seem to believe they know the answer: whatever context gives results that are closest to the standard economic model." Or the final sentence of the paper: "Given that BEs [behavioral economists] have proposed some of the most novel and provocative hypotheses about individual behaviour, BE may well be the single best application of EE [experimental economics] methods."

§6 (p.F32) brings up a very strange exaggerated accusation of experimental economics: "a common failure by EE's [experimental economists] to assign subjects randomly to different treatments."

I agree with the criticism in §1 that experimental economists have not been well aware of issues of internal-external validity for a long time, and the present popularity of field studies is an unbalanced counterswing to catch up with what other social sciences have routinely known for longer times. %}
Loewenstein, George F. (1999) "Experimental Economics from the Vantage-Point of Behavioural Economics," *Economic Journal* 109, F25–F34. https://doi.org/10.1111/1468-0297.00400

{% On visceral factors. %}

Loewenstein, George F. (2000) "Emotions in Economic Theory and Economic Behavior," *American Economic Review, Papers and Proceedings* 90, 420–432.

{% The quantitatively-oriented tradeoff approach of classical decision theory can be applied to only a limited number of real-life decisions. This paper describes many reasons for why other factors can play a role in real-life decisions.

The enthusiasm of the author appears from sentences such as "Decision research is currently in ferment, the most intellectually vibrant period that I have witnessed since joining the field in the mid-1980s" (p. 504, closing comment), and the importance of his own contributions to the field appears from the discussions of those. %}

Loewenstein, George F. (2001) "The Creative Destruction of Decision Research," *Journal of Consumer Research* 24, 499–505.

{% **value of information**: short paper arguing for intrinsic value of information. Loewenstein will work extensively on it later, e.g. in Golman, Gurney, & Loewenstein (2021, Psychological Review). %}

Loewenstein, George F. (2006) "The Pleasures and Pains of Information," *Science* 312, 704–706.

{% Loss aversion: let people predict for which price they will sell; some minutes later they have to sell, and ask higher prices. %}

Loewenstein, George F. & Daniel Adler (1995) "A Bias in the Prediction of Tastes," *Economic Journal* 105, 929–937.

{% The authors kind of implicitly equate libertarian paternalism with asymmetric paternalism, implicitly arguing that if you do no coerce people then you will not make deliberate rational people go wrong. %}

Loewenstein, George F., Troyan Brennan & Kevin G. Volpp (2007) "Asymmetric Paternalism to Improve Health Behaviors," *Journal of the American Medical Association* 298, 2415–2417.

{% **time preference**; p. 203: refs on **free will/determinism**

intertemporal separability criticized %}

Loewenstein, George F. & John Elster (1992) "*Choice over Time.*" Russell Sage Foundation, New York.

{% %}

Loewenstein, George F., Ted O'Donoghue, & Matthew Rabin (2003) "Projection Bias in Predicting Future Utility," *Quarterly Journal of Economics* 118, 1209–1248.

{% %}

Loewenstein, George F. & Emily Haisley (2007) "The Economist as Therapist: Methodological Issues Raised by 'Light' Paternalism." *In* Andrew Caplin & Andrew Schotter (2008, eds.), *Perspectives on the Future of Economics: Positive and Normative Foundations, Vol. 1. in the Handbook of Economic Methodologies,* 210–248, Oxford University Press, Oxford, England.

{% Source dependence means a different thing here than in Tversky's sense of sources of uncertainty being collections of events in decision under uncertainty. Here it means a preference for a good when self chosen than when given by someone else. They demonstrate this. It is a problem in Ellsberg-urn studies of ambiguity if subjects can choose the color to gamble on, the most common way to control for suspicion (**suspicion under ambiguity**). %}

Loewenstein, George F. & Samuel Issacharoff (1994) "Source Dependence in the Valuation of Goods," *Journal of Behavioral Decision Making* 7, 157–168.

{% **time preference**;

preferring streams of increasing income;

P. 350: intertemporal additivity has never been viewed as normatively compelling

Preferences over sequences; argue for violations of intertemporal separability (**intertemporal separability criticized**); more extensive version is, apparently, Loewenstein & Prelec (1993) Psych. Rev. 100, 91–108. %}

Loewenstein, George F. & Drazen Prelec (1991) "Negative Time Preference," *American Economic Review, Papers and Proceedings* 81, 347–352.

{% **time preference**; **DC = stationarity** (p. 575 top & p. 592 3rd para & p. 595 3rd para; also that they call the (constant) discounted utility model normative.);

Eq. (21): Horst & I can do state-dept. EU also for time context.

The distributional condition that the authors state on top of p. 579 is a special case of Savage's (1954) P4. The authors refer to K&T (1979 p. 290) where it indeed also appears. %}

Loewenstein, George F. & Drazen Prelec (1992) "Anomalies in Intertemporal Choice: Evidence and an Interpretation," *Quarterly Journal of Economics* 107, 573–597.

{% **time preference** %}

Loewenstein, George F. & Drazen Prelec (1993) "Preferences for Sequences of Outcomes," *Psychological Review* 100, 91–108.

{% %}

Loewenstein, George F., Daniel Read, & Roy F. Baumeister (2003, eds.) "*Time and Decision: Economic and Psychological Perspectives on Intertemporal Choice.*" Russell Sage Foundation, New York.

{% **time preference**. **dominance violation by pref. for increasing income**: Assume that two wage profiles give the same sum of money over time but the first, at each timepoint, gives a higher total up to that timepoint than the second (e.g., first decreases, second increases). Then in fact by no more than monotonicity (if money is the only relevant attribute), one should prefer the first profile. Discounting only adds to that. However, the majority of subjects prefers the second profile.

They explained the issue to the subjects, also mentioning psychological arguments for why one might still want to prefer the second profile. A little more than half of the subjects adhered to a preference over profile 1. This suggests that it is not irrationality, but people deliberately have their utility depend on other things than absolute level of money.

intertemporal separability criticized: sequence effects

P. 71: "An important question concerns whether violations of present value maximization (and therefore dominance) should be treated as errors in decision making or as rational manifestations of a preference function that includes arguments other than absolute levels of consumption. This question is analogous4 to the debate over the status of Savage's independence axiom."

P. 82: "Whether the observed preference for increasing payments is treated as rational or as a mistake depends on whether we are willing to accept a more complex utility function than has generally been assumed." %}

Loewenstein, George F. & Nachum Sicherman (1991) "Do Workers Prefer Increasing Wage Profiles?," *Journal of Labor Economics* 9, 67–84.

{% **time preference;** cite data of very high discount rates, exceeding 25%.

P. 184 seems to write:

> In this study, and some others described here, the questions asked were hypothetical. Of course, all things being equal it would be better to study actual choices. However, there are serious trade-offs between hypothetical and real money methods. Using hypothetical questions one can ask subjects to consider options that incorporate large amounts of money, both gains and losses, and delays of a year or more. In studies using real choices, the experimenter must reduce the size of the stakes and the length of the delay, and it is difficult to investigate actual losses. Also, in a hypothetical question, one can ask the subject to assume that there is no risk associated with future payments, while in experiments using real stakes, subjects must assess the experimenter's credibility. %}

Loewenstein, George F. & Richard H. Thaler (1989) "Anomalies: Intertemporal Choice," *Journal of Economic Perspectives* 3 no. 4, 181–193.

{% This paper expresses many subjective opinions about paternalism, and I agree with all of them. §2 describes the history of the ordinal revolution, and the new developments of economics opening up more to nonrevealed preference inputs as propagated by Kahneman and others, which fully agrees with the history described in §§2-3 of Abdellaoui, Barrios, & Wakker (2007).

paternalism/Humean-view-of-preference

conservation of influence: p. 1796: "The strong preference people show for the default option suggests that more than rational self interest is at work."

P. 1797 "the main problem with experienced utility is its failure to incorporate non-hedonic aspects of experience, such as meaning and capabilities (even if such capabilities are not used) that are important to people but have little impact on their subjective happiness."

P. 1797: "Given the limitations of measures of welfare based either on decision utility or on experience utility, is there any hope for coming up with a normatively compelling welfare criterion? In Section 6, we argue that no simple criterion based on either concept can surmount these problems. Instead, evaluations of welfare will inevitably have to be informed by a combination of both approaches, patched together in a fashion that will depend on the specific context."

P. 1804, §5.7: "In this section we have argued that a major—indeed perhaps fatal—problem with experience utility is its failure to incorporate dimensions of experience other than simple happiness that people justifiably care about. To some extent, we may be able to overcome these flaws by expanding and improving the measures we include as part of experience utility. It is theoretically possible to capture people's experience of meaning and purpose in their lives, independent from their moment to moment affect. But we expect that this will not address all the problems we have raised with experience utility. Instead, we believe that there are circumstances that matter to people independent of their influence on moment to moment experience. Despite other patent flaws, decision utility has the advantage of capturing these values in a way that experience utility does not—e.g., if an individual cares about meaning, he or she can incorporate that concern into their choices."

P. 1805, §6.1.2 is on debiasing, citing studies by Ubel et al. trying to debias the overweighting of small probabilities.

Several sentences show the enthusiastic style of Loewenstein. P. 1798 ℓ. 4-5: "an issue of growing importance in an age of increasing income inequality."

P. 1804 ℓ. –9: "Such a policy ignores the problems raised by the phenomenon of hedonic adaptation,": hedonic adaptation is not the problem, but one of many symptoms of the problem, being that people have no anchor for the scales offered to them so that interpersonal comparisons (and even between- over time, as with adaptation) are problematic, as often in between-subject studies.

P. 1805 4th para, suggests that, in order to investigate if a decision of nonsafe sex was wise, the ultimate criterion should come from investigating neural processes in the brains of the people involved. "If we could investigate the brain waves of each partner." %}

Loewenstein, George F. & Peter A. Ubel (2008) "Hedonic Adaptation and the Role of Decision and Experience Utility in Public Policy," *Journal of Public Economics* 92, 1795–1810.

{% **inverse S:** p. 276 argues for it, with the reason that people are not sufficiently sensitive towards probabilities. %}

Loewenstein, George F., Elke U. Weber, Christopher K. Hsee, & Edward S. Welch (2001) “Risk as Feelings,” *Psychological Bulletin* 127, 267–286.

{% %}

Loewenstein, Yonatan, Drazen Prelec, & H. Sebastian Seung (2009) “Operant Matching as a Nash Equilibrium of an Intertemporal Game,” *Neural Computation* 21, 2755–2773.

{% **standard-sequence invariance**: P and Q are jazz records. (A,P) designates receiving $A and P. An additive model is assumed. It is pointed out that (A,P) ~ (B,Q) and (A',P) ~ (B',Q) imply that the utility difference between A and B is the same as between A' and B'. It is studied with five subjects and four such indifferences. %}

Loewenton, Edward & R. Duncan Luce (1966) “Measuring Equal Increments of Utility for Money without Measuring Utility Itself,” *Psychonomic Science* 6, 75–76.

{% **foundations of statistics**; criticizes hypotheses testing on six points: (1) The usual “point” H_0 is impossible beforehand; you don’t want to know it is untrue, you want to know by how much it is untrue; sufficiently large samples always become significant (I think that has been called “statistically significant but not psychologically/economically/medically meaningful”). (2) Often H_0 is rejected but it is not clear what the alternative is (“A depends on B” can be just anything). (3) With H_1 vague, also power is vague. Power is especially important if H_0 is not rejected. (4) Artificial dichotomy reject/not-reject: Jf one study accepts H_0 and the other not that does not mean a contradiction! (5) One routinely assumes linear relations (regression) or normal distributions. A nice example can be found in Fig.1 about high-learned people who forget as low-learned but with a delay of two days, but this relationship is not detected by common methods. (6) The Bayesian point that p-value does not consider the relevant conditioning.

Then four remedies are given: (1) Plots are clearer than tables. (2) Confidence intervals help to describe power (can be depicted in plots around the estimations). (3), about normalization in meta-analyses, I will not discuss here. (4) “Contrasts” (I think, specify alternative hypotheses and see how well they fit data)

Conclusion: "Hypothesis testing provides appearance of objectivity ... only illusion of insight.," suggesting different preferable frequentist methods (confidence intervals, plots, etc.). Gives many references to discussions of hypothesis testing. %}

Loftus, Geoffrey R. (1996) "Psychology Will Be a Much Better Science when We Change the Way We Analyze Data," *Psychological Science* 7, 161–171.

{% A loose-hand survey as intro to the special issue of the journal. %}

Long, Elisa F., Gilberto Montibeller, & Jun Zhuang (2022) "Health Decision Analysis: Evolution, Trends, and Emerging Topics," *Decision Analysis* 19, 255–264.
https://doi.org/10.1287/deca.2022.0460

{% %}

Loomes, Graham (1988) "Further Evidence of the Impact of Regret and Disappointment in Choice under Uncertainty," *Economica* 55, 47–62.

{% %}

Loomes, Graham (1988) "When Actions Speak Louder than Prospects," *American Economic Review* 78, 463–470.

{% %}

Loomes, Graham (1989) "Predicted Violations of the Invariance Principle in Choice under Uncertainty," *Annals of Operations Research* 19, 103–113.

{% Asks subjects to choose x to optimize (p,x; q,20–x; r,0) and also in (p',x; q',20–x; r',0) with p'/p = q'/q. EU predicts same x. This is not found. EV predicts x = 20 or x = 0, but there were remarkably many deviations.

PT falsified: regarding **inverse S:** for RDU, his evidence cannot be reconciled with an inverse S weighting function (p. 104) but it can neither be with a convex (pp. 1-3).

Uses $2p^3 - 3p^2 + 2p$ as inverse S weighting function. %}

Loomes, Graham (1991) "Evidence of a New Violation of the Independence Axiom," *Journal of Risk and Uncertainty* 4, 92–109.

{% %}

Loomes, Graham (1993) “Disparaties between Health State Measures: An Explanation and Some Implications.” *In* Bill Gerrard (ed.) *The Economics of Rationality*, 149–178 (Ch. 9), Routledge, London.

{% %}

Loomes, Graham (1995) “The Myth of the HYE,” *Journal of Health Economics* 14, 1–7.

{% A more elaborate paper is Dubourg, Jones-Lee, & Loomes (1997, Economica). %}

Loomes, Graham (1997) “Valuing Health and Safety: Some Economic and Psychological Issues.” *In* Robert F. Nau, Erik Gr∅nn, Mark J. Machina, & Olvar Bergland (eds.) *Economic and Environmental Risk and Uncertainty*, 3–32, Kluwer, Dordrecht.

{% **Christiane, Veronika & I**

Considers risky choices for monetary stakes, and risky choices where the stake is a probability of gaining a prize (there is only one fixed prize, and one neutral outcome). The two quantities give similar phenomena. In the case of probabilities of gaining a prize, **RCLA** trivially prescribes all choices through stoch. dom. So, the data violate RCLA with only two outcomes! The data suggest that subjects simply do numerical heuristics. %}

Loomes, Graham (1998) “Probabilities vs Money: A Test of Some Fundamental Assumptions about Rational Decision Making,” *Economic Journal* 108, 477–489.

{% Argues that the violations of EU are not caused by what the nonEU theories describe but by fundamental issues such as subjects not even having prefs but just using heuristics to produce answers. %}

Loomes, Graham (1999) “Some Lessons from Past Experiments and Some Challenges for the Future,” *Economic Journal* 109, F35–F45.

{% **error theory for risky choice**; **Best core theory depends on error theory**: seems to be. %}

Loomes, Graham (2005) "Modelling the Stochastic Component of Behaviour in Experiments: Some Issues for the Interpretation of Data," *Experimental Economics* 8, 301–323.

{% The author considers the probability triangle, with probability distributions over three fixed outcomes $x_3 \succ x_2 \succ x_1$. Then prospects can be characterized as $S = (p_1, p_2, p_3)$ and $R = (q_1, q_2, q_3)$. Nontrivial choices will have $p_1 < q_1$ & $p_3 < q_3$ (then R is more risky than S). Under EU, S is preferred iff $(q_1-p_1)/(q_3-p_3) \geq (U(x_3)-U(x_2))/(U(x_2)-U(x_1))$. The author proposes a generalization $\varphi(P) \geq \xi(X)$ where P is a measure depending only on the probabilities and X one depending only on the outcomes. This model is called PRAM (perceived relative argument model), with P the perceived relative argument due to probabilities and X the one due to outcomes. It entails a kind of separability between probabilities and outcomes.

The most salient aspect is that the model violates transitivity, somewhat like regret theory but now with a similar thing in the probability dimension. The author considers special cases of the functions, pointing out that they can accommodate known paradoxes and preference cycles, with some forms in Eqs. 11-13 adding only one or two parameters to EU. (P. 910: the version with one parameter is violated by common consequence.)

Some limitations: I cannot imagine how this model could in any tractable way be extended beyond the probability triangle. Further, intransitive models are hard to extend beyond binary choices. It would be interesting to pin down more precisely what the implications of the model are; it has some separability of outcomes and probabilities, with may be the possibility to build in rank dependence.

A detail: P. 903 Eq. 2 on RDU is not correct because q_1 and p_1 should be handled as worst ranks, with $1-w(1-p_1)$ rather than $w(p_1)$ the weight of p_1 for instance. This affects the following analysis in details but not in substantive manners.

P. 906 footnote 8 erroneously thinks that in modern 1992 PT (called CPT by the author) there would be no more certainty effect.

P. 913: “CPT (taken to be the flagship of non-EU models)” (**Prospect theory/Rank-Dependent Utility most popular for risk**)

The experimental evidence in §5 does not test the basic model, but only qualitative add-on predictions (such as testing risk aversion when supposedly testing EU). The RIS is used to incentivize. %}

Loomes, Graham (2010) “Modeling Choice and Valuation in Decision Experiments,” *Psychological Review* 117, 902–924.
https://doi.org/10.1037/a0019807

{% **utility elicitation**; relates PE (if I remember well, they call it SG) to TTO; p. 305 top of 2nd column explicitly leaves it open if patient utilities or community utilities are to be used, in agreement with what I think, and deviating from the unfortunate viewpoints of Gold et al. (1996).

intertemporal separability criticized: p. 303 (quality of life depends on past and future health)

risk seeking for small-probability gains: p. 305, bottom of 2nd column, points out that even people who are generally risk averse can be risk seeking for treatments with low-probability-high-effects, such as for heart and liver transplants, and coronary and neonatal intensive care units.

P. 306 middle of 2nd column: “Given that decisions have to be made, and cannot be postponed until researchers have perfected the decision tools, the use of QALYs at their present stage of development may be defended as being no worse than any alternative measures.” Then warns that we should not be too quick.

P. 307 first column suggests that nonEU theories be used in utility measurement. %}

Loomes, Graham & Linda McKenzie (1989) “The Use of QALYs in Health Care Decision Making,” *Social Science and Medicine* 28, 299–308.

{% N = 234 volunteers all individually interviewed at their homes! Are asked some simple statistical questions (prob of picking diamond card for instance), some public-risk questions (new monarch next year), and some private risks (you lose wallet in next X days). First asking statistical questions lowers other probability estimates, and “insensitivity to temporal scope” (burglary in your house next X years too independent of X), mostly for personal risks, then for public risks, then for statistical). Findings and tests are thin given the experimental investment. %}

Loomes, Graham & Judith Mehta (2007) "The Sensitivity of Subjective Probability to Time and Elicitation Method," *Journal of Risk and Uncertainty* 34, 201–216.

{% **error theory for risky choice**: Test EU and prospect theory/RDU, with error-theories added. Their footnote 11 points out that they do not consider losses, so that RDU is the same as PT.

Watch out: they do old-fashioned bottom-up RDU integration, with w around 0 relevant to worst outcomes and w around 1 relevant to best outcomes.

P. 104, next-to-last para: "expected utility theory and with its most prominent rival, rank-dependent theory." P. 115, beginning of §6: "In part, we made this choice in recognition of the prominence of RD [rank-dependent utility] in the literature: it is probably the most widely-used non-EU theory. But we were also influenced by the properties of the data." (**Prospect theory/Rank-Dependent Utility most popular for risk**)

P. 119, next-to-last para: "these results establish that RD [RDU] model has significantly greater explanatory power than the EU model."

They find (p. 123) that deviations from EU decrease as subjects get more experienced (more repeated choices). Conclusion will claim convergence to EU

inverse S & **risk seeking for small-probability gains**: They find and model overweighting of the best outcome (called "bottom-edge effect") and, remarkably, not of the worst (see their p. 115 last para, and p. 116 between Eq. 11b and 12a); (**EU+a*sup+b*inf**). It implied that the Prelec one-parameter family performed worse than the simple overweighting of best outcome.

equate risk aversion with concave utility under nonEU: unfortunately, in their writing they often equate utility with risk attitude, which is not correct for rank-dependent utility.

Endnote 12 points out that non-cumulative weighting theories (they say it for Viscusi's prospective reference theory) cannot treat overweighting of good outcomes differently than of bad outcomes.

They also test which probabilistic choice model works best.

parametric fitting depends on families chosen: seem to point that out. %}

Loomes, Graham, Peter G. Moffat, & Robert Sugden (2002) "A Microeconometric Test of Alternative Stochastic Theories of Risky Choice," *Journal of Risk and Uncertainty* 24, 103–130.

{% They propose a model of consumer preference with loss aversion, explaining the discrepancy between WTP and WTA. They assume that consumers are uncertain about what their true preferences are (reminding me of Kreps' 92 work on it). For instance, an owner of a mug, when exchanging it for a chocolate, may just be uncertain whether the exchange is a gain or loss. Then the usual loss aversion can come into play, with status quo bias and so on. P. 121 end of §1 describes it clearly. They do the Sugden extension of allowing the reference point to be random (what I like to call random reference theory).

For multiattribute outcomes such as commodity bundles, it is well known that one can do loss aversion in two ways. One is attribute-wise, having within each attribute a reference level, and maybe gains in some attribute levels and losses in others, such as in Tverky & Kahneman (1991, QJE). The other is global, taking one indifference class of multiattribute outcomes as reference level, and all preferred outcomes as gains, and the dispeferred ones as losses. In the latter case, being a gain or a loss is a holistic property. The latter was the approach of, for instance, Wakker & Tversky (1993, JRU) in which outcomes can even be from connected topological spaces, which includes commodity bundles as special case and works globally. The authors call the former, attribute-wise, approach dimension-based, and the holistic approach they call taste uncertainty approach. The attribute-wise approach has only been considered in the literature in combination with additive separability across attributes, and the authors go at great length to emphasize the empirical failures of it.

They also compare extensively with Köszegi-Rabin (2006), where reference point is endogenous and not exogenous as in this paper. There also is a μ function in K-R applying only to m differences (m something like basic utility) so that absolute m levels then do not affect degree of loss aversion. In this paper, the degree of loss aversion can depend entirely on the wealth level and the authors emphasize this much.

P. 118 end of 2nd para is interesting: one can measure the degree of loss aversion by finding sequences of exchanges, all much disliked, that end where they started, and finding a net compensation required to implement the cycle.

I liked §4, which discusses how experience can reduce uncertainty and, hence, loss aversion, and discrepancy between WTP and WTA. But p. 131 is strange in claiming that attribute-wise models of loss aversion cannot accommodate reduction of loss aversion by learning. What they mean to say is that these models do not consider learning explicitly in their model. Of course everone using them will say that, if learning is incorporated, then it will reduce loss aversion. %}

Loomes, Graham, Shepley Orr, & Robert Sugden (2009) "Taste Uncertainty and Status Quo Effects in Consumer Choice," *Journal of Risk and Uncertainty* 39, 113–135.

{% **PT falsified**: Measure certainty equivalents of prospects, allowing for choice errors. Find violations of PT, and suggest that a similarity theory may fit better. The authors are negative on PT (which they call CPT): "If CPT is to justify its current status as the front runner among alternatives to EUT, it should be able to organise the data from our CREPROBS treatment; but it cannot do so," (p. 209). The main purpose of the paper is to argue for the use of error theories. %}

Loomes, Graham & Ganna Pogrebna (2014) "Testing for Independence while Allowing for Probabilistic Choice," *Journal of Risk and Uncertainty* 49, 189–211.

{% Abstract opens with the cliché word policy, as does the 2nd column on the opening page 166. The paper tests preference reversals reckoning with probabilistic choice, and still finding preference reversals, consistently with other papers. %}

Loomes, Graham & Ganna Pogrebna (2017) "Do Preference Reversals Disappear When We Allow for Probabilistic Choice?," *Management Science* 63, 166–184. https://doi.org/10.1287/mnsc.2015.2333

{% Subjects chose x to optimize (p+ε:x, p–ε:T–x, 1–2p:K) with the other parameters fixed, ε > 0. K = T/2 (so that certainty results with x = T/2) or K = 0 was chosen. Under EU's second-order risk aversion, x > T/2, under 1st order risk aversion x =

T/2 can occur. The authors indeed found x = T/2 for several subjects. Unfortunately, no statistical analysis is given, so it is not clear if the data can result from merely noise.

Because the common outcome K was displayed as such, subjects may have ignored it. %}

Loomes, Graham & Uzi Segal (1994) "Observing Different Orders of Risk Aversion," *Journal of Risk and Uncertainty* 9, 239–256.

{% Typical of their early experimental papers. They find more preference cycles in direction predicted by regret theory than the other way around. They argue that preference reversals may reflect genuine intransitivities, as predicted by regret theory. Later papers by (some of) these authors will argue that event-splitting effects rather than intransitivities may explain the early findings of regret theory.

The authors used a version of RIS where, prior to the experiment, subjects received an envelope containing the no. of the choice implemented for real at the end, which, as the authors argue, reduces the risk of hedging. The same procedure was used by Epstein & Halevy (2018), and it is similar to the Prince method of Johnson et al. (2021 JRU). However, it crucially differs and loses several pros of Prince, as explained in my annotations at Johnson et al. (2021 JRU). %}

Loomes, Graham, Chris Starmer, & Robert Sugden (1989) "Preference Reversal: Information-Processing Effect of Rational Non-Transitive Choice?," *Economic Journal* 99, Supplement, 140–151.

{% Find intransitivities while ruling out choice-matching discrepancy and some other biases. %}

Loomes, Graham, Chris Starmer, & Robert Sugden (1991) "Observing Violations of Transitivity by Experimental Methods," *Econometrica* 59, Supplement, 425–439.

{% Show that preference violate monotonicity in a way predicted by regret theory. %}

Loomes, Graham, Chris Starmer, & Robert Sugden (1992) "Are Preferences Monotonic: Testing Some Implications of Regret Theory," *Economica* 59, 17–33.

{% Shaping hypothesis: Because agents are uncertain about what their preferences are, they let them be influenced by market prices observed in previous rounds. So, the market shapes preferences. Then, if anomalies disappear in repeated markets, it may not be because of increased rationality but just by the shaping hypothesis. The issue is investigated experimentally. They find convergence of WTA to WTP, which in itself does not make clear if it is the shaping hypothesis or a convergence to true preference. Some other anomalies, less clearly visible to subjects, such as overbidding, however, remain, as does a large variance in preference (not suggesting convergence to true preference). Hence, the authors suggest that the shaping hypothesis is more plausible than a convergence to true preference. %}

Loomes, Graham, Chris Starmer, & Robert Sugden (2003) "Do Anomalies Disappear in Repeated Markets?," *Economic Journal* 113, C153–C166. https://doi.org/10.1111/1468-0297.00108

{% In repeated markets WTP-WTA disparaties are reduced, but preference reversals are not. %}

Loomes, Graham, Chris Starmer, & Robert Sugden (2010) "Preference Reversals and Disparities between Willingness to Pay and Willingness to Accept in Repeated Markets," *Journal of Ecomic Psychology* 31, 374–387.

{% **risky utility u = strength of preference v (or other riskless cardinal utility, often called value)**: P. 807: assume experienced utility, called "choiceless." Say it is Bernoullian

§V argues that regret is not irrational.

P. 818: Probabilistic reduction is called the "equivalence axiom." It is what Wakker (2010, Assumption 2.1.2) called the decision under risk assumption.

utility = representational, p. 817: "While we do not share the methodological position that the only satisfactory theories are those formulated entirely in terms of empirical propositions, …"

Some drawbacks of regret theory:

(1) The psychological regret that explains much of common ratio, is fundamentally different than what regret theory does. It is that if an outcome 0 has certainty of foregoing sure $1M (M: Million), then regret is strong, but if it is

only a probability of foregoing $1M then regret almost entirely disappears. It is a nonlinearity in probability, a sort of certainty effect. It then is important that the regret of getting the smallest outcome 0 instead of the second-smallest $1M is big. The regret theory explanation goes in the other direction: The regrets of getting the smallest outcome 0 instead of the 2^{nd}-smallest outcome 1M, and of getting the 2^{nd} smallest outcome 1M instead of the largest outcome, should be relatively small, and the regret of getting the smallest instead of the highest outcome should be disproportionally large. So, the regret of getting 0 instead of 1M should not be big, but small. This is unrelated to what happens in reality. By implying the sure-thing principle regret theory is not well suited for explaining Allais.

(2) Regret is clearly a second-order effect relative to utility difference. Probability weighting, for instance, is an independent component that may explain even more than utility, but regret is second-order and only adds nuances. %}

Loomes, Graham & Robert Sugden (1982) "Regret Theory: An Alternative Theory of Rational Choice under Uncertainty," *Economic Journal* 92, 805–824.

{% %}

Loomes, Graham & Robert Sugden (1983) "Regret Theory and Measurable Utility Theory," *Economics Letters* 12, 19–22.

{% %}

Loomes, Graham & Robert Sugden (1983) "A Rationale for Preference Reversal," *American Economic Review* 73, 428–432.

{% %}

Loomes, Graham & Robert Sugden (1984) "The Importance of What Might Have Been." *In* Ole Hagen & Fred Wendstøp (eds.) *Progress in Utility and Risk Theory*, 219–235, Reidel, Dordrecht.

{% **information aversion**;

Argue that regret theory is not open to aversion to information.

P. 650: "Thus we do not accept that the apparently remarkable result of the farmer rejecting costless perfect information is achieved 'via the principles of regret theory'," %}

Loomes, Graham & Robert Sugden (1984) "Regret Theory and Information: A Reply," *Economic Journal* 94, 649–650.

{% **dynamic consistency**: what they call dynamic consistency is what Machina (1989) and others call consequentialism (and what I like to call forgone-event independence in March 2000). This paper introduces their disappointment model, similar to Bell (1985)

biseparable utility: yes for the special case where their disappointment function has a kink but is linear otherwise. %}

Loomes, Graham & Robert Sugden (1986) "Disappointment and Dynamic Consistency in Choice under Uncertainty," *Review of Economic Studies* 53, 271–282.

{% %}

Loomes, Graham & Robert Sugden (1987) "Testing for Regret and Disappointment in Choice under Uncertainty," *Economic Journal* 97, Supplement, 118–129.

{% **utility = representational**, P. 272: "Here "utility" is to be interpreted in the classical Benthamite or Bernouillian [Bernoullian] sense, as a sensation or mental state."

Beginning of §4 shows that transitivity implies that ψ(x,y) + ψ(y,z) = ψ(x,z) (called regret neutrality). §II.7 of Sugden (2004) "Alternatives to Expected Utility" shows that regret neutrality implies expected utility. Therefore, regret theory reduces to expected utility if and only if transitivity. The same point is stated by Kreweras (1961). %}

Loomes, Graham & Robert Sugden (1987) "Some Implications of a More General Form of Regret Theory," *Journal of Economic Theory* 41, 270–287.

{% **Best core theory depends on error theory**: seems to be; **error theory for risky choice**; refer to BDM (Becker-DeGroot-Marschak) for random utility model, not to literature from mathematical psychology. Point out that different assumptions

about stochastic choice have different predictions, such as degree of violations of stochastic dominance. %}

Loomes, Graham & Robert Sugden (1995) "Incorporating a Stochastic Element into Decision Theory," *European Economic Review* 39, 641–648.

{% **error theory for risky choice**; %}

Loomes, Graham & Robert Sugden (1998) "Testing Different Stochastic Specifications of Risky Choice," *Economica* 65, 581–598.

{% Introduction to pref. reversal; rest, however, is only on preference cycles for losses, whether as predicted by regret theory; **real incentives/hypothetical choice**; they find on p. 259 that actual and hypothetical choices are similar. %}

Loomes, Graham & Caron Taylor (1992) "Non-Transitive Preferences over Gains and Losses," *Economic Journal* 102, 357–365.

{% %}

Loomes, Graham & Martin Weber (1996) "Endowment Effects for Risky Assets." *In* Wulf Albers, Werner Güth, & Eric van Damme, *Experimental Studies of Strategic Interaction: Essays in Honor of Reinhard Selten*, 494–512, Springer, Berlin.

{% %}

Loonstra, Frans (1946) "Ordered Groups," *Koninklijke Academie der Wetenschap Amsterdam*, 49, 41–46.

{% %}

Lootsma, Freerk A. (1993) "Scale Sensitivity in the Multiplicative AHP and SMART," *Journal of Multi-Criteria Decision Analysis* 2, 87–110.

{% %}

Lopes, Lola L. (1981) "Decision Making in the Short Run," *Journal of Experimental Psychology, Human Learning and Memory* 7, 377–385.

{% %}

Lopes, Lola L. (1982) "Doing the Impossible: A Note on Induction and the Experience of Randomness," *Journal of Experimental Psychology, Learning, Memory, and Cognition* 8, 626–636.

{% Seems to write:

"the simple, static lottery or gamble is as indispensable to research on risk as is the fruitfly to genetics" (p. 137). %}

Lopes, Lola L. (1983) "Some Thoughts on the Psychological Concept of Risk," *Journal of Experimental Psychology: Human Perception and Performance* 9, 137–144.

{% This paper is one of the predecessors of rank-dependent utility;

sign-dependence: Says that gains and losses are often treated separately in applications. P. 482: first evaluate gain part, then loss part, then combine these two, possibly additively.

Proposes that choices be determined by EV and "riskiness," where latter is cumulative distributional thing. She proposes to not yet introduce the utility function. Gives motivation that weights should depend on rank-ordering of outcomes, but then gives examples (such as where probability of winning $50 or more decides) that do not show rank-dependence as in the modern RDU. Predicts pessimism; i.e., lower outcomes get greater weight. Does give arguments where there is the idea, implicitly, that cumulative events rather than receipt of fixed outcomes, are natural primitives. %}

Lopes, Lola L. (1984) "Risk and Distributional Inequality," *Journal of Experimental Psychology: Human Perception and Performance* 10, 465–485.

{% Nice intro on behaviorism and switch to cognitive models in psychology.

Gives arguments that subjects more naturally think in terms of cumulative events than in terms of fixed outcomes. Uses this finding to argue for cumulative approaches! Wow! %}

Lopes, Lola L. (1986) "What Naive Decision Makers Can Tell Us about Risk." *In* Luciano Daboni, Aldo Montesano, & Marji Lines (eds.) *Recent Developments in the Foundations of Utility and Risk Theory*, 311–326, Reidel, Dordrecht.

{% P. 258: S**EU = SEU**

losses give more/less noise: seems to find more

P. 283: "Risk attitude is more than the psychophysics of money"

Gives arguments that subjects more naturally think in terms of cumulative events than in terms of fixed outcomes. Uses this finding to argue for cumulative approaches!

Seems to use the term "cautiously-hopeful" for **inverse S.** %}

Lopes, Lola L. (1987) "Between Hope and Fear: The Psychology of Risk," *Advances in Experimental Social Psychology* 20, 255–295.

{% Cardinal utility is psychophysical entity: French school

P. 407: the term risk aversion has nothing to do theoretically either with risk or with aversion. %}

Lopes, Lola L. (1988) "Economics as Psychology: A Cognitive Assay of the French and American Schools of Risk Theory." *In* Bertrand R. Munier (ed.) *Risk, Decision and Rationality*, 405–416, Reidel, Dordrecht.

{% Multioutcome lotteries; conclude that PT does not do well (**PT falsified**); seems that "cautiously hopeful" is her term for **inverse S** %}

Lopes, Lola L. (1990) "Re-Modeling Risk Aversion: A Comparison of Bernoullian and Rank Dependent Value Approaches." *In* George M. von Furstenberg (ed.) *Acting under Uncertainty: Multidisciplinary Conceptions*, 267–299, Kluwer, Dordrecht.

{% %}

Lopes, Lola L. (1993) "Reasons and Resources: The Human Side of Risk Taking." *In* Nancy J. Bell & Robert W. Bell (eds.) *Adolescent Risk Taking*, 29–54, Sage, Lubbock TX.

{% review %}

Lopes, Lola L. (1994) "Psychology and Economics - Perspectives on Risk, Cooperation, and the Marketplace," *Annual Review of Psychology* 45, 197–227.

{% Links process-oriented theories to algebraic decision theories.

inverse S: p. 207 gives many citations to extent to which people pay attention to good and bad outcomes.

linear utility for small stakes: p. 215 explains why utility is assumed linear. %}

Lopes, Lola L. (1995) "Algebra and Process in the Modeling of Risky Choice," *Psychology of Learning and Motivation* 32, 177–220.

{% Writes very positive about her, I think confused, 1981 paper. %}

Lopes, Lola L. (1996) "When Time is of the Essence: Averaging, Aspiration, and the Short Run," *Organizational Behavior and Human Decision Processes* 65, 179–189.

{% %}

Lopes, Lola L. & Gregg C. Oden (1987) "Distinguishing between Random and Nonrandom Events," *Journal of Experimental Psychology: Learning, Memory, and Cognition* 13, 392–400.

{% There is a clear definition of SP/A theory, clearer than Lopes' papers, in Ch. 26 of Shefrin, Hersh M. (2008) "*A Behavioral Approach to Asset Pricing Theory;* 2nd *edn.*"

In SP/A theory, a prospect (lottery over money) depends on

(1): SP. This is a rank-dependent utility, with linear utility, and a weighting function that is a convex combination of a power function p^r and a dual power function $1 - (1{-}p)^{r'}$, where the first captures pessimism and the second optimism. For the claims about mixed weighting functions in Eqs. 9 and 10 (p. 290), it is important to know that the parameters q_r and q_p are supposed to be positive (I assume), so that the w-weighted curve is convex and the (1−w) weighted curve is concave, and the convex mix gives an **inverse S**-shape.

(2) A: an aspiration level, i.e., an outcome, is chosen, and A is the probability of (weakly!?) exceeding it.

A weak point is that how these two are combined is not specified. Lola must have thought: "Attack is the best way to defend." So, she emphasizes this as a strong point. P. 291 end of penultimate para writes that, if these two components prefer a different prospect (so, if the case is not totally trivial), then SP/A predicts “conflict.” This gives a revealed-preference oriented economist little hope of being informed about what choice then results. The text then writes that such conflict cannot result from “single-criterion” models such as CPT (p.s.: CPT and all economic models can consider multi-criteria optimization in utility), which further reduces my hope of being informed about the resulting choice in any not-completely-trivial situation. P. 300 2nd para will mention an aggregation of the two components but it is not clear how, apparently through a numerical Table 5.

The first para on p. 292 confuses monotonicity with absolute risk aversion, and erroneously claims that CPT would have constant absolute risk aversion.

Although in several places the paper writes that it, unlike prospect theory, has no reference point but *instead* an aspiration level, SP/A theory turns out to have a reference point still because it does distinguish between gains and losses, where every parameter in the model (including probability weighting, contrary to what Shefrin, 2008, p. 429 last sentence, claims) can depend on the sign (pp. 290-291 & 299). In particular, the aspiration level can be different for gains than for losses (then how about mixed prospects?), and will later (p. 300 top) be taken to be 0 for losses and, ad hoc, 1 for gains.

P. 302, Eq. 16 suddenly does aggregate SP and A into a decision formula, although it is a probabilistic choice model, with no deterministic model specified. For me, the formula comes out of the blue, seeming to assign the same weight to SP as to A. (I’d expect SP to have more weight.) Does this satisfy stochastic dominance? Some form of transitivity?

P. 310 penultimate para has a nice text on risk aversion being conflated with utility.

Shefrin (2008 p. 431 bottom) writes that the weighting function in prospect theory captures perception, but in SP/A it captures emotions.

In Table 5 it is amazing that the very crude A-criterion alone (just the probability of exceeding aspiration, which is nothing but probabilities related to 0) explains data so well. Then SP/A will do better than PT! Makes me wonder about the stimuli.

PT falsified: not strongly. Mostly, Lopes’ SP/A theory fits data better than her implementation of PT (which is questionable given that she, erroneously, thinks that PT satisfies constant absolute risk aversion).

1. **convex utility for** loss**es**: for losses subjects are risk-neutral more than risk-seeking

2. Subjects seem to prefer (0.5: 50, 0.5: 150) to 100 for sure. Seems to agree with Lopes SP/A theory, while violating PT. (Is like {**risk seeking for symmetric fifty-fifty gambles}**, but not symmetric about 0.)

risk averse for gains, risk seeking for losses: seem to be risk neutral for losses; multioutcome lotteries.

loss aversion without mixed prospects: they claim to estimate loss aversion λ, but they do not consider mixed prospects and, therefore, it is impossible to estimate λ.

linear utility for small stakes: p. 290 footnote 1 %}

Lopes, Lola L. & Gregg C. Oden (1999) "The Role of Aspiration Level in Risky Choice: A Comparison of Cumulative Prospect Theory and SP/A Theory," *Journal of Mathematical Psychology* 43, 286–313.
https://doi.org/10.1006/jmps.1999.1259

{% **real incentives/hypothetical choice**: A sender randomly sees a blue or green circle. Then sends message to receiver if it was green or red. Gets €15 if signaling green (independent of what was really seen) and €14 if signaling blue. 1/3 of the subjects rather sends true signal than most-gaining signal: lie aversion. %}

López-Pérez, Raúl & Eli Spiegelman (2013) "Why Do People Tell the Truth? Experimental Evidence for Pure Lie Aversion," *Experimental Economics* 16, 233–247.

{% %}

Lopomo, Giuseppe & Efe A. Ok (2001) "Bargaining, Interdependence, and the Rationality of Fair Division," *RAND Journal of Economics* 32, 263–283.

{% **real incentives/hypothetical choice**: on p. 51, they justify their use of hypothetical choices rather than real incentives as follows:

"The experimental approach will by necessity be limited to small gambles, whereas we were interested in lotteries with very large payoffs."

risk averse for gains, risk seeking for losses: not found. They asked 17 shipowners for certainty equivalents of 11 gambles, with outcomes between −10 and +100 and probabilities between 1/6 and 5/6, mostly 1/2. The data are remarkable. People are risk seeking under (imaginary) good liquidity, risk neutral or risk averse under weak liquidity. Probably fun through **utility of gambling** was going on. %}

Lorange, Peter & Victor D. Norman (1973) "Risk Preference in Scandinavian Shipping," *Applied Economics* 5, 49–59.

{% **confirmatory bias**: subjects received info about capital punishment, which led to polarization instead of the, normatively to be expected, convergence to neutrality. %}

Lord, Charles G., Lee Ross, & Mark R. Lepper (1979) "Biased Assimilation and Attitude Polarization: The Effects of Prior Theories on Subsequently Considered Evidence," *Journal of Personality and Social Psychology* 37, 2098–2109.

{% **methoden & technieken** %}

Lord, Frederic M. & Melvin R. Novick (1968) "*Statistical Theories of Mental Test Scores.*" Addison-Wesley, London.

{% On the butterfy effect. %}

Lorenz, Edward N. (1963) "Deterministic Nonperiodic Flow," *Journal of the Atmospheric Sciences* 20, 130–141.

{% **measure of similarity** %}

Lord, Philip W., Robert D. Stevens, Andy Brass, & Carole A. Goble (2003) "Investigating Semantic Similarity Measures across the Gene Ontology: The Relationship between Sequence and Annotation," *Bioinformatics* 19, 1275–1283.

{% This paper, in a prominent journal, with quite some citations, and coverage in the popular press, is very very weak. It illustrates how the academic system can malfunction. It is interesting because of its extremity and I, hence, provide details.

Wisdom of the crowd: Imagine asking many individuals to estimate something, say the weight of a particular cow (Dalton 1907). Let w denote the true weight, x_i the estimate of individual i, and x the average (arithmetic or geometric) or median estimate, depending on context; I will write average in what follows. The individual estimates can be far off ($|x_i - w|$'s large), but sometimes not systematically so, and then $|x - w|$ can be small meaning that x is a good estimate of w. The latter can be surprisingly good, of course depending much on the stimuli considered. If surprisingly good, people use the term wisdom of the crowd, or wisdom of crowds.

This paper studies the wisdom of the crowd. Individuals estimate, being rewarded for small distance from truth, and it is inspected whether group average is close to truth, where the latter is (to be) taken as wisdom of group-as-a-whole. In a first round, subjects just submit their estimates. Then in later rounds they receive feedback about the estimate of one or a few or all others, and then can change their estimate. Unsurprisingly, and shown by many studies, the estimations usually converge, giving same group-average but smaller within-group group variance. (Some paradoxical opposite findings, usually for emotionally loaden topics such as the desirability of capital punishment with no clear true answer and with richer information-sharing, are known as confirmatory bias.) This convergence is also the empirical finding of this paper. What the paper adds is many provocative, but all erroneous, interpretations.

Although many statistic books warn against interpreting a null found, the authors do interpret their null of group average x not being affected by their ways of information sharing. And although I would interpret their ways of info sharing then as irrelevant to the goodness of group prediction, x not being affected, the authors interpret their null as “undermining” for wisdom of the crowd. They seem to have in mind that wisdom of the crowd is driven by group diversity and that hence every decrease in group diversity is bad, forgetting that the real criterion is how close x is to w and that group diversity is only an instrument to make x get close to w. If not the average w were the criterion, but something like the union of the info of the members of the group, then it could be different and diversity could be desirable. This point may underly many interpretations of the authors although it should not do so in the situation specified by the authors themselves (where only $|x-w|$ matters).

With some effort, I could think of a situation in which group diversity does impove the group average: If we vary the group diversity *under the condition* of keeping the average individual distance, so, the average of $|x_i-w|$, fixed. So, not the distance of the average, but the average of the distance, is kept fixed. This condition is very rarely satisfied, and absolutely not in the experiments of this paper. My best guess for this paper is that the authors (+ referees + editor + many citing it affirmatively) are continuously confused on this point: whereas in reality the distance of average remains constant, they think that the average of distance remains constant.

The convergence of individuals can be interpreted as improvements of the individual wisdoms, implying that the crowd has less wisdmom to add to the individuals and, hence, the wisdom-of-the-crowd effect became less? This interpretation is highly irrelevant because only $|x-w|$ really matters.

Another problem of the authors' accepted null just discussed is that it is not really an accepted null. As the authors call it somewhere (last footnote on p. 9022), it is "partially supported by the significance tests," and they sometimes find that x actually has come closer to w, so, has really been improved. The end of the footnote reassures us that we need not worry here: "as this effect may be different for different sets of questions." The latter holds not only for this claimed accepted null but for everything else in this paper too. Although p. 9022 (colum 1 ℓ. −7) properly indicates that the above effect is just a statistical effect, the authors still use the misplaced term "social influence effect" for it (p. 9022 1st column last para).

The authors signal a second supposed problem, using what they call a "new indicator" on p. 9021. The perfect wisdom of the crowd according to this indicator occurs if the true value is a median (so, it is between the two middle scores if even group). The indicator considers how many group members should change their opinion to achieve this perfectness. This indicator is served by increasing variance given constant average x (which surely is not always a good thing I would say). Here is an algorithm of achieving universal maximal wisdom for all questions ever to be faced by mankind, simply by maximizing variance: You form a two-person group with one other person (so, even number). Take a big number M, exceeding any other number you will ever meet in your life. Your guess (of whatever; you don't care what) is M, and your partner's guess is −M. Every answer to every question ever faced is between your two (middle) scores and, hence, you two have achieved universal maximal wisdom. Of course, this is nonsensical, showing that the criterion proposed by the authors is not sensible.

And then the authors signal a third supposed problem. If the individuals in the crowd converge, with diversity decreasing, then their confidence in their judgments will increase. If their average x is close to the true value w, then this increase is good. If, however, x is far off, then it is bad. The authors only consider the latter case in their discussion.

The writing is annoying. I think that it is obvious that info sharing usually improves group estimates. The authors claim on p. 9021, ℓ. 2, that it "can undermine" wisdom of the crowds, and this claim can be. But p. 9021 2nd column ℓ. −5 claims that the wisdom of the crowd "is undermined" which at best is misleading, can only be defended if they claim to only refer to their own experiments. P. 9021 2nd column end of 1st para crosses the line by writing "The reason to use two different kinds of social influence was to demonstrate the robustness of our effects with regard to the specific kind of social influence." This erroneouly suggests universality of their finding.

It seems that their statistics is problematic. Figure 2 on p. 9023, seems not to give what the text claims, with full info in fact going the other way. Close inspection of, for instance, degrees of freedom in their estimates, seems to show errors there.

Farrell (2011) properly criticizes the main mistakes in this paper. %}

Lorenz, Jan, Heiko Rauhut, Frank Schweitzer, & Dirk Helbing (2011) "How Social Influence Can Underdermine the Wisdom of Crowd Effect," *Proceedings of the National Academy of Sciences* 108, 9020–9025.

{% The authors measure matching probabilities and use source theory, and the ambiguity indexes of Baillon et al. (2018 Econometrica), for three emotionally and cognitively different natural sources of uncertainty, and for the "artificial" source of uncertainty in Ellsberg's three-color paradox. There are thorough within- and between-subject comparisons. They find more source preference, but less sensitivity, for the natural sources than for Ellsberg. They don't find serious

source preference differences between the three natural sources, even though they are emotionally and cognitively quite different. They do find serious differences in insensitivity between them. %}

Lotito, Gianna, Anna Maffioletti, & Michele Santoni (2024) "Testing Source Influence on Ambiguity Reaction: Preference and Insensitivity," *Journal of Risk and Uncertainty* 69, 349–411.
https://doi.org/10.1007/s11166-024-09444-4

{% %}

Lourens, Peter F. (1984) "The Formalization of Knowledge by Specification of Subjective Probability Distributions." Ph.D. Dissertation, University of Groningen.

{% %}

Lourens, Peter F. (1981) et al.: Discussion of meaning of probability, NRC Handelsblad of Friday July 24 and days before.

{% %}

Louviere, Jordan J. (1988) "*Analyzing Decision Making: Metric Conjoint Analysis.*" Sage, Newbury Park, CA.

{% Classic textbook on conjoint analysis. %}

Louviere, Jordan J., David A. Hensher, & Joffre D. Swait (2000) "*Stated Choice Methods, Analysis and Applications.*" Cambridge University Press, New York.

{% **CBDT** %}

Lovallo, Dan, Carmina Clarke, & Colin F. Camerer (2012) "Robust Analogizing and the Outside View: Two Empirical Tests of Case-Based Decision Making," *Strategic Management Journal* 33, 496–512.

{% Seems that he independently invented the Choquet integral, known in combinatorial optimization as the Lovász extension. %}

Lovász, Laszlo (1983) “Submodular Functions and Convexity.” *In* Achim Bachem, Martin Grötschel & Bernard Korte (eds.) *Mathematical Programming—The State of the Art*, 235–257, Springer, Berlin.

{% Nice citation for ambiguity aversion.

“The oldest and strongest emotion of mankind is fear, and the oldest and strongest kind of fear is fear of the unknown.” %}

Lovecraft, Howard P.

{% **updating: discussing conditional probability and/or updating**; **state-dependent utility**: Considers the problem of identifying probabilities and utilities under state-dependent utility. Considers cases of updating. Uses comparative informativeness, weaker than Blackwell ranking, and then gets identification from observing stochastic choices. %}

Lu, Jay (2019) “Bayesian Identification: A Theory for State-Dependent Utilities,” *American Economic Review* 109, 3192–3228.

{% Assumes that the ambiguity attitude, being set of priors in maxmin EU, is random, and recovers it from observed probabilistic choice. %}

Lu, Jay (2021) “Random Ambiguity,” *Theoretical Economics* 16, 539–570. https://doi.org/10.3982/TE3810

{% This paper proposes a measure of ambiguity in a financial market, having to do with volatility of existing distributions. Several papers proposed the distance between a reference distribution and an empirical distribution as degree of ambiguity, e.g. based on entropy. The novelty of this paper is that it proposes and analyzes the Hellinger distance for this purpose. %}

Lu, Tao, Lihong Zhang, Xiaoquan M. Zhang, & Zhenling Zhao (2024) “Beyond Risk: A Measure of Distribution Uncertainty,” *Informations Systems Research*, forthcoming. https://doi.org/10.1287/isre.2022.0089

{% Section 2 explains the concept of disposition. Well, preferences are dispositions, as Ramsey (1931) nicely explained. %}

Luc, Joanna (2024) "Can Dispositions Replace Laws in the Description of the Physical World?" *Journal for General Philosophy of Science* 55, 347–376. https://doi.org/10.1007/s10838-023-09657-2

{% First reference on representative agent. %}
Lucas, Robert E. (1978) "Asset Prices in an Exchange Economy," *Econometrica* 46, 1429–1445.

{% **intertemporal separability criticized**: p. 169 seems to write: "time-additivity is neither a desirable nor an analytically necessary property to impose on preferences" %}
Lucas, Robert E. & Nancy L. Stokey (1984) "Optimal Growth with Many Consumers," *Journal of Economic Theory* 32, 139–171.

{% %}
Luce, Bryan R. & Anne Elixhauser (1990) "*Standards for Socioeconomic Evaluation of Health Care Products and Services*." Springer, Berlin.

{% **just noticeable difference**: seems that he has this. %}
Luce, R. Duncan (1956) "Semiorders and a Theory of Utility Discrimination," *Econometrica* 24, 178–191.

{% Abstract: "… preferences between pure alternatives and likelihood judgments between events are asssumed to be independent probabilistic processes." Is formalized in §5.

Condition R.1 shows that Luce considers compounded gambles, with events independently repeatable.

just noticeable difference: gives mathematical theorems, for probabilistic choice, relating them to cardinal utilities.

P. 205, ℓ. –7/–8: "In particular, there is a good deal of skepticism about **finite additivity.**" Def. 6 Condition (iii) assumes binary complementarity for two-outcome gambles.

P. 206, next-to-last para, points out that str. of pr. alone cannot explain choice probabilities because there may be transparent cases of monotonicity.

Sentence on p. 213/214 points out that there is no mathematically interesting nonEU theory.

P. 222, ℓ. 3–6, on whether or not just noticeable differences can be the basis of cardinal utility, and exactly pinning down in the first sentence the weakness of just noticeable differences as basis of cardinal utility:

> "First of all, to treat the jnd [just noticeable difference] as a unit in any way, one must be assured that, for a particular individual, jnd's are equal throughout his utility scale. This means, in effect, that one must show that the utility function under consideration is a sensation scale."

Here sensation scale refers to just noticeable differences. %}

Luce, R. Duncan (1958) "A Probabilistic Theory of Utility," *Econometrica* 26, 193–224.

{% An update with corrections is in Luce (1990, Psychological Review). %}

Luce, R. Duncan (1959) "On the Possible Psychophysical Laws," *Psychological Review* 66, 81–95.

{% %}

Luce, R. Duncan (1959) "*Individual Choice Behavior*." Wiley, New York.

{% %}

Luce, R. Duncan (1966) "Two Extensions of Conjoint Measurement," *Journal of Mathematical Psychology* 3, 348–370.

{% %}

Luce, R. Duncan (1967) "Sufficient Conditions for the Existence of a Finitely Additive Probability Measure," *Annals of Mathematical Statistics* 38, 780–786.

{% Luce's work on uncertainty in the 1990 and his 2000 book comprised a joint receipt operation that I, frankly, do not like. It is used to get cardinal utility on outcomes which I prefer to derive from joint measurement techniques applied to events treated as attributes, as in my tradeoff technique. This 1972 paper is already using a joint receipt operation, although not using the term yet. %}

Luce, R. Duncan (1972) "Conditional Expected, Extensive Utility," *Theory and Decision* 3, 101–106.

{% %}

Luce, R. Duncan (1978) "Conjoint Measurement." *In* Clifford A. Hooker, James J. Leach, & Edward F. McClennen (eds.) *Foundations and Applications of Decision Theory, Vol. I,* 311–336, Kluwer (= Reidel), Dordrecht.

{% %}

Luce, R. Duncan (1978) "Lexicographic Tradeoff Structures," *Theory and Decision* 9, 187–193.

{% %}

Luce, R. Duncan (1980) "Several Possible Measures of Risk," *Theory and Decision* 12, 217–228.

{% %}

Luce, R. Duncan (April 1986, revision of 1985) "Uniqueness and Homogeneity of Ordered Relational Structures," Harvard University, Department of Psychology, Boston, MA, USA.

{% Just repetition of Narens & Luce (1985) %}

Luce, R. Duncan (1986) "Comments on Plott and on Kahneman, Knetsch, and Thaler," *Journal of Business* 59, S337–S343.

{% %}

Luce, R. Duncan (1988) "Rank-Dependent, Subjective Expected-Utility Representations," *Journal of Risk and Uncertainty* 1, 305–332.

{% %}

Luce, R. Duncan (1990) "Rational versus Plausible Accounting Equivalences in Preference Judgments," *Psychological Science* 1, 225–234.
Reprinted with minor changes in Ward Edwards (1992, ed.) "*Utility Theories: Measurements and Applications,*" 187–206. Kluwer, Boston.

{% Imagine two ratio scales x and y that are related through a mapping f, through y = f(x). Such data are found for instance in cross-modality matching, where subjects say if sound y is as loud as color x is intense. If f reflects physical properties that are to be preserved after rescalings, it is plausible that for each rescaling x --> rx of x (r > 0) there is a corresponding rescaling
y --> s(r)y (s(r) > 0) of y such that still s(r)y = f(rx). This implies functional equations that, in turn, imply that f is a power function. This was basically shown by Luce (1959), but there were some confusions and debates, surveyed and updated here. The present paper considers more complex relations between x and y, focusing on x and y being ratio scales. %}

Luce, R. Duncan (1990) “On the Possible Psychophysical Laws” Revisited: Remarks on Cross-Modal Matching,” *Psychological Review* 97, 66–77.

{% **biseparable utility**: Does it and it is central here. Axiomatizes it but points out that he can only do it using the joint receipt operation. He also uses some nonbehavioral uniqueness axiom. End of paper points out that extension from binary to other prospects is not very clear.

event/outcome driven ambiguity model: event driven

binary prospects identify U and W;

P. 86: “… because choice indifference points are tedious and tricky to estimate.”

P. 99, penultimate sentence: “It should be remarked that binary theories that are weaker than SEU do not automatically deal with more complex gambles.” %}

Luce, R. Duncan (1991) “Rank- and Sign-Dependent Linear Utility Models for Binary Gambles,” *Journal of Economic Theory* 53, 75–100.

{% P. 5 gives transitivity and monotonicity as a principle, replace something by something better is always good. %}

Luce, R. Duncan (1992) “Where Does Subjective Expected Utility Fail Descriptively?,” *Journal of Risk and Uncertainty* 5, 5–27.

{% %}

Luce, R. Duncan (1992) “Generalized Concatenation Structures that Are Translation Homogeneous between Singular Points,” *Mathematical Social Sciences* 24, 79–103.

{% §8 seems to mention sign-dependent SEU. %}

Luce, R. Duncan (1992) “A Theory of Certainty Equivalents for Uncertain Alternatives,” *Journal of Behavioral Decision Making* 5, 201–216.

{% %}

Luce, R. Duncan (1993) “*Sound & Hearing.*” Erlbaum, Mahwah, NJ.

{% %}

Luce, R. Duncan (1995) “Joint Receipt and Certainty Equivalents of Gambles,” *Journal of Mathematical Psychology* 39, 73–81.

{% Enrico & I: p. 85 criticizes Wakker & Tversky (1993) for taking rank- and sign-dependence into the preference axioms;

P. 306 aggressively criticizes Tversky & Kahneman (1992) for having used power utility whereas an axiom written by Duncan (invariance w.r.t. adding a constant) and incorrectly ascribed by him to Tversky & Kahneman (“which they clearly believe”) would imply exponential utility. %}

Luce, R. Duncan (1996) “The Ongoing Dialog between Empirical Science and Measurement Theory,” *Journal of Mathematical Psychology* 40, 78–98.

{% **risky utility u = strength of preference v (or other riskless cardinal utility, often called value)**: p. 298, §1.3: “Now, if utility really is a measurable concept—some economists and many psychologists have strong doubts—it seems unlikely that there should be more than one such measure. This issue is analogous to one that recurred in psychical measurements where often one can measure the same physical attribute in more than one way. There one usually finds that there are linking laws showing that the several, apparently distinct, ways of measuring the attribute really are basically the same measure. A familiar example is mass. …”

biseparable utility: uses it.

P. 304, top, criticizes use of comonotonicity by me and others in axiomatizations and calls it “contrived”

inverse S: P. 306 considers case of two subjects, one with $p^{0.5}$, other with $p^{1.5}$, as probability transformation function. Their average then gives inverse S shape probability transformation. Nice example! Estes (1956) seems to give general viewpoints on curves derived from group data. %}

Luce, R. Duncan (1996) “When Four Distinct Ways to Measure Utility Are the Same,” *Journal of Mathematical Psychology* 40, 297–317.

{% %}

Luce, R. Duncan (1997) “Associative Joint Receipts,” *Mathematical Social Sciences* 34, 51–74.

{% **coalescing**;

SPT instead of OPT: P. 101 incorrectly writes that Fennema & Wakker (1997) had proposed Luce’s Eq. (11) for gains and losses separately. This is not true. Fennema & Wakker explicitly state on p. 54, two lines above their Eq. (1): “We only give the PT value for prospects … with both positive outcomes (gains) and negative outcomes (losses).”

P. 103 gives concise description of configural weight theory.

In later writings Luce pointed out, based on cummunication with Marley, that the derivation of RDU in this paper is not correct. Status-quo event commutativity is too weak because it only gives a decomposition into utility and decision weight for the best outcome, not for the worst. %}

Luce, R. Duncan (1998) “Coalescing, Event Commutativity, and Theories of Utility,” *Journal of Risk and Uncertainty* 16, 87–114.

{% **criticisms of Savage’s basic framework** §1.1.6.1.

Note: Luce uses term accounting indifferences and not term accounting equations.

P. 7 explains why Luce’s gambles are not formally acts à la Savage.

Pp. 22-23, §1.3: This section illustrates something that I regret. The author explains that he wants to get cardinality (my term) for consequences. For this purpose he introduces joint receipts (his 4th approach). The first approach he suggests is to assume multiattributes on the consequences and then use joint analysis techniques. What he does not realize is that one can consider different events or disjoint probabilities in lotteries to be attributes, and then use the conjoint techniques there. (I do that, using conjoint analysis techniques treating events as attributes, in many papers, using for instance a tradeoff technique.) Similarly, for intertemporal choice one can treat the different timepoints as different attributes. But he lists such use of timepoints as a third, different, approach. He clearly does not realize here that uncertainty and intertemporal can be treated as special cases of conjoint analysis, as done for instance in Ch. 6 of Krantz et al. (1971). This explains his unfortunate move of using joint receipts.

Luce cites Keeney & Raiffa (1976) for deriving cardinality (my term) from multi-attributes. But Keeney & Raiffa use the probabilities of lotteries, and the EU assumed there, to get cardinality, which is more in the spirit of using events/disjoint probabilities as attributes.

Pp. 22-23: "People are surprisingly flexible about doing unusual things for an experimenter even though they have had no experience in life with such judgments."

Paternalism: p. 25, on conditions that are normative but not descriptive: "It is equally important to know about these, for it is here where prescriptive training can come into play."

P. 26, **total utility theory**: "The approach to utility measurement we are taking is thus a very classical one—purely behavioral. Within the psychological, but not the economic, community, such behavioral approaches are decidedly out of fashion, and have been ever since the so-called "cognitive revolution"."

linear utility for small stakes: p. 86 argues for this claim.

P. 55, opening sentence of §2.4.2 is nice: "Although this line of rational argument seems fairly compelling in the abstract, it loses its force in some concrete situations." Wu, Zhang, & Gonzalez (2004 p. 401) have a similar sentence.

biseparable utility: Ch. 3 gives biseparable utility; i.e., RDU representations for binary acts. Unfortunately, there are difficult technical assumptions such as gains partition in Def. 3.6.1, p. 113. Event commutativity is a kind of weakened version of bisymmetry (or autodistributivity), restricted to two outcomes x,y. Luce's repeated-events setup would have been the perfect context for full-force multi-symmetry such as used by Nakamura (1990, JET) and others!

binary prospects identify U and W

concave utility for gains, convex utility for losses: p. 83, end of §3.3.1: "Taken together, these studies provide sufficiently many examples of all four patterns that any overall generalization about the convexity or concavity of utility functions seems unwarranted. The most one can say is that concavity for gains and convexity for losses appears to be the most likely of the four patterns."

inverse S: p. 100, §3.4.2.5: "Conclusion: from all of the data in this section, I think one must conclude that the inverse S-shaped pattern for weights describes a majority of people. I remain perplexed about why so much of the earlier data failed to detect this."

In all the discussion of data here, Luce considers only the case of known probabilities, and not unknown probabilities.

P. 262: "In addition, of the several proposed weighting functions, the Prelec one is by far the most satisfactory." %}

Luce, R. Duncan (2000) "*Utility of Gains and Losses: Measurement-Theoretical and Experimental Approaches*." Lawrence Erlbaum Publishers, London.

{% **dynamic consistency: favors abandoning RCLA. E**qs 3 & 4 show that power probability weighting holds iff the simplest RCLA ((x,p),q) ~ (x,pq)). Luce also gives N-reduction invariance as a simpler condition to axiomatize Prelec's compound invariance family.

Big caveat in this all is that Luce assumes backward induction, as in all his works: In the compound gamble ((x,p),q), (x,p) can be replaced by its unconditional certainty equivalent. Under nonexpected utility this condition is not a simple monotonicity condition but it is a highly questionable separability condition (**restrictiveness of monotonicity/weak separability**). Because of this extra assumption, he can simplify Prelec's axiom otherwise. %}

Luce, R. Duncan (2001) "Reduction Invariance and Prelec's Weighting Functions," *Journal of Mathematical Psychology* 45, 167–179.

{% Applies the axiomatizations that he developed for decision under uncertainty, to psychological intensity measurements, such as the loudness as subjective perception of sounds in two ears, say 50 DB to left ear and 57 to right. %}

Luce, R. Duncan (2002) "A Psychophysical Theory of Intensity Propertions, Joint Presentations, and Matches," *Psychological Review* 109, 520–532.

{% Some improvements over Luce (2002, Psychological Review). %}

Luce, R. Duncan (2004) "Symmetric and Asymmetric Matching of Joint Presentations," *Psychological Review* 111, 446–454.
(Correction in Luce 2008, Psychological Review).

{% Considers models where the zero outcome (reference point, or unitary outcome as the author calls it) plays a special role deviating from usual models such as rank-dependent models. %}

Luce, R. Duncan (2004) "Increasing Increment Generalizations of Rank-Dependent Theories," *Theory and Decision* 55, 87–146.

{% Is critical about RDU theories not incorporating violations of framing, **coalescing**, and so on. See beginning of §2, and top of p. 114. %}

Luce, R. Duncan (2008) "Purity, Resistance, and Innocence in Utility Theory," *Theory and Decision* 64, 109–118.

{% %}

Luce, R. Duncan (2008) "Correction to Luce (2004)," *Psychological Review* 115, 601.

{% Seems to argue on p.7 against using average estimates (as with representative agent) because those may display properties not present for individuals. %}

Luce, R. Duncan (2010) "Interpersonal Comparisons of Utility," *Theory and Decision* 68, 5–24.

{% Summary of his main ideas and conditions on decision under uncertainty and joint receipt. Nice intro. %}

Luce, R. Duncan (2010) "Behavioral Assumptions for a Class of Utility Theories: A Program of Experiments," *Journal of Risk and Uncertainty* 40, 19–37.

{% %}

Luce, R. Duncan (2012) "Predictions about Bisymmetry and Cross-Modal Matches from Global Theories of Subjective Intensities," *Psychological Review* 119, 373–387.

{% Misperceived payoffs means nothing other than that payments are in something physical such as money which may be different from utility. The paper then analyzes how utility can be measured and then brought in into game theory. A point also central in Sugden (2000). %}

Luce, R. Duncan & Ernest W. Adams (1956) "The Determination of Subjective Characteristic Functions in Games with Misperceived Payoff Functions," *Econometrica* 24, 158–171.

{% %}

Luce, R. Duncan, Robert R. Bush, & Eugene Galanter (1963, eds.) *Handbook of Mathematical Psychology*, Vol. I. Wiley, New York.

{% %}

Luce, R. Duncan, Robert R. Bush, & Eugene Galanter (1963, eds.) *Handbook of Mathematical Psychology*, Vol. II. Wiley, New York.

{% Ch. 10 §5, by Luce & Suppes, is on probabilistic choice theory. See my comments on that chapter with Luce & Suppes. %}

Luce, R. Duncan, Robert R. Bush, & Eugene Galanter (1965, eds.) *Handbook of Mathematical Psychology* Vol. III. Wiley, New York.

{% **just noticeable difference** %}

Luce, R. Duncan & Ward Edwards (1958) "Derivation of Subjective Scales from Just Noticeable Differences," *Psychological Review* 65, 222–237.

{% **biseparable utility; event/outcome driven ambiguity model: event driven** %}

Luce, R. Duncan & Peter C. Fishburn (1991) "Rank- and Sign-Dependent Linear Utility Models for Finite First-Order Gambles," *Journal of Risk and Uncertainty* 4, 29–59.
https://doi.org/10.1007/BF00057885

{% Extends Luce & Fishburn (1991) to utility that need not be additive in joint receipt but can incorporate a multiplicative interaction term. If joint receipt is addition, then U must be exponential. %}

Luce, R. Duncan & Peter C. Fishburn (1995) "A Note on Deriving Rank-Dependent Utility Using Additive Joint Receipts," *Journal of Risk and Uncertainty* 11, 5–16.

{% **standard-sequence invariance**? %}

Luce, R. Duncan & David H. Krantz (1971) "Conditional Expected Utility," *Econometrica* 39, 253–271.

{% P. 49, ℓ. 10:

"are blurred together in the topological formulations". Fuhrken & Richter (1991, p. 94) have a similar statement.

Ch. 21 is on empirical status of Archimedean axiom. Also on impossibility to have finite number of first-order statements to axiomatize additive conjoint measurement. Theorem 21.21 shows that Archimedean axiom has no empirical meaning in additive conjoint measurement. %}

Luce, R. Duncan, David H. Krantz, Patrick Suppes, & Amos Tversky (1990) "*Foundations of Measurement, Vol. III. (Representation, Axiomatization, and Invariance).*" Academic Press, New York.

{% Discuss, a.o., the log-law of Fechner-Weber versus the power law of Stevens. %}

Luce, R. Duncan & Carol L. Krumhansi (1988) "Measurement, Scaling, and Psychophysics." *In* Richard C. Atkinson, Richard J. Herrnstein, Gardner E. Lindzey, & R. Duncan Luce (eds.) *Stevens Handbook of Experimental Psychology* 1, 3–74, Wiley, New York.

{% %}

Luce, R. Duncan & Anthony A.J. Marley (2000) "On Elements of Chance," *Theory and Decision* 49, 97–126.

{% %}

Luce, R. Duncan & Anthony A.J. Marley (2005) "Ranked Additive Utility Representations of Gambles: Old and New Axiomatizations," *Journal of Risk and Uncertainty* 30, 21–62.

{% **decreasing ARA/increasing RRA**: seem to use power utility;

Consider variable reference levels; assume that reference level is smallest gain when only gains, smallest loss when only losses. %}

Luce, R. Duncan, Barbara A. Mellers, & Shi-Jie Chang (1993) "Is Choice the Correct Primitive? On Using Certainty Equivalents and Reference Levels to Predict Choices among Gambles," *Journal of Risk and Uncertainty* 6, 115–143.

{% %}

Luce, R. Duncan & Louis Narens (1978) "Qualitative Independence in Probability Theory," *Theory and Decision* 9, 225–239.

{% %}

Luce, R. Duncan & Louis Narens (1981) "Axiomatic Measurement Theory," *SIAM-AMS Proceedings* 13, 213–235.

{% %}

Luce, R. Duncan & Louis Narens (1983) "Symmetry, Scale Types, and Generalizations of Classical Physical Measurement," *Journal of Mathematical Psychology* 27, 44–85.

{% %}

Luce, R. Duncan & Louis Narens (1984) "Classification of Real Measurement Representations by Scale Type," *Measurement* 2, 39–44.

{% I like this paper for its many ideas. §7 is on decision under uncertainty. Does not give a general version of RDU because it considers only 2-outcome gambles and, as pointed out also by Fishburn (1988, Uncertainty Aversion ..., page 15), it does not provide an axiomatization.

biseparable utility: For a long time I thought that Theorem 7.1 & 7.2.2 show that the most general two-dimensional model to preserve interval scaling is two-dimensional RDU but in Nov. 2022 I did not see how. Sokolov (2011) is clearer. This Luce & Narens paper is difficult to read because it uses the homogeneity- and uniqueness-terminology of the preceding sections. Note how they use Eq. 7.5. Brief and more accessible accounts may be in other papers by Luce, such as

Luce (1988, JRU, §1), Luce (1990, Psychological Science 1, p. 228), and Luce (1991, JET, §1). Pfanzagl (1968, Ch. 6 such as Theorem 6.1.1 (p. 97) may be similar, without rank dependent restriction. %}

Luce, R. Duncan & Louis Narens (1985) "Classification of Concatenation Measurement Structures According to Scale Type," *Journal of Mathematical Psychology* 29, 1–72.

{% %}

Luce, R. Duncan & Louis Narens (1986) "Measurement: The Theory of Numerical Assignments," *Psychological Bulletin* 99, 166–180.

{% %}

Luce, R. Duncan & Louis Narens (1987) "Measurement Scales on the Continuum," *Science* 236, 1527–1532.

{% %}

Luce, R. Duncan & Louis Narens (1994) "Fifteen Problems Concerning the Representational Theory of Measurement." *In* Patrick C. Humphreys & Patrick Suppes (eds.) *Scientific Philosopher*, 219–249, v. 2. Kluwer Academic Publishers, Dordrecht.

{% **utility of gambling** %}

Luce, R. Duncan, Che-Tat Ng, & Anthony J. Marley (2009) "Utility of Gambling under P(olynomial)-Additive Joint Receipt and Segregation or Duplex Decomposition," *Journal of Mathematical Psychology* 53, 273–286.

{% **utility of gambling** %}

Luce, R. Duncan, Che-Tat Ng, Anthony J. Marley, & János Aczél (2008) "Utility of Gambling I: Entropy Modified Linear Weighted Utility," *Economic Theory* 36, 1–33.

{% **utility of gambling** %}

Luce, R. Duncan, Che-Tat Ng, Anthony J. Marley, & János Aczél (2008) "Utility of Gambling II: Risk, Paradoxes, and Data," *Economic Theory* 36, 165–187.

{% P. 5 seems to write: "Indeed, one hopes that the unrealistic assumptions and the resulting theory will lead to experiments designed in part to improve the descriptive character of the theory."

P. 27/28 do EU-axiomatization by substitution axiom. (**substitution-derivation of EU**)

P. 28 has discussion of mountain climber whose utility of outcomes essentially depends on the probabilities ("gestalt" of prospect as they nicely write), something Deneffe and I once discussed. (**utility depends on probability**)

Fallacy 2: an agent might care about variance of utility.

P. 32, Fallacy 3: people who equate risky utility with cardinal utility (without further ado)

P. 280-282 points out that regret leads to intransitivities, citing Chernoff's observation entailing a violation of independence of irrelevant alternatives.

revealed preference; p. 288, §13.3, Example:

> A gentleman wandering in a strange city at dinner time chances upon a modest restaurant which he enters uncertainly. The waiter informs him that there is no menu, but that he may have either broiled salmon at $2.50 or steak at $4.00 this evening. In a first-rate restaurant his choice would have been steak, but considering his unknown surroundings and the different prices he elects the salmon. Soon after the waiter returns from the kitchen, apologizes profusely, blaming the uncommunicative chef for omitting to tell him that fried snails and frog's legs are also on the bill of fare at $4.50 each. It so happens that our hero detests them both and would always select salmon in preference to either yet his response is "Splendid, I'll change my order to steak." ... He, like most of us, has concluded from previous experience that only "good" restaurants are likely to serve snails and frog's legs, and, so, the risk of a bad steak is reduced in his eyes.

§13.4: on decision making under complete ignorance.

§13.5: pp. 304-305 present the maxmin EU model and the α-maxmin model, referring to Hurwicz (1951, Econometrica) for it. %}

Luce, R. Duncan & Howard Raiffa (1957) "*Games and Decisions.*" Wiley, New York.

{% P. 380 top writes, nicely, about recent developments in psychology that do not use techniques of measurement theory:

"A general comment: we are very aware that the measurement approach we take here is not currently fashionable, having been "replaced" by various process models. Unlike the measurement models for which the behavioral assumptions are directly testable, the process models are composed of unobservable, hypothetical mechanisms. We feel that the added flexibility of process models comes at the (usually unacknowledged) very high cost of unobservable mechanisms which, to this day, has not really been resolved by such imaging techniques as fMRI. And we feel that the very successful approach of four centuries of classical physics has not been given anything like a comparable effort in psychology. The first author has devoted the last 12 years of his career attempting to apply our knowledge of measurement to developing both psychophysical and utility measurement models, and collaborating with the second author and others he has focused on experimental studies suggested by these models."

Section 2 first points out that preference conditions such as double cancellation, in the presence of separability/monotonicity, are somewhat redundant relative to their indifference versions such as the Thomsen condition. Then it argues that the Thomsen condition is not statistically symmetric in a way that I did not really try to understand. I guess that the hexagon condition and the Reidemeister condition are symmetric. The hexagon condition is, in the presence of separability (= independence = monotonicity) and the other conditions, where unrestricted solvability can readily be weakened to restricted solvability, necessary and sufficient for additive representation. All alternative conditions discussed here are (necessary) and stronger than hexagon and, hence, trivially are also necessary and sufficient.

P. 380 discusses a nice alternative reinforcement of the hexagon condition, being the less known commutativity axiom defined by Falmagne (1976) and discussed by Gigerenzer & Strube (1983). I formulate it directly in terms of indifferences:

If

(a,r) ~ (m,s) & (m,p) ~ (c,q)

(a,p) ~ (n,q)

then (n,r) ~ (c,s) .

In words, both the upper two and the lower two indifferences show that the distance from a to c is matched by that from p to q plus that from r to s.

The hexagon condition is the special case where we impose the implication only if s = p and m = n. This observation provides a proof alternative to that in the Appendix of this paper, using the well-known result that the hexagon condition characterizes additive representation in the presence of the other conditions (Karni & Safra 1998). %}

Luce, R. Duncan & Ragnar Steingrimsson (2011) "Theory and Tests of the Conjoint Commutativity Axiom for Additive Conjoint Measurement," *Journal of Mathematical Psychology* 55, 379–385.

{% **error theory for risky choice**: Chs. 19.5-19.8, pp. 331-402, are on probabilistic choice theories. §19.5.3 is on random utility, and Ch. 19.7 on probabilistic choice for decision under uncertainty. P. 334 footnote 6 provides the counterargument against Fechnerian (strong) utility model of p(x,y) and p(y,z) being close to 0.5, but y dominating z by very small differences but clearly, so that p(y,z) = 1. They cite Leonard J. Savage (personal communication) for it. Definition 22 (p. 340) defines weak stochastic transitivity.

inverse S: §4.3 reviews the literature up to that point on probability transformation, finding inverse S as the prevailing pattern. %}

Luce, R. Duncan & Patrick Suppes (1965) "Preference, Utility, and Subjective Probability." *In* R. Duncan Luce, Robert R. Bush, & Eugene Galanter (eds.) *Handbook of Mathematical Psychology*, Vol. III, 249–410, Wiley, New York.

{% Derives additively decomposable representation for two components, by means of weak ordering, unrestricted solvability, the Archimedean axiom, and a cancellation axiom that is the Thomsen condition with preference instead of equivalence. Introductory text is nice. It first demonstrates the conjoint measurement technique in physical examples when a direct concatenation operation is also available. Next it extends that to cases (prevailing in social sciences) where no concatenation operation is available but still the conjoint measurement techniques can be adopted.

P. 5 gives a useful sentence for people who inefficiently apply "ordinal" conjoint measurement techniques in situations where cardinal information is easily available: "That we can devise alternative ways to measure familiar physical quantities is philosophically interesting, but is of little practical significance to physics as long as conventional measurement based on concatenation is possible. In the behavioral and biological

sciences, however, these new methods may be of considerable importance. Many of the quantities that one would like to measure, and that many scientists have felt it should be possible to measure, do not come within the scope of the classical axiomatization because no one has been able to devise a natural concatenation operation."

(P. 12/13: They don't give correct description of Debreu (1960) by writing joint independence condition but not the hexagon condition. P. 14 shows that Pfanzagl's bisymmetry implies the preference-version of Thomsen condition.

§9, p. 14, presents standard sequences. %}

Luce, R. Duncan & John W. Tukey (1964) "Simultaneous Conjoint Measurement: A New Type of Fundamental Measurement," *Journal of Mathematical Psychology* 1, 1–27.

{% Suggest that of the violations of SEU commonly found, reference dependence may have more rationality status than the other violations. Receipt of two sums of money need not be the same as receiving their sum. %}

Luce, R. Duncan & Detlof von Winterfeldt (1994) "What Common Ground Exists for Descriptive, Prescriptive and Normative Utility Theories," *Management Science* 40, 263–279.

{% P. 189 gives references to people who treat gaines and losses separately. %}

Luce, R. Duncan & Elke U. Weber (1986) "An Axiomatic Theory of Conjoint, Expected Risk," *Journal of Mathematical Psychology* 30, 188–205.

{% Examine preference reversals, asking subjects how certain they are about their preferences. More certain subjects have fewer preference reversals. %}

Luchini, Stéphane & Verity Watson (2013) "Uncertainty and Framing in a Valuation Task," *Journal of Economic Psychology* 39, 204–214.

{% Mostly a general book on statistical research. Some case studies of marketing are discussed. %}

Luck, David J., Hugh G. Wales, & Ronald S. Rubin (1952) "*Marketing Research.*" Prentice-Hall, New Jersey. (5th edn. 1978.)

{% The authors report a preference reversal: Jf, in isolation, a risky payoff and a delayed payoff are equivalent (I assume that the certainty equivalent and the present value are the same) then in direct choice they prefer the delayed payoff. %}

Luckman, Ashley, Chris Donkin, & Ben R. Newell (2017) "People Wait Longer when the Alternative is Risky: The Relation between Preferences in Risky and Inter-Temporal Choice," *Journal of Behavioral Decision Making* 30, 1078–1092.

{% **risky utility u = strength of preference v (or other riskless cardinal utility, often called value; time preference: comparing risky and intertemporal utility)**: The authors study choices with time and risk. Reckoning with parsimony (avoiding overfitting) they find that assuming one common utility function is best. With my interest in one common cardinal utility for all decision contexts, I like this much.

Unfortunately, the authors consider only risky prospects with one nonzero outcome, and this implies that a joint power of probability weighting and utility is indeterminate in the multiplicate prospect theory (w(p)U(x)) assumed. Similarly, the authors consider only intertemporal prospects with one nonzero outcome, and this implies that a joint power of the discount function and utility is indeterminate in the multiplicative discounted utility (D(t)U(x)) assumed. Because they consider power (CRRA) utility, this means that the utility functions are unidentifiable and any conclusion about equal or different utility cannot be drawn. %}

Luckman, Ashley, Chris Donkin, & Ben R. Newell (2018) "Can a Single Model Account for Both Risky Choices and Inter-Temporal Choices? Testing the Assumptions Underlying Models of Risky Inter-Temporal Choice," *Psychonomic Bulletin & Review* 25, 785–792.

{% Does what the title says, and finds that debiasing is effective. The end of the abstract mentions absence of conceptual rigor as a challenge for future research. Many references. %}

Ludolph, Ramona & Peter J. Schulz (2017) "Debiasing Health-Related Judgments and Decision Making: A Systematic Review," *Medical Decision Making* 38, 3–13.

{% Find extremity orientedness in DFE. (**DFE-DFD gap but no reversal**) The authors say that this gives more risk seeking for gains and more risk aversion for losses, and is opposite to prospect theory. However, a crucial point here is whether the extreme outcomes have low or high probability because, if low, then the finding agrees with prospect theory. I did not see this point discussed, although I may not have searched long enough. The authors do discuss 50-50 probabilities, e.g. p. 153 penultimate para, but I did not see this solve my problem. %}

Ludvig, Elliot A., Christopher R. Madan, & Marcia L. Spetch (2014) "Extreme Outcomes Sway Risky Decisions from Experience," *Journal of Behavioral Decision Making* 27, 146–156.

{% Study DFD-DFE gap for events with probability ½. Find usual reflection with risk aversion for gains and risk seeking for losses for DFD, but find the entire opposite for DFE. The authors suggest that their finding for DFE may be due to utility being convex for gains and concave for losses, but it may equally well be the w(½) > ½ for DFE and, in fact, the latter explanation is more plausible because the uncertainty about outcomes is different under DFE than under DFD and not the outcomes themselves. My biggest problem is that it is not at all clear what the subjects are maximizing in this experiment. My main problem is not that the choices are hypothetical per se, but that even when allowing for that it still is not clear what the (hypothetical) motivation should be. They do repeated choices, receiving points after each choice, but it is unclear what these points serve for. In the first experiment, during the experiment, some high total scores up to then were displayed and subjects were encouraged to try to beat these scores. Whatever findings this paper has, can be driven by whatever motivation came from such encouragements, and thus does not speak to general risk attitudes. %}

Ludvig, Elliot A. & Marcia L. Spetch (2011) "Of Black Swans and Tossed Coins: Is the Description-Experience Gap in Risky Choice Limited to Rare Events?," *PLoS ONE* 6, e20262.

{% Use dynamic inconsistency of CEU (Choquet expected utility) to derive implications in (il)liquid assets. %}

Ludwig, Alexander & Alexander Zimper (2006) "Investment Behavior under Ambiguity: The Case of Pessimistic Decision Makers," *Mathematical Social Sciences* 52, 111–130.

{% **updating: nonadditive measures**: use Neo-Additive Capacities and do updating there. %}

Ludwig, Alexander & Alexander Zimper (2008) "A Parsimonious Model of Subjective Life Expectancy,"

{% **DC = stationarity**. Para on pp. 1274-1275 and especially p. 1275 last sentence of 2nd para: "This property of exponential discounting is referred to as the stationarity axiom (Koopmans, 1960) and guarantees that an exponential discounter will never exhibit dynamic inconsistency."

N = 51 subjects, with hypothetical choice. The author implicitly assumes linear utility. Tests hyperbolic discounting $t \rightarrow \frac{1}{1+kt}$. Considers a number of choices, then adds three front-end delays (10, 20, 30 days). Finds decreasing impatience, but not as strong as hyperbolic discounting would predict.

Strangely enough, the whole paper focuses entirely on hyperbolic suggesting that no one has tested it yet, to cite more advanced literature only on the last page 1278, including the extensive parametric tests by Takahashi et al. (2008). %}

Luhmann, Christian C. (2013) "Discounting of Delayed Rewards is not Hyperbolic," *Journal of Experimental Psychology: Learning, Memory, and Cognition* 39, 1274–1279.

{% %}

Lukas, Josef (1987) "Additiv Verbundene Messung der Wahrgenommenen Flächengrösse: Ein Experimentelles Verfahren zur Lösung des Testbarkeitsproblems," *Zeitschrift für Experimentelle und Angewandte Psychologie* 34, 416–430.

{% %}

Lundberg, Erik (1972) "Invar Svennilson: A Note on his Scientific Achievements and a Bibliography of his Contributions to Economics," *Swedish Journal of Economics* 74, 313–328.

{% Surveys role of (cognitive) financial literacy on financial decisions. %}
Lusardi, Annamaria & Olivia S. Mitchell (2014) "The Economic Importance of Financial Literacy: Theory and Evidence," *Journal of Economic Literature* 52, 5–44.

{% **tradeoff method**: discuss it.
Show that risk attitudes measured experimentally in the lab, are related to actual decisions about eating "risky" (genetically modified) food. %}
Lusk, Jayson L. & Keith H. Coble (2005) "Risk Perceptions, Risk Preference, and Acceptance of Risky Food," *American Journal of Agricultural Economics* 87, 393–405.

{% **loss aversion: erroneously thinking it is reflection**: Happening here. They consider bargaining with either only gains or only losses, and never mixed prospects, implying that loss aversion plays no role, unlike what they claim. They use the term loss aversion for utility being different for losses than for gains. (Which, given different domains, is by definition.) %}
Lusk, Jayson L. & Darren Hudson (2010) "Bargaining over Losses," *International Game Theory Review* 12, 83–91.

{% %}
Luttmer, Erzo G.J., & Thomas Mariotti (2003) "Subjective Discounting in an Exchange Economy," *Journal of Political Economy* 111, 1–30.

{% A short proof is provided by Lindenstrauss (1966) %}
Lyapunov, Alexey A. (1940) "Sur les Fonctions-Vecteurs Complètement Additives," *Bulletin de l'Académie des Sciences de l'URSS, Série Mathématique* 4, 465–478.

{% %}

Lybbert, Travis J. & David R. Just (2007) “Is Risk Aversion Really Correlated with Wealth? How Estimated Probabilities Introduce Spurious Correlation,” *American Journal of Agricultural Economics* 89, 964–979.

{% P. 44 says some on the abandoning of behaviorism, but not much in detail. %}
Lyons, William (1986) “*The Disappearance of Introspection.*” MIT Press, Cambridge, MA.

{% **dynamic consistency**

Discussed in Paris on March 8, 1999.

Uses a “piece-wise monotonicity condition”: If, given every element of a partition, I prefer replacing f by g only given that one element of the partition, then I prefer replacing f by g in total. Given dynamic consistency (which is defined in this paper to imply reduction of events), the condition is weaker than forgone-event independence but is “in that spirit.” The definition of “interim Pareto optimal” is in the same spirit. %}
Ma, Chenghu (1998) “A No-Trade Theorem under Knightian Uncertainty with General Preferences,”

{% Real incentives with RIS.

Paper considers classical preference reversals under risk, and under ambiguity (generated by uniform 2nd-stage probability distributions over probability intervals, discussed in §8; **second-order probabilities to model ambiguity**). The author finds stronger, very strong, preference reversals under ambiguity. Data fitting shows that utility is the same under risk and ambiguity, both for choice and for WTA (p. 2060), going somewehat against the smooth model. It is all perfectly well explained by a(mbiguity-generated) insensitivity, with inverse S being more pronounced for ambiguity than for risk (**inverse S + uncertainty amplifies risk**).

§7 reports parametric fitting where for ambiguity the midpoints of the probability intervals are taken as argument. The weighting function is similar to the source functions of Abdellaoui et al. (2011 American Economic Review). %}
Maafi, Hela (2011) “Preference Reversals under Ambiguity,” *Management Science* 57, 2054–2066.
https://doi.org/10.1287/mnsc.1110.1396

{% %}

Maas, Arne (1991) “A Model for Quality of Life after Laryngectomy,” *Social Science and Medicin* 33, 1373–1377.

{% %}

Maas, Arne (1992) “The Use of Conjoint Measurement in Medical Decision Making,” Ph.D. dissertation, Dept. of Psychology, University of Nijmegen, the Netherlands.

{% %}

Maas, Arne (1993) “A Relativized Measure of Circularity,” *Mathematical Social Sciences* 26, 79–91.

{% %}

Maas, Arne (1994) “Time-Intensity Measurement: A Feasibility Study,” LPVD 94 3025, Unilever Research, Vlaardingen, the Netherlands.

{% %}

Maas, Arne (1996) “A Method for Solving Intransitivities.” *In* Wing Hong Loke (ed.) *Perspectives on Judgment and Decision-Making*, Scarecrow, Lanham, MD.

{% %}

Maas, Arne (2003) “McDonald’s Springt in Culturele Valkuil,” *Adformatie* (Nov. 16), 31.

{% %}

Maas, Arne (2004) “De Mondiale Consument als Universele Vergissing,” *Tijdschrift voor Marketing* 38 (January 2004) 40–41.

{% ISBN: 9789051798265. %}

Maas, Arne (2013) “*De Redenloze Consument. Over Framing in Marketing*.” Rotterdam University Press, Rotterdam, the Netherlands.

{% **risky utility u = strength of preference v (or other riskless cardinal utility, often called value)** %}

Maas, Arne, Thom G.G. Bezembinder, & Peter P. Wakker (1995) "On Solving Intransitivities in Repeated Pairwise Choices," *Mathematical Social Sciences* 29, 83–101.
https://doi.org/10.1016/0165-4896(94)00769-5
Direct link to paper

{% **utility elicitation** %}

Maas, Arne & Lucas J.A. Stalpers (1992) "Assessing Utilities by Means of Additive Conjoint Measurement: An Application in Medical Decision Analysis," *Medical Decision Making* 12, 288–297.

{% %}

Maas, Arne & Peter P. Wakker (1994) "Additive Conjoint Measurement for Multiattribute Utility," *Journal of Mathematical Psychology* 38, 86–101.
https://doi.org/10.1006/jmps.1994.1005
Direct link to paper

{% %}

Maccheroni, Fabio & Massimo Marinacci (2006) "A Strong Law of Large Numbers for Capacities," *Annals of Probability* 33, 1171–1178.

{% Consider smooth model, and calculate ambiguity premiums, i.e., Pratt-Arrow type risk premiums, in the second stage, and implications for investments. %}

Maccheroni, Fabio, Massimo Marinacci, & Doriana Ruffino (2013) "Alpha as Ambiguity: Robust Mean-Variance Portfolio Analysis," *Econometrica* 81, 1075–1113.
http://dx.doi.org/10.3982/ECTA9678

{% **biseparable utility violated**;

This paper was previously entitled: "Ambiguity Aversion, Malevolent Nature, and the Variational Representation of Preferences." It generalizes the existing axioms of maxmin EU in a natural manner, coming with an easy-to-write new model unifying many existing things, so, the paper is important and pretty.

They consider the following generalization of maxmin EU, with S a Savagean state space and infimum INF below over all probability measures over S

$$\mathrm{INF}\ [\int_S \big(U(f(s)\big)dP(S) + c(P)]$$

with c a convex function of probability measures. The maxmin EU, with set D of probability measures, results by letting c be 0 on D and infinite outside of D. In general, the bigger c(P), the less likely it is that P will deliver the inf and be relevant. Hence, P's judged implausible by the agent have higher c values. One way to go is to take some "most plausible" probability measure Q as starting point, and then to use the above model where c is a distance measure of P from Q. One such distance measure could be the relative entropy or that multiplied by some positive factor, and this is what Hansen & Sargent did in macro-economics. Thus, the authors have obtained a joint generalization of maxmin EU and Hansen & Sargent. Another distance measure could be a generalized Gini index and then, if I understood right, the mean-variance model comes out, that is, the mean-variance model only where it is interesting; i.e., where it is monotonic. (Because of their monotonicity imposed on c their functional simply truncates mean-variance where it starts violating monotonicity).

The interpretation that P is less plausible the larger c (c is better taken relative to a utility level of P), suggests a belief interpretation.

The authors use the Anscombe-Aumann framework which, in my interpretation and also put central by them, means just linear utility. They use the axioms of Gilboa & Schmeidler (1989) with certainty independence weakened. They do not take, for all prospects f,g and constants (certain acts) c, c´

$$\alpha f + (1-\alpha)c \succcurlyeq \alpha g + (1-\alpha)c \text{ n } \Rightarrow \beta f + (1-\beta)c' \succcurlyeq \beta g + (1-\beta)c'$$

(which is one way to state certainty independence) but they take this axiom only for $\beta = \alpha$. It amounts to considering translation invariance $\big($adding the constant $\alpha(c-c')$ to everything$\big)$ but not scale invariance.

Relative to maxmin EU they seem to add only one "parameter" being c. But c is a formidable parameter. First we go from S to the set of all probability measures on S which is of higher cardinality, and then c maps this set to the reals, being again a higher level of cardinality. So, c is not just one parameter/dimension added like U, but it is an infinity more. (Basu & Echenique

2020 give a formal way to assess such cardinality.) Thus, that they can accommodate so many existing models may be no surprise, and measurability/testability and prediction is the problem. Maxmin EU is already of an untractably high dimensionality because of the set of priors to be chosen, and this model goes way beyond it. It may however be a convenient starting point for specifying special cases, showing unity.

Axiom A8 (weak monotone continuity) ensures that only countably additive probability measures are involved. %}

Maccheroni, Fabio, Massimo Marinacci, & Aldo Rustichini (2006) "Ambiguity Aversion, Robustness, and the Variational Representation of Preferences," *Econometrica* 74, 1447–1498. https://doi.org/10.1111/j.1468-0262.2006.00716.x

{% Dynamic version of their variational model. %}

Maccheroni, Fabio, Massimo Marinacci, & Aldo Rustichini (2006) "Dynamic Variational Preference," *Journal of Economic Theory* 128, 4–44.

{% Use a variation of mean-variance analysis that avoids violation of monotonicity. For mean-variance, such a violation of monotonicity can result if an outcome is increased that is much higher than the expectation, so much that its increase worsens the variance more than that it improves the expectation. The basic idea of this paper is to simply truncate at the level of outcomes where the worsening of the variance becomes worse than the improvement of the expectation (and, I guess, condition on the non-truncated event). This is a special case of their variational preference model. They use their model to get a variation of CAPM. I do not understand their claim that they avoid arbitrage. They base this claim on not violating monotonicity, but arbitrage involves more, being linear combinations of prospects.

Even if they fix the monotonicity violation of mean-variance, I find it crude to simply ignore the best outcomes. %}

Maccheroni, Fabio, Massimo Marinacci, Aldo Rustichini, & Marco Taboga (2009) "Portfolio Selection with Monotone Mean-Variance Preferences," *Mathematical Finance* 19, 487–521.

{% The authors bring useful generalizations of Yaari (1969) type preference conditions, extending them from Yaari's expected utility to biseparable utility. The authors use the term solvable somewhat differently than done in mathematical psychology (Krantz et al. 1971). They give several useful technical results. Proposition 3 shows that, once we have a nondegenerate biseparable representation and the topology on the outcome set X is connected, then continuity on X and existence of certainty equivalents is enough to give full continuity. It is based on Lemma 8: Jf X is connected and has a real-valued representation, then continuity of preference is equivalent to existence of a continuous representation.

The central preference condition is as follows. There are two preference relations $\succcurlyeq_1$ and $\succcurlyeq_2$ for decision under uncertainty, both bisepartable, with the same outcome set X but possibly different events.

$x_{A_2}y \succ_2 z \Rightarrow x_{A_1}y \succ_1 z$

Again, A_2 and A_1 may be different. By Lemma 5, which I think is the main result, this implies $\rho_1(A_1) \geq \rho_2(A_2)$, where ρ is the authors' notation of the weighting function. This is relatively easy to prove under differentiability, but is more difficult in general. The proof is by contradiction. First step is to show that the negation to be proved contradictory implies that u_2 is more concave than u_1. This brings in enough differentiability.

Theorem 6 shows that two decision makers are equally willing to bet (on two different events) iff they have the same utility (up to unit and level of course) and the same ρ values of the two events. This greatly improves a related result by Ghirardato & Marinacci (2002), as explained in the bottom of p. 694. It is well consistent with common uniqueness results for biseparable representations. %}

Maccheroni, Fabio, Massimo Marinacci, & Jingni Yang (2022) "On the Cardinal Utility Equivalence of Biseparable Preferences," *Theory and Decision* 92, 689–701.
https://doi.org/10.1007/s11238-022-09877-w

{% Find evidence for superadditivity, rather than the commonly found subadditivity, in probability judgment. Suggest it occurs when there is little evidence for the events. %}

Macchi, Laura, Daniel Osherson, & David H. Krantz (1999) "A Note on Superadditive Probability Judgment," *Psychological Review* 106, 210–214.

{% %}
Mach, Ernest (1883) "Die Mechanik in Ihrer Entwicklung Historisch-Kritisch Dargestellt." Translated into English by Thomas J. McCormack (1893) "The Science of Mechanics: A Critical and Historical Account of Its Development," Open Court, La Salle, Illinois. (6th edn. 1960.)

{% %}
Mach, Ernst (1896) "*Prinzipien der Wärmelehre.*" Leipzig.

{% %}
Machauer, Archim & Martin Weber (1998) "Bank Behavior based on Internal Credit Ratings of Borrowers," *Journal of Banking and Finance* 22, 1355–1383.

{% %}
Machielse, Irma A. (1995) "Wat Wil de Verzekerde," Zorg en Zekerheid, Sector Zorg, Afdeling Beleidsinformatie & Onderzoek, Leiden, the Netherlands.

{% %}
Machina, Mark J. (1981) " 'Rational' Decision Making versus 'Rational' Decision Modeling," A Review of Maurice Allais & Ole Hagen (eds.) "Expected Utility Hypotheses and the Allais Paradox," *Journal of Mathematical Psychology* 24, 163–175.

{% %}
Machina, Mark J. (1981) "On Path Independent Randomized Choice," *Econometrica* 49, 1345–1347.

{% **uncertainty amplifies risk**: somewhat on p. 292: "It is useful to keep in mind the distinction between an oversensitivity to changes in the probabilities of small probability events and any tendency, under conditions of uncertainty rather than risk, to *overestimate* the probabilities of rare events." [Italics from original.]

biseparable utility violated: Eq. 6 proposes a quadratic form $EU_1 + (EU_2)^2/2$, with EU_2 a different expected utility model than EU_1, suggesting that this is about the simplest deviation from expected utility conceivable. It violates biseparable utility.

Yaari (1987) p. 111 last para writes that this paper is on its way to become a milestone, but then points out that there is no preference foundation for Machina's model. %}

Machina, Mark J. (1982) " 'Expected Utility' Analysis without the Independence Axiom," *Econometrica* 50, 277–323.

{% %}

Machina, Mark J. (1982) "A Stronger Characterization of Declining Risk Aversion," *Econometrica* 50, 1069–1079.

{% %}

Machina, Mark J. (1983) "Generalized Expected Utility Analysis and the Nature of Observed Violations of the Independence Axiom." *In* Bernt P. Stigum & Fred Wendstøp (eds.) "*Foundations of Utility and Risk Theory with Applications*," Ch. 12, 263–293, Reidel, Dordrecht.

{% P. 97 argues that any theory violating stoch. dominance will be: "in the author's view at least, unacceptable as a descriptive or analytical model of behaviour." %}

Machina, Mark J. (1983) "The Economic Theory of Individual Behavior toward Risk: Theory, Evidence and New Directions," Technical Report No. 433, Center for Research on Organizational Efficiency, Stanford University, Stanford.

{% %}

Machina, Mark J. (1983) "Axioms and Models in Decision Making under Uncertainty," A Review of Peter C. Fishburn, "The Foundations of Expected Utility," *Journal of Mathematical Psychology* 27, 328–334.

{% **dynamic consistency: favors abandoning RCLA when time is physical**

Mark cites Markowitz (1959), Mossin (1969), and Spence & Zeckhauser (1972) on induced preferences in temporal choices. The basic example is as follows:

I have to choose, to take a train or bus tomorrow. I am indifferent. However, (0.5: train, 0.5: bus) I prefer strictly less. Do I violate betweenness, expected utility, and am I non-Bayesian? No. The explanation: one thing (I had not yet told), the lottery will only be resolved tomorrow. Now, if surely train, I now have to order a train ticket, a day ahead. Bus, similarly. However, with the lottery I don't know what to order. What is going on is that the option "train" in the lottery is different than if certain. It is endowed with less info. It is "train without knowing so a day ahead."

Such situations arise if besides the decision considered, choosing from a set X, and receiving it real time elapses, and we have to make another decision, choosing from a set A, in the meantime. Then every $x \in X$ is combined with the $a \in A$ that maximizes U(x,a). Then preferences are quasiconvex in probability. (**quasi-concave so deliberate randomization**: well, Mark uses the term quasiconvex; these terms are nonuniversal).

The paper writes on the maths of using Mark's 1982 model in such situations. %}

Machina, Mark J. (1984) "Temporal Risk and the Nature of Induced Preferences," *Journal of Economic Theory* 33, 199–231.

{% **quasi-concave so deliberate randomization** %}

Machina, Mark J. (1985) "Stochastic Choice Functions Generated from Deterministic Preferences over Lotteries," *Economic Journal* 95, 575–594. https://doi.org/10.2307/2233028

{% **survey on nonEU**

P. 148: "Note that it is neither feasible nor desirable to capture all conceivable sources of uncertainty when specifying the set of states for a given problem: it is not feasible since no matter how finely the states are defined there will always be some other random criterion on which to further divide them, and not desirable since such criteria may affect neither individuals' preferences nor their opportunities. Rather, the key requirements are that the states be mutually exclusive and exhaustive so that exactly one will be realized, and (for purposes of the present discussion) that the individual cannot influence which state will actually occur." (not really, but related to, **criticisms of Savage's basic framework**) %}

Machina, Mark J. (1987) "Choice under Uncertainty: Problems Solved and Unsolved," *Journal of Economic Perspectives* 1 no. 1, 121–154.

{% %}

Machina, Mark J. (1987) "Decision-Making in the Presence of Risk," *Science* 236, 537–543.

{% **dynamic consistency**: **favors abandoning forgone-event independence, so, favors resolute choice**; this is the spirit of this paper.

@@@@@BEGINNING OF ABBREVIATED READING@@@@@@@

Reading the most essential subparts, on nonEU with dynamic-choice arguments, goes as follows:

Pp. 622-1636, i.e., up to and including §3.2, present elementarities of decision under risk, in a very didactical manner. Very good for novices, but can be skipped by experts. Experts only note that RCLA is assumed throughout. One then reads §3.3 and §4, skipping the right half of p. 1637 and the rest of §3.3 ("Classical Argument … the information!"), the last four lines of §4.1 in the left column of p. 1642 and the rest of §4.1 ("Consequentialism in … two prospects"), and the right part of p. 1644 and the rest of §4 ("Analogy with … nonsensical behavior."). Instead of the rest of the paper, one can read the following summary, where I explain Machina's preferred solution, what he thinks is rational, in words. I do it for Figure 7 (p. 1637), the right figure there. From the prior perspective, the agent prefers going up. If she were at the decision node and the past had not existed, she would have preferred going down there, going for certainty. However, in the tree as is, the posterior agent at the decision node, will go up as the prior agent wanted. But this is not against the preference of the posterior agent. The posterior agent really herself prefers going up there: Beause of the risk borne in the past. Because at some past time there was a 0.89 probability of going down to 0, even if it is now known that it did not happen. So, risks borne in the past continue to be relevant, also if now counterfactual. This approach is sometimes called resolute choice. It is neither naïve nor sophisticated (in the usual interpretation). It is a bit like precommitment also if there is no precommitment device. The parental example should justify this approach. Mother can tell Bernjamin that there is no unfairness because in the past there has been a chance that Benjamin would win, even if now we know that that just did not happen.

@@@@@@@END OF ABBREVIATED READING@@@@@@@@@

dynamic choice

Dutch book; **dynamic consistency**;

(**consequentialism/pragmatism**). in mom-example argument that incorporating all relevant aspects in consequences is intractable. This argument is discussed extensively and in detail in §6.6. P. 1662 writes, for instance, that EU and its separability may be rational if we can observe consequences in sufficient detail:

"For my part, I will grant that sepa rability may well be rational provided the descriptions of the consequences are sufficiently deep to incorporate any relevant emotional states, such as disappointment (e.g., at having won $0 when you might have won $5 million), regret (at hav ing forgone a sure chance of $1 million and then landing a 1 percent chance of $0), jealousy (over your favorite movie star), feelings of un fairness (that Benjamin won the treat in an unfair flip), and so on."

Mark cites related views by Samuelson.

The paper clarifies many issues in this domain and introduces the current terminology for dynamic decisions in decision under risk, although it did not define it explicitly and the readers have to infer it from the context. In other fields in economics, the term dynamic consistency is often used in a weaker sense, and in philosophy the term consequentialism is used in vaguer/broaer ways. What Mark calls dynamic consistency is what in intertemporal choice, after Halevy (2015), is called time consistency.

P. 1624 middle of right column writes that expeted utility automatically has consequentialism satisfied. Strictly speaking, EU is a static theory, and it is open what dynamic principles it satisfies. But it is very natural to implement it dynamically while satisfying the natural conditions, so much that this is often considered part of EU theory,

On p. 1624, 2nd column, ℓ. 13, Mark discusses the, sometimes hidden, assumption of consequentialism (= what I like to call forgone-branch independence). This assumption is discussed on p. 173, as part of the "first objection" in §4 of Wakker (1988) "Nonexpected Utility as Aversion of Information," *JBDM* 1 (e.g. through the requirement that information should be free of charge).

Points 2 & 3 on pp. 1662-1663: That EU can be satisfied if consequences are described in any detail, but that economists cannot have such descriptions and, also, that EU then becomes irrefutable. P. 1663: "The above compromise tries simultaneously to acknowledge (a) the normative appeal of separability at some deep enough level of consequence description, (b) normative reasons why preferences might be nonseparable at the level of description typically used by economists"

P. 1663: last sentence argues for nonEU normative: "Along with the critique of Section 4 and the dynamic model of Section 5, it is offered as a contribution to what I have termed the "normative goal" in the campaign for the general acceptance and use of non-expected utility models."

Some criticisms:

- Pp. 1623-624: his argument against intransitivity: If it existed, we should constantly see people get money pumpted. Since we don't see that, there are no intransitivities in economics. My objection: such money pumping can only happen in free markets where intransitivities are known to others. (There is also Sugden's counter that agents seeing the money pump coming will stay out.)

- His discussion of replacement vs. mixture separability does not make clear that replacement separability is a bit weaker, readily implied by mixture separability, but that the other implication needs continuity for its proof (see Fishburn & Wakker 1995).

- The discussion of incoherent probabilities on pp. 1635-1636 suggests that he does not know the Dutch book/nonarbitrage argument.

I once asked Mark about when the risk is not randomness in nature, but epistemic. Say, the risk concerns something about the 101-200th digit of the number pi. Then, if the uncertainty gets resolved, one knows that in a way the risk from the past never existed. Does Mark then still advocate his approach? Mark did not answer in the sense that he said he had to think about it. %}

Machina, Mark J. (1989) "Dynamic Consistency and Non-Expected Utility Models of Choice under Uncertainty," *Journal of Economic Literature* 27, 1622–1688. http://www.jstor.org/stable/2727025

{% %}

Machina, Mark J. (1989) "Comparative Statics and Non-Expected Utility Preferences," *Journal of Economic Theory* 47, 393–405.

{% **dynamic consistency** %}
Machina, Mark J. (1991) "Dynamic Consistency and Non-Expected Utility." *In* Michael Bacharach & Susan Hurley (eds.) *Foundations of Decision Theory*, 39–91, Basil-Blackwell, Oxford.

{% **dynamic consistency**
P. 172 $\ell\ell$. 3-4 does not fully write but strongly suggests that Tversky would consider violations of EU to be normative. But this is not so, as Tversky wrote on an occasion or two, and told me in personal comunication.
P. 173 last section of Section IV defends nonEU as rational. %}
Machina, Mark J. (1992) Book Review of: Edward F. McClennen (1990) "Rationality and Dynamic Choice: Foundational Explorations," Cambridge University Press, Cambridge; *Theory and Decision* 33, 265–271.

{% Wrote: "The publication history of the rank-dependent expected utility attests to its role as the most natural and useful modification of the classical expected utility formula." (**Prospect theory/Rank-Dependent Utility most popular for risk**) %}
Machina, Mark J. (1994) Book Review of: John Quiggin (1993) "Generalized Expected Utility Theory - The Rank-Dependent Model," Kluwer Academic Publishers, Dordrecht; *Journal of Economic Literature* 32, 1237–1238.

{% Uses, nicely, the term **probability triangle**. %}
Machina, Mark J. (1995) "Non-Expected Utility and the Robustness of the Classical Insurance Paradigm," *Geneva Papers in Risk and Insurance Theory* 20, 9–50.

{% %}
Machina, Mark J. (2001) "Payoff Kinks in Preferences over Lotteries," *Journal of Risk and Uncertainty* 23, 207–261.

{% Opening para: "The appearance of Ellsberg's classic 1961 article posed such a challenge to accepted theories of decision making that, after an some initial rounds of discussion, the issues he

raised remained well known but largely unaddressed, simply because researchers at the time were helpless to address them. It took more than a quarter of a century, and the successful resolution of separate issues raised by Allais (1953), before decision scientists were in a position to take on the deeper issues raised by the Ellsberg paradox." This underscores how innovative Gilboa & Schmeidler's ambiguity decision models were at the end of the 1980. %}

Machina, Mark J. (2001) "Further Readings on Choice under Uncertainty, Beliefs and the Ellsberg Paradox," Preface to Daniel Ellsberg (2001) "*Risk, Ambiguity and Decision.*" Garland Publishers, New York, pp. xxxix ff.

{% Assumes preference functional V over acts under uncertainty in Savage-model. State space is interval such as s = temperature of Bejing, etc. Assumes that V is differentiable w.r.t. small variations in state. This implies that acts depending only on kth digit of s become like objective probability distributions as k increases. So, we can infer the risk preference functional therefrom. It has often been said, and I agree, that risk (known probabilities) is not different from uncertainty (unknown probabilities), but instead is a limiting case. This paper substantiates this claim, and even proves it in a formal mathematical manner. Those who say that objective probabilities do not exist and should not be used, and that only a subjective Savage state space should be considered, get objective probabilities delivered in their backyard by this paper.

The two-stage Anscombe-Aumann framework with mixing before states is more general than this model as commonly used today, with mixing after the states (the former can allow for correlations, latter can concern only marginals). As a model, Mark's model comes out equivalent to mixing before, but further preference restrictions follow that in fact make it equivalent to mixing after (p. 16).

As regards dynamic decision principles, the paper seems to assume the RCLA + **dynamic consistency** of Machina (1989) (§2.2 & p. 15) as if generally accepted. The model of the paper comes out equivalent, not by assumption but by implication (p. 16).

P. 23 middle para epresses source dependence. P. 24 uses the term "source of uncertainty."

P. 32 points out that monotonicity in Grant (1995) can be generated from set-inclusion. %}

Machina, Mark J. (2004) “Almost-Objective Uncertainty,” *Economic Theory* 24, 1–54.

{% The result of over ten years of work, presented already in Cachan 1992 under the title “Robustifying the Classical Model of Risk Preferences and Beliefs” %}

Machina, Mark J. (2005) “Expected Utility/Subjective Probability’ Analysis without the Sure-Thing Principle or Probabilistic Sophistication,” *Economic Theory* 26, 1–62.

{% The paper provides two examples of plausible preferences that violate RDU (CEU (Choquet expected utility) as Machina call it) for uncertainty. Baillon, L’Haridon, & Placido (2009) later showed that the examples also violate most other nonEU models for uncertainty popular today in the Anscombe-Aumann framework; without that framework, Machina’s counterexamples only concern RDU. In particular, the examples violate the comonotonic sure-thing principle and even tail independence. I find the second example, the reflection example (pp. 389-390), impressive, nay, brilliant. But other than that I prefer different interpretations and explanations than the author gives for almost everything. The basic problem is that I think that the cognitive component of ambiguity is decisive in Mark’s examples, as explained well by Baillon, L’Haridon, & Placido (2009), and confirmed empirically by L’Haridon & Placido (2010). But Mark, having worked almost exclusively on risk, is not open to the cognitive side and goes for motivational diminishing marginal effects-type arguments.

The reflection example (with my interpretations): An urn contains 100 balls. 50 balls marked 1 or 2 in unknown proportion, and 50 marked 3 or 4 in unknown proportion. One ball is drawn randomly. E_j: the number drawn is j. Consider (with $1000 as unit) preferences between f_5 and f_6, and then between f_7 and f_8:

		#50	#50
f_5	=	(E_1:4, E_2:8,	E_3:4, E_4:0),
f_6	=	(E_1:4, E_2:4,	E_3:8, E_4:0),
f_7	=	(E_1:0, E_2:8,	E_3:4, E_4:4),
f_8	=	(E_1:0, E_2:4,	E_3:8, E_4:4),

Ambiguity averse people will have $f_6 > f_5$ because f_6 has one outcome, 4, resulting with known probability ½, whereas f_5 has all outcomes ambiguous. For

exactly the same reason, ambiguity averse people will have $f_7 > f_8$. These claims were later confirmed empirically by L'Haridon & Placido (2010).

Btw., because of informational symmetry, f_7 is like f_6 and f_8 is like f_5, so that the second preference follows from the first from informational symmetry.

RDU however predicts indifference between the four acts because RDU considers likelihoods of what are known as goodnews events ("decumulative events;" "ranks"). For all four acts, the goodnews event of receiving 8 contains one E_j, the goodnews event of receiving 4 or 8 contains three E_js, and the goodnews event of receiving 0, 4, or 8 contains all four E_js. Beause of informational symmetry, each goodnews event has the same weight under each act, implying immediately that the four acts are indifferent by RDU, simply having identical Choquet integals. (Btw: Machina uses a different reasoning, being that the comonotonic sure-thing principle, and even tail independence, require that a strict preference between f_5 and f_6 be the same as between f_7 and f_8, rather than between f_8 and f_7 as informational symmetry has it. Because informational symmetry is unquestionable, RDU hence cannot have strict preferences and must have indifferences.)

(Another btw.:

Sarin & Wakker 1992 axiomatized RDU using an axiom that acts are equivalent whenever all goodnews events have the same likelihood, in an axiom called cumulative dominance.)

I like Machina's reflection example much because it addresses a fundamental issue of RDU, being that RDU focuses on likelihoods of goodnews events, but Machina's example shows that subjects are also partially driven by likelihoods of separate-outcome events, as considered in old pre-rank-dependent nonadditive probability models such as separable prospect theory. (**PT falsified**)

I regret that Machina does not refer to the role of separate-outcome events and the unambiguity of one outcome in his reasoning against indifference. He instead uses a complex riding-on reasoning (f_5 has two small ambiguities and f_6 one big; if one had something like aversion to mean-preserving spreads one would prefer f_5). As Baillon, l'Haridon, & Placido rightfully point out, ambiguity is more cognitive than motivational, is more subject to diminishing sensitivity, and it is more categorical ambiguous versus unambiguous than more versus less. Hence, Machina's reasoning that the two ambiguities of f_5 will count more negatively than the one ambiguity of f_6 can only be understood by specialists, and then after some effort. It will not enter the mind of any natural subject. Mark thus does not choose side for one strict preference or the other even though it is clear enough I think, and he further refers to an unclear tradeoff between objective and subjective uncertainty.

Machina's 50-51 example, while equally valid as the reflection example, is less clear. Now unambiguity must be traded against an objective-likelihood argument in a first choice problem (between f_1 and f_2) and also in a second choice problem (between f_3 and f_4). In the second choice problem the ambiguity degree of all goodnews events is the same as in the first and it can be proved under RDU that the preference in the second choice problem should be the same as in the first. In the second choice problem the ambiguity degree of all separate-outcome events is not the same as in the first, and therefore choices can be different. Because of the tradeoff with objective probability this example is less clear, and will work less well empirically than the reflection example. Machina's explanation on pp. 388-389 again (as in the reflection example) does not raise the argument of a separate-outcome event, unfortunately. Instead, it raises an unclear correlation argument. One problem is that correlation is not defined as he discusses it. You need numbers to correlate, so, how should this be with events? Indicator functions will not help. He could formalize the first point in terms of stochastic-like or sigma-algebra-like independence. (Btw., p. 388 last line "corrected" should be "correlated" and this is a typo.) Mark proceeds with claiming that in the second choice problem some correlations are lower, and this is not clear either.

Mark also overstates implications. P. 389 4th para suggests that models like RDU, which maintain comonotonic separability, kep the Ellsberg problem. He tries to suggest there that his example is as strong and fundamental as Ellsberg's. This is not so; it is different, and less strong, albeit surely interesting.

P. 390 writes: "If there is a general lesson to be learned from Ellsberg's examples and the examples here, it is that the phenomenon of ambiguity aversion is intrinsically one of nonseparable preferences across mutually exclusive events, and that models that exhibit full—or even partial—event-separability cannot capture all aspects of this phenomenon.."

This text suggests that all models of nonEU for ambiguity should consider interactions and violations of separabililty of events. I in fact agree with this general point but I disagree that Machina's examples, which are only two examples, (nor the Ellsberg examples which Machina puts on the same footing there), could prove this in general, as Machina is suggesting. Even worse, Machina claims that *every* partial form of event-separability will fail. This claim is completely unfounded. Machina has done no more than show a problem for comonotonic separability (sure-thing principle) and even for tail-separability (independence). Theories that completely give up any event-separability may be very general and, thus, intractable. For the same reason, the general Machina (1982) nonexpected utility, while useful to bring some theoretical points, is too general for most purposes.

Something else I found amazing is that on several occasions (p. 390 2nd para "the issue is not how individuals *ought* to choose …" and the closing sentence on p. 391) Machina treats ambiguity purely descriptively, and nothing normatively. I as Bayesian like to have ambiguity only descriptively, but still would not explicitly exclude any normatively-based discussion of it. %}

Machina, Mark J. (2009) "Risk, Ambiguity, and the Rank-Dependence Axioms," *American Economic Review* 99, 385–392. https://doi.org/10.1257/aer.99.1.385

{% "Science is the process of distributing zeros throughout the determinant matrix" citation of which Mark did not remember what the source was. Maybe Samuelson? %}

Machina, Mark J. (2010), lecture

{% Considers the Ellsberg 3-color paradox. The two commonly assumed strict preferences violate the sure-thing principle, as is well known. This paper shows, nicely, that one of the two strict preferences implies the other by the sure-thing principle (+ some natural symmetry assumptions), so that one strict preference already gives a violation of the sure-thing principle. Moreover, in the derivation of the one strict preference from the other one only needs the restriction of the sure-thing principle to events with known probabilities, where the sure-thing principle is less controversial. (Jaffray always pleaded for the latter condition.) Thus, one of the two strict preferences, together with the symmetry conditions, already implies a violation of the sure-thing principle.

As for source method: Another thing I like is that the paper shows that the Ellsberg 3-color urn is best taken as a mix of two sources of uncertainty (what Mark calls pure objectivity and pure subjectivity). This point had been alluded to before by Ergin & Gul (2009) and Abdellaoui et al. (2011 American Economic Review p. 718), but Machina makes it more clear than anyone else did. Unfortunately, he does not explicitly connect to the idea of sources.

There are interpretations in the paper that I find unfortunate. The sure-thing principle for events with known probabilities is best taken as a special case of the general sure-thing principle, and not as a different condition. This paper tries to suggest that the conditions for purely objective and "purely subjective" (a term of this paper that I do not find very useful) are two different animals. What could prove the paper's claim better than the (erroneous) claim that, whereas the general sure-thing principle is violated by the two strict preferences of Ellsberg, the sure-thing principle for known probabilities would even imply those preferences, rather than be violated by them? So, the paper makes this, incorrect, claim (end of abstract: "the standard Ellsberg-type preference reversal is actually implied by the Independence Axiom over its purely objective uncertainty;" there are similar claims on p. 433 1st para & end of p. 435).). This is not so. Only that condition TOGETHER WITH one of the two strict preferences (and some natural symmetry conditions) does so.

Claims of compatibility with the sure-thing principle over *purely* subjective uncertainty (p. 433 top) are also misleading, because it is only compatible in the sense of not directly violating a very particular version of the condition restricted to very particular events chosen by Mark.

The demonstration that one strict preference in the 3-color Ellsberg paradox, together with the usual informational symmetries, and the sure-thing principle for events with known probabilities implies the other strict preference, is as follows. Assume 1 R(ed) ball and 2 B(lack) and Y(ellow) balls in unknown proportion, the usual informational symmetries, the sure-thing principle, and $100_R0 \succ 100_B0$. Number the three balls, with ball R no. 1. Denote by BY (ball 2 is B and ball 3 is Y), YB, BB, and YY the four possible compositions of the urn, where the one R ball is suppressed. Now, subtly, as in Table 4 (p. 432), interpret 100_B0 as (1/3:0, 1/3:($100_{\{BB,BY\}}0$, 1/3:$100_{\{BB,YB\}}0$), where the first probability 1/3 describes what happens under ball 1 (a payment contingent on the composition of the urn, yielding 100 if BB or BY and 0 otherwise), the second what happens under ball 2, and the third what happens under ball 3. Interpret 100_R0 as (1/3:100, 1/3:0, 1/3:0). So, we rewrite the assumed preference (reordering outcomes for the unambiguous prospect) as

(**1/3: 0**, 1/3:0, 1/3:100) ≻ (**1/3: 0**, 1/3:($100_{\{BB,BY\}}0$, 1/3:$100_{\{BB,YB\}}0$).

By the s.th.pr. we get, replacing the bold common outcome,

(**1/3: 100**, 1/3:0, 1/3:100) ≻ (**1/3: 100**, 1/3:($100_{\{BB,BY\}}0$, 1/3:$100_{\{BB,YB\}}0$), rewritten as

(1/3:0, 1/3:100, 1/3:100) ≻ (1/3:100, 1/3:($100_{\{BB,BY\}}0$, 1/3:$100_{\{BB,YB\}}0$). The latter says: $100_{\{B,Y\}}0 \succ 100_{\{B,R\}}0$. This is the second strict preference that is traditionally taken as second assumption. QED %}

Machina, Mark J. (2011) "Event-Separability in the Ellsberg Urn," *Economic Theory* 48, 425–436.

{% This paper presents some examples on choice under ambiguity that trigger new thoughts and insights. It discusses implications for some theories. I have different opinions about interpretations of RDU (I prefer this term to CEU (Choquet expected utility)) and about Anscombe-Aumann (AA), and also about the Allais paradox, explained below.

The paper is entirely focused on the Anscombe-Aumann framework, as if the only way to go as soon as a model has both risk and ambiguity, which is the common thinking in the field today (2015), but that I disagree with. A first stage has ambiguous (horse) events, a second stage has risk (roulette) events, and backward induction is used where first the second-stage lotteries are replaced by their certainty equivalents according to EU, then processed according to an ambiguity theory handling the uncertainty about the horses. Not only the EU assumption is empirically questionable here, but also the backward induction assumption is. It entails conditioning on each individual ambiguous event, that is, treating each such event as separable. While still questionable, it is relatively least questionable if the resolution of risk comes in a stage after the resolution of ambiguity, so, if it is two-stage as usually assumed in Anscombe-Aumann and as also assumed above. A typical case is where the second-stage risk is conditional on the first-stage resolution; i.e., the roulette lottery l_i will only be carried out if horse h_i wins the race. This is the case of pp. 3821-3822 where first the composition of the Ellsberg urn (the horse) is determined and the corresponding objective risk (roulette lottery) is only carried out if the corresponding composition of the urn obtains. However, this paper assumes all resolutions of uncertainty simultaneously (p. 3818 footnote 11), making it yet more questionable. For instance, Eq. 6 on p. 3819 is without further ado or justification taking the order of integration as in AA, taking each event E_i as separable. 2021: I think that Machina was well aware of all this but was very political and did it so as to fit with the fashion in the field, which I regret.

Several authors argued that the two-stage setup of Anscombe-Aumann with the risky events second and then backward induction is unfortunate. Conditioning and separability are, under the assumption of EU for risk, more plausible for roulette events and, hence, it would work better to put the horse race first. Wakker (2011 Theory and Decision, p. 19 top and p.19 penultimate para) cites Jaffray (personal communication) for this viewpoint. Further arguments are in Wakker (2010 §10.7), Baillon, Chen, & Halevy (2015), and Bommier (2017).

For the above reason, footnote 11 on p. 3818, claiming simultaneous resolution of all uncertainties in this paper, is misleading. It makes the backward induction assumed throughout the paper less convincing. As I wrote above, pp. 3821-3822, describing Ellsberg's urn as two-stage, is for instance very very hard to reconcile with the simultaneity claim of footnote 11.

P. 3815: The slightly bent coin example is a small variation of Machina's (2009) reflection example. The risk in the 2009 example need not be perfect risk, but can be a little ambiguity, close to risk, maintaining the paradox. This is what the bent coin example illustrates. These two examples are genuine counterexamples to RDU. RDU assumes that people go entirely by cumulative events, but in reality people are still guided a bit also by single-outcome events, and these examples beautifully show it.

P. 3815 thermometer example uses the basic idea of Machina (2004 ET). If the DM is subject to the Allais paradox for risk, then in a continuum state space with enough differentiability it will show up. For instance, if we measure temperature, we can gamble on the 5^{th} & 6^{th} digits and these are by all means subject to objective probabilities (my country-man the philosophical mathematician L.E.J. Brouwer would say that it is undetermined), and can be used to bring up the

Allais paradox with risk. This point can be understood without reading the mathematical proofs that Machina provides for completeness.

P. 3815, the third example on ambiguity at high versus low outcomes, considers Ellsberg's 3-color paradox, with outcomes 100, c, and 0, where c is the CE (certainty equivalent) of $100_{0.5}0$, assuming EU for risk. In urn 1 we have the highest outcome 100 at the unambiguous color red, and the other outcomes at the other colors (0 for black and c for white). In urn 2 we have the lowest outcome 0 at the unambiguous color red, and the other outcomes at the other colors (c for black and 100 for white). In the former case, ambiguity is at the lower outcomes, and in the latter it is at the higher outcomes. DMs may well strictly prefer one urn to the other and not be indifferent. If we, however, use an Anscombe-Aumann framework conditioning on the true composition of the urn, then, as shown in the table on p. 3831, conditional on each composition of the urn, the two urns assign the same EU to each composition. Hence, all Anscombe-Aumann based models require indifference. The example, if not giving indifference, falsifies the Anscombe-Aumann approach.

DETOUR [Wakker (2010 Figure 10.7.1] I hope that the readers can now bear a self-reference. Wakker (2010 Figure 10.7.1) illustrates the same kind of failure of Anscombe-Aumann but I think more clearly. It assumes two horses s_1 and s_2. In the first choice situation in the left figure the choice is between (s_1: $100_{0.5}0$, s_2: $100_{0.5}0$) and (s_1: c, s_2: $100_{0.5}0$). It assumes c such that we have indifference, and assumes $c = 40$, but I will maintain Machina's notation c here. Under Anscombe-Aumann, c must then be the CE of $100_{0.5}0$. The second choice situation in the right figure has a choice between (s_1: $100_{0.5}0$, s_2: c) and (s_1: c, s_2: c). So, the common outcome under s_2, $100_{0.5}0$, has been replaced by another, under Anscombe-Aumann equivalent, common outcome c. It is plausible that ambiguity aversion gives a strict preference for the sure c in the second situation, but Anscombe-Aumann requires indifference. This example considers two choices as does Machina's (c is derived from an indifference there too), but has simpler stimuli and the violation of indifference is more plausible, with a clear direction predicted. Note that under Anscombe-Aumann all four prospects considered in my example assign the same EU to s_1 and s_2, and should all four be indifferent. A difference with Machina's example is that my example does not appeal to whether ambiguity aversion is increasing or decreasing in outcomes, but to ambiguity aversion per se.

[END OF DETOUR]

P. 3815: "objective uncertainty … specification of subjective uncertainty as a *distinct* concept" [italics added]

P. 3818: If we face the simultaneous uncertainty of an ambiguous horse race and a risky lottery, then in general under nonEU correlations between conditional lotteries may be relevant. If lottery 1 gives a high outcome conditional on s_1, then does lottery 2 give a high outcome under s_2? Outside the separability of EU this can be relevant. However, by the very notation on p. 3818, by describing only the roulette lotteries conditional on the horses (explicitly called conditional on p. 3820 ℓ. 3), Machina already excludes such info, and is already focusing on the Anscombe-Aumann framework with the questionable conditioning-on/separability-of horses. This affects all models considered, in Eqs. 1-6. Whereas smooth preferences, variational preferences, and multiple priors, have only been considered in the Anscombe-Aumann framework, RDU has well been considered outside of it (Gilboa 1987; Wakker 2010), and I regret that Machina implicitly assumes that it satisfies Anscombe-Aumann. Footnote 34 on p. 3832 states the point, and p. 3835 lines −4/−2 also:

"and hence cannot be strictly ranked by models which evaluate the objective uncertainty in mixed prospects solely through these statewise values."

P. 3821 ℓ. −3 is misleading in calling the Anscombe-Aumann framework the "appropriate state space" although a linguistic escape route for the author can be that some lines before he has conditioned on the Anscombe-Aumann framework.

P. 3829 ℓ. −3 and elsewhere: I would not take the example as single-source. The 7th decimal generates a different subalgebra than the 1st digit and East-West, and these different subalgebras are better taken as different sources. The whole source method assumes one grand state space, with sources different subalgebras (or more general systems than algebras because intersection-closedness is not a natural requirement here).

Conclusions of the paper such as RDU being violated by examples are often misleading because it is not RDU but it is RDU-joint-with-Anscombe-Aumann. A linguistic escape route for the author can be that on p. 3819 he *defines* RDU as incorporating Anscombe-Aumann, so, whatever he says about RDU is to be taken that way.

In the *ambiguity at low versus high outcomes problem, RDU (without Anscombe-Aumann) can very easily accommodate strict preferences*. I write v for weighting function rather than the usual W to avoid confusion with W for white. For empirical plausibility we would need nonEU for risk, but let me stay with the paper and Anscombe-Aumann and have EU for risk. Then we let the decision weight of event R always be 1/3, so $v(R \cup E) - v(E) = 1/3$ for each disjoint event E. We set $v(R \cup W) = 0.6 < 2/3$ inducing pessimism for the low-ranked events in Urn 1, and $v(W) = 0.4 > 1/3$ generating optimism for the high-ranked events in Urn 2. A strict preference for urn 2 results. If we want to use a more detailed state space specifying the compositions of the urns, then we take the weighting function v such that the union of all events giving W has v-value 0.4, the union of all events giving $R \cup W$ has v--value 0.6, and so on. The latter weighting function does NOT have the horse events (composition of urn) separable and, hence, does not fit in the Anscombe-Aumann framework, but this is desirable to avoid the unwarranted separabilities.

P. 3835 end of 1st para, misleadingly, writes: "But for that same reason so would each of the four major models, which suggests that correcting for attitudes toward objective risk, none can depart from SEU in the direction of a Friedman-Savage (1948)-type aversion to ambiguity in low-likelihood disasters coupled with a preference for ambiguity in low-likelihood high-stakes gains." Not only can RDU without Anscombe-Aumann do this easily, but more than that, what the author describes is the major empirical finding (likelihood insensitivity generated by ambiguity; **ambiguity seeking for unlikely**). Footnote 42 there nicely points out that the smooth model cannot accommodate the ambiguity seeking for unlikely combined with ambiguity aversion for likely.

criticism of monotonicity in Anscombe-Aumann (1963) for ambiguity: p. 3835 3rd bulleted point: One has to read this point three times before one sees that the diplomat/politician Machina in fact says that the Anscombe-Aumann framework itself is violated here. The Anscombe-Aumann framework is described using the complex words "by models which evaluate the objective uncertainty in mixed prospects solely through these statewise values."

Another disagreement: I think that the Allais paradox, for which common

consequence is most important, reveals the certainty effect and violation of the sure-thing principle, and shows violation of expected utility as much for risk as for uncertainty. It shows the violation in an absolute sense, and the Ellsberg paradox shows it in a relative sense. I thus deviate from people who say “Allais is for risk and Ellsberg is for uncertainty.” This paper is entirely in the latter spirit. See, for instance, §III on p. 3822. %}

Machina, Mark J. (2014) “Ambiguity Aversion with Three or More Outcomes,” *American Economic Review* 104, 3814–3840. https://doi.org/10.1257/aer.104.12.3814

{% %}

Machina, Mark J. & William S. Neilson (1987) “The Ross Characterization of Risk Aversion: Strengthening and Extension,” *Econometrica* 55, 1139–1149.

{% The definitions of mean-preserving spreads were given explicitly by Rothschild & Stiglitz for discrete distributions and density functions. This paper shows that these also hold for general distributions. %}

Machina, Mark J. & John W. Pratt (1997) “Increasing Risk: Some Direct Constructions,” *Journal of Risk and Uncertainty* 14, 103–127.

{% This paper characterizes the first part of EU (that uncertainties are expressed in terms of probabilities) without requiring the second part (that probability-weighted average utility is used as evaluation), calling the first part probabilistic sophistication. This separation into two steps had often been described before, for instance in Cohen, Jaffray, & Said (1987), but also in decision-analysis works of the 1960s. The present paper is the first to give a decision foundation to it.

restrictiveness of monotonicity/weak separability: p. 754: stochastic dominance is defined for general outcomes, using the subjective preference relation over outcomes, as in Fishburn & Vickson (1978, §2.21). %}

Machina, Mark J. & David Schmeidler (1992) “A More Robust Definition of Subjective Probability,” *Econometrica* 60, 745–780. https://doi.org/10.2307/2951565

{% **dynamic consistency**: the paper takes no stance on which to abandon.
P. 118: Beliefs are derived from bets. In several places the authors write that probabilistic sophistication is normative (last sentence of abstract, "correct," "proper," last sentence of §1 ("rational formulation"), p. 121 next to last sentence ("proper *normative* term"). P. 122, point 2, claims that most people think that violations of expected utility are not mostly due to violations of probabilistic sophistication, but are mostly due to violations of expected utility with probabilities given. Both claims go against Schmeidler (1989). Fortunately, both authors have dissociated themselves from both of these claims on later occasions. %}

Machina, Mark J. & David Schmeidler (1995) "Bayes without Bernoulli: Simple Conditions for Probabilistically Sophisticated Choice," *Journal of Economic Theory* 67, 106–128.

{% **survey on nonEU** %}

Machina, Mark J. & Marciano Siniscalchi (2014) "Ambiguity and Ambiguity Aversion." *In* Mark J. Machina & W. Kip Viscusi (eds.) "*Handbook of the Economics of Risk and Uncertainty*, Vol. 1," 729–807, Elsevier, Amsterdam.

{% **questionnaire versus choice utility**: seems to criticize economists who asked business men for their probability judgments. %}

Machlup, Fritz (1946) "Marginal Analysis and Empirical Research," *American Economic Review* 36, 519–544.

{% Rational inattention means one does not have unbounded rationality, but processing information has a cost and, hence, one ignores part (**value of information**; **calculation costs incorporated**). %}

Mackowiak, Bartosz, Filip Matejka, & Mirko Wiederholt (2023) "Rational Inattention: A Review," *Journal of Economic Literature* 61, 226–273.
https://doi.org/10.1257/jel.20211524

{% DFE-DFD: in this paper they only use 50-50 prospects, but find risk seeking for gains (**risk seeking for symmetric fifty-fifty gambles**) and risk aversion for losses. %}

Madan, Christopher R., Elliot A. Ludvig, & Marcia L. Spetch (2014) "Remembering the Best and Worst of Times: Memories for Extreme Outcomes Bias Risky Decisions," *Psychonomic Bulletin and Review* 21, 629–636.

{% **real incentives/hypothetical choice, for time preferences**: They seem to compare real with hypothetical choice. Discount rate 0.053 for hypothetical and 0.037 for real. %}

Madden, Gregory J., Andrea M. Begotka, Bethany R. Raiff, & Lana L. Kastern (2003) "Delay Discounting of Real and Hypothetical Rewards," *Experimental and Clinical Psychopharmacology* 11, 139–145.

{% r**eal incentives/hypothetical choice, for time preferences**: seems to be on it %}

Madden, Gregory J., Bethany R. Raiff, Carla H. Lagorio, Andrea M. Begotka, Angela M. Mueller, Daniel J. Hehli, & Ashley A. Wegener (2004) "Delay Discounting of Potentially Real and Hypothetical Rewards: II. Between- and within-Subject Comparisons," *Experimental and Clinical Psychopharmacology* 12, 251–261. https://doi.org/10.1037/1064-1297.12.4.251

{% %}

Maddy, Penelope (1988) "Believing the Axioms. I," *Journal of Symbolic Logic* 53, 481–511.

{% Show that complexity negatively affects the value in choices between lotteries over two-period payments. Complexity here is a broad term, capturing for instance whether or not outcomes are equally likely or not, and time also plays a role. %}

Mador, Galit, Doron Sonsino, & Uri Benzion (2000) "On Complexity and Lotteries' Evaluations — Three Experimental Observations," *Journal of Economic Psychology* 21, 625–637. https://doi.org/10.1016/S0167-4870(00)00023-4

{% Seem to show that default enrolment in pension savings, as in the later paper Thaler & Benartzi (2004), actually reduces total savings because people who by themselves would have saved more now save only the default. %}

Madrian, Brigitte & Dennis F. Shea (2001) "The Power of Suggestion: Inertia in 401(k) Participation and Savings Behavior, *Quarterly Journal of Economics* 116, 1149–1159.

{% Seems to use a dynamic ambiguity model (model misspecification) to explain the equity premium puzzle. %}
Maenhout, Pascal J. (2004) "Robust Portfolio Rules and Asset Pricing," *Review of Financial Studies* 17, 951–983.

{% In agreement with the finding of Tversky & Fox (1995, QJE), they find that WTP and WTA give less ambiguity aversion than pairwise choice. They show how this phenomenon will generate preference reversals. %}
Maffioletti, Anna (2002) "The Effect of Elicitation Methods on Ambiguity Aversion: An Experimental Investigation."

{% %}
Maffioletti, Anna & Michele Santoni (2000) "Do Trade Union Leaders Exhibit Ambiguity Reaction?," *Rivista Internazionale di Scienze Sociali* 4, 357–376.

{% %}
Maffioletti, Anna & Michele Santoni (2002) "Ambiguity and Partisan Business Cycles," *Finanzarchiv* 59, 387–406.

{% **natural sources of ambiguity**
Throughout, measure everything by asking for minimal selling prices and taking those as certainty equivalents. This can be expected to have generated a general overestimation of the certainty equivalents and, thus, to a general underestimation of risk aversion, which is indeed found.

EXPERIMENT 1 (N = 25): Do usual Ellsberg urn. In addition, fictitious elections where highly reputable opinion polls agency says the probability of some party winning is from [0.4,0.6], [0.3,0.7], [0.2,0.8], [0.1,0.9], or [0.0, 1.0], respectively. So, it is always for probability 05 plus ambiguity. They find risk neutrality and ambiguity aversion. The latter increases as the ambiguity (the interval around 0.5) gets larger.

ambiguity seeking for unlikely: they report this on p. 222.

EXPERIMENT 2 (N = 34): They used the **random incentive system** with random prize system (Becker DeGroot Marschak; BDM). Now it referred to some real elections in Italy and the UK, taking place some days after the election (**natural sources of ambiguity**). First minimal selling task for known probabilities 0.1, 0.2, …, 0.9, where they find risk neutrality. Then subjects had to give minimal selling prices for a number of disjoint events related to the elections. The authors assumed linear utility, and thus derived decision weights. The decision weights turn out to add to considerably more than 1 in total. Together with the risk neutrality found for given probability, it suggests massive **ambiguity seeking** (comparing with risk neutrality for given probabilities makes it interpersonal comparison, which as such is not affected by the underestimations of risk aversion generated by asking for minimal selling prices). Strange and interesting.

correlation risk & ambiguity attitude: although they have the data, they do not report this. %}

Maffioletti, Anna & Michele Santoni (2005) "Do Trade Union Leaders Violate Subjective Expected Utility? Some Insights from Experimental Data," *Theory and Decision* 59, 207–253.
https://doi.org/10.1007/s11238-005-8633-3

{% r**eal incentives/hypothetical choice, for time preferences**: seems to be on it %}

Magen, E., Dweck, C. S., & James J. Gross (2008) "The Hidden Zero Effect: Representing a Single Choice as an Extended Sequence Reduces Impulsive Choice," *Psychological Science* 19, 648–649.
https://doi.org/10.1111/j.1467-9280.2008.02137.x

{% The author assumes prospect theory (new '92 version). He lets π-expectation denote the PT value if utility were linear and there were no loss aversion; i.e., of decision weights were probabilities. In terms of these, gives results on risk aversion. In particular he shows that if utility functions for gains and for losses are both power functions, with powers between 0 and 1 and loss-power closer to 1 (closer to linear), then weak risk aversion in sense of π-expectation must be

violated. Note that the preference conditions use probability weighting as input, and are directly observable to the extent that probability weighting is. This paper further demonstrates that power-utility is questionable near 0. In 2022 I added here that this is related to Wakker (2008, Health Economics). %}

Maggi, Mario A. (2006) "Loss Aversion and Perceptual Risk Aversion," *Journal of Mathematical Psychology* 50, 426–430.

{% **Kirsten&I**: results like: If space of programs is compact, locally convex, etc., and functional is upper continuous, etc., then optimum exists. %}

Magill, Michael J.P. (1981) "Infinite Horizon Programs," *Econometrica* 49, 679–711.

{% Final sentence (translated from Dutch to English): "So even if you were not permitted to add up apples and oranges, it is best to still do it, at least if you're an economist." %}

Magnus, Jan R. (1997) "Appels en Peren," *Univers* 15 (December 11) 4.

{% Shows terminology for doing additive representation theory for economists: technology, input, and the like. %}

Magnus, Jan R. & Alan D. Woodland (1990) "Separability and Aggregation," *Economica* 57, 239–247.

{% Reply by Eels (1987); also concerns **R.C. Jeffrey model** %}

Maher, Patrick (1987) "Causality in the Logic of Decision," *Theory and Decision* 22, 155–172.

{% Popper, Kuhn, Bayesians %}

Maher, Patrick (1990) "Why Scientists Gather Evidence," *British Journal for the Philosophy of Science* 41, 103–119.

{% **dynamic consistency**: The authors use the term preference reversal differently than the experimental decision literature does. They test dynamic and sequential reformulations of the 3-color Ellsberg paradox and find that these reformulations matter. That is, they find some dynamic decision principles violated. Seems that they find dynamic consistency violated. %}

Maher, Patrick & Yoshihisa Kashima (1997) "Preference Reversal in the Ellsberg Problems," *Philosphical Studies* 88, 187–207.

{% **Dutch book**: The author proposes an interpretation of Dutch books that implies the laws of probability withouit implying perfect knowledge about oneself. The reasonings involve bets oin own probability judgments. %}

Mahtani, Anna (2015) "Dutch Books, Coherence, and Logical Consistency," *Nous* 49, 522–537.

{% **normal/extensive form** %}

Mailath, George J., Larry Samuelson, & Jeroen M. Swinkels (1994) "Normal Form Structures in Extensive Form Games," *Journal of Economic Theory* 64, 325–371.

{% %}

Mak, King-Tim (1987) "Coherent Continuous Systems and the Generalized Functional Equation of Associativity," *Mathematics of Operations Research* 12, 597–625.

{% %}

Mak, King-Tim (1988) "Separability and the Existence of Aggregates." *In* Wolfgang Eichhorn (ed.) *Measurement in Economics* (Theory and Applications of Economic Indices), 649–670, Physica-Verlag, Heidelberg.

{% Review of quality of life measurements of elderly. %}

Makai, Peter, Werner B.F. Brouwer, Marc A. Koopmanschap, Elly A. Stolk, & Anna P. Nieboer (2014) "Quality of Life Instruments for Economic Evaluations in Health and Social Care for Older People: A Systematic Review," *Social Science & Medicine* 102, 83–93.

{% Didactical text to show how EU can be used in farming. %}

Makeham, John P., Alfred H. Halter, & John L. Dillon (1968) "*Best-Bet Farm Decisions*." The Agricultural Business Research Institute, University of New England, Armidale, Australia.

{% %}
Makridakis, Spyros & Robert L. Winkler (1983) "Averages of Forecasts: Some Empirical Results," *Management Science* 29, 987–996.

{% This paper considers the generalized bisymmetry functional equation

$G(F_1(x_{11},..,x_{m1}),\ldots,F_n(x_{1n},..,x_{mn})) = F(G_1(x_{11},..,x_{1n}),\ldots,G_m(x_{m1},..,x_{mn}))$

and shows that it holds if and only if the overall function is a continuous strictly increasing transformation of an additively decomposable function, i.e., of a sum of $m \times n$ functions $H_{ij}(x_{ij})$. This under usual assumptions of monotonicity, continuity, and domain. The "subfunctions" G, F, G_1, …, G_m, F_1, …,F_n are similarly strictly increasing continuous transformations of additively decomposable functions. The author points out that this result is essentially equivalent to the economic problem of consistent aggregation, by Nataf (1948) and others. %}
Maksa, Gyula (1999) "Solution of Generalized Bisymmetry Type Equation without Surjectivity Assumptions," *Aequationes Mathematicae* 57, 50–74.

{% %}
Maksa, Gyula (2000) The Generalized Associativity Equation Revisited," *Rocznik Naukowo-Dydaktyczny Akademii Peagogicznej W Krakowie, Prace Matematyczne* 17, 175–180.

{% %}
Maksa, Gyula (2005) "Quasisums and Generalized Associativity," *Aequationes Mathematicae* 69 (1), 6–27.

{% %}
Malakooti, Benham (1991) "Measurable Value Functions for Ranking and Selection of Groups of Alternatives," *Journal of mathematical Psychology* 35, 92–99.

{% Considers decision under risk. Start from a risk averse expected utility (EU) model, say with logarithmic utility (this is what the author does, writing it a bit differently). This model will not be used subjectively, but objectively, as an

objective risk measure serving as objective input for determining subjective preferences. Under this model, for any lottery we can calculate: (1) expected value (EV); (2) certainty equivalent (CE) (3) risk premium (RP), being EV – CE. The RP is an index of risk aversion. Under this EU model, one evaluates every lottery by its CE, i.e.:

(1) EV – RP

The novelty of the paper is to instead use an evaluation

(2) EV - rRP

for some $0 \leq r < 1$. Thus, one can choose all kinds of reduced risk aversion. For instance, one can let the starting EU model be the most risk averse model that is conceivable. Then all intermediate levels of risk aversion can be obtained by choosing z.

The model can be rewritten as

(4) (1-r)EV + rCE.

So, it is not a convex combination of functionals, but of their CEs. %}

Malakooti, Behnam (2020) “Geometric Dispersion Theory of Decision Making under Risk: Generalizing EUT, RDEU, & CPT with Out-of-Sample Empirical Studies,” Working paper, Case Western Reserve University, Cleveland.

{% Uses Malakooti’as geometric dispersion theory; see my annotations at his paper. %}

Malakooti, Behnam, Mohamed Komaki, & Camelia Al-Najjar (2021) “Basic Geometric Dispersion Theory of Decision Making under Risk: Asymmetric Risk Relativity, New Predictions of Empirical Behaviors, and Risk Triad,” *Decision Analysis* 18, 41–77.
https://doi.org/10.1287/deca.2019.0404

{% **foundations of quantum mechanics** %}

Maleeh, Reza (2015) “Bohr’s Philosophy in the Light of Peircean Pragmatism,” *Journal for General Philosophy of Science* 46, 3–21.

{% %}

Maleki, Hamed & Sajjad Zahir (2013) "A Comprehensive Literature Review of the Rank Reversal Phenomenon in the Analytic Hierarchy Process," *Journal of Multi-Criteria Decision Analysis* 20, 141–155.

{% %}
Malinas, Gary (1993) "Reflective Coherence and Newcomb's Problems: A Simple Solution," *Theory and Decision* 35, 151–166.

{% He pointed out (also in 1950 in first drafts) that vNM got independence implicitly in by transferring probability mixing from lotteries to equivalence classes of lotteries. %}
Malinvaud, Edmond (1952) "Note on von Neumann-Morgenstern's Strong Independence Axiom," *Econometrica* 20, 679.

{% **revealed preference** %}
Malishevski, Andrey V. (1993) "Criteria for Judging the Rationality of Decisions in the Presence of Vague Alternatives," *Mathematical Social Sciences* 26, 205–247.

{% **foundations of quantum mechanics** %}
Malley, James D. & John Hornstein (1993) "Quantum Statistical Inference," *Statistical Science* 8, 433–457.

{% %}
Malmnäs, Per-Erik (1981) "*From Qualitative to Quantitative Probability.*" Almqvist & Wiksell International, Stockholm.

{% **loss aversion: erroneously thinking it is reflection**: In several places, for instance in the title, the authors suggest that they investigate loss aversion. In reality they only investigate reflection, i.e., risk aversion for gains versus risk seeking for losses. Although they are in the context of prospect theory, they unfortunately equate risk aversion with concave utility and risk seeking with convex utility (**equate risk aversion with concave utility under nonEU**). This is only correct if we assume no probability weighting (an assumption common in finance) and nonmixed prospects. The latter the authors seem to assume

throughout although it is not clear (see below).

The authors consider WTP-WTA for gain or loss lotteries, which they designate as gain- or loss domain. My concern here is that if one pays for a gain prospect in WTP, then because of the payment one may still lose. Hence one in reality then deals with mixed prospects, and not with gain prospects as the authors assume. The authors, however, throughout assume to be either in a gain-domain where there are only gains, or in a loss domain where there are only losses. Then loss aversion never plays a role. All their speculations, indeed, only concern reflection and not loss aversion, although they suggest otherwise.

P. 104 bottom affirmatevely cites a strange claim from another paper that subjects with an unbounded utility function for gains and a bounded utility function for losses are risk seeking, with some other similar claims. Probably this claim was only made for a particular utility family used, probably CARA (linear-exponential) and then in EU I guess.

The first two experiments do WTP-WTA with 2nd price sealed bid auction, and the third does money allocation. The authors investigate patterns of risk attitude such as the fourfold pattern, but find all kinds of patterns (**reflection at individual level for risk**). Because of my confusion about whether the authors deal with mixed prospects or not, I do not know how to interpret their results. %}

Malul, Miki, Mosi Rosenboim, & Tal Shavit (2013) "So when Are You Loss Averse? Testing the S-Shaped Function in Pricing and Allocation Tasks," *Journal of Economic Psychology* 28, 631–645.

{% The authors explain that BDM measurements can be distorted by context dependence, where they take context dependence in a general sense. The authors then propose a somewhat complex learning theory to analyze BDM. They derive some QUALITATIVE predictions, and test those.

Johnson et al. (2021) explained the malfunctioning of BDM because researchers randomize the prize to be won, whereas they should randomize the choice situation. %}

Mamadehussene, Samir & Francesco Sguera (2023) "On the Reliability of the BDM Mechanism," *Management Science* 69, 1166–1179.
https://doi.org/10.1287/mnsc.2022.4409

{% **intuitive versus analytical decisions**; Compare result of decision analysis to directly expressed intuitive preference (which probability at … would make these two treatments indifferent?, etc.)

Their text suggests they take direct intuitive judgment as gold standard and think that decision analysis should merely agree with direct intuition, in deviation from Raiffa's (1961) citation on decision analysis "We do not have to teach people what comes naturally." Compare Kimbrough & Weber (1994) who also confront decision analysis results with direct intuitive choices. %}

Man-Son-Hing, Malcolm, Andreas Laupacis, Annette M. O'Connor, Dougal Coyle, Renee Berquist, & Finlay McAlister (2000) "Patient Preference-Based Treatment Thresholds and Recommendations: A Comparison of Decision-Analytic Modeling with the Probability-Tradeoff Technique," *Medical Decision Making* 20, 394–403.

{% Introduces fractals (although he does not use that term yet) to suggest that the length of the English coast is infinite. %}

Mandelbrot, Benoit (1967) "Statistical Self-Similarity and Fractional Dimension," *Science* 156, 636–638.

{% P. 254 cites a letter by Goethe (January 16, 1797), writing: "I am inclined to offer Mr. Vieweg from Berlin an epic poem, Hermann and Dorothea … Concerning the royalty we will proceed as follows: I will hand over to Mr. Counsel Böttiger a sealed note which contains my demand, and I wait for what Mr. Vieweg will suggest to offer for my work. If his offer is lower than my demand, then I take my note back, unopened, and the negotiation is broken. If, however, his offer is higher, then I will not ask for more than what is written in the note to be opened by Mr. Böttiger." %}

Mandelkow, Karl Robert (1968; ed) "*Goethes Briefe*." Wegner, Hamburg.

{% Seems to have written that private vices lead to public benefits, meaning that if all individuals pursue their self-interest then this will give good results for society. It is, I think, a poem with comments added later. %}

Mandeville, Bernard (1714) "The Fable of the Bees, or Private Vices, Public Benefits."

{% %}

Mandler, Michael (1999) "*Dilemmas in Economic Theory: Persisting Foundational Problems of Microeconomics*." Oxford University Press, New York.

{% A discussion piece arguing for incomplete preference %}
Mandler, Michael (2004) "Status Quo Maintenance Reconsidered: Changing or Incomplete Preferences?," *Economic Journal* 114, F518–F535.

{% A discussion piece arguing for incomplete preference. Distinguishes between actively chosen bundels and passively retained bundles. %}
Mandler, Michael (2005) "Incomplete Preferences and Rational Intransitivity of Choice," *Games and Economic Behavior* 50, 255–277.

{% Argues for non-revealed-preference inputs, such as neuroeconomic measurements of utility.

Cardinality and ordinality are meta-properties in the sense that they relate to properties of, say, utility functions. Consider the property of being vNM utility in the sense that probability-weighted average represents choices over prospects (EU). For each preference relation, the set of vNM functions consists of one such function together with all of its strictly increasing affine transforms. The general concept of vNM utility can be called cardinal. Each single vNM utility u can also be called cardinal. One can look at the set of all strictly increasing affine transforms of u; i.e., the set of all possible u's to represent the given preference through probability-weighted average. Work by Luce & Narens on n-point uniqueness and m-point homogeneity, and other works by Eichhorn if I remember right and in Foundations of Measurement Vol. II if I remember right, give reasons why ordinal and cardinal scales naturally arise, as do nominal scales, ratio scales, absolute scales, and possibly metric scales (preserving orderings of differences that need not be cardinal if the range is coarser than a continuum) and why other kinds of scales are not natural to arise. One thing is that sets of admissible transformations have nice group structures.

This paper looks only at the latter thing, taking sets of functions. It designates such sets with the broad term psychology. It considers, for instance, the set of all concave functions, or the set of all continuous functions, without yet relating it to defining properties. A nice illustration is from work on stochastic dominance and

incomplete preferences: Jf we only know that utility is concave, we can already conclude that a prospect is more preferred than a mean-preserving spread.

The paper organizes concepts such as one "psychology" being weaker than another if being a superset; etc. Then the set of all concave utility functions is intermediate between an ordinal and cardinal class.

A nice example of a singleton psychology is in health, where cardinal utility is further pinned down by setting U = 0 at death and U = 1 for perfect health, so that utility is uniquely determined and so that all utility results from all different studies can immediately be compared.

The paper points out that properties such as continuity of utility can now be given a background justification, being of a continuous psychology (p. 1131). %}

Mandler, Michael (2006) "Cardinality versus Ordinality: A Suggested Compromise," *American Economic Review* 96, 1114–1136.

{% %}

Mandler, Michael (2007) "Strategies as States," *Journal of Economic Theory* 135, 105–130.

{% On **revealed preference** with choice functions and incompleteness.

Considers sequential trades but one-shot consumption at the end of all trades. We can thus observe several preferences. Distinguishing incompleteness and indifference is not possible in one-shot decisions, but it is in sequential decisions. Real indifference is preference substitutability. Incompleteness must be involved if a sequence of nonpreferences, if taken as indifference, would lead to the choice of a dominated option. %}

Mandler, Michael (2009) "Indifference and Incompleteness Distinguished by Rational Trade," *Games and Economic Behavior* 67, 300–314.

{% **one-dimensional utility**: A preference relation can be rewritten as a lexicographic combination of binary criteria. The length can be taken as an index of complexity, i.e., of the number of free parameters, important in parsimony-fit discussions. However, the results of this paper concern one-dimensional utility and cardinalities, whence they are not directly useful for empirical purposes.

I sometimes disagree with interpretations. Thus, §4, p. 565, claims that psychologists object to utility theory because they doubt the concept of indifference, but I think that there do not exist such general conceptions. And pp. 567-568, §5, write that the most important result in utility theory is the equivalence, for weak orders, of a countable order-dense subset and the existence of quantitative utility, but I think that this result is not particularly useful. %}

Mandler, Michael (2021) "The Lexicographic Method in Preference Theory," *Economic Theory* 71, 553–577.
https://doi.org/10.1007/s00199-020-01256-2

{% Imagine maximization of a preference relation with 2^n indifference classes. We can do this maximization by asking n yes-or-no questions, each time dropping the alternatives with the "no" answer: First question separates upper and lower half, 2nd separates upper half of upper half and upper half of lower half from lower half of upper half and lower half of lower half, and so on. So, this is an efficient procedure-like way to maximize utility. Nice! %}

Mandler, Michael, Paola Manzini, & Marco Mariotti (2011) "A Million Answers to Twenty Questions: Choosing by Checklist," *Journal of Economic Theory* 147, 71–92.

{% N = 74. Hypothetical (footnote 11, p. 447: Because BDM (Becker-DeGroot-Marschak) needs (according to the authors) EU. Btw, although EU, implemented the natural way in dynamic choice, is sufficient for BDM, it is not necessary! A common confusion.

PT falsified: when they tried to refine EU by CEU (Choquet expected utility), they actually got worse results. So, CEU picks up more noise than essential things (overfitting). To elicit CEU, they first assume EU for given probabilities so as to get utility and then elicit capacities from that. Or they equate the capacity of an event with the probability of a matched known-probability event, which also requires EU for risk. Martin Weber (personal communication) conjectured that the poor performance of CEU may be due to subjects first getting many known-probability questions preceding the ambiguity questions which may have distorted their ambiguity perception.

ambiguity seeking for losses: They find ambiguity aversion for gains but, on average, ambiguity neutrality for losses. P. 448 2nd para: significant difference between gains and losses. Capacities for losses are significantly different than for gains.

reflection at individual level for ambiguity: although they have the data, within-subject, they do not report it.

P. 442 $\ell\ell$. 4-5: they apparently assume EU for risk. %}

Mangelsdorff, Lukas & Martin Weber (1994) "Testing Choquet Expected Utility," *Journal of Economic Behavior and Organization* 25, 437–457.

{% They give subjects hypothetical info, such as imagining $1500 damage to their car and what would they do, and then after do simple cognitive task. Poor people do worse on the cognitive task than rich people. In a control treatment poor behave as well as rich, so, it is the info that does it. In a 2nd treatment, they ask farmers in India to do the cognitive task shortly before their harvest (then pressure and uncertainty) and after. Again, before the farmers do worse than after. The authors interpret their findings as meaning that financial uncertainty makes poor cognitively worse and, hence, makes them take worse decisions (poverty trap). Problem is that there are too many confounds. It may just be that the hypothetical info in the first treatment just at that moment annoys poor people more than rich and nothing more than that causes the difference. The authors try to control for some things such as physical measurements of stress (**decision under stress**), but there remain too many emotions uncontrolled to come to their interpretations. Psychologists, when studying such vaguely defined concepts, will use 15 rather than 2 experiments, each individually questionable but together making the story plausible. There are many studies into priming effects, where small ad hoc details rather than something as far reaching as cognitive ability impacts choices.

When the authors write, top middle column first page: "This suggests a causal, not merely correlational, relationship between poverty and mental function. We tested this using two" they are overly optimistic about the possible correlations found and even more about that being causal. %}

Mani, Anandi, Sendhil Mullainathan, Eldar Shafir, & Jiaying Zhao (2013) "Poverty Impedes Cognitive Function," *Science* 341, 976–980.

{% Try to replicate findings by Ariely, Loewenstein & Prelec (2003) with N = 116 subjects on anchoring. They find the same effects, but considerably weaker. They

argue that fundamentals in economics may be less in danger than often thought and suggested by Ariely et al.

Simonsohn, Simmons, & Nelson (2014) criticized this study, arguing that it has the same effect size as Ariely et al, but has too much noise to draw any conclusion, so that it does not disprove the findings of Ariely et al., and does not provide the new evidence claimed in the title.

This paper next presents a theoretical model, with researcher competence as a parameter, to analyze how big the chance at false positives is. Has to do with the publication bias.

Findings similar to this paper are in Ioannidis (2005 *PLoS Medicine*).

It is not very surprising that findings of great irrationality are volatile and can much depend on very small details, in the same way as loss aversion is very volatile. Yet such irrationalities, such as loss aversion, are often so strong that we should reckon with them. %}

Maniadis, Zacharias, Fabio Tufano, & John A. List (2014) “One Swallow Doesn’t Make a Summer: New Evidence on Anchoring Effects,” *American Economic Review* 104, 277–290.

{% **crowding-out**: p. 62 seems to point out that a rise in interest rate crowds out private investment. %}

Mankiw, N. Gregory (1994) “*Macroeconomics.*” Worth Publishers, New York.

{% Compare VAS evaluations from the general public with those from patients in a health state. Cannot compare well in an absolute sense because of different endpoints to the scale. But relative weightings can be compared. There is agreement on physical dimensions such as mobility, but there is discrepancy regarding mental aspects such as fear and suffering from pain. %}

Mann, Rachel, John Brazier, & Aki Tsuchiya (2009) “A Comparison of Patient and General Population Weightings of EQ-5D Dimensions,” *Health Economics* 18, 363–372.

{% %}

Manne, Alan S. (1952) “The Strong Independence Assumption-Gasoline Blends and Probability Mixtures,” *Econometrica* 20, 665–668.

{% **Z&Z**

The RAND Health Insurance Experiment, seems to have shown that under free health care the consumers spend 46% more than in a plan with 95% coinsurance. %}

Manning, Willard G., Joseph P. Newhouse, Naihua Duan, Emmett B. Keeler, Arleen Leibowitz, & M. Susan Marquis (1987) "Health Insurance and the Demand for Medical Care: Evidence from a Randomized Experiment," *American Economic Review* 77, 251–277.

{% P. 416 defines uncertainty as decisions with known probabilities; i.e., what is more commonly called risk. P. 416: "For whatever reason, the study of decisions under ambiguity has remained a peripheral concern of the profession."

Ambiguity is handled through statistical identification techniques.

Seems to allow for incomplete preferences under ambiguity, and writes on p. 418 and elsewhere as if a general fact that addition of new choice alternatives may lead to inferior action under ambiguity, something that in fact only follows in the very particular model that the author will consider later. %}

Manski, Charles F. (2000) "Identification Problems and Decisions under Ambiguity: Empirical Analysis of Treatment Response and Normative Analysis of Treatment Choice," *Journal of Econometrics* 95, 415–442.

{% **proper scoring rules-correction**;

Based on lecture and, hence, not judged by the usual criteria of rigor, conciseness, innovativeness, and completeness of references. Hence, the quality of this paper is lower than usual in top journals. Yet, as these things go, it is often cited.

probability elicitation;

questionnaire versus choice utility: pleas for incorporating also choiceless data. Reports some studies by himself such as telephonic interviews asking people for direct probability judgments.

He takes "rational expectations" to mean that consumers know true probabilities. His "solution" to the problem of ambiguity is that subjects be allowed to express intervals of probability.

P. 1337, for economists' reasons to exclude choiceless data: "I sought to determine the scientific basis underlying economists' hostility to measurement of expectations [direct judgments of subjective probabilities], but found it to be meager." Big self--assured words on a big issue! He then, however, does not connect with the broader issue of the ordinal revolution, the relevant issue, but only considers discussions of probability judgment.

P. 1343, on problem whether direct judgments of probability (expectations) are valid, mentions that they have "face validity," and then naively continues: "Having demonstrated that probabilistic questioning does "work" … "

§§5 ff. become more informal.

§7 refers to studies where probability judgments were used to predict economic actions. %}

Manski, Charles F. (2004) "Measuring Expectations," *Econometrica* 72, 1329–1376.

{% Derives equilibrium result that price reflects a particular quantile of the beliefs of the agents. %}

Manski, Charles F. (2006) "Interpreting the Predictions of Prediction Markets," *Economics Letters* 91, 425–429.

{% A follow-up paper on his minimax-type ambiguity decision model, without references to the decision-theory literature such as Gilboa & Schmeidler. Seems to recommend diversified treatment of identical persons (…) so as to turn unknown ambiguous probabilities into known probabilities, reminiscent of Raiffa (1961; not cited). %}

Manski, Charles F. (2009) "The 2009 Lawrence R. Klein Lecture: Diversified Treatment under Ambiguity," *International Economic Review* 50, 1013–1041.

{% Argues, right so, that in prescriptive decision analysis only one choice situation is for real, and the rest is hypothetical to improve the real decision. If choice axioms are imposed only on the real situation then not much more than dominance can be thought of. %}

Manski, Charles F. (2011) "Actualist Rationality," *Theory and Decision* 71, 297–324.

{% The abstract writes that the paper reviews recent work on ambiguity, but the intro adds that it is recent work only by the author himself. %}

Manski, Charles F. (2011) "Choosing Treatment Policies under Ambiguity," *Annual Review of Economics* 3, 25–49.
http://dx.doi.org/10.1146/annurev-economics-061109-080359

{% **probability communication**: argues that probability estimates should also report error. %}

Manski, Charles F. (2015) "Communicating Uncertainty in Official Economic Statistics: An Appraisal Fifty Years after Morgenstern," *Journal of Economic Literature* 53, 631–653.

{% **foundations of statistics**: argues against hypothesis testing, favoring his version of Wald's regret decision theory. %}

Manski, Charles F. (2019) "Treatment Choice with Trial Data: Statistical Decision Theory Should Supplant Hypothesis Testing," *American Statistician* 73, 296–304.
https://doi.org/10.1080/00031305.2018.1513377

{% **foundations of statistics**: Paper does what title says, with also remarks on foundations of statistics such as hypothesis testing. The author for instance points out that NP hypothesis testing is different than maximizing expected gain/loss. But he does not go into deeper reasons why/how, staying at the level of proposing models. %}

Manski, Charles F. (2021) "Econometrics for Decision Making: Building Foundations Sketched by Haavelmo and Wald," *Econometrica* 89, 2827–2853.

{% %}

Mansour, Selima Ben, Elyès Jouini, & Clotilde Napp (2006) "Is there a "Pessimistic" Bias in Individual Beliefs? Evidence from a Simple Survey," *Theory and Decision* 61, 363–371.

{% A single-valued choice function is derived from two binary relations, where maximization is lexicographically. If the first relation is incomplete then new things can occur. They relate it to Tversky's elimination by aspects and characterize it. %}

Manzini, Paola & Marco Mariotti (2007) "Sequentially Rationalizable Choice," *American Economic Review* 97, 1824–1839.

{% %}

Manzini, Paola & Marco Mariotti (2008) "On the Representation of Incomplete Preferences over Risky Alternatives," *Theory and Decision* 65, 303–323.

{% Consider revealed preference, but choices can depend on the psychological state of mind of the agent. %}

Manzini, Paola & Marco Mariotti (2015) "State Dependent Choice," *Social Choice and Welfare* 45, 239–268.

{% **real incentives/hypothetical choice, for time preferences**: use real incentives, students themselves have to pick up money; longest period is 9 months. %}

Manzini, Paola, Marco Mariotti, & Luigi Mittone (2010) "Choosing Monetary Sequences: Theory and Experimental Evidence," *Theory and Decision* 69, 327–354.

{% Extend Ryan's result on left-monotone risk aversion to unbounded random variables. %}

Mao, Tiantian & Taizhong Hu (2012) "Characterization of Left-Monotone Risk Aversion in the RDEU Model," *Insurance: Mathematics and Economics* 50, 413–422.

{% Gives many arguments for why inconsistency of preference may be rational. That it may be rational to maintain ambiguity about "true" preferences. There are many nice sentences, although I disliked the bombastic writing in his 1996 paper.

On advantage of representative agent for decision models:

P. 588: "So long as we use individual choice models to predict the behavior of relatively large numbers of individuals or organizations, some potential problems are avoided by the familiar advantages of aggregation."

This paper uses term ambiguity in sense of uncertainty/variability of

consumer's preference relation. Pp. 591-592 discuss aspiration levels and step-function-tastes.

P. 593: posterior rationality: Intentions discovered as interpretation of action afterwards; evaluation after the fact.

The central focus of the paper is **paternalism/Humean-view-of-preference**: p. 594: Simon showed that actual human choice behavior is more intelligent than it appeared, and that conforming it more to normative theory may be bad. The paper lists many arguments in favor of not-well-specified preferences. I interpret the author's arguments in favor of ambiguity as criticisms of completeness more than of other consistency conditions. Such as p. 597: to avoid being manipulated by others in game situations (≈**suspicion under ambiguity**). And pp. 598-599 that list five reasons. And P. 603, which can be taken to argue that for th rule for organisations that for criteria to judge people, such as employees or students, an advantage of being vague is that people, not knowing the criteria well, will just do best-quality work because that is their best proxy of the criterion. If a criterion is very clear, people will work for the criterion, not for intrinsic goodness: "And precision in objectives does not allow creative interpretation of what the goal might mean (March, 1978). Thus, the introduction of precision into the evaluation of performance involves a tradeoff between the gains in outcome attributable to closer articulation between action and performance on an index of performance and the losses in outcomes attributable to misrepresentation of goals, reduced motivation to development of goals, and concentration of effort on irrelevant ways of beating the index." (**completeness criticisms**)

P. 597: "We do not believe that what we do must necessarily result from a desire to achieve preferred outcomes."

P. 597 properly criticizes Stigler & Becker (1977):

"to trivialize the issue into a 'definitional problem.' By suitably manipulating the concept of tastes, one can save classical theories of choice as 'explanations' of behavior in a formal sense, but probably only at the cost of stretching a good idea into a doubtful ideology (Stigler & Becker, 1977)."

The text then immediately continues with a nice statement of the point that a normative theory can be useful only if it sometimes !deviates! from actual behavior, the point also stated nicely by Raiffa (1961):

"More importantly from the present point of view, such a redefinition pays the cost of destroying the practical relevance of normative prescriptions for choice. For prescriptions are useful only if we see a difference between observed procedures and desirable procedures."

P. 602, on inconsistency: "the other problems probably require a deeper understanding of contradiction as it appears in philosophy and literature" %}
March, James G. (1978) "Bounded Rationality, Ambiguity and the Engineering of Choice," *Bell Journal of Economics* 9, 587–608.

{% Has a way of learning that, apparently, increases risk aversion for gains and decreases it for losses. The bombastic writing of the author discourages me from reading more. See:
Abstract: "the fact that … may reflect accumulated learning rather than *inexplicable* human traits or utility functions." [italics added]
Opening sentence of main text: "Two of the *grandest* theoretical traditions for understanding human choices are found in theories of rational choice and theories of experiential learning." [italics added] %}
March, James G. (1996) "On Learning Risk Attitudes: Learning to be Risk Averse," *Psychological Review* 103, 309–319.
https://doi.org/10.1037/0033-295X.103.2.309

{% %}
March, James G. & Zur Shapira (1992) "Variable Risk Preferences and the Focus of Attention," *Psychological Review* 99, 172–183.

{% Criticizes the often-used misleading interpretation of invariance w.r.t. scale as if this concerned only a rescaling of the modeling of outcomes without empirical meaning. %}
Marchant, Thierry (2008) "Scale Invariance and Similar Invariance Conditions for Bankruptcy Problems," *Social Choice and Welfare* 31, 693–707 (Erratum pp. 709–710.)

{% Characterizes utilitarianism where only ordinal individual prefs are given and integrated into social pref, with the domain being set of lotteries over a finite set. %}
Marchant, Thierry (20019) "Utilitarianism without Individual Utilities," *Social Choice and Welfare* 53, 1–19.
https://doi.org/10.1007/s00355-019-01177-7

{% Study the Balloon Analogue Risk Task (BART), surveying it, and relating it to sensation seeking and impulsivity for 2120 subjects in a meta-analysis. The authors are throughout very positive on the predictive power of risk-attitude measurements. P. 30: "Borrowing from Appelt et al. (2011), we strongly believe that only measures with a theoretical tie with risky decision making are likely to result in consistent findings both inside and outside the laboratory setting."

P. 27 2nd column: find positive relation between age and risk aversion in age range 11-23 years (**relation age-risk attitude**) and no relation with gender (**gender differences in risk attitudes**). %}

Marco Lauriola, Angelo Panno, Irwin P. Levin, & Carl W. Lejuez (2014) "Individual Differences in Risky Decision Making: A Meta-analysis of Sensation Seeking and Impulsivity with the Balloon Analogue Risk Task," *Journal of Behavioral Decision Making* 27, 20–36. https://doi.org/10.1002/bdm.1784

{% Whereas many axiomatizations of generalized means use associativity plus symmetry, this paper shows that the weaker strong decomposability suffices. %}

Marichal, Jean-Luc (2000) "On an Axiomatization of the Quasi-Arithmetic Mean Values without the Symmetry Axiom," *Aequationes Mathematicae* 59, 74–83.

{% Characterizes the Choquet integral through linear-minimum conditions in terms of the Möbius transform. %}

Marichal, Jean-Luc (2000) "An Axiomatic Approach of the Discrete Choquet Integral as a Tool to Aggregate Interaction Criteria," *IEEE Transactions on Fuzzy Systems* 8, 800–807.

{% qualitative probability. %}

Marinacci, Massimo (1992) "A Note on Comparative Probability Structures." Dept. of Economics, Northwestern University.

{% %}

Marinacci, Massimo (1996) "Decomposition and Representation of Coalitional Games," *Mathematics of Operations Research* 21, 1000–1015.

{% Vitaly (1925), in working with inner and outer measures, already used what can be recognized as the Choquet integral, but only as intermediate tool without interest of its own, and only on ℝ as domain. %}

Marinacci, Massimo (1997) "Vitali's Early Contribution to Non-Additive Integration," *Rivista di Matematica per le Scienze Economiche e Sociali* 20, 153–158.

{% Characterizes infinite sequences with zero discounting. %}

Marinacci, Massimo (1998) "An Axiomatic Approach to Complete Patience and Time Invariance," *Journal of Economic Theory* 83, 105–144.

{% %}

Marinacci, Massimo (1999) "Limit Laws for Non-Additive Probabilities and Their Frequentist Interpretation," *Journal of Economic Theory* 84, 145–195.

{% %}

Marinacci, Massimo (1999) "Upper Probabilities and Additivity," *Sankhya: The Indian Journal of Statistics* 61, 358–361.

{% If two convex-ranged (For every $A \subset C$ and $P(A) \leq \beta \leq P(C)$ there exists $A \subset B \subset C$ with $P(B) = \beta$) countably additive probability measures P and Q have a probability $0<p<1$ such that $P^{-1}(p) = Q^{-1}(p)$ then they are the same, so, they are uniquely determined by it. Amarante, Liebrich, & Munari (2025 MOR) generalize it. %}

Marinacci, Massimo (2000), "A Uniqueness Theorem for Convex-Ranged Probabilities," *Decisions in Economics and Finance* 23, 121—132.
https://doi.org/10.1007/s102030070003

{% Assumes α-maxmin ($\alpha \times \min + (1-\alpha) \times \max$) for $\alpha \neq 1/2$. An event is defined to be unambiguous if the binary acts w.r.t. the event can be represented by SEU (i.e., all probability measures in the set of priors assign same probability to the event). Note that this definition is not in terms of prefs. Pref. defs can be given by using existing axiomatizations of SEU. Pfanzagl (1959) already axiomatized it. This definition is typical for people interested only in ambiguity aversion/seeking, and ignores insensitivity. (**Ambiguity = amb.av = source.pref, ignoring insensitivity**)

The paper shows under regularity assumptions that, if α-maxmin holds, probabilistic sophistication holds, and there exists one unambiguous event in the above sense, then SEU must hold throughout. It is like a continuous strictly increasing function w from [0,1] to [0,1] with w(0) = 0 and w(1) = 1, if it is convex and if there is a p with w(p) + w(1−p) = 1 (implying that not both w(p) and w(1−p) can be below the diagonal), then w must be linear.

Without the assumption of an unambiguous event the implication need not hold. Any RDU with convex probabibility weighting is maxmin EU (α = 1), not SEU, and there exists no nontrivial unambiguous event (there is such an example at the end of §3). Although this model is maxmin EU in a formal sense, it is not "in spirit." My interpretation is not so much that we may study ambiguity attitudes in the maxmin EU model while assuming SEU as ambiguity-neutrality benchmark, so, not so much that we may assume probabilistic risk attitude away without loss of generality (see p. 756 3rd para). Instead, my interpretation is that multiple priors (in the classical sense with EU for each probability measure) may only be appropriate if we have extraneous prior reasons to believe that probabilistic risk attitude plays no role; i.e., that people do EU for given probabilities. So, it is not a consequence but a prior requirement. %}

Marinacci, Massimo (2002) "Probabilistic Sophistication and Multiple Priors," *Econometrica* 70, 755–764.

{% **updating under ambiguity with sampling**: seems to provide conditions under which ambiguity fades away in sampling with replacement from the same ambiguous urn. %}

Marinacci, Massimo (2002) "Learning from Ambiguous Urns," *Statistical Papers* 43, 145–151.

{% **survey on nonEU**: many examples of decision under uncertainty/ambiguity, with calculations in all kinds of models added, on p. 1030 ff., 1037 ff., 1042 ff., 1057 ff., 1070 ff.

This paper can take the space to didactically and well explain the author's general views on ambiguity comprehensively. It well presents mainstream thinking today, even though my views are quite different. The paper has many valuable historical references.

The author throughout assumes that there is a true objective (physical) but unknown probability model. P. 1024 end of 3rd para states this, not as a general fact, but as an assumption and focus of the paper. The author uses here, as in other papers, the broad term probability model for probability measure, and the broad term model (uncertainty) for (uncertainty only about) that true probability measure. The author mostly assumes a two-stage setup, where in the lowest, first, stage uncertainty is objective, captured by the objective probability measure. P. 1024 bottom states this, not as a general fact, but as an assumption and focus of the paper, where the set of possible probability measures is taken as a datum. The author uses the term generative (or data generating) mechanism (p. 1024 3rd para) and calls this uncertainty physical. (So, they cannot be purely and only subjective as in Savage, 1954, as I understood them to possibly be in the smooth model.) However, the end of p. 1024 end of 4th para confuses me because it writes that this uncertainty is epistemic, apparently because the agent knows/has info about this uncertainty (reiterated on p. 1040). But if I understand this right then every physical object can be called epistemic.

As often done today, a two-stage model is introduced by first specifying a set of possible 1st stage probabilized uncertainties on Savage (outcome-relevant) states, and only then imposing second-order uncertainty over them, thus appealing to the popular concept of sets of priors. The set of possible priors is then the support of the second-order uncertainty (expressed through a probability measure μ). P. 1024 last line (also p. 1037 2nd para) takes the set of possible probabilities as datum, so, exogenous. I assume that μ is not datum, but subjective.

The author refers here, as in other places (p. 2037 footnote 32), to statistics. Classical statistics has a same informational structure, with probabilities over observations objective, but a second stage (what the true hypothesis/statistical parameter) with the uncertainty unprobabilized. But this is the only analogy there is. There is a big difference with statistics. It is that in statistics the second-stage events are outcome-relevant and the first-stage is only instrumental, whereas in the authors' model it is the other way around. Next I give a more detailed explanation of this difference:

[DIFFERENCE STATISTICS AND AUTHOR'S MODEL; BEGINNING] In the author's model, the 1st stage generative mechanism with objective probabilities ("physical") is about (Savage) states and they are outcome relevant. The 2nd stage epistemic ("model") uncertainty is only instrumental, to give info about the 1st stage uncertainty. Once you know which Savage state is true, you know which outcome you get and you don't care anymore about the 2nd stage epistemic uncertainty. In statistics these things are the other way around. The 1st stage generative mechanism with objective probabilities ("physical") is about observations of statistics and they are NOT outcome relevant. They are only instrumental to give info about the epistemic 2nd stage uncertainty. The 2nd stage epistemic ("model") uncertainty is about the statistical hypotheses (using the author's term; or statistical parameters in estimations) and these are outcome relevant. Once you know which hypothesis is true, you know which outcome you get and you don't care anymore about the 1st stage objective uncertainty.

[DIFFERENCE STATISTICS AND AUTHOR'S MODEL; END]

P. 1025: "The often-made modeling assumption that a true generative mechanism exists is unverifiable in general and so of a metaphysical nature" P. 1045 bottom repeates this. This interpretation gets closer to the smooth model as I understand it. If no explicit physical mechanism (such as unknown composition of an urn) can be specified that underlies the physical probabilities, then I think that this physical interpretation is not very useful and I would just leave it at subjective (so, epistemic).

P. 1025: In the sentence "In any event, the assumption underlies a fruitful causal approach that facilitates the integration of empirical and theoretical methods—required for a genuine scientific understanding." The intimidating "required" can only refer to the latter integration and not to the former modeling assumption.

P. 1025: "We assume that the DMs' ex-ante information also enables them to address model uncertainty through a subjective prior probability over models" restricts the author's approach to cases where RCLA is abandoned. Although later he will consider alternatives such as alpha maxmin in which no such 2nd order distribution is assumed, as then explained.

P. 1025: "The second layer is ignored by classical statistics." is negative about approaches that do not assume a 2^{nd} order probability distribution.

P. 1026: 'The two layers of analysis motivated by such a distinction naturally lead to two-stage decision criteria: actions are first evaluated with respect to each possible probability model, and then such evaluations are combined by means of the prior distribution." This is in fact assuming backward induction, giving up RCLA, which in nonEU is controversial. Machina (1989) argued against it for decision under risk.

P. 1027 discusses physical probability as propensity, citing Popper. I find Ramsey (1931) the best text on this point.

criticisms of Savage's basic framework: well, a discussion. P. 1029, §2.2, presents the Wald decision framework, with act set A, state space S, and a consequence function ρ mapping each (a,s) to a consequence c from a consequence space C.

P. 1035: The term consequentialism used here is not to be confused with the dynamic decision principle of Machina (1989). P. 1036 then presents Savage's framework as a special case, suggesting and citing Marschak & Radner's (1972) arguing that Wald's framework is more natural. The author supports this view by writing that the Savage construction can give artificial objects. I see things differently. First, all other approaches can equally well give artificial objects. Further, I feel that of acts, states, and consequences, acts are most basic (first thing is that a decision is faced), and states and consequences are next equally (non)basic. But this gives me no preference between the two frameworks. What is best in applications depends on which acts, states, and consequences come naturally, and which additional artificial constructions are then useful. There is no general rule what would always be best. I guess that Savage's framework is most natural in most situations. And that it is the one used in more than 95% of the papers in our field, to the extent that many researchers only know it and even are not aware of alternatives sometimes being preferable.

P. 1038 health insurance example, and other examples similarly: If four experts each give one guess of the physical probability measure, then the set of priors is taken as the set of those four. But I think that in such situations many other probabilities are possible too, and it is not the case that one of the four estimates of the experts must be THE exact true physical probability measure.

Experts are not generative mechanisms. The author writes in the overview that model misspecification will be ignored, and thus can justify treating expert opinions this way. Probably model misspecification would magnify issues without making them fundamentally different. In personal communication the author told me that this, just taking the probabilities expressed as set of priors, is a pragmatic way of modeling such situations and the set of priors should not be taken too literally as the set containing the true but unknown probability.

P. 1039 footnote 37 cites the evidentialist view of probability, with several references. I know this under the name logical view of probability, with Carnap the main advocate. Carnap is not cited here, but in footnote 14 (p. 1027), and I am not sure if for the author evidentialist and logical view are the same, as they are for me.

P. 1042: crisp acts are not affected by ambiguity.

P. 1045 reiterates that the generative mechanism, taken as physical, may be unobservable and then the second-order probability measure μ can only be observed from hypothetical betting behavior.

Section 4 is useful in describing the smooth model including the assumptions underlying it.

Footnote 52, p. 1050, cites works related to the smooth model. I would also cite Kahneman & Tversky (1975, p. 30 ff.), who had the smooth model for ambiguity for two outcomes, Dobbs (1991) who had a different but similar model, and recursive EU by Neilson (cited in Footnote 56), and Kreps & Porteus (1978) who used the same functional form.

P. 1051 in §4.1 is especially useful in discussing portability. In the smooth model, φ, the utility transformer in the second stage, is assumed to depend only on the subject and to be invariant across different decision situations. So, it is assumed that once φ has been elicited using, say, Ellsberg urns, then it applies to all situations of uncertainty. This is a strong assumption, giving the richness of uncertain events, but it is then very good in being tractable.

SEU = risk: It is discussed on p. 1051 bottom ff. P. 1061 will cite someone arguing that it is not intuitive to treat objective and subjective (in the sense of comprising ambiguity) probabilities the same way.

P. 1052 ff. discusses source dependence, but takes source differently than I do.

P. 1052 2nd para 2nd sentence: "We distinguished two sources of uncertainty, physical and epistemic." So, this is how the author takes it: one source is the epistemic 2nd stage uncertainty, the attitude to which is captured by the utility-transformer φ. The other source(s) are the generative mechanisms the attitude to which is captured by the risk-attitude function u. So, it is categorical and dichotomous, with only two (kinds of) sources, epistemic or physical, and there are two kinds of attitudes, φ and u respectively. The only thing that can bring changes, and a gradual path from one kind of uncertainty to the other, is the 2nd order distribution μ. My work on the source idea is different. There can be many kinds of sources of uncertainty, inducing many kinds of attitudes with higher and lower degrees of pessimism (and insensitivity). In this respect my use of sources is more general and accordingly less tractable.

P. 1052 2nd para 2nd sentence: The sentence cited above restricts applicability of the smooth model. It must then be possible to interpret the first-order (subjective?) probability distributions on the Savage state space as physical. This is conceivable for the Ellsberg urn, but not for virtually all natural uncertainties. P. 1024 end of 3rd para has stated that this paper assumes that a "true probability" on S exists (but is unknown) but, again, this is restrictive.

P. 1052 penultimate para also writes: "different confidence in such [probability] judgements (whatever feature of a source causes it) translate as different degrees of aversion to uncertainty across sources, and so in different von Neumann-Morgenstern utility functions." I think that here he is confused. The vNM utility function u reflects only taste and φ is taken to reflect the ambiguity attitude of the agent which in the author's interpretation is separate from the state of info, so, the confidence in probability judgments. This was discussed by Hill (2019 pp. 247-249).

P. 1052 footnote 54: Smith (1969) did not have the idea of source. He did discuss the competence effect, one of the several factors that impact ambiguity attitude, several of which were studied by Yates and co-authors in several papers. But mentioning a factor that impacts ambiguity attitude is too far a cry from the source idea, being way more general. Tversky has the priority of the source concept, in Heath & Tversky (1991), mentioning it briefly in Tversky & Kahneman (1992), where I usually take Tversky & Fox (1995) as the main reference for introducing it in a mature form.

P. 1053 2nd para refers to the "negative attitude" of the DM towards ambiguity, focusing on ambiguity aversion.

P. 1055, §4.2, middle, discusses CARA and CRRA φ. In the former case, it can be argued that ambiguity attitude is constant and in this way independent of outcomes. But it is constant only in an absolute sense then. In the second case, it is constant and independent of outcomes only in relative sense. Footnote 60 there discusses constant absolute ambiguity aversion w.r.t. utility units, by Grant & Polak (2013) and others.

§4.1, p. 1057 ff. discusses the Ellsberg two-urn paradox, assuming all priors.

P. 1072 ff., §4.6, discusses the maxmin EU model of Gilboa & Schmeidler (1989). P. 1063 points out that here the set of priors can be taken subjectively, to induce ambiguity aversion. P. 1063 middle points out that priors are only in or out, and the 2nd stage μ plays no role. P. 1082 2nd para ff. repeats the point.

P. 1066 gives examples and calculations, interpreting some quantities as ambiguity premiums.

The analysis of ambiguity attitudes on p. 1070 focuses on ambiguity aversion. (**Ambiguity = amb.av = source.pref, ignoring insensitivity**?) %}

Marinacci, Massimo (2015) "Model Uncertainty," *Journal of the European Economic Association* 13, 1022–1100.
https://doi.org/10.1111/jeea.12164

{% Presents and derives many mathematical properties of nonadditive set functions. %}

Marinacci, Massimo & Luigi Montrucchio (2004) "Introduction to the Mathematics of Ambiguity." *In* Itzhak Gilboa (ed.) *Uncertainty in Economic Theory: Essays in Honor of David Schmeidler's 65th Birthday*, 46–107, Routledge, London.

{% %}

Marinacci, Massimo & Luigi Montrucchio (2004) "A Characterization of the Core of Convex Games through Gateaux Derivatives," *Journal of Economic Theory* 116, 229–248.

{% %}

Marinacci, Massimo & Luigi Montrucchio (2005) “Ultramodular Functions,” *Matematics of Operations Research* 30, 311–332.

{% **three-doors problem** %}
Marinoff, Louis (1996) “A Reply to Rapoport,” *Theory and Decision* 41, 157–164.

{% %}
Mariotti, Marco (1995) “The Subjective Probabilities and Non-Expected Utilities of Cautious von Neumann-Morgenstern Expected Utility Maximizers,”

{% %}
Mariotti, Marco (1995) “Is Bayesian Rationality Compatible with Strategic Rationality?,” *Economic Journal* 105, 1099–1109.

{% **Nash bargaining solution** %}
Mariotti, Marco (1998) “Nash Bargaining Theory when the Number of Alternatives Can Be Finite,” *Social Choice and Welfare* 15, 413–421.

{% **revealed preference** %}
Mariotti, Marco (2008) “What Kind of Preference Maximization Does the Weak Axiom of Revealed Preference Characterize?,” *Economic Theory* 35, 403–406.

{% Roman general around 100 BC; started “burial club”: if a member died, the others paid funeral. Is early form of insurance. %}
Marius, Gaius

{% **real incentives/hypothetical choice**: Stated preference is what mainstream economists call hypothetical choice. Revealed preference is then called real choice (market data and so on). The “data fusion literature” investigates how to combine them, and use one to predict the other. The paper gives references. %}
Mark, Tami L. & Joffre D. Swait (2004) “Using Stated Preference and Revealed Preference Modeling to Evaluate Prescribing Decisions,” *Health Economics* 13, 563–573.

{% %}

Markle, Alex, George Wu, Rebecca White, & Aaron Sackett (2018) “Goals as Reference Points in Marathon Running: A Novel Test of Reference-Dependence,” *Journal of Risk and Uncertainty* 56, 1–32.

{% Proposed reference point; **risky utility u = strength of preference v (or other riskless cardinal utility, often called value)**;

Note that he uses the terms convex and concave conversely than is done nowadays (1970-2023). I will use the terms in their current sense.

Predicts concave utility (risk aversion) for small losses (roughly, the threshold is somewhere between –$100 and –$10,000) and convex utility (risk seeking) for small gains (threshold somewhere between $100 and $10,000), exactly opposite to the predictions of prospect theory.

P. 154, I assume that the first inequality sign below Fig. 5 is a typo and should be reversed.

P. 154 following Fig. 5 he seems to suggest loss aversion, P. 157 top of 2nd column, however, suggests that there is an inflection point with almost linear utility around 0, strangely enough.

P. 155, top of first column, explicitly discusses variation in reference point through prior endowment subtracted from the gamble outcomes.

P. 156 mentions the tendency to take more risk after prior wins (now called the house money effect).

P. 157 makes explicit that it is a weak point that there is no theory about the location of the reference point. %}

Markowitz, Harry M. (1952) “The Utility of Wealth,” *Journal of Political Economy* 60, 151–158.

{% %}

Markowitz, Harry M. (1959) “Portfolio Selection: The Efficient Diversification of Investments,” Yale UP, New Haven.

{% A book by Jason Zweig (“Your money or your brain”) seems to give the following citation of Markowitz:

"I should have computed the historical co-variances of the asset classes and drawn an efficient frontier. I visualized my grief if the stock market went way up and I wasn't in it — or if it went way down and I was completely in it. So I split my contributions 50/50 between stocks and bonds" %}

Markowitz, Harry M.

{% Reviews literature on relating mean-variance to EU. %}

Markowitz, Harry (2014) "Mean–Variance Approximations to Expected Utility," *European Journal of Operational Research* 234, 346–355.

{% %}

Marley, Anthony A.J. & R. Duncan Luce (2001) "Ranked-Weighted Utilities and Qualitative Convolution," *Journal of Risk and Uncertainty* 23, 135–163.

{% %}

Marley, Anthony A.J. & R. Duncan Luce (2005) "Independence Properties vis-à-vis Several Utility Representations," *Theory and Decision* 58, 77–143.

{% Uses event commutativity and some other natural and structural axioms to axiomatize **biseparable utility. A**ssume solvability both for events and for outcomes. P. 44 points out that Axiom A.10, requiring existence of a particular mapping on events, is not behavioral in the usual sense. P. 43, following Eq. 10, points out that this approach needs independent repetitions of events. Axiom A.4 seems to imply that there are no nonempty null events. The event space must be infinite though because of denseness.

P. 45, Theorem 4.1: I think that axiom A.10 is not necessary for general RDU because the set of events need not be sufficiently rich. %}

Marley, Anthony A.J. & R. Duncan Luce (2002) "A Simple Axiomatization of Binary Rank-Dependent Utility of Gains (Losses)," *Journal of Mathematical Psychology* 46, 40–55.

{% %}

Marley, Anthony A.J., R. Duncan Luce, & Imre Kocsis (2008) "A Solution to a Problem Raised in Luce & Marley (2005)," *Journal of Mathematical Psychology* 52, 64–68.

{% **Christiane, Veronika & I** %}

Marques, J. Frederico (1999) "Changing 'Europe'—The Euro as a New Subject for Psychological Research in Numerical Cognition," *European Psychologist* 4, 152–156.

{% Let subjects choose between risky options with probabilities of outcomes known, and ambiguous (called uncertain) options giving probability intervals and also outcome intervals, with varying degrees of ambiguity. The more ambiguity, the more people dislike it. Find it for gambles with positive, zero, and negative a-neutral (taken via midpoints of intervals) expected value. I guess that subjects had to pay some amount to receive a possibility to gain an amount, which means that all gambles considered are mixed. They also consider group decisions. %}

Marquis, Donald G. & H. Joseph Reitz (1969) "Effect of Uncertainty on Risk Taking in Individual and Group Decisions," *Behavioral Science* 14, 281–288.
https://doi.org/10.1002/bs.3830140403

{% **Z&Z**; Re-analyze hypothetical choices in the famous RAND data using prospect theory. Find support for loss aversion and risk seeking for losses (**risk averse for gains, risk seeking for losses**). Unfortunately, there are so many unclear points in their modeling of prospect theory that the results are not clear to me. They do not consider probability weighting (which in itself can be an OK working hypothesis for pragmatic reasons, made by many) but do consider the certainty effect. The latter is, however, typically modeled through probability weighting. Apparently they have some utility-of-gambling model in mind such as for instance Diecidue, Schmidt, & Wakker (2004), but this is not clear. They do what they call seggregation, where they do not integrate the riskless and risky payments but evaluate them separately and additively, as a kind of additive version of Luce's joint receipt. Kahneman & Tversky (1979) considered something in this spirit but, for a positive prospect that yields \$x >0 as minimal outcome and with probability p y > x, took as evaluation, where I write U for utility = value function, U(x) + w(p)(U(y) − U(x)) which is just the regular rank-dependent evaluation and y is the INTEGRATED payment to be added to the reference point r so that final wealth is r+y. These authors further seggregate payments added to the reference point as a kind of mental accounting, which is a fundamental deviation from PT.

Pp. 422-423 has nice distinction between initial wealth and reference point.

utility concave near ruin: p. 423 takes utility for losses first convex but for large losses concave.

P. 425: their parameter estimates find CONSTANT utility on [−200,0] which is as much against loss aversion as one can think of and is clearly absurd.

They do not consider loss aversion.

P. 423 footnote 7 points out that they tested their model not only with status quo as reference point but also with complete insurance, but this fitted the data worse. %}

Marquis, M. Susan & Martin R. Holmer (1996) “Alternative Models of Choice under Uncertainty and Demand for Health Insurance,” *Review of Economics and Statistics* 78, 421–427.

{% Contrary to a claim by Machina, Marschak does not object, on p. 320, to EU; he doesn’t even mention it. He objects to EV only, and says that other moments will be relevant as well. %}

Marschak, Jacob (1938) “Money and the Theory of Assets,” *Econometrica* 6, 311–325.

{% %}

Marschak, Jacob (1948) (Title unknown), Cowles Commission Discussion Paper, Economics No. 226 (hectographed), July, 1948.

{% %}

Marschak, Jacob (1949) “Measurable Utility and the Theory of Assets,” (abstract), *Econometrica* 17, 63–64.

{% P. 193 mentions maxmin over expected values, but in the context of game theory (where the unit of payment is utility so that expected value = expected utility), citing von Neumann & Morgenstern, and then argues that in individual choice Savage's minimax regret is preferable. %}

Marschak, Jacob (1949) "Role of Liquidity under Complete and Incomplete Information," *American Economic Review, Papers and Proceedings* 39, 182–195.

https://www.jstor.org/stable/1831743

{% **dynamic consistency**: favors abandoning **RCLA** when time is physical, because of **utility of gambling**. Mentions two 1948 working papers.
independence/sure-thing principle due to mutually exclusive events: Von Neumann & Morgenstern (1944 §3.3.2, p. 18) mention the point more or less, they never state the independence condition (or s.th.pr.). Hence, I think the priority of this insight should go to Marschak, who states it (p. 134), although only in passing by. In a 1950 letter to Samuelson Marschak states it more clearly. Samuelson (1952) then also states it.
utility depends on probability: p. 138 for mountain climber %}

Marschak, Jacob (1950) "Rational Behavior, Uncertain Prospects, and Measurable Utility," *Econometrica* 18, 111–141.

{%: Luce says: p. 176 gives the independence axiom; this lecture was given on Dec.6, 1950. %}

Marschak, Jacob (1951) "Why "Should" Statisticians and Businessmen Maximize "Moral Expectation"?" *In* Jerzy Neyman (1951, ed.) *Proceedings of the Second Berkeley Symposium on Mathematical Statistics and Probability*, University of California Press, Berkeley.

{% %}

Marschak, Jacob (1954) "Probability in the Social Sciences." *In* Paul F. Lazersfeld (ed.) *Mathematical Theory in the Social Sciences*, 166–215, The Free Press, New York.

{% **second-order probabilities** ; **calculation costs incorporated**: maybe he has it in this paper, or in one of his others; I don't remember (2022) %}

Marschak, Jacob (1975) "Personal Probabilities of Probabilities," *Theory and Decision* 6, 121–153.

{% **risky utility u = transform of strength of preference v**: first sentence of §II.9, p. 168: "If one could assume that, by good luck, the functions s and B to coincide" (here s is the psychological utility function, B the vNM) %}

Marschak, Jacob (1979) "Utilities, Psychological Values, and the Training of Decision Makers." *In* Maurice Allais & Ole Hagen (eds.) *Expected Utility Hypotheses and the Allais Paradox*, 163–174, Reidel, Dordrecht.

{% %}

Marschak, Jacob & Roy Radner (1972) "*Economic Theory of Teams.*" Yale University Press, New Haven.

{% Independence as monotonicity w.r.t. a variabele partition. (**restrictiveness of monotonicity/weak separability**) %}

Marschak, Thomas (1987) "Independence versus Dominance in Personal Probability Axioms." *In* Walter P. Heller, Ross M. Starr, & David A. Starrett (eds.) *Uncertainty, Information and Communication, Essays in Honor of Kenneth J. Arrow*, Vol. III, 129–171, Cambridge University Press, Cambridge.

{% Stigler Footnote 250 refers to p. 94 of 8th edn. for example of carpet to cover floor where last yard has more utility than yards before. To preserve diminishing marginal utility, Marshall says that whole carpet should be taken as one object.

marginal utility is diminishing: pp. 398-400: Risk aversion is ascribed to diminishing marginal utility; Footnote IX in Mathematical Appendix proves that risk aversion iff u concave, well he derived it only for two-outcome gambles. Marshall seems to have been the first to demonstrate this point. Bernoulli 1738 §13 also suggests it and §14 first sentence claims it in general, but does not really prove it.

Citation: "The argument that fair gambling is an economic blunder is generally based on Bernoulli's or some other definite hypothesis. But it requires no further assumption than that, firstly the pleasure of gambling may be neglected; and, secondly, φ´´ is negative for all values of x, where φ(x) is the pleasure derived from wealth equal to x" (Then Marshall gives a proof,

only for two-outcome gamble. He continues: "It is true that this loss of probable happiness need not be greater than the pleasure derived from the excitement of gambling, and we are thrown back upon the induction that pleasures of gambling are in Bentham's phrase "impure;" since experience shows that they are likely to engender a restless, feverish character, unsuited for steady work as well as for the higher and more solid pleasures of life." (Marshall, 1920: 843).

linear utility for small stakes: This is crucial for Marshall to obtain cardinal utility. Seems to be in Book III.

Seems that he is generally attributed the formal application of ceteris paribus in economics. %}

Marshall, Alfred (1890) "*Principles of Economics*." 8th edn. 1920 (9th edn. 1961), MacMillan, New York.

{% **decreasing/increasing impatience**: seem to find that utility of life duration has increasing risk aversion, which indirectly implies increasing impatience. %}

Martin, Andrew J., Paul Glasziou, R. John Simes, & Thomas Lumley (2000) "A Comparison of Standard Gamble, Time Trade-off, and Adjusted Time Trade-Off Scores," *International Journal of Technology Assessment in Health Care* 6, 137–147.

{% %}

Martin, Scott L. & William Terris (1991) "Predicting Infrequent Behavior: Clarifying the Impact on False-Positive Rates," *Journal of Applied Psychology* 76, 484–487.

{% Compare matching and choice, where opaque means that choice questions leading to an indifference are interspersed with other questions so that subjects do not know. Then preference reversals can be avoided. It adds to Bostic, Herrnstein, & Luce (1990). %}

Martinez, Fernando I. Sanchez, José Luis Pinto, Jose María Abellán Perpiñan, & Murcia Jorge Martínez Pérez (2014) "Avoiding Preference Reversals with Opaque Methods," in preparation.

{% **conservation of influence**: Discusses and cites several books and works by Ian Hacking on the differences between natural and social sciences. Seems to be

mainly that the construction of social sciences and of our image of man is interactive with our construction work. %}
Martínez, María Laura (2009) “Hacking’s Proposal for the Distinction between Natural and Social Sciences,” *Philosophy of the Social Sciences* 39, 212–234.

{% Relate concavity of utility of income to concavity properties of utility of commodity bundles to be bought for the income. %}
Martínez-Legaz, Juan E. & John K. -H. Quah (2007) “A Contribution to Duality Theory, Applied to the Measurement of Risk Aversion,” *Economic Theory* 30, 337–362.

{% Compare evaluating an uncertain act (E_1:x_1, …, E_n:x_n) with evaluating a riskless act, receiving outcome α for sure: in the former case there are two differences: (1) there are n outcomes to be considered, rather than only one, which makes it more complex. (2) there are probabilities involved. This complicates decisions under uncertainty and may enhance suboptimal decisions there. To separate the above differences (1) and (2), the authors consider an intermediate treatment (1.5): One receives all outcomes x_1,…, x_n; i.e., their sum. It has complication (1) but not (2). They do an experiment where they measure the optimality loss in cases (1) and (1.5) relative to (2). %}
Martínez-Marquina, Alejandro, Muriel Niederle, & Emanuel Vespa (2019) “Failures in Contingent Reasoning: The Role of Uncertainty,” *American Economic Review* 109, 3437–3474.

{% Consider a variation of the Anscombe-Aumann framework that Machina called the Aumann-Anscombe framework: Roulette precedes the horse race. Assume expected utility for the roulette wheel. Then, mainly, an axiom that they call extended monotonicity, but that in fact is multiattribute risk neutrality, gives expected utility over the horses. Consider weakenings. Pretty use of that axiom. (It is also similar to bisymmetry.) %}
Martins-da-Rocha, Victor Filipe & Rafael M. Rosa (2021) “An Anscombe– Aumann Approach to Second-Order Expected Utility,” working paper.

{% **conservation of influence**: seems to write, according to Georgescu-Roegen (1954, QJE, p. 511), in "Equivalent form of value (pp. 64ff) that all commodities must have a common facto (pp. 43-45)" %}

Marx, Karl (1932) "*Capital. Vol. I.*" Kerr & Co, Chicago.

{% %}

Mas-Colell, Andreu (1974) "An Equilibrium Existence Theorem without Complete or Transitive Preferences," *Journal of Mathematical Economics* 1, 237–246.

{% Shows that every continuous consumer is limit of differentiable consumers.

No experiment can prove nondifferentiability. %}

Mas-Colell, Andreu (1974) "Continuous and Smooth Consumers: Approximation Theorem," *Journal of Economic Theory* 8, 305–336.

{% **revealed preference** %}

Mas-Colell, Andreu (1978) "On Revealed Preference Analysis," *Review of Economic Studies* 45, 121–131.

{% Has been most popular textbook for teaching micro for many years. I find that amazing because whatever I read in it was dry, no ideas at all, just the formalities, and those in inefficient manners, needlessly complex. I taught game theory from it for one year and was unsatisfied so I switched to Peters' (2008) textbook. All students I spoke expressed negative judgments about the Mas-Colell et al. book.

P. 185 presents the St. Petersburg paradox in utility units. That one would be willing to give up all of one's wealth for it is called "patently absurd."

inverse S: The classical economists' view of p. 185: "The concept of risk aversion provides one of the central analytical techniques of economic analysis, and it is assumed in this book whenever we handle uncertain situations." %}

Mas-Colell, Andreu, Michael D. Whinston, & Jerry R. Green (1995) "*Microeconomic Theory.*" Oxford University Press, New York.

{% %}

Masatlioglu, Yusufcan & Efe A. Ok (2005) "Rational Choice with Status Quo Bias," *Journal of Economic Theory* 121, 1–29.

{% In a lab experiment, a simple lottery decides if subjects gain a prize. But they only get it, and are informed about it, in half an hour. At the beginning of that half hour, they can choose signals about the chance of winning the prize. Here the info is clearly almost entirely noninstrumental, only they have half an hour more or less to think about it, which doesn't count for anything. So, preference for info must be entirely intrinsic. It does mean that we are studying here something of very very small value.

A field experiment in a way is opposite. Subjects can get informed about the potential of getting Alzheimern or about their IQ, and can choose between dfferent signals (hypothetical I assume). Here the info is very instrumental and things will depend much on the particular value of the particular info, rather than on a general intrinsic attitude towards info.

value of information: The lab and field experiments show that people have a preference for positively skewed information structures and against negatively skewed information structures. The authors analyze it theoretically using Machina's (1982) local utility, giving equivalence results in terms of concavity/convexity of 2nd derivatives, and relate their findings to related findings on violations of RCLA. An easier theoretical explanation comes from source theory with insensitivity. Insensitivity in fact means oversensitivity to info coming (close to) certainty, which more easily explains the preference for positively skewed information structures and against negatively skewed information structures. %}

Masatlioglu, Yusufcan, Yesim Orhun, & Collin Raymond (2023) "Intrinsic Information Preferences and Skewness," *American Economic Review* 113, 2615–2644.
https://doi.org/10.1257/aer.20171474

{% They show that for Köszegi-Rabin the choice-acclimating personal equilibrium (CPE), when taken in its most popular form with gain-loss utility μ that has a kink at 0 but is linear otherwise, is exactly the intersection of quadratic and rank-dependent utility. Proposition 3: then loss aversion $\lambda \geq 1$ iff mixture averse, so, under RDU, iff w convex (this uses my 1994 theorem), and ≤ 1 iff mixture

loving, so, w concave. In the proof, p. 2780, the authors indicate a generalization of my 1994 result: It also holds if w is not increasing, with no change in the proof required. Proposition 7 shows that now loss aversion iff first-order risk aversion under RDU, consistent with a claim by Köbberling & Wakker (2005) that most of first-order risk aversion is due to loss aversion.

Footnote 18 thinks, erroneously, that proofs with differentiability can be transferred to general strictly increasing functions because the latter are almost everywhere differentiable. Paradís, Viader, & Bibiloni (2001 Theorem 3.1) give a counterexample. %}

Masatlioglu, Yusufcan & Collin Raymond (2016) "A Behavioral Analysis of Stochastic Reference Dependence," *American Economic Review* 106, 2760–2782.

{% Experimentally examine reference dependence in multiattribute choice. They compare the well-known model of Tversky & Kahneman (1991) with a model by Masatlioglua & Ok developed in some papers. In the latter model, the agent has two selves, and an alternative is preferred to the status quo only if both selves agree. The two models correctly predict choices if one alternative dominates the status quo but the other does not. They do not in other cases, and there the model of Masatlioglua & Ok, which predicts no reference effect there, is confirmed. %}

Masatlioglua, Yusufcan & Neslihan Uler (2013) "Understanding the Reference Effect," *Games and Economic Behavior* 82, 403–423.

{% Seems to describe wishful thinking: assigning higher likelihood to preferred outcome. %}

Mascaro, Guillermo F. (1969) " 'Wishful Thinking' on the Presidential Election," *Psychological Reports* 25, 357–358.

{% %}

Maschler, Michael, Eilon Solan, & Shmuel Zamir (2013) "*Game Theory*." Cambridge University Press, Cambridge.

{% Use choice list to measure risk aversion. Groups are more risk averse than individuals. %}

Masclet, David, Nathalie Colombier, Laurent Denant-Boemont, & Youenn Lohéac (2009) "Group and Individual Risk Preferences: A Lottery-Choice Experiment with Self-Employed and Salaried Workers," *Journal of Economic Behavior and Organization* 70, 470–484.

{% Characterizes maximization of sum on $\mathbb{R}^n$. Every x_j in $(x_1,\ldots,x_n)$ is interpreted as utility level of individual i, is taken as empirical primitive, and the sum is interpreted as utilitarianism. Elimination of indifferent individuals is Debreu's (1960) separability. Full comparability amounts to both constant relative and constant absolute risk aversion and, jointly with separability, generates the linear representation. %}

Maskin, Eric (1978) "A Theorem on Utilitarianism," *Review of Economic Studies* 45, 93–96.

{% %}

Maskin, Eric (1979) "Decision Making under Ignorance with Implications for Social Choice," *Theory and Decision* 11, 319–337.

{% **ubiquity fallacy**: seems that he writes on p. 1: "I suppose it is tempting, if the only tool you have is a hammer, to treat everything as if it were a nail." %}

Maslow, Abraham H. (1966) "*The Psychology of Science a Reconnaissance.*" Harper and Row, New York.

{% **losses from prior endowment mechanism**: Discuss it in footnote 4, p. 189. Consider choices between loss-prospects, and find some deviations from expected utility when there are small-probability losses. Argue that, in view of such deviations, policy decisions based on expected utility can be wrong. Do not use prospect theory to analyze it. %}

Mason, Charles F., Jason F. Shogren, Chad Settle, & John A. List (2005) "Investigating Risky Choices over Losses Using Experimental Data," *Journal of Risk and Uncertainty* 31, 187–215.

{% Gives common psychophysical measurement methods. Noted that upward matching gives different results than downward. %}

Massaro, Dominic W. (1975) "*Experimental Psychology and Information Processing.*" Rand McNally, Chicago.

{% Survey of neural networks, suited for mathematicians. %}
Masson, Egill & Yih-Jeou Wang (1990) "Introduction to Computation and Learning in Artificial Neural Networks," *European Journal of Operational Research* 47, 1–28.

{% Find that explaining incentive compatibility to subjects increases truth-telling. Do it for Vickrey auctions. %}
Masuda, Takehito, Ryo Mikami, Toyotaka Sakai, Shigehiro Serizawa, & Takuma Wakayama (2022) "The Net Effect of Advice on Strategy-Proof Mechanisms: An Experiment for the Vickrey Auction," *Experimental Economics* 25, 902–941. https://doi.org/10.1007/s10683-021-09736-5

{% They characterize a sort of state-dependent generalization of generalized quasi-arithmetic means, which in an ordinal sense is equivalent to an additively decomposable representation: $(x_1,\ldots,x_n) \mapsto (f_1 + \cdots + f_n)^{-1}\big((f_1(x_1) + \cdots + f_n(x_1))\big)$. They use a generalized bisymmetry condition. %}
Matkowski, Janusz & Zsolt Páles (2015) "Characterization of Generalized Quasi-Arithmetic Means," *Acta Scientiarum Mathematicarum* 81, 447–456.

{% They test to what extent prudence can predict self-protection decisions, but find violations of expected utility. Inverse S probability weighting can explain it. %}
Masuda, Takehito & Eungik Lee (2019) "Higher Order Risk Attitudes and Prevention under Different Timings of Loss," *Experimental Economics* 22, 197–215.

{% This didactical survey paper mostly focuses on the relations between introspective and behavioral measurements of risk preference, a topic on which the authors are experts. %}
Mata, Rui, Renato Frey, David Richter, Jürgen Schupp, & Ralph Hertwig (2018) "Risk Preference: A View from Psychology," *Journal of Economic Pespectives* 32, 155–172.

{% This paper is on rational inattention. Agents can receive info, maybe even perfect, but info is costly, so costly that they may prefer not to get all kinds of info. It can be taken as a special case of models where cost of information is incorporated. Marschak worked on that long ago.

The agents can, in a first stage, choose between several information structures. Each gives a signal with some probability. The signals are used to condition on, so as to improve subjective probabilities over outcome relevant events. Outcomes are monetary and utility is linear. There are costs of information structures. The agent maximizes expected value. This leads to a two-stage optimization problem. The agent may have to forego good and even perfect info if it is too expensive. This is called rational inattention. Beccause, after choice of an info structure, there is randomness of the signal that will result, there is randomness in the act that the agent will choose. The authors assume an entropy-based cost function. That leads to a Luce probabilistic choice model.

P. 273 Eq. 1: I did not understand that the choice probability depends only on the real payoff v_i of action i,f and not on the other payoffs possible. This real payoff requires knowledge of the true state of nature - to be determined a priori before the choice of act, in the probability of that choice of act?? α_i is derscribed as a weight attached to action i based on prior information and information-processing strategy, but then it is added to outcome v_i so that it has a monetary unit?? They depend on the cost of info parameter λ, a dependency not expressed on notation. It seems that priors of agents can also change.

P. 278 displays an entropy formula. I understand well what entropy is, but the interpretation written by the authors below I do not understand. It is claimed to measure “the average unlikeliness of events.” They see how it varies if M, the nr. of elements in the partition of events considered, increases, and then so does the entropy. But this holds for EVERY increasing function instead of $-\log(P_i)$ in the entropy formula, and is just a trivial fact. The essence is that, for fixed M, entropy increases with uniformity, due mainly to convexity of $-\log(P_i)$.

I regret that this paper and its outlet has the proofs of theorems online. In cases where I as a mathematician can play the role of specialist who checks proofs, something I often did, I will not do it for online proofs. Those texts have too little quality guarantee and maybe even too little stability guarantee. I rather treat such cases as unreliable, unverifiable, and better to be ignored and not used. For a good view on this point, see Spiegler (2023). %}

Matejka, Filip & Alisdair McKay (2015) "Rational Inattention to Discrete Choices: A New Foundation for the Multinomial Logit Model," *American Economic Review* 105, 272–298.
http://dx.doi.org/10.1257/aer.20130047

{% This paper gives empirical evidence that people, when remembering options chosen, misremember in moving positive attributes of options not chosen to options chosen. It is a special case of confirmation bias and cognitive dissonance. It reminds me of the Steven Stills (1971) song "[If you can't be with the one you love,] love the one you're with." I felt my economic background when thinking "They had better done with real incentives" (they used hypothetical choice). %}

Mather, Mara, Eldar Shafir, & Marcia K. Johnson (2000) "Misremembrance of Options Past: Source Monitoring and Choice," *Pychological Science* 11, 132–138.

{% %}

Matheson, James E. & Robert L. Winkler (1976) "Scoring Rules for Continuous Probability Distributions," *Management Science* 22, 1087–1096.

{% A meta-analysis on measurements of discount rates. Finds average annual rate of 0.33, which is a discount factor of $e^{-0.33} = 0.72$.

They can apparently correct for publication bias (via correlation of discount rate estimates with their standard errors it seems), and p. 320 writes that the publication bias may drive the rate up from 0.33 to 0.80.

P. 320 writes: "it does not matter systematically for the reported discount rates whether experiments use real or hypothetical rewards." (**real incentives/hypothetical choice**)

lab gives higher rate than field. %}

Matousek, Jindrich, Tomas Havranek, & Zuzana Irsova (2022) "Individual Discount Rates: A Meta-Analysis of Experimental Evidence," *Experimental Economics* 25, 318–358.

https://doi.org/10.1007/s10683-021-09716-9

{% **CBDT**; %}

Matsui, Akihiko (2000) "Expected Utility and Case-Based Reasoning," *Mathematical Social Sciences* 39, 1–12.

{% This paper considers additive conjoint measurement for a preference relation on a product set X_1 x … x X_n. It assumes that every X_j is endowed with an operation o_j. It imposes the usual Hölder-type axioms to get an additive representation u_j for every o_j. Then additive representation $u_1(x_1) + … + u_n(x_n)$ can be obtained the same way as $p_1x_1 + … + p_nx_n$ is axiomatized by the de Finetti additivity type axiom ($a \sim b \Rightarrow a + c \sim b + c$) where now addition is in terms of o_j; i.e., each a_j of de Finetti is replaced by $u_j(x_j)$ and so on. This is Definition 5. (**Dutch book**) %}

Matsushita, Yutaka (2010) "An Additive Representation on the Product of Complete, Continuous Extensive Structures," *Theory and Decision* 69, 1–16.

{% %}

Matsushita, Yutaka (2017) "A Generalized Extensive Structure that is Equipped with a Right Action and Its Representation," *Journal of Mathematical Psychology* 81, 28–39.

{% **nonconstant discount = nonlinear time perception**: paper puts it central for constant and hyperbolic discounting and examines other things such as subadditivity w.r.t. subintervals. %}

Matsushita, Yutaka (2023) "Timescale Standard to Discriminate between Hyperbolic and Exponential Discounting and Construction of a Nonadditive Discounting Model," *Theory and Decision* 95, 33–54. https://doi.org/10.1007/s11238-022-09916-6(0123456789

{% Pp. 57-58 on Sébastien le Prestre de Vauban (1633-1707, French military engineer, politically influential and writer on many topics including forestry:

"This vision notwithstanding, Vauban recognized that few prorietors could afford to wait decades — lifetimes, even, depending on the tree's type and intended purpose — before realizing a return

on their investment. Fewer still would embark on what might only amount to ancestral largesse compared with the annual returns from grain or even coppices. He resigned himself to hoping that landowners would "do their best, while conceding that plantations were really "an activity of the King, for only the crown had the authority and incentive to cultivate timber of the long term."
%}

Matteson, Kieko (2015) "*Forests in Revolutionary France: Conservation, Community, and Conflict, 1669-1848*." Cambridge University Press, Cambridge UK.

{% P. 414: "In financial applications, prospect theory developed by Kahneman and Tversky (1979) and Tversky and Kahneman (1992) appears to offer the most promising non-expected utility theory for explaining decision making under risk (Barberis and Thaler, 2003)." (**Prospect theory/Rank-Dependent Utility most popular for risk**) The authors point out, citing literature in the intro and §1, that in finance people usually considered only loss aversion, but this paper shows that probability weighting is important. Their simulations then show that probability weighting is the biggest component affecting hedging, more than loss aversion or utility curvature. Unfortunately, they refer to utility curvature as "risk aversion." (**equate risk aversion with concave utility under nonEU**) %}

Mattos, Fabio, Philip Garcia, & Joost M.E. Pennings (2008) "Probability Weighting and Loss Aversion in Futures Hedging," *Journal of Financial Markets* 11, 433–452.
https://doi.org/10.1016/j.finmar.2008.04.002

{% Seems that he had a brief statement, in an addendum to his book, on natural selection as a mechanism of evolutionary adaptation, preceding Darwin. %}

Matthew, Patrick (1831) "*On Naval Timber and Arboriculture*." Adam Black, Edinburgh.

{% r**eal incentives/hypothetical choice, for time preferences**: seems to be on it %}

Matusiewicz, Alexis K., Anna E. Carter, Reid D. Landes, & Richard Yi (2013) "Statistical Equivalence and Test-Retest Reliability of Delay and Probability Discounting Using Real and Hypothetical Rewards," *Behavioural Processes* 100, 116–122.

https://doi.org/10.1016/j.beproc.2013.07.019

{% **revealed preference**; related to paper Hans Peters and me. %}
Matzkin, Rosa L. (1991) "Axioms of Revealed Preference for Nonlinear Choice Sets," *Econometrica* 59, 1779–1786.

{% %}
Matzkin, Rosa L. & Marcel K. Richter (1991) "Testing Strictly Concave Rationality," *Journal of Economic Theory* 53, 287–303.

{% %}
Maule, A. John, G. Robert J. Hockey, & Larissa Bdzola (2000) "Effects of Time-Pressure on Decision Making under Uncertainty: Changes in Affective State and Information Processing Strategy," *Acta Psychologica* 104, 283–301.

{% This paper shows one thing: [rewriting lotteries by collapsing outcomes should not affect evaluation] implies EU-maximization. %}
Maxwell Christopher (1990) "Decision Weights and the Normal Form Axiom," *Economics Letters* 32, 211–215.

{% **free will/determinism**: Free will seems to rule out determinism but also does not sit well with chance. %}
May, Joshua (2014) "On the very Concept of Free Will," *Synthese* 191, 2849–2866.

{% Argues for Intransitive. %}
May, Kenneth O. (1954) "Intransitivity, Utility, and the Aggregation of Preference Patterns," *Econometrica* 22, 1–13.

{% Argues for Intransitive. %}
May, Regine M. (1987) "*Realismus von Subjektiven Warscheinlichkeiten: Eine Kognition-Psychologische Analyse Inferentieller Prozesse beim Overconfidence*." Peter Lang, Frankfurt am Main.

{% Formulate it in context of multi-criteria decision making. P. 298 1/3: that capacity is exponentially complex. Considers a form of ordinal information, with only finitely many preferences expressed, and then characterizes 2-additive capacities. Surprisingly, belief functions can be captured by a 2-additive capacity. %}

Mayag, Brice, Michel Grabisch & Christophe Labreuche (2011) "A Representation of Preferences by the Choquet Integral with Respect to a 2-Additive Capacity," *Theory and Decision* 71, 297–324.

{% **real incentives/hypothetical choice**: He criticized Thurstone (1931) for using hypothetical choice. P. 97 seems to have written:

"Housewives' answers, for example, indicated an elastic demand for milk, while objective studies showed the demand to be inelastic". %}

Mayer, Joseph (1933) "The Meeting of the Econometric Society in Syracuse, New York, June, 1932," *Econometrica* 1, 94–104.

{% **foundations of statistics**; has ensuing discussion; %}

Mayo, Deborah G. (2014) "On the Birnbaum Argument for the Strong Likelihood Principle," *Statistical Science* 29, 227–239.
https://doi.org/10.1214/13-STS457

{% **foundations of statistics**

Nice discussion of the main issues in statistics, but purely from the frequentist classical perspective, often taking it as self-evident that this is the thing to do.

The authors take as self-evident that tests by default are two-sided.

A central topic in this paper is whether or not one should take thresholds with binary decisions. Several authors argued against it ("no threshold view"), arguing for instance that one should just give p-values without discussing a threshold such as 0.05. However, I have no difficulty with thresholds. Often one had to take a decision of choosing between two things and then a threshold is to be specified.

P. 5 discusses that in classical tests one does not consider the probability of the observation, but of that observation or any other observation that would give even stronger evidence against H_0. They write: "The error probability is accorded to the test procedure, not to the observed data."

P. 6, §2.2: Neyman saw statistical testing more as deciding than as inference.

They often write circularly, just describing meaning of p-value and then saying that this is what is needed. For example, p. 7: "Data x provide evidence for a claim H to the extent that H has passed a severe test with x." Here they out of the blue declare p-value to be the exactly right criterion. P. 8 5th para cites Fisher making a similar claim.

P. 220 bottom: It is tantalizing that the majorit of papers and textbooks give incorrect definitions of confidence intervals. Glad to see that this paper does it right: "a confidence interval (CI) at level 1– c consists of parameter values that are not statistically significantly different from the data at significance level c."

Pp. 11-12: that the probabilistic assumptions underlying a statistical test can be taken flexibly and need not hold exactly.

Pp. 13-14, §4.1, cites people favoring the likelihood principle. They write: "A central problem is that any hypothesis that perfectly fits the data is maximally likely." My reply: then arguments against the hypothesis should come from elsewhere than the data.

P. 15 §4.2: "However, some critics charge that unless the p-value is mistakenly interpreted as a posterior probability, it is of questionable relevance to inference. That assumes a philosophy of inference at odds with statistical significance testing."

P 18: "any measure for showing apparent structures in data is susceptible to the generation of spurious results via data dredging, and would be susceptible to the same perverse incentive."

Pp. 19-20, § 3.1.1, is interesting on a case in the US supreme court.

P. 19: "It is important to recognize that the problem of selective reporting and data dredging can occur when using Bayes factors, likelihood ratios, and other alternative methods."

Pp. 20-21, §5.1.2, is on the stopping rule paradox

Pp. 220-221, §5.3.2, is on the Bayesian approach. P. 220 writes a characteristic sentence: "Computing a PPV [Bayesian posterior predictive value] is apt in given contexts of predicting the prevalence of properties, e.g., the presence of disease in high throughput screening, but it does not provide an assessment of plausibility or well-testedness of a particular hypothesis." p-values say more about whether the experiment/experimenter are good than whether the statistical hypothesis holds true. However, the primary purpose of research is not to push the career of a researcher or to please his ego, but to provide useful info to mankind. Hence p-values are not the relevant quantities.

P. 221 1st para writes a sentence I do not understand: "Moreover, from the fact that

H comes from a pool where k% are true, we do not get the probability that this particular H is true. Such an assignment is fallacious, for the same reason a confidence level is not the probability a particular interval is true." I think we do get the prob, which is k/100.

P. 26 1st para is circular: "But, as we have already noted, any account that obeys the LP [likelhood principle] violates error statistics principles. Hearing them laud the LP, the practitioner is rightly worried that their recommendations will not control error probabilities." It is circular because error probabilities are simply defined as p-values.

P. 27 middle: "For example, thoughtful tests turn on specifying ahead of time outcomes that will not be allowed to count in favor of a claim." Yes, for p-values the test has to be specified beforehand, but for Bayes factors not.

P. 29, closing sentence: "This is another reason that calls to abandon statistical significance are damaging scientific practice." %}

Mayo, Deborah G. & David Hand (2022) "Statistical Significance and Its Critics: Practicing Damaging Science, or Damaging Scientific Practice?," *Synthese* 200, 220.
https://doi.org/10.1007/s11229-022-03692-0

{% **foundations of statistics**; %}

Mayo, Deborah G. & Aris Spanos (2006) "Severe Testing as a Basic Concept in a Neyman–Pearson Philosophy of Induction," *Philosophy of Science* 57, 323–357.

{% **foundations of statistics**: collection of discussions of Bayesian versus classical statistics. %}

Mayo, Deborah G. & Aris Spanos (2012) "*Error and the Growth of Experimental Knowledge*." University of Chicago Press, Chicago.

{% **foundations of statistics**: the author gives axiomatizations of the likelihood principle, well acquainted with the work of Evans, Fraser, & Monette (1986). %}

Mayo-Wilson, Conor (2019) "Qulitative, Objective Likelihoodism," lecture at Progic 2019 workshop in Frankfurt, July 8, 2019.

{% **proper scoring rules**: They do not only use the properness condition of de Finetti in terms of preferences (they call this pragmatic) but also an epistemic criterion, referring to distance from true measure in some sense; maybe distance from true

state of nature. They get impossibility results for sets of priors extending preceding results in the literature. %}

Mayo-Wilson, Conor & Gregory Wheeler (2016) "Scoring Imprecise Credences: A Mildly Immodest Proposal," *Philosophy and Phenomenological Research* 93, 55–78.

{% Seem to argue that BDM (Becker-DeGroot-Marschak) is hard to understand. %}

Mazar, Nina, Botond Koszegi, & Dan Ariely (2014) "True Context-Dependent Preferences? The Causes of Market-Dependent Valuations," *Journal of Behavioral Decision Making* 27, 200–208.

{% Seems to have proposed hyperbolic discounting over the interval [t,t+d] (time t and duration d) as (1 + kt)/(1 + k(t+d)). %}

Mazur, James E. (1987) "An Adjusting Procedure for Studying Delayed Reinforcement." *In* Michael L. Commons, James E. Mazur, John A. Nevin, & Howard Rachlin (eds.) *Quantitative Analyses of Behavior 5*, 55–73, Lawrence Erlbaum, Hillsdale NJ.

{% Analyzes saving behavior of family, by relating its risk aversion and prudence to that of its members. Paper shows that, paradoxically, insurance component of risk sharing can raise saving, and that increased prudence of one individual can lower family prudence and, hence, household saving. Hara utility plays an important role, with paradoxes avoided iff all members have same HARA. %}

Mazzocco, Maurizzo (2004) "Saving, Risk Sharing, and Preferences for Risk," *American Economic Review* 94, 1169–1182.

{% Assume expected utility with HARA utility, and also intertemporal separability and separability between consumption and leisure. Show that assumption of homogenous risk preferences can lead astray. Do empirical testing in rural India. Eficient risk sharing is rejected in villages, but accepted in castes. %}

Mazzocco, Maurizio & Shiv Saini (2012) "Testing Efficient Risk Sharing with Heterogeneous Risk Preferences," *American Economic Review* 102, 428–468.

{% %}

McCabe, Kevin, Daniel Houser, Lee Ryan, Vernon Smith, & Theodore Trouard (2001) “A Functional Imagining Study of Cooperation in Two-Person Reciprocal Exchange,” *Proceedings of the National Academy of Sciences* 98, 11832–11835.

{% **probability communication**: graphical ways to communicate small probabilities. %}

McCaffery, Kirsten J., Ann Dixon, Andrew Hayen, Jesse Jansen, Sian Smith, & Judy M. Simpson (2012) “The Influence of Graphic Display Format on the Interpretations of Quantitative Risk Information among Adults with Lower Education and Literacy: A Randomized Experimental Study,” *Medical Decision Making* 32, 532–544.

{% %}

McCaffery Edward J., Daniel Kahneman, & Matthew L. Spitzer (1995) “Framing the Jury: Cognitive Perspectives on Pain and Suffering Awards,” *Virginia Law Review* 81, 1341–1420.

{% %}

MacCallum, Robert C., Shaobo Zhang, Kristopher J. Preacher, & Derek D. Rucker (2002) “On the Practice of Dichotomization of Quantitative Variables,” *Psychological Methods* 7, 19–40.

{% This paper generalizes the Harsanyi aggregation theorem, by considering very general individual preference relations and social preference relation, imposing axioms such as unanimity and anonymity, and then deriving general aggregation rules. Completeness is not required. The paper does so for both fixed and variable population size. The paper does assume probability distributions over social states available.

May I repeat the one-line verbal proof that Wakker (1992, Economic Theory) gave of Harsanyi/Anscombe-Aumann theorems: “If a linear function is a function of linear functions, then the linear function is a linear function of the linear functions.” %}

McCarthy, David, Kalle Mikkola, & Teruji Thomas (2020) “Utilitarianism with and without Expected Utility,” *Journal of Mathematical Economics* 87, 77–113.

{% **proper scoring rules**: Theorem 1: Imagine a forecaster reports subjective probabilities q = (q_1, …, q_n) of events E_1,…,E_n, and gets paid f_i(q), where forecaster wants to maximize subjective expected value w.r.t. subjective probabilities p_1,…,p_n. Then f is a proper scoring rule, giving $q_j = p_j$ in the optimum, if and only if f_j(q) is the partial derivative w.r.t. q_i of a convex function f(q) that is homogeneous of the first degree. %}

McCarthy, John (1956) "Measures of the Value of Information," *Proceedings of the National Academy of Sciences* 42, 654–655.

{% %}

McCarthy, John & Patrick J. Hayes (1969) "Some Philosophical Problems from the Standpoint of Artificial Intelligence." *In* Bernard Meltzer & Donald Michie (eds.) *Machine Intelligence* Vol. 4, 463–502, Edinburgh University Press, Edinburgh, UK.

{% %}

McCauley, Clark, Nathan Kogan, & Allan I. Teger (1971) "Order Effects in Answering Risk Dilemmas for Self and Others," *Journal of Personality and Social Psychology 20*, 423–424.

{% **survey on belief measurement**: survey of calibration; follow-up of Lichtenstein, Fischhoff, & Phillips (1982). %}

McClelland, Alastair & Fergus Bolger (1994) "The Calibration of Subjective Probabilities: Theories and Models 1980-1994." *In* George Wright & Peter Ayton (eds.) *Subjective Probability*, 453–481, Wiley, New York.

{% **risk averse for gains, risk seeking for losses**: For small losses in insurance framework, people are risk neutral for moderate probabilities, for small probabilities some (25% for \$4, 15% for \$40) ignore the risk but most become risk averse.

(very) small probabilities: Seem to show that there are two types of persons, one type fully ignoring small probabilities and the other overweighting them. Nice reference for this point. %}

McClelland, Gary H., William D. Schulze, & Don L. Coursey (1993) "Insurance for Low-Probability Hazards: A Bimodal Response to Unlikely Events," *Journal of Risk and Uncertainty* 7, 35–51.

{% **dynamic consistency** %}
McClennen, Edward F. (1983) "Sure-Thing Doubts." *In* Bernt P. Stigum & Fred Wendstøp (eds.) *Foundations of Utility and Risk Theory with Applications*, 117–136, Reidel, Dordrecht.

{% **dynamic consistency**; discusses resolute choice. P. 100/101 describes **sophisticated choice**. This paper is, to the best of my knowledge, the first to introduce resolute choice. He says that, if prior agent did planning, then posterior agent prefers following that because of the very fact of prior planning. P. 103: "For such agents, the ex post situation is different from what it would have been if there had been no ex ante resolve."

Proposes that because of that the prior agent can get it his way in the dynamic Allais paradox, that Ulysses can sail past the Syrens without extraneous things such as being tied up by his men.

Final paragraph suggests that not only prefs but also consequences themselves, can have been changed as a result of the very fact of prior planning; i.e., that prior planning can be an attribute of a consequence.

Also discusses prisoner's dilemma but I will not discuss that here. %}
McClennen, Edward F. (1985) "Prisoner's Dilemma and Resolute Choice." *In* Richmond Campbell & Lanning Sowden (eds.) *Paradoxes of Rationality and Cooperation*, 94–104, University of British Columbia Press, Vancouver.

{% **dynamic consistency**: f**avors abandoning forgone-event independence, so, favors resolute choice**, mostly in context of prisoners dilemma where it is part of the defended cooperative solution. It is argued that by cooperating the opponent is also made to cooperate so that it is really for higher monetary benefits that one is resolute and cooperative. The term context-sensitive preferences (e.g. §6) and the text show that McClennen thinks, à la Machina, that preferences at some moment depend on counterfactual forgone events. Argues on p. 110/11 that resoluteness can do the same, endogenously, as precommitment, but cheaper. §11 discusses forgone-branch independence (often called consequentialism) and deliberately wants to deviate from it. %}

McClennen, Edward F. (1988) “Constrained Maximization and Resolute Choice,” *Social Philosophy and Policy* 5, 95–118.

{% **dynamic consistency** %}

McClennen, Edward F. (1988) “Dynamic Choice and Rationality.” *In* Bertrand R. Munier (ed.) “*Risk, Decision and Rationality,*” 517–536, Reidel, Dordrecht.

{% **dynamic consistency**: f**avors abandoning forgone-event independence, so, favors resolute choice**

Describe a.o. history of ?independence? in Chs 3 and ??, Par.3.5 and Chrs. 7,8 tell about role of forgone-branch independence with descriptions of contributions by Ramsey and others (Chernoff?)

de novo tree (cut off prehistory);

normal form tree (prior choice, choose from strategies)

Separability of McClennen = consequentialism of Machina = what I like to call forgone-branch independence

dynamic consistency + consequentialism of McClennen =

dynamic consistency of Machina

Myopic: SEP + CON of McClennen, not dynamic consistency

Sophisticated (Strotz schijnt ’t): SEP + DC of McClennen, not CON

Resolute: DC + CON of McClennen, not SEP

Cubitt (1996) mentions “NEC” (normal-extensive coincidence), suggesting it is vague because normal and extensive have not been defined, but suggesting it comprises RCLA + Machina-DC (minus Cubitt-DC?) %}

McClennen, Edward F. (1990) “*Rationality and Dynamic Choice: Foundational Explorations.*” Cambridge University Press, Cambridge.

{% **foundations of statistics**; important criticism;

That people look too much at statistical significance and ignore substantive significance. That, for large samples, one can detect with high significance a minor and fully unimportant difference, gives nice historical examples, e.g., Meehl (1970) with 55,000 high-school students where about everything

correlated with everything significantly. Closing sentence of §III: "The siren song of "significance" is a hazard to navigation." %}

McCloskey, Donald N. (1985) "The Loss function has Been Mislaid: The Rhetoric of Significance Tests," *American Economic Review, Papers and Proceedings* 75, 201–205.

{% Discusses (claimed) misunderstandings of Coase's intentions with his theorem. %}

McCloskey, Deirdere (1998) "Other Things Equal: The So-Called Coase Theorem," *Eastern Economic Journal* 24, 367–371.

{% **real incentives/hypothetical choice, for time preferences**; Seem to use dated checks/vouchers; use **random incentive system** with one choice per person played for real.

Choices with only future rewards involve only cortex, the analytic part of our brains. Choices with one present and one future reward involve both cortex and limbic system; latter is emotional part of brains that we share with virtually all animals. For β-δ (quasi-hyperbolic) model, it is argued that β concerns lymbic system and δ the cortex. N = ?

If they do more difficult choices then visual and motoric parts of brains do not become more active than for simple choices, but analytic parts do.

DC = stationarity in very explicit and annoying manner. P. 504 2nd para: "It is well accepted that rationality entails treating each moment of delay equally, thereby discounting according to an exponential function" %}

McClure, Samuel M., David I. Laibson, George F. Loewenstein, & Jonathan D. Cohen (2004) "Separate Neural Systems Value Immediate and Delayed Monetary Rewars," *Science* 306, 503–507.

{% **utility elicitation: different EU methods give different curves**: p. 188 %}

McCord, Mark R. & Richard de Neufville (1983) "Empirical Demonstration that Expected Utility Analysis is Not Operational." *In* Bernt P. Stigum & Fred Wendstøp (eds.) *Foundations of Utility and Risk with Applications*, 181–199, Reidel, Dordrecht.

{% **utility elicitation**; p. 281 states Raiffa's 1961 argument that a normative theory can be useful only if it sometimes !deviates! from actual behavior, but in a way expressing that the authors don't like the argument.

risky utility u = strength of preference v (or other riskless cardinal utility, often called value): p. 295 observes that differences between utility and value are of same magnitude as various utility functions assessed in different ways. %}

McCord, Mark R. & Richard de Neufville (1983) "Fundamental Deficiency of Expected Utility Decision Analysis." *In* Simon French, Roger Hartley, Lyn C. Thomas, & Douglas J. White (eds.) *Multi-Objective Decision Making*, 279–305, Academic Press, New York.

{% **utility elicitation**; Use 10 specialist subjects. Inductively defining $x_{j+1} \sim (p,x_j; 1-p, 0)$ they calculate vNM utilities under SEU. Utilities depend on p, rejecting SEU. The higher p, the higher the utility. %}

McCord, Mark R. & Richard de Neufville (1984) "Utility Dependence on Probability: An Empirical Demonstration," *Large Scale Systems* 6, 91–103.

{% **utility elicitation**; discrepancies between utility elicitations are greatly reduced if certain outcomes and, therefore, the certainty effect are avoided. %}

McCord, Mark R. & Richard de Neufville (1985) "Assessment Response Surface: Investigating Utility Dependence on Probability," *Theory and Decision* 18, 263–285.

{% **utility elicitation**; recommend not using $\beta \sim (p{:}\gamma, 1-p{:}\alpha)$ but $(\lambda\beta, \underline{1-\lambda{:}c}) \sim (\lambda p{:}\gamma, \lambda(1-p){:}\alpha , \underline{1-\lambda{:}c})$ but for utility elicitation, to avoid the certainty effect.

Find that otherwise utilities depend on probability used in elicitation.

Officer & Halter (1968) argued before (e.g. bottom of p. 259) that a method that does not invoke riskless gambles (called "Ramsey method" in their paper) is better. Davidson, Suppes, & Siegel (1957) did the same, to improve on Mosteller & Nogee (1951) who had used sure outcomes.

A nice theoretical follow-up is Cerreia-Vioglio, Dillenberger, & Ortoleva

(2015). They show that their cautious utility model holds iff M&d always give more risk aversion. %}

McCord, Mark R. & Richard de Neufville (1986) " "Lottery Equivalents": Reduction of the Certainty Effect Problem in Utility Assessment," *Management Science* 32, 56–60.
https://doi.org/10.1287/mnsc.32.1.56

{% Subjects have inconsistencies between choosing and ranking. When confronted with it, all subjects wanted to correct. Slovic & Tversky (1974) follow up on this. %}

MacCrimmon, Kenneth R. (1968) "Descriptive and Normative Implications of the Decision-Theory Postulates." *In* Karl H. Borch & Jan Mossin (eds.) *Risk and Uncertainty*, 3–23, St. Martin's Press, New York.

{% As there existed almost no experimental papers in those days, the authors set their own standards for what an experimental paper is supposed to do. They set their standards high, leading to an impressive comprehensive test of virtually all relevant preference conditions related to EU.

P. 369 §5.3: common ratio brings more EU violations than common consequence.

P. 370 Rule 19: Be ambiguity averse for large stakes, but **ambiguity seeking** for small. Here ambiguity attitude is outcome dependent. (**event/outcome driven ambiguity model: outcome driven**)

P. 377 rule 5 is more or less source preference, although it also brings up chances when explaining to subjects.

second-order probabilities to model ambiguity: p. 379 last para already puts up the point central in Halevy (2007): that ambiguity may result from a perceived 2nd order perception.

P. 380: do Ellsberg with slightly higher outcomes for ambiguous events, to rule out indifference

natural sources of ambiguity: p. 382: "Our general interest, though, is how people treat real situations of uncertainty. … To obtain some information about this, we included the two stock price bets corresponding to the earlier MacCrimmon study, i.e., X´: the price of Pierce Industries goes down (x´) or does not go down ($\bar{x}$´)."

P. 390: Newcomb's problem;

P. 394 ff. §9.3 tests independence of irrelevant alternatives.

P. 398: "Thus there must be some balance struck between redefining consequences to avoid a violation and letting a violation stand."

find that Ellsberg paradox induces more violations of EU than Allais paradox. %}

MacCrimmon, Kenneth R. & Stig Larsson (1979) "Utility Theory: Axioms versus "Paradoxes" ." *In* Maurice Allais & Ole Hagen (eds.) *Expected Utility Hypotheses and the Allais Paradox*, 333–409, Reidel, Dordrecht.

{% %}

MacCrimmon, Kenneth R. & David M. Messick (1976) "A Framework for Social Motives," *Behavioral Science* 2l, 86–100.

{% Have theory of random preference; extensively discussed by Butler & Loomes (2007, American Economic Review). %}

MacCrimmon, Kenneth R. & Maxwell Smith (1986) "Imprecise Equivalences: Preference Reversals in Money and Probability," University of Columbia Working paper 1211.

{% Nice brief didactical paper on which statistical tests to use. %}

McCrum-Gardner, Evie (2008) "Which is the Correct Statistical Test to Use?," *British Journal of Oral and Maxillofacial Surgery* 46, 38–41.

{% %}

McCulloch, Alasdair John (2024) "Ambiguity Transformation Theory: From Risk to Uncertainty," working paper.

{% A Bonetti paper has argued against the systematic prohibition of deception. These authors argue in favor of such a prohibition. %}

McDaniel, Tanga & Chris Starmer (1998) "Experimental Economics and Deception: A Comment," *Journal of Economic Psychology* 19, 403–409.

{% %}

McDaniels, Timothy L. (1995) “Using Judgment in Resource Management: A Multiple Objective Analysis of a Fisheries Management Decision,” *Operations Research* 43, 415–426.

{% **natural-language-ambiguity**: seems to argue that tolerance of ambiguity (in general natural-language sense) is truly related to individual personality traits rather than a situation-dependent/content-specific expression of psychological stress. %}

MacDonald, Alan P. Jr. (1970) “Revised Scale for Ambiguity Tolerance: Reliability and Validity,” *Psychological Reports* 26, 791–798.

{% **PT, applications**, politics %}

McDermott, Rose (2001) “*Risk-Taking in International Politics: Prospect Theory in American Foreign Policy*.” University of Michigan Press, Ann Arbor.

{% %}

MacDonald, Don H, John H. Kagel, & Raymond C. Battalio (1991) “Animals’ Choices over Uncertain Outcomes: Further Experimental Results,” *Economic Journal* 101, 1065–1084.

{% **error theory for risky choice** %}

McFadden, Daniel L. (1974) “Conditional Logit Analysis of Qualitative Choice Behavior.” *In* Paul Zarembka (ed.) *Frontiers of Econometrics*, 105–142, Academic Press, New York.

{% **error theory for risky choice** %}

McFadden, Daniel L. (1976) “Quantal Choice Analysis: A Survey,” *Annals of Economic and Social Measurement* 5, 363–390.

{% **error theory for risky choice**; good reference on representative agent model %}

McFadden, Daniel L. (1981) “Econometric Models of Probabilistic Choice.” *In* Charles F. Manski & Daniel L. McFadden (eds.) *Structural Analysis of Discrete Data and Econometric Applications*, 198–272, MIT Press, Cambridge, MA.

{% P. 97: a large reference list on WTP (“value non-use public goods”) and its discrepancies

P. 98: “…arbitragers are pervasive only in a limited number of highly organized markets, such as financial markets.”

P. 98: second-most expensive wine is the one mostly sold.

P. 99: “Economics needs to catch up to marketing to understand the extent to which the mix and presentation of products reflects anomalies in consumer behavior.”

P. 110, concluding sentence, on constructive preference: “Then, careful attention to the processes that consumers use to define tasks … and construct preferences …may allow one to look behind the superficial errors to uncover stable principles, attitudes, and preferences upon which a new economic analysis might be built.” (See also p. 97.) %}

McFadden, Daniel L. (1999) “Rationality for Economists?,” *Journal of Risk and Uncertainty* 19, 73–105.

{% %}

McFadden, Daniel L. (2001) “Economic Choices,” *American Economic Review* 91, 351–378.

{% **Z&Z & paternalism/Humean-view-of-preference**: End of paper, §VI, will discuss the privatization of Medicare in the US starting Jan 01 2006, and an empirical investigation into consumer choices. The first five sections discuss that people often don’t take optimal decisions because of the many biases, and to what extent they need assistance, referring to libertarian paternalism of Thaler & Sunstein (2003).

P. 12 has nice citation of owner of restaurant who, when told to reposition his wine list so as to increase profits based on behavioral biases, replied:
“tell me something I didn’t learn in hotel school.”
Slovic, Lichtenstein, & Fischhoff (1988 p. 628) have a similar text referring to car salespeople.

§VI is about Medicare Part D, the privatization starting Jan 06. It discusses adverse selection and, what it considers to be more serious, moral hazard, referring to the joint work with Winter et al. (2006), who had 4739 people of 50 years and older fill out forms on self-administered internet questionnaire from November 7–15, 2005. There were N = 1996 Medicare-eligible persons (aged 65

and higher). The paper makes some plausible average-estimates of costs for groups of people, speculates on what optimal decisions are for them, and sees if these groups do what is estimated to be optimal. In particular, they asked subjects to choose between some hypothetical plans, all with same actuarial value. Here subjects often chose suboptimal, such as choose a clearly riskier plan rather than a safer.

P. 23: "The new Medicare Part D prescription drug insurance market illustrates that leaving a large block of uninformed consumers to "sink or swim," and relying on their self-interest to achieve satisfactory outcomes, can be unrealistic. To make the Part D market work, in the sense that it provides choices that consumers want, and achieves the efficiencies it seeks, CMS will have to make a diligent effort to manage the market, and to reach all consumers and provide them with information and assistance in making wise choices." Then it pleas for libertarian paternalism, though not taking all the nuances of libertarian paternalism. %}

McFadden, Daniel L. (2006) "Free Markets and Fettered Consumers," *American Economic Review* 96, 5–29.

{% **error theory for risky choice** %}

McFadden, Daniel L. (2010) "Sociality, Rationality, and the Ecology of Choice." *In* Stefane Hess & Andrew Daly (eds.) *Proceedings from the Inaugural International Chice Modeling Conference*, 1–17, Emerald Group Publishing Limited, Bingley, UK.

{% %}

McFadden, Myra (1963) "*Sets, Relations, and Functions.*" McGraw-Hill, New York.

{% Guessing games find nonlinear probability weights; p 604/605 says it is difficult to measure subjective probability or utility when neither scale is objectively given and processed linearly; **tradeoff method** of Wakker & Deneffe (1996) shows a way!

inverse S: Confirmed; finds risk seeking for low probability high gains, risk neutrality for prob, of gain between .15 and .22, and risk aversion for higher probabilities, from data on betting behavior in horse races (mostly from 1947-1953). %}

McGlothlin, William H. (1956) “Stability of Choices among Uncertain Alternatives,” *American Journal of Psychology* 69, 604–615.

{% The keyword **Best core theory depends on error theory**, not updated since about 2020, in this bibliography gives papers showing that. This paper also discusses the point regarding the common ratio effect. The paper argues, in an experiment and through simulations, that the common ratio effect does not occur under some error theories that they claim are common. However, a paper by Alós-Ferrer, Fehr, Fehr-Duda, & Garagnani (2024) reacted to it by using a permissive error theory that fully confirmed the common ratio effect. So did many other papers and the effect is psychologically very plausible. %}

McGranaghan, Christina, Kirby Nielsen, Ted O’Donoghue, Jason Somerville, & Charles D. Sprenger (2024) “Distinguishing Common Ratio Preferences from Common Ratio Effects Using Paired Valuation Tasks,” *American Economic Review* 114, 307–347. https://doi.org/10.1257/aer.20221535

{% If gains and losses are judged jointly on a common bipolar scale than a loss of a similar size as a gain is judged to generate stronger feelings. If they are judged on different separate scales then this need not be, because subjects may use different normalizations for losses than for gains. This paper also is somewhat related to the question of whether loss aversion in decision making means stronger feelings or similar feelings but being more salient or being weighted more despite not being felt stronger. %}

McGraw, A. Peter, Jeff T. Larsen, Daniel Kahneman, & David Schkade (2010) “Comparing Gains and Losses,” *Psychological Science* 21, 1438–1445.

{% **foundations of statistics** %}

McGrayne, Sharon Bertsch (2011) “*The Theory That Would Not Die: How Bayes’ Rule Cracked the Enigma Code, Hunted down Russian Submarines, and Emerged Triumphant from Two Centuries of Controversy*.” Yale University Press, New Haven, CT.

{% **criticisms of Savage's basic framework**: seems to be discussed on p. 13, where they find Wald's (1950) model more natural than Savage's (1954). %}

McGuire, Charles Bartlett & Roy Radner (1972, eds.) "*Decision and Organization.*" North-Holland, Amsterdam.

{% **Newcomb's problem; conservation of influence**; Biggest problem for evidential decision theory seems to be the medical Newcomb problems. The author argues that new defenses don't work, and that causation remains essential. %}

McKay, Phyllis (2007) "Freedom, Fiction and Evidential Decision Theory," *Erkenntnis* 66, 393–407.

{% **time preference**: find that discounting is not constant; **risk averse for gains, risk seeking for losses**? %}

MacKeigan, Linda D., Lon N. Larson, JoLaine R. Drugalis, J. Lyle Bootman & Lawton R. Burns (1993) "Time Preference for Health Gains versus Health Losses," *Pharmaco Economics* 3, 374–386.

{% **ordering of subsets**; Generalizes the Villegas (1964) axiomatization of comparative probability by allowing for atoms. One way is when there is an atomless event at least as likely as its complement. A second way is if for each atom there is a sort of sufficient richness called third-order swarming. %}

Mackenzie, Andrew (2019) "A Foundation for Probabilistic Beliefs with or without Atoms," *Theoretical Economics* 14, 709–778. https://doi.org/10.3982/TE2427

{% **natural-language-ambiguity**: seems to argue that tolerance of ambiguity (in general natural-language sense) is truly related to individual personality traits rather than a situation-dependent/content-specific expression of psychological stress. %}

McLain, David L. (1993) "The MSTAT-I: A New Measure of an Individual's Tolerance for Ambiguity," *Educational and Psychological Measurement* 53, 183–189.

{% **natural-language-ambiguity**: seem to investigate tolerance of ambiguity (in general natural-language sense) not only from negative perspective regarding threat, discomfort, and anxiety, but also regarding positive aspects such as curiosity and attraction toward ambiguous situations. %}

McLain, David L., Efstathios Kefallonitis, & Kimberly Armani (2015) "Ambiguity Tolerance in Organizations: Definitional Clarification and Perspectives on Future Research," *Frontiers in Psychology* 6, 1–7.

{% **time preference**: study order effects. H**YE** is measured one-stage, p. 115 bottom agrees with criticisms of the two-stage; holistic as well as composite value assessment for lifetime treatment paths? %}

MacKeigan, Linda D., Bernie J. O'Brien, & Paul I. Oh (1999) "Holistic versus Composite Preferences for Lifetime Treatment Sequences for Type 2 Diabetes," *Mediocal Decision Making* 19, 113–121.

{% **common knowledge** %}

McKelvey, Richard & Talbot Page (1986) "Common Knowledge, Consensus, and Aggregate Information," *Econometrica* 54, 109–127.

{% P. 1325 uses the idea to pay in probability at a prize so as to obtain linear utility, referring to a working paper Grether (1981) for it. %}

McKelvey, Richard & Talbot Page (1990) "Public and Private Information: An Experimental Study of Information Pooling," *Econometrica* 58, 1321–1339.

{% Introduced the beautiful concept of Quantal response equilibrium (QRE):

Each player assigns a value to each strategy. The players do not choose the best strategy with probability 1, but choose each strategy with a probability depending on the value of the strategy and some noise parameter. The value of a strategy depends on the probabilities with which the other players choose strategies (e.g. it is its expected utility, or its prospect-theory value). This generates a circularity, with values depending on probabilities and probabilities on values. If such "circular" values and probabilities can nevertheless be assigned consistently, then we have a QRE. %}

McKelvey, Richard & Thomas Palfrey (1995) "Quantal Response Equilibria for Normal Form Games," *Games and Economic Behavior* 10, 6–38. http://dx.doi.org/10.1006/game.1995.1023

{% Have N = 64 students do hypothetical intertemporal choice, and fit exponential discounting and three hyperbolic discounting families, one 1-parameter and two 2-parameter. The 2-parameter fit much better, although they do not statistically punish for the extra parameters. %}

McKerchar, Todd L., Leonard Green, Joel Myerson, T. Stephen Pickford, Jade C. Hill, & Steven C. Stout (2009) "A Comparison of Four Models of Delay Discounting in Humans," *Behavioural Processes* 81, 256–259.

{% **completeness criticisms** & **quasi-concave so deliberate randomization**: Considers cases where persons prefer to have a lottery over prospects rather than any of them, as an instance of incompleteness (called undecideness on p. 239), and other configurations of incompleteness. P. 244 discusses Danan's operationalization through preference for delay (may relate to changes of mind), and Eliaz & Ok's (2006) intransitivity operationalization. %}

McKiernan, Daniel Kian (2012) "Indifference, Indecision, and Coin-Flipping," *Journal of Mathematical Economics* 48, 237–246.

{% **SIIA/IIIA** %}

McLean, Iain (1995) "Independence of Irrelevant Alternatives before Arrow," *Mathematical Social Sciences* 30, 107–126.

{% **random incentive system between-subjects** (paying only some subjects): 1/10 of subjects was paid. **real incentives/hypothetical choice, for time preferences**: Receive payment in either 2 or 5 weeks. Implementation not further specified, and subjects sampling not either.

Investigate how people predict intertemporal choices by others. %}

McLeish, Kendra N. & Robert J. Oxoby (2009) "Stereotypes in Intertemporal Choice," *Journal of Economic Behavior and Organization* 70, 135–141.

{% **statistics for C/E** %}

McNeil, Barbara J., Robert A. Dudley, Bernard Hoop, Charles Metz, Mark Thompson, & James Adelstein (1981) "A Cost-Effectiveness Analysis of Screening for Hepatitis B Surface Antigen in India," *Medical Decision Making* 1, 345–359.

{% framing à la Asian disease (now in 2024 I find this term politically incorrect); %}
McNeil, Barbara J., Stephen G. Pauker, Harold C. Sox, & Amos Tversky (1982) "On the Elicitation of Preferences for Alternative Therapies," *New England Journal of Medicine* 306, 1259–1262.

{% %}
McNeil, Barbara J., Stephen G. Pauker, & Amos Tversky (1982) "On the Framing of Medical Decisions." *In* David E. Bell, Howard Raiffa, & Amos Tversky (1988, eds.) "*Decision Making, Descriptive, Normative, and Prescriptive Interactions*," 562–568, Cambridge University Press, Cambridge.

{% **simple decision analysis cases using EU**;
real incentives/hypothetical choice: This paper is a classic that founded medical decision making. It uses the CE (certainty equivalent) method to elicit the utility of life duration. **These questions can only be hypothetical (p. 1398 top)!** By the criterion, advocated by many experimental economists, that only real-incentive choices should be considered, this paper should be ignored, and most of the field of medical decision making should be closed down.
They find extreme risk aversion. %}
McNeil, Barbara J., Ralph Weichselbaum, & Stephen G. Pauker (1978) "Fallacy of the Five-Year Survival in Lung Cancer," *New England Journal of Medicine* 299, 1397–1401.

{% **simple decision analysis cases using EU**;
utility elicitation; Use CEs (certainty equivalents) to measure utility for life duration, then TTOs for artificial speech, then calculated adjusted TTO. %}
McNeil, Barbara J., Ralph Weichselbaum, & Stephen G. Pauker (1981) "Speech and Survival: Tradeoffs between Quality and Quantity of Life in Laryngeal Cancer," *New England Journal of Medicine* 305, 982–987.

{% %}

McNeil, Alexander J., Rüdiger Frey, & Paul Embrechts (2015) "*Quantitative Risk Management: Concepts, Techniques and Tools*," Revised Edition. Princeton University Press, Princeton.

{% **paternalism/Humean-view-of-preference**: Opening sentences say, as did Arrow long ago, that long time both normative and descriptive studies assumed rationality, and that it changed early 1980s, when they departed. Now there is what the authors call the reconciliation problem.

P. 556: Freedom interpretation appeals to free choice and consumer sovereignty. (Evolutionary justification could be: If let all choose what they want, the best will survive. This evolutionary argument ignores evolution at the group level.) Section 2 nicely relates Kahneman et al.'s (1997) Back to Bentham to the happiness literature. I favor the approach described in Abdellaoui, Barrios, & Wakker (2007), where introspective data is to be used when it can be related to revealed-preference data. We should keep the virtues of the ordinal revolution.

Section 3 uses term soft paternalism to combine libertarian and asymmetric paternalism.

P. 560 top says that nudging takes advantage of preference incoherence. I would rather take it as preference incompleteness, although one can lead that into incoherence by letting variations in framing decide.

P. 560 $\ell\ell$. –9 ff. takes loss aversion as a "fundamental asymmetry in human desire, rather than a mistake …" This is opposite to definitions/intrpretations that I prefer, where loss aversion is a pure framing effect distinct from the rational basic utility.

P. 561 discusses Bleichrodt, Pinto, & Wakker (2001) but, incorrectly, claims that BPW would consider reference dependence as true preference rather than a bias. This is not so.

Section 4 is on consumer sovereignty as discussed by some people. %}

McQuillin, Ben & Robert Sugden (2012) "Reconciling Normative and Behavioural Eonomics: The Problems to Be Solved," *Social Choice and Welfare* 38, 553–567.

{% Builds on Sugden's model where freedom of choice and opportunity sets have intrinsic value. %}

McQuillin, Ben & Robert Sugden (2012) "How the Market Responds to Dynamically Inconsistent Preferences," *Social Choice and Welfare* 38, 617–634.

{% Noncooperative coalitional bargaining, solvable by backward induction, leading to Shapley value. %}

Mcquillin, Ben & Robert Sugden (2016) "Backward Induction Foundations of the Shapley Value," *Econometrica* 84, 2265–2280.

{% **foundations of statistics**: argue for keeping p-values, but no more setting a threshold and just taking it as a continuous index. %}

McShane, Blake, David Gal, Andrew Gelman, Christian Robert, and Jennifer Tackett (2019) "Abandon Statistical Significance," *American Statistician* 73, 235–245. https://doi.org/10.1080/00031305.2018.1527253

{% **utility families parametric**: use (Eq. 10) an IPT (inverse-power transformation) family,

$1/\big(1+\exp(-\alpha-\beta(1/k)\log(1+kX))\big)$

which is S-shaped. %}

Meade, Nigel & Towhidul Islam (1995) "Forecasting with Growth Curves: An Empirical Comparison," *International Journal of Forecasting* 11, 199–215.

{% %}

Meder, David, Finn Rabe, Tobias Morville, Kristoffer H. Madsen, Magnus T. Koudahl, Ray J. Dolan, Hartwig R. Siebner, & Oliver J. Hulme (2019) "Ergodicity-Breaking Reveals Time Optimal Economic Behavior in Humans," working paper, Danish Research Centre for Magnetic Resonance, Copenhagen University Hospital Hvidovre, Hvidovre, Denmark.

{% **measure of similarity;** Do what their title says. %}

Medin, Douglas L., Robert L. Goldstone, & Arthur B. Markman (1995) "Comparison and Choice: Relations between Similarity Processes and Decision Processes," *Psychonomic Bulletin and Review* 2, 1–19.

{% **losses from prior endowment mechanism**: Subjects received $2. They could either insure a 0.01 probability of losing the $2, or reeive the expected value of it, $0.02. Most preferred the insurance. This may be due to loss aversion and probability weighting. Here transaction costs of the $0.02 transaction may also play a role. %}

Meeker, Daniella, Christin Thompson, Greg Strylewicz, Tara K. Knight, & Jason N. Doctor (2015) "Use of Insurance Against a Small Loss as an Incentive Strategy," *Decision Analysis* 12, 122–129.

{% **intuitive versus analytical decisions** %}

Meehl, Paul E. (1954) "*Clinical versus Statistical Prediction: A Theoretical Analysis and a Review of the Evidence*." University of Minnesota Press, Minnesota.

{% %}

Meester, Ronald, Marieke Collins, Richard Gill, & Michiel van Lambalgen (2006) "On the (Ab)Use of Statistics in the Legal Case against the Nurse Lucia de B.," *Law Probability and Risk* 5, 233–250.

{% Introduced the equity premium puzzle; if people who bought stocks just before the 1929 stock market crash held on to their stocks for 30 years they would be better off than with bonds.

Use power utility, p. 154 list about five empirical estimates of power. %}

Mehra, Rajnish & Edward C. Prescott (1985) "The Equity Premium: A Puzzle," *Journal of Monetary Economics* 15, 145–162.

{% Trivial rewriting of an axiom of Keeney & Raiffa and much talking that that increase insight etc. %}

Mehrez, Abraham & Amiram Gafni (1985) "A Note on an Application of the Trade-Off Method in Evaluating a Utility Function," *Managerial Decis. Econ.* 6, 191–192.

{% **utility elicitation** %}

Mehrez, Abraham & Amiram Gafni (1987) "An Empirical Evaluation of Two Assessment Methods for Utility Measurement for Life Years," *Socio-Econ. Plann. Sci.* 21, 371–375.

{% **utility elicitation** %}

Mehrez, Abraham & Amiram Gafni (1987) "The Optimal Treatment Strategy: A Patient's Perspective," *Management Science* 33, 1602–1612.

{% **utility elicitation** %}

Mehrez, Abraham & Amiram Gafni (1989) "Quality-Adjusted Life-Years, Utility Theory and Healthy Years Equivalents," *Medical Decision Making* 9, 142–149.

{% **utility elicitation** %}

Mehrez, Abraham & Amiram Gafni (1990) "Evaluating Health Related Quality of Life: An Indifference Curve Interpretation for the Time Trade-Off Technique," *Social Science and Medicine* 31, 1281–1283.

{% **utility elicitation** %}

Mehrez, Abraham & Amiram Gafni (1991) "Healthy Years Equivalents: How to Measure Them Using the Standard Gamble Method," *Medical Decision Making* 11, 140–146.

{% **utility elicitation** %}

Mehrez, Abraham & Amiram Gafni (1993) Reply, *Medical Decision Making* 13, 168–169.

{% **utility elicitation**; %}

Mehrez, Abraham & Amiram Gafni (1993) "Healthy Years Equivalents versus Quality-Adjusted Life Years: In Pursuit of Progress," *Medical Decision Making* 13, 287–292.

{% **one-dimensional utility** %}

Mehta, Ghanshyam B. (1998) "Preference and Utility." *In* Salvador Barberà, Peter J. Hammond, & Christian Seidl (eds.) *Handbook of Utility Theory, Vol. 1, Principles*, 1–47, Kluwer Academic Publishers, Dordrecht.

{% %}
Mehta, Judith, Chris Starmer, & Robert Sugden (1992) "An Experimental Investigation of Focal Points in Coordination and Bargaining: Some Preliminary Results." *In* John F. Geweke (ed.) *Decision Making under Risk and Uncertainty: New Models and Findings*, 211–220, Kluwer Academic Publishers, Dordrecht.

{% %}
Mehta, Judith, Chris Starmer, & Robert Sugden (1994) "Focal Points in Pure Coordination Games: An Experimental Investigation," *Theory and Decision* 36, 163–185.

{% Apparenty the first paper to systematically do the informal tests of focal points that Schelling had done informally. They add things such as a control group to verify that there is no system in random answering, so that there is really a focal-point thing going on. %}
Mehta, Judith, Chris Starmer, & Robert Sugden (1994) "The Nature of Salience: An Experimental Investigation of Pure Coordination Games," *American Economic Review* 84, 658–674.

{% **Christiane, Veronika & I** %}
Meier-Pesti, Katja & Erich Kirchler (2003) "Attitudes towards the Euro by National Identity and Relative National Status," *Journal of Economic Psychology* 24, 293–299.

{% **foundations of probability** %}
Meijs, Wouter (2005) "Probabilistic Measures of Coherence," Ph.D. dissertation.\

{% This paper measures risk aversion, loss aversion, discounting, and present bias, for subjects from eight countries in Europe. N > 12,000 subjects. They correlate those with demographic variables. For parametric families, they use quasi-

hyperbolic discounting for time. For risk, they assume EU but with sign dependence and a kink in utility at 0. They call is prospect theory but their footnote 13 writes that they do not consider probability weighting. They thus use sign-dependent CRRA utility with a kink at 0. Section 2, pp. 80-84, usefully surveys many other studies that did the same, e.g. in Table 2.

P. 78 is typical of experimental economists when writing: "Preferences are elicited using Multiple Price List (MPL) designs, as *introduced* by Holt and Laury (2002) for risk preferences, and by Coller and Williams (1999) for time preferences." [italics added] (**Prospect theory not cited**)

Findings:

risk aversion is negatively correlated with income

negative relationship between risk aversion and cognitive ability (**cognitive ability related to risk/ambiguity aversion**)

time discounting is negatively associated with age

men are also more present biased than women.

older respondents and males are less loss averse. (**relation age-risk attitude**) %}

Meissner, Thomas, Xavier Gassmann, Corinne Faure, & Joachim Schleich (2023) "Individual Characteristics Associated with Risk and Time Preferences: A Multi Country Representative Survey," *Journal of Risk and Uncertainty* 66, 77–107. https://doi.org/10.1007/s11166-022-09383-y

{% An experiment, where the receipt of info should have no strategic value. Cite much literature on this. The experiment is model-free, but the authors use the Epstein-Zin model for analyzing. In this regard, they emphasize having consumption rather than money. %}

Meissner, Thomas & Philipp Pfeiffer (2022) "Measuring Preferences over the Temporal Resolution of Consumption Uncertainty," *Journal of Economic Theory* 200, 105379.

{% **real incentives/hypothetical choice**: seems to be on it:

Peep & I: Under heading of "Post-Experimental Interviews," just before Discussion: They confronted subjects with their violations of dominance. All subjects then wanted to change their replies. %}

Mellers, Barbara A., Patricia M. Berretty, & Michael H. Birnbaum (1995) "Dominance Violations in Judged Prices of Two- and Three-Outcome Gambles," *Journal of Behavioral Decision Making* 8, 201–216.

{% %}

Mellers, Barbara A., Shi-jie Chang, Michael H. Birnbaum, & Lisa D. Ordóñez (1992) "Preferences, Prices, and Ratings in Risky Decision Making," *Journal of Experimental Psychology: Human Perception and Performance* 18, 347–361.

{% %}

Mellers, Barbara A. & Alan D.J. Cooke (1992) "Tradeoffs Depend on Attribute Range," *Journal of Experimental Psychology: Human Perception and Performance* 20, 1055–1067.

{% %}

Mellers, Barbara A., Lisa D. Ordóñez, & Michael H. Birnbaum (1992) "A Change-of-Process Theory for Contextual Effects and Preference Reversals in Risky Decision Making," *Organizational Behavior and Human Decision Processes* 52, 331–369.

{% %}

Mellers, Barbara A., Virginia Richards, & Michael H. Birnbaum (1992) "Distributional Theories of Impression Formation," *Organizational Behavior and Human Decision Processes* 51, 313–343.

{% Show that risk attitudes depend on the domain of risk, also if only financial risk. %}

Mellers, Barbara A. & Ilana Ritov (2010) "How Beliefs Influence the Relative Magnitude of Pleasure and Pain," *Journal of Behavioral Decision Making* 23, 369–382.

{% Ask subjects, after lottery is played, how elated versus disappointed they felt. Of course, elation/disappointment depends on the other options and outcomes. Thus, a negative outcome in some situation can give higher elation than a positive

outcome in another situation. Note that elation/disappointment is not hedonic utility as in Kahneman, Wakker, & Sarin (1997) but is only a special regret-like emotion. The term "emotional" in the title refers to this measure of elation/disappointment **real incentives/hypothetical choice**: They told the subjects there would be real payment according to the sum total of the payments in all the gambles they participated in, but in reality gave each subject a predetermined payment which the subjects seem not to have noticed. %}

Mellers, Barbara A., Alan Schwartz, Katty Ho, & Ilana Ritov (1997) "Decision Affect Theory: Emotional Reactions to the Outcomes of Risky Options," *Psychological Science* 8, 423–429.

{% They discuss the IARPA forecast tournament. In 2011 the Intelligence Advanced Research Project Agency (IARPA; https://www.iarpa.gov/index.php/about-iarpa), the research wing of the intelligence community, sponsored a multiyear forecasting tournament. Five university-based programs competed to develop the most innovative and accurate methods possible to predict a wide range of geopolitical events. But they analyze one small subquestion: If a group that participated in it, gives more nuanced answers to subjective-attitude questions about politics or so but unrelated to the questions of the competition, than a control group who did not participated. They find it weakly. One confound can be that the experimental group just got conditioned to answer in refined ways for this experiment, losing this attitude the moment they are outside this experiment.

The authors have an enthusiastic style when writing about their forecasting tournaments, as for instance on their 2nd page: "Tournaments are inherently multifaceted manipulations that have arisen in response to the practical demands of real-world organizations to provide policy-makers with timely probability estimates of the consequences of options (Tetlock & Gardner, 2015; Wolfers & Zitzewitz, 2004)." Or the last page: "Notwithstanding this litany of limitations, we caution against underestimating the societal value of forecasting tournaments."

A nice text that logically distinct concepts can still be empirically related: "From a formal philosophical perspective, these two classes of variables are clearly logically distinct. Forecasts are beliefs about matters of (future) fact, whereas policy attitudes are ultimately value judgments about what society ought to do. But of course that does not imply that fact-grounded forecasts and value-grounded attitudes must also be psychologically distinct."

Section 3.5, on incentives: It is important for properness that there are no other incentives interfering. The description of the incentives here is vague though. For example, is “dependent upon one’s skills” linear?? %}

Mellers, Barbara A., Philip Tetlock, & Hal R. Arkes (2019) “Forecasting Tournaments, Epistemic Humility and Attitude Depolarization,” *Cognition*, 188, 19–26.

{% Nice title.

P. 229 Figure 4 depicts the basic model, with H transforming physical stimulus (probability, outcome, or whatever) into subjective perception (decision weight, utility, or whatever), then C turning subjective perception into subjective value evaluation (such as EU), and then J turning this subjective value into response to experimental question (e.g. monetary equivalent, binary choice, and so on). The authors discuss the related separation for some models, where it is usually debatable, of course. Then they discuss it for their preferred theory: Change-of-process theory. The latter assumes subjective perception H (or at least utility u) constant, and only what comes after changes per context.

Pp. 231 ff. describes the theory that is the authors’, and also my, favority: Change-of-process theory. It assumes that the utility function is invariant, and it is the other components that are changing and causing preference reversals (something the title also refers to). But what I found missing is any argument for it. It is presented out of the blue. My argument comes from something that psychologists do not think about: The normative approach. I think that EU is normative, so, each person has a utility function representing him if-he-were-rational. Hence, I try to find their utility functions, resolving all biases at best no matter how many they are. And thus I have a prior belief in the existence of invariant utility prior to having seen any data. The authors do not think this way, at the end of §VII doubting the very existence of true preferences.

P. 232: Strangely enough, the authors assume a model for one-nonzero-outcome prospects that combines probabilities and outcomes additively rather than multiplicatively. This cannot work well for probability 0 (and, similarly, outcome 0). They investigate this mathematical problem the Ψ way: By running an experiment. (So, they had subject choose between a 0 chance of gaining $200 and a 0 chance of gaining $100, for instance). P. 234 3rd para describes the results: The experiment confirms the mathematical failure of their model. To defend, they resort to Ψ's ultimate weapon: context dependence!

Section VII last para similarly investigates the philosophical question of the existence of true preference by doing an experiment.

Pp. 242-243, **risky utility u = strength of preference v (or other riskless cardinal utility, often called value)**: they indicate the support of their change-of-process theory, and their supportive experimental findings, for this view. %}

Mellers, Barbara A., Elke U. Weber, Lisa Ordonez, & Alan D.J. Cooke (1995) "Utility Invariance despite Labile Preferences," *Psychology of Learning and Motivation* 32, 221–245.

{% On the violations of monotonicity generated by the zero-outcome effect. For example, (.95, $96; .05, $24) receives lower CE (certainty equivalent) than (.95, $96; .05, $0) (p. 339 2nd column 2nd paragraph.).

real incentives/hypothetical choice: pp. 82-83 explain that 36% violated dominance with real incentives, 45% with hypothetical; difference was nonsignificant. %}

Mellers, Barbara A., Robin Weiss, & Michael H. Birnbaum (1992) "Violations of Dominance in Pricing Judgments," *Journal of Risk and Uncertainty* 5, 73–90.

{% Measure additive subjective beliefs using the exchangeability method and analyze them. %}

Menapace, Luisa, Gregory Colson, & Roberta Raffaelli (2015) "Climate Change Beliefs and Perceptions of Agricultural Risks: An Application of the Exchangeability Method," *Global Environmental Change* 35, 70–81.
https://doi.org/10.1016/j.gloenvcha.2015.07.005

{% Nice didactical introduction to topology, very elementary (explaining sets, intersections, etc.). Especially nice because there is a whole chapter on the elementary aspects of connectedness. %}

Mendelson, Bert (1962) "*Introduction to Topology*." Dover Publications, New York. (3rd edn. 1990)

{% %}

Meng, Juanjuan & Xi Weng (2017) "Can Prospect Theory Explain the Disposition Effect? A New Perspective on Reference Points," *Management Science* 64, 3331–3351.

{% **foundations of statistics**; p. 1143, 2nd paragraph refers to some people who criticize p-value for violating likelihood principle. %}

Meng, Xao-Li (1994) "Posterior Predictive p-Values," *Annals of Statistics* 22, 1142–1160.

{% Measure risk attitudes for three groups: (1) subjects who did DUR before; (2) subjects who did decision under ambiguity before where they knew the set of possible outcomes; (3) subjects who did decision under ambiguity before where they did not entirely know the set of possible outcomes. As the authors properly discuss on p. 153, Case (3) can be considered to be a special case of Case (2), but it is one with more ambiguity. The authors find that subjects become more risk averse as they were exposed to more ambiguity before. This is a spillover effect. %}

Mengel, Friederike, Elias Tsakas, & Alexander Vostroknutov (2016) "Past Experience of Uncertainty Affects Risk Aversion," *Experimental Economics* 19, 151–176.

{% Seems to be one of the inventors of marginal utility, together with Jevons and Walras.

marginal utility is diminishing: according to Larrick one of the first to suggest decreasing marginal utility. %}

Menger, Karl (1871) "*Principles of Economics.*" Translated into English by James Dingwall & Bert F. Hoselitz, Free Press of Glencoe, New York, 1950.

{% Points out that St. Petersburg-like gambles with infinite expected utility can be constructed as soon as utility is unbounded.

Suggests that people ignore (discount?) **(very) small probabilities**. Suggests that people would not pay one dollar for a probability of 1/10,000,000 to gain

$10,000,000. However, big lotteries in Spain suggest otherwise.

Footnote 11 on p. 221 in the English translation (and, it seems to be, a footnote on p. 471 of the original) refers to Buffon as the first to suggest that people neglect very small probabilities. Buffon seems to take as example a probability of 1/10189 for a fifty-year old man to die within the next 24 hours, which, he says, people perceive as zero. %}

Menger, Karl (1934) "Das Unsicherheitsmoment in der Wertlehre," *Zeitschrift für National-ökonomie* 51, 459–485. Translated into English by Wolfgang Schoellkopf as "The Role of Uncertainty in Economics," *in* Shubik, Martin (1967, ed.) "*Essays in Mathematical Economics in Honor of Oskar Morgenstern*," Princeton University Press, Princeton, NJ, 211–231.

{% Foreword announcing many papers propagatng the Bayesian approach. %}

Mengersen, Kerrie L. & Christian P. Robert (2014) "Big Bayes Stories—Foreword," *Statistical Science* 29, 1.
https://doi.org/10.1214/14-sts467

{% %}

Menges, Günter (1974, ed.) "*Information, Inference and Decision.*" Reidel, Dordrecht.

{% Benartzi & Thaler (1995) like explanation for the paradox of momentum returns. The momentum returns claims that buying stock that fared well last period and selling those that fared worst give better returns than market. %}

Menkhoff, Lukas & Maik Schmeling (2006) "A Prospect-Theoretical Interpretation of Momentum Returns," *Economics Letters* 93, 360–366.

{% Consider seven ways to measure risk aversion, of which four relate to incentivized risky choices, one to hypothetical choice, and two concern introspective measurements. Combinations of the seven of course improve predictive power. %}

Menkhoff, Lukas & Sahra Sakha (2017) "Estimating Risky Behavior with Multiple-Item Risk Measures," *Journal of Economic Psychology* 59, 59–86.

{% **statistics for C/E** %}

Mennemeyer, Stephen T. & Louis P. Cyr (1997) “A Bootstrap Approach to Medical Decision Analysis,” *Journal of Health Economics* 16, 741–747.

{% **real incentives/hypothetical choice**: This paper compares real incentives vs. hypothetical choice for risk aversion, time preference, and environmental evaluations. It finds little difference. The paper is typical of some experimental economics papers in only citing within-clan. (**Prospect theory not cited**) %}

Mentzakis, Emmanouil & Jana Sadeh (2021) “Experimental Evidence on the Effect of Incentives and Domain in Risk Aversion and Discounting Tasks,” *Journal of Risk and Uncertainty* 62, 203–224. https://doi.org/10.1007/s11166-021-09354-9

{% **value of information**: estimates value of future research by taking expected value of info and then simulating results of the future research. %}

Menzies, Nicolas A. (2016) “An Efficient Estimator for the Expected Value of Sample Information,” *Medical Decision Making* 36, 308–320.

{% **PT, applications**: in political science
Prospect theory/Rank-Dependent Utility most popular for risk: Abstract: “Prospect theory is the most influential behavioral theory of choice in the social sciences.” %}

Mercer, Jonathan (2005) “Prospect Theory and Political Science,” *Annual Review Political Science* 8, 1–21.

{% **ranking economists**: Table 2 & p. 402 write that Kahneman & Tversky (1979) is the most-cited paper in business and economics. %}

Merigó, Jose Maria, Alba Rocafort, & Juan Pedro Aznar-Alarcón (2016) “Bibliometric Overview of Business & Economics Research,” *Journal of Business Economics and Management* 17, 397–413. https://doi.org/10.3846/16111699.2013.807868

{% They ask financial traders introspective questions, about how they anticipate future gains/losses and how they experience gains/losses already realized. For anticipation, loss aversion is two, but for experience it is less than 1.5. %}

Merkle, Christoph (2020) “Financial Loss Aversion Illusion,” *Review of Finance* 24, 381–413.

{% A follow-up on Imas, Alex (2016 AER). They find higher risk taking after unrealized gains but the same after unrealized losses. But they do not find things, going partly against Imas (2016), if there is no positive skew. %}

Merkle, Christoph, Jan Müller-Dethard, & Martin Weber (2021) “Closing a Mental Account: The Realization Effect for Gains and Losses,” *Experimental Economics* 24, 303–329.
https://doi.org/10.1007/s10683-020-09663-x

{% Seems to give definition of nonatomic finitely additive probability measure but is abstract. %}

Mertens, Jean-François (1990) “Extension of Games, Purification of Strategies, and Lyapunov’s Theorem.” *In* Jean-Jaskold Gabszewicz, Jean-François Richard, & Laurence A. Wolsey (eds.) *Economic Decision-Making: Games, Econometrics and Optimisation*, Contributions in Honour of Jacques H. Drèze, North-Holland, Amsterdam.

{% Harsanyi (1968) formulated games with incomplete information with the concept of type of player, getting a Nobel prize for it. But Harsanyi is not 100% mathematician because because type is a circular definition, comprising probability distributions over types. Zamir once told me, in positive words, that Harsanyi was very good because he made the “right mistakes.” As I see it, Mertens & Zamir (1985) did the real work, in this paper. Unfortunately, this paper has been written in a completely inaccessible manner, as I had to decide after investing some three days, and others confirmed. Brandenburger & Dekel (1993) seems to be readable version. %}

Mertens, Jean-François & Shmuel Zamir (1985) “Formulation of Bayesian Analysis for Games with Incomplete Information,” *International Journal of Game Theory* 14, 1–29.

{% %}

Merton Robert C. (1969) "Lifetime Portfolio Selection under Uncertainty: The Continuous-Time Case," *Review of Economics and Statistics* 51, 247–257.

{% **utility families parametric**: Table I p. 389 describes the HARA (hyperbolic absolute risk aversion) family. It contains

(1) For $\gamma \leq 1$: the power family with powers not exceeding 1, where both the function and its argument can be translated.

(2) For $\gamma \leq 1 < \infty$: $-(k-x)^\gamma$ only for $x \leq k$. For x exceeding k the function would be decreasing for natural numbers γ and imaginary for other γ, so, not nice. This function is again concave.

(3) The exponential family (for $\gamma = \infty$).

. %}

Merton, Robert C. (1971) "Optimum Consumption and Portfolio Rules in a Continuous-Time Model," *Journal of Economic Theory* 3, 373–413.

{% Seems to discuss that often time is ready for a good idea, and then many researchers independently invent that idea. Example can be rank-dependent utility by Weymark (1981), Quiggin (1982), Yaari (1987), Allais (1988), with the same idea for uncertainty by Schmeidler (1989). %}

Merton, Robert C. (1973) "*The Sociology of Science.*" University of Chicago Press, Chicago.

{% %}

Merton, Robert C. (1973) "Theory of Rational Option Pricing," *Bell Journal of Economics and Management Science* 4, 141–183.
https://doi.org/10.2307/3003143

{% %}

Merton, Robert C. (1993) "Operation and Regulation in Financial Intermediation: A Functional Perspective." *In* Peter Englund (ed.) *Operation and Regulation of Financial Markets*, 17–68, The Economic Council, Stockholm.

{% Consider some properties of functionals defined on infinite sequences $x_1,x_2, \ldots,$ such as comononic additivity, with several examples with special roles for liminf, limsup, and the like. Nice term: Infinitary operator. No reference to Koopmans or intertemporal choice, but oriented towards the fuzzy literature. %}
Mesiar, Radko & Endre Pap (2008) "Aggregation of Infinite Sequences," *Information Sciences* 178, 3557–3564.

{% Finds a very strong positive correlation between chocolate consumption and number of Nobel prizes in economics, per inhabitant, for countries. An exception is Sweden that has way more Nobel prizes, maybe because of a home bias. %}
Messerli, Franz H. (2012) "Chocolate Consumption, Cognitive Function, and Nobel Laureates," *New England Journal of Medicine* 367, 1562–1564.
http://dx.doi.org/10.1056/nejmon1211064

{% %}
Meyer, Andrew & Shane Frederick (2021) "Forming and Revising Intuitions," working paper.

{% The longshot bias in financial markets may be explained because a high payoff is salient in its context and there comes less sensitivity to probability. %}
Meyer, Andrew & Sean Hundtofte (2023) "The Longshot Bias Is a Context Effect," *Management Science* 69, 6954–6968.
https://doi.org/10.1287/mnsc.2023.4684

{% **decreasing ARA/increasing RRA**: reviews several studies, and mostly supports it.
This paper examines what a transformation of a scale does to the index of relative risk aversion, theoretically, and in some empirical studies. %}
Meyer, Donald J. & Jack Meyer (2005) "Relative Risk Aversion: What Do We Know?," *Journal of Risk and Uncertainty* 31, 243–262.

{% **conservation of influence**: Paper proposes to use marginal utility rather than absolute utility, supporting the view that differences of utility are more basic than utility, which is the insight of the marginal revolution. It nicely takes up Pratt's

(1964) insights.

§4, nicely, explains how decision theory can be done with marginal utility rather than absolute utility. EU can be calculated doing integration by parts (requiring the distribution function and not just the density function).

The paper in §5 proposes a new parametric family of utility, with marginal utilities specified such that both absolute and relative risk aversion have constant elasticity. There is no closed expression for absolute utility then, the primitive of marginal utility. %}

Meyer, Jack (2010) "Representing Risk Preferences in Expected Utility Based Decision Models," *Annals of Operations Research* 176, 179–190.

{% %}

Meyer, Jack & Robert H. Rasche (1992) "Sufficient Conditions for Expected Utility to Imply Mean-Standard Deviation Rankings: Empirical Evidence Concerning the Location and Scale Condition," *Economic Journal* 102, 91–106.

{% %}

Meyer, Richard F (1976) "Preferences over Time." *In* Ralph L. Keeney & Howard Raiffa (1976) *Decisions with Multiple Objectives*, 473–514, Wiley, New York (2nd edn. 1993, Cambridge University Press, Cambridge).

{% Suggest use of PT? %}

Meyerowitz, Beth E. & Shelly Chaiken (1987) "The Effect of Message Framing on Breast Self-Examination Attitudes, Intentions, and Behavior," *Journal of Personality and Social Psychology* 52, 500–510.

{% They test stimuli as in Andreoni & Sprenger (2012), but with different correlations. A mistake of A&S was that their theoretical analysis assumes correlations but their stimuli have stochastic independence. This paper (M&Z) uses stimuli with correlations properly implemented and shows that a separation between risk attitude and intertemporal substitution, rather than the certainty effect suggested by A&S, can explain the findings, referring to nonexpected utility theories like Epstein & Zin (1989).

Related comments were made by Cheung (2015 AER) and Epper & Fehr-Duda (2015 AER). %}

Miao, Bin & Songfa Zhong (2015) "Risk Preferences Are not Time Preferences: Separating Risk and Time Preference: Comment," *American Economic Review* 105, 2272–2286. https://doi.org/10.1257/aer.20131183

{% **quasi-concave so deliberate randomization**: they find this for welfare allocations. %}

Miao, Bin & Songfa Zhong (2018) "Probabilistic Social Preference: How Machina's Mom Randomizes Her Choice," *Economic Theory* 65, 1–24. https://doi.org/10.1007/s00199-016-1015-y

{% %}

Miao, Jianjun & Neng Wang (2011) "Risk, Uncertainty, and Option Exercise," *Journal of Economic Dynamics and Control* 35, 442–461.

{% %}

Michell, Joel (1986) "Measurement Scales and Statistics: A Clash of Paradigms," *Psychological Bulletin* 100, 398–407.

{% Seems to have nice discussion of psychological use of additive conjoint measurement. Pp. 47-59 seem to discuss Hölder in detail. %}

Michell, Joel (1990) "*An Introduction to the Logic of Psychological Measurement*." Lawrence Erlbaum Associates, Hillsdale, NJ.

{% %}

Michell, Joel (1993) "The Origins of the Representational Theory of Measurement: Helmholtz, Hölder, and Russell," *Stud. Hist. Phil. Sci.* 24, 185–206.

{% %}

Michell, Joel (1999) "*Measurement in Psychology: Critical History of a Methodological Concept*." Cambridge University Press, New York.

{% %}

Michenaud, Sebastien & Bruno Solnik (2008) “Applying Regret Theory to Investment Choices: Currency Hedging Decisions,” *Journal of International Money and Finance* 27, 677–694.

{% **foundations of probability**: discusses that in diagnosis uncertainty should be processed through probabilities and Bayes formula. %}

Miettinen, Olli S. (2001) “The Modern Scientific Physician: 3. Scientific Diagnosis,” *Canadian Medical Association Journal* 18, 781–782.

{% %}

Miguel, Edward (2021) “Evidence on Research Transparency in Economics,” *Journal of Economic Perspectives* 35, 193–214. https://doi.org/10.1257/jep.35.3.193

{% %}

Mijovic-Prelec, Danica & Drazen Prelec (2010) “Self-Deception as Self-Signalling: A Model and Experimental Evidence,” *Philosophical Transaction of the Royal Society* 365, 227–240.

{% Seems to mention -f´´//f´ as measure for concavity, as Rich Gonzalez told me August 1994 %}

Mikusinski, Jan (1948) “Sur les Moyennes de la Forme $\psi^{-1}[\Sigma q\psi(x)]$,” *Studia Mathematica* 10, 90–96.

{% Seems to be the famous experiment where subjects were led to administer high levels of electric shocks to others in fictitious learning experiments. %}

Milgram, Stanley (1975) “*Obedience to Authority: An Experimental View*.” Harper and Row, New York

{% **common knowledge** %}

Milgrom, Paul (1981) “An Axiomatic Characterization of Common Knowledge,” *Econometrica* 49, 219–222.

{% **Z&Z**; gekregen van Harald Uhlig in jan. 1998 %}
Milgrom, Paul & John Roberts (1992) "*Economics, Organization and Management.*" Prentice-Hall, Englewood Cliffs, NJ.

{% **common knowledge**; showed that under common prior assumption willingness to bet against each other cannot be common knowledge. %}
Milgrom, Paul & Nancy L. Stokey (1982) "Information, Trade, and Common Knowledge," *Journal of Economic Theory* 26, 17–27.

{% Work about preference for some numbers. For example, people primarily find 67 aversive, next 53 boring, and then 51 and 49. 87 and 83 are "heavy," and 22 and 4 are "light."
Erna kreeg ze baan bij afdeling publieksstudies. %}
Milikowski, Marisca (1995) "Knowledge of Numbers," Ph.D. dissertation, Dept. of Psychology, University of Amsterdam.

{% Easiest to remember: 8, 1, 100, 2, 17, 5, 9, 10, 99, 11
hardest to remember: 82, 56, 61, 94, 85, 45, 83, 59, 41, 79
good: 10, 100, 36, 8, 24, 66, 16, 4, 1
bad: 37, 93, 41, 51, 39, 17, 13, 59, 29, 43 %}
Milikowski, Marisca & Jan J. Elshout (1995) "What Makes a Number Easy to Remember," *British Journal of Psychology* 86, 537–547.

{% On debiasing. %}
Milkman, Katherine L., Dolly Chugh, & Max H. Bazerman (2009) "How Can Decision Making Be Improved?," *Perspectives on Psychological Science* 4, 379–383.

{% Huge metastudy on nudge units. %}
Milkman, Katherine L., Dena Gromet, Hung Ho, Joseph S. Kay, Timothy W. Lee, Pepi Pandiloski, Yeji Park, Aneesh Rai, Max H. Bazerman, John Beshears, Lauri Bonacorsi, Colin F. Camerer, Edward Chang, Gretchen B. Chapman, Robert B. Cialdini, Hengchen Dai, Lauren Eskreis-Winkler, Ayelet Fishbach, James J.

Gross, Samantha Horn, Alexa Hubbard, Steven J. Jones, Dean Karlan, Tim Kautz, Erika Kirgios, Jowoon Klusowski, Ariella S. Kristal, Rahul Ladhania, George F. Loewenstein, Jens Ludwig, Barbara A. Mellers, Sendhil Mullainathan, Silvia Saccardo, Jann Spiess, Gauri Suri, Joachim H. Talloen, Jami Taxer, Yaacov Trope, Lyle Ungar, Kevin G. Volpp, Ashley V. Whillans, Jonathan Zinman, Angela L. Duckworth (2021) "Megastudies Improve the Impact of Applied Behavioural Science," *Nature* 600, 478–483.

{% Clients from a dvd rental company will often be more quick to rent a should movie (a useful movie to see) than a want movie (one that is nice to see) but then first watch the want movie and later the should movie. That is, should movies are watched relatively later. The authors interpret this finding as a preference reversal or time inconsistency, such as because of present bias, and as showing that the present bias is bigger for want things than for should things. %}
Milkman, Katherine L., Todd Rogers, & Max H. Bazerman (2009) "Highbrow Films Gather Dust: Time-Inconsistent Preferences and Online DVD Rentals," *Management Science* 55, 1047–1059.

{% **foundations of probability**: later editions of Mill (1843) seem to admit the (subjective) more probable than concept and relate it to betting on. (See Daston 1994). %}
Mill, John Stuart (1843) "*A System of Logic, Ratiocinative and Inductive*." Ed. J. M. Robson, Vols. 7 and 8 of The Collected Works of John Stuart Mill, Toronto/London: University of Toronto Press, 1974.

{% **ratio bias** %}
Miller, Dale T., William Turnbull, & Cathy McFarland (1989) "When a Coincidence is Suspicious: The Role of Mental Simulation," *Journal of Personality and Social Psychology* 57, 581–589.

{% Reformulate Popper's claims about inductive probability probabilistically. %}
Miller, David (1990) "A Restoration of Popperian Inductive Scepticism," *British Journal for the Philosophy of Science* 41, 137–140.

{% That we can only think in terms of a limited number of categories.
optimal scale levels: seems to argue that for unipolar scales five answer levels is optimal, and for bipolar scales it is seven. %}

Miller, George A. (1956) "The Magical Number Seven, Plus or Minus Two: Some Limits on Our Capacity for Processing Information," *Psychological Review* 63, 81–97.

{% r**eal incentives/hypothetical choice, for time preferences**: seems to be on it %}

Miller, Jonathan R. (2019) "Comparing Rapid Assessments of Delay Discounting with Real and Hypothetical Rewards in Children," *Journal of the Experimental Analysis of Behavior* 111, 48–58.
https://doi.org/10.1002/jeab.493

{% **updating: discussing conditional probability and/or updating**; **three-doors problem**: Discussed in the beginning at p. 145 (and again p. 151) with references given. The paper has a nice collection of similar paradoxes. Deeper paradoxes, such as the waiting rule paradox or sleeping beauty, are not discussed in this paper.

The writing of the paper is sometimes unfortunate.

(1) On p. 145, the authors give an incomplete description of the Monty Hall problem (not specifying the strategy of the host), only write "under natural assumptions that we discuss later", and then discuss much the mistakes made there. However, those mistakes are only mistakes under the common assumptions of the Monty Hall problem, and those are not at all natural, it being a very peculiar game. Those common assumptions will only be specified on p. 151, but without them the text on p. 145 is incomprehensible.

(2) Similarly, in the alternating paradox on p. 155, the description suggests the right procedure to be assumed (two-stage, that first a relevant (having heads on first or second toss) triple of coin flips is selected at random, and only then a relevant pair of tosses (two consecutive tosses of which the first is heads) is selected from the triple), with probability at heads < 1/2. But the vague "at random" at the end of the first sentence does not make it fully clear. It is linguistically possible that not the relevant triple is chosen at random, but the relevant pair is chosen at random (if you know what I mean), in which case

probability heads is 1/2. This is the more so as the opening sentence cannot always be (if tails on the first two tosses) and has to be partly retracted later anyhow. To get the selection of a relevant pair, are we conditioning on the event of a triple chosen at random and containing a relevant pair, or on a relevant pair chosen and then the corresponding triple taken?

(3) The last example of Zenet's student pretending clairvoyant abilities, will never work. The experimenter will just verify all predictions made and see that they were right 50% of the times, as with rndomness. She may get the idea of choosing a statistical analysis à la Gilovich et al. streaks only if she knows about the students strategy of always predicting after three heads observed (serving as a "streak"), but then she is not fooled by the student anymore and in fact knows that this "clairvoyance" is just a very simple strategy, related to the gambler's fallacy. The authors seem to deliberately avoid making this point clear.

It is true that many people, when analyzing data, are not aware of biases in their sampling, and the hot-hand example of Gilovich et al. (1985) is a sad example. Similarly, in extensive game theory, many game theorists just use Bayesian updating for every event specified in their own way without verifying the underlying random process and that there may be more info than just the event they chose to condition on. %}

Miller, Joshua B. & Adam Sanjurjo (2019) "A Bridge from Monty Hall to the Hot Hand: The Principle of Restricted Choice," *Journal of Economic Perspectives* 33, 144–162.

{% Seems to be an early reference using the choice list to measure indifference. %}

Miller, Louis, David E. Meyer, & John T. Lanzetta (1969) "Choice among Equal Expected Value Alternatives: Sequential Effects of Winning Probability Level on Risk Preferences," *Journal of Experimental Psychology* 79, 419–423.

{% **proper scoring rules**: The correlation in agents' private information can be used to induce truthful revelation. P. 1360 left column bottom cites classics on this insight.

If we cannot objectively observe if event obtains, we may still have proper scoring rules truth-revealing by letting experts predict other experts' answers and assuming particular correlations between their beliefs. This is similar to Prelec (2004, Science). %}

Miller, Nolan, Paul Resnick, & Richard J. Zeckhauser (2005) "Eliciting Informative Feedback: The Peer-Prediction Method," *Management Science* 51, 1359–1373.

{% Principal-agent with more productive agent more risk seeking, and ways to seek jobs to identify him. %}

Miller, Nolan, Alexander F. Wagner, & Richard J. Zeckhauser (2013) "Solomonic Separation: Risk Decisions as Productivity Indicators," *Journal of Risk and Uncertainty* 46, 265–297.

{% **value of information**, à la Kreps & Porteus (1978) and Grant, Kajii, & Polak: Extensive survey of psychological investigations into attitudes towards information (e.g. if you can predict in dentist chair what will happen to you or not). Information can also have value if no future actions are influenced by it, to cope with stress for instance. (**decision under stress**) %}

Miller, Suzanne M. (1981) "Predictability and Human Stress: Toward a Clarification of Evidence and Theory." *In* Leonard Berkowitz (ed.) *Advances in Experimental Social Psychology* 14, 203–256, Academic Press, New York.

{% A survey on motivational interviews. They serve to make people change behavior. But there are all kinds of rules like no coercion and central role for empathy. It is prescriptive and a bit like nudge but with more restrictions. %}

Miller, William R. & Gary S. Rose (2009) "Toward a Theory of Motivational Interviewing," *American psychologist* 64, 527–537. https://doi.org/10.1037/a0016830

{% **probability communication**;

ratio bias: denominator neglect. They investigate it for CE tasks, where it seems not to have been done before. Relate it to numeracy (Berlin numeracy task); higher numeracy gives more EV maximization, which can be taken as rational. More precisely, it gives less concave utility and more linear probability weighting. Unfortunately, the authors use the T&K'92 one-parameter family of probability weighting, so, we cannot distinguish between level (optimism) and

inverse S (likelihood insensitivity).

P. 2 cites many papers that argue that this is because lower numeracy gives more nonlinear perception.

cognitive ability related to likelihood insensitivity (= inverse S) %}

Millroth, Philip & Peter Juslin (2015) "Prospect Evaluation as a Function of Numeracy and Probability Denominator," *Cognition* 138, 1–9. https://doi.org/10.1016/j.cognition.2015.01.014

{% **cognitive ability related to risk/ambiguity aversion**: A thorough study, with many references, replicating the choice paradoxes of Kahneman & Tversky (1979), and relating them to numeracy (measured using Berlin Numeracy Test; p. 518). As with KT, choices are hypothetical.

P. 525, Conclusion: (i) the replication does not come out very well and the authors find quite less of the paradoxes than KT did. (ii) the paradoxes involving probability weighting come out stronger than those involving reference or sign dependence. (iii) they also find, surprisingly, that high-numerate subjects commit more paradoxes than low-numerate.

The low-numerate use super-pessimistic strategies of just minimizing the probability of the minimal outcome, which does not give the paradoxes. This may be (part of) the explanation (p. 524, §4.3).

p. 517: single-subject design means every subject makes only one choice—many experimental economists take this as gold standard.

P. 518: use Bayes factor in Bayesian hypothesis testing, briefly explained, with references to justify it.

P. 521: when finding differences between two groups, one should always verify that not noise was different for one group, and caused the difference. The authors discuss this in detail, although defensively, on pp. 521-522. %}

Millroth, Philip, Håkan Nilsson, & Peter Juslin (2019) "The Decision Paradoxes Motivating Prospect Theory: The Prevalence of the Paradoxes Increases with Numerical Ability," *Judgment and Decision Making* 14, 513–533. https://doi.org/10.1017/S1930297500006161

{% Relate verbal risk measures to verbal risk behavior. %}

Mills, Britain, Valerie F. Reyna, & Steven Estrada (2008) "Explaining Contradictory Relations between Risk Perception and Risk Taking," *Psychological Science* 19, 429–433.

{% **Dutch book** %}
Milne, Peter (1990) "Scotching the Dutch Book Argument," *Erkenntnis* 32, 105–126.

{% **foundations of probability**; **foundations of quantum mechanics** %}
Milne, Peter (1993) "The Foundations of Probability and Quantum Mechanics," *Journal of Philosophical Logic* 22, 129–168.

{% Presents axioms for the **principle of complete ignorance**. Characterizes α-Hurwicz criterion and similar models. Allows for probabilistic mixing where payments are expectations (p. 55 and footnote 1), which means doing α-maxmin with prior mixing and not posterior; prior mixing is more general than posterior. But the mixing is only considered if all nonmixed acts are available, so, it is not really α-maxmin. %}
Milnor, John (1954) "Games against Nature." *In* Robert M. Thrall, Clyde H. Coombs, & Robert L. Davis (eds.) *Decision Processes*, 49–59, Wiley, New York.

{% Distinguish intrinsic values from instrumental ones. Typical of former is that they easily generate discontinuities. Axioms are given to distinguish the two. %}
Minardi, Stefania, Fan Wang; & Itzhak Gilboa (2025) "Consumption of Values," *Management Science* 71, 2623–2634.
ttps://doi.org/10.1287/mnsc.2023.01632

{% Seem to consider preferences over pairs of acts, much like strengths of preferences, but they interpret it as degree of confidence in preferring one over the other. %}
Minardi, Stefania & Andrei Savochkini (2015) "Preferences with Grades of Indecisiveness," *Journal of Economic Theory* 155, 300–331.

{% Give necessary and sufficient conditions for the smooth ambiguity model with constant absolute ambiguity aversion in an Anscombe-Aumann setting. Their conditions concern the certainty equivalent function. They impose mathematical properties on this functional that hold iff it corresponds with the smooth model. These mathematical properties involve moment matrices and are not directly related to observable preference conditions. %}

Minardi, Stefania & Andrei Savochkini (2017) “Characterizations of Smooth Ambiguity Based on Continuous and Discrete Data,” *Mathematics of Operations Research* 42, 167–178.

{% **state space derived endogeously**: Derive subjective state space subjectively, in presence of updating (**updating: discussing conditional probability and/or updating**). The agent’s state space may differ from the analyst’s state space by being coarser. This reminds me of Tversky’s support theory. They maintain additive separability over disjoint events. They show how their model can accommodate confirmatory bias and correlation neglect. %}

Minardia, Stefania & Andrei Savochkin (2019) “Subjective Contingencies and Limited Bayesian Updating,” *Journal of Economic Theory* 183, 1–45. https://doi.org/10.1016/j.jet.2019.05.007

{% The authors measure the ambiguity aversion indexes of Baillon et al. (2018) for individuals and groups of three in anonimity decisions, for gains and losses. They consider natural uncertain events, i.e., not the artificial Ellsberg urns but temperature events. No differences are found and no relations with demographics. The fourfold pattern of ambiguity is confirmed. When restricting to well-understanding subjects, for gains groups are more ambiguity averse and a-insensitive. %}

Minnich, Aljoscha & Andreas Lange (2024) “Ambiguity Attitudes of Individuals and Groups in Gain and Loss Domains,” working paper.

{% **updating under ambiguity**:

Measures attitudes using Baillon et al.’s (2018) indexes in a general population, and study updating sfter point estimators, interval estimators, or their combination, where info can be confirmatory or opposite (surprising). Ambiguity attitudes are rather robust to new information and variants of signals. Variants of signals do impact belief updating and matching probabilities, but not ambiguity attitudes. %}

Minnich, Aljoscha, Hauke Roggenkamp, & Andreas Lange (2024) "Ambiguity Attitudes and Surprises: Experimental Evidence on Communicating New Information within a Large Population Sample," *Journal of Economic Behavior and Organization* 228, 106778.
https://doi.org/10.1016/j.jebo.2024.106778

{% **updating under ambiguity** summary of Peter Walley's ideas, focusing on the mathematical axioms. %}

Miranda, Enrique (2008) "A Survey of the Theory of Coherent Lower Previsions," *International Journal of Approximate Reasoning* 48, 628–658.

{% **updating: nonadditive measures**: %}

Miranda, Enrique & Ignacio Montes (2015) "Coherent Updating of Non-Additive Measures," *International Journal of Approximate Reasoning* 56, 159–177.

{% %}

Miron-Shatz, Talya, Yaniv Hanoch, Benjamin A. Katz, Glen M. Doniger, & Elissa M. Ozanne (2015) "Willingness to Test for BRCA1/2 in High Risk Women: Influenced by Risk Perception and Family Experience, rather than by Objective or Subjective Numeracy?," *Judgment and Decision Making* 10, 386–399.

{% **conservation of influence**: pp. 13-15 seem to explain that marginal utility was developed in explicit analogy to energetics. %}

Mirowski, Philip (1988) "*Against Mechanism; Protecting Economics from Science.*" Rowman & Littlefield, Totowa, NJ.

{% **conservation of influence**: Bob Nau sent me an email 11Oct90 about this book, which compares utility with potential energy. %}

Mirowski, Philip (1989) "*More Heat than Light.*" Cambridge University Press, New York.

{% Seems to point out that correlation of behavior rarely exceeds 0.2 or 0.3. %}
Mischel, Walter (1968) "*Personality and Assessment.*" Wiley, New York.

{% Pp. 147-148 seem to point out, in the discussion of a personality coefficient, that the fraction of cross-sectional variation in a specific behavior that can be accounted for by responses to a survey questionnaire typically ranges from .04 to .09. %}
Mischel, Walter (1971) "*Introduction to Personality.*" Holt, Rinehart, and Winston, New York.

{% Seems to show that self-control of children waiting for a cookie predicts career-success in later life. %}
Mischel, Walter, Yuichi Shoda, & Monica I. Rodriguez (1989) "Delay of Gratification in Children," *Science* 244, 933–938.

{% They seem to present implicit risk approach: delayed consequences are associated with an implicit risk value. %}
Mishel, Walter & Joan E. Grusec (1967) "Waiting for Rewards and Punishments: Effects of Time on Probability and Choice," *Journal of Personality and Social Psychology* 5, 24–31.

{% **cognitive ability related to discounting** & **cognitive ability related to risk/ambiguity aversion**: Measured immediacy effect and risk aversion (through choices and also BART) (all incentivized) and several introspective indexes of impulsivety. Immediacy effect was related with introspective measures but not with risk aversion. I did not check out how risk aversion was related to introspective measures. %}
Mishra, Sandeep & Martin L. Lalumière (2017) "Associations between Delay Discounting and Risk-Related Behaviors, Traits, Attitudes, and Outcomes," *Journal of Behavioral Decision Making* 30, 769–781. https://doi.org/10.1002/bdm.2000

{% Optimal control problems of central banks. %}

Mitchell, Daniel, Haolin Feng, & Kumar Muthuraman (2014) "Impulse Control of Interest Rates," *Operations Research* 62, 602–615.

{% A meta-meta study on the relation between lab- and field experiments. %}
Mitchell, Gregory (2012) "Revisiting Truth or Triviality: The External Validity of Research in the Psychological Laboratory," *Perspectives on Psychological Science* 7, 109–117.

{% Mention scenario misspecification as a cause of biases. %}
Mitchell, Robert C. & Richard T. Carson (1989) "*Using Surveys to Value Public Goods: The Contingent Valuation Method.*" Resources for the future, Washington DC.

{% r**eal incentives/hypothetical choice, for time preferences**: seems to be on it %}
Mitchell, Suzanne H. & Vanessa B. Wilson (2012) "Differences in Delay Discounting between Smokers and Nonsmokers Remain when Both Rewards Are Delayed," *Psychopharmacology* 219, 549–562.
https://doi.org/10.1007/s00213-011-2521-z

{% Their finding may be due to utility curvature, which is more linear for losses than for gains. All choices are hypothetical. %}
Mitchell, Suzanne H. & Vanessa B. Wilson (2010) "The Subjective Value of Delayed and Probabilistic Outcomes: Outcome Size Matters for Gains but not for Losses," *Behavioural Processes* 83, 36–40.

{% Fit hyperbolic and quasi-hyperbolic discount functions to data. %}
Mitchell, Suzanne H., Vanessa B. Wilson, & Sarah L. Karalunas (2015) "Comparing Hyperbolic, Delay-Amount Sensitivity and Present-Bias Models of Delay Discounting," *Behavioural Processes* 114, 52–62.

{% They consider preferences over infinite sequences as, for instance, in intertemporal choice. Then, often, regular fairness conditions are irreconcilable with strong Pareto, and weaker versions of fairness are considered. This paper shows that a necessary and sufficient condition for such fairness conditions to be reconcilable anywhere is that the set of permutations involved satisfies cyclicity and is a group. %}

Mitra, Tapan & Kaushik Basu (2007) "On the Existence of Paretian Social Welfare Quasi-Orderings for Infinite Utility Streams with Extended Anonymity." *In* John Roemer & Kotaro Suzumura (eds.) *Intergenerational Equity and Sustainability*. Palgrave, London, 2007).

{% %}

Mitra, Tapan & Efe A. Ok (1996) "Personal Income Taxation and the Principle of Equal Sacrifice Revisited," *International Economic Review* 37, 925–948.

{% %}

Mitra, Tapan & Efe A. Ok (1997) "On the Equitability of Progressive Income Taxation," *Journal of Economic Theory* 73, 316–334.

{% %}

Mitra, Tapan & Efe A. Ok (1998) "The Measurement of Income Mobility: A Partial Ordering Approach," *Economic Theory* 12, 77–102.

{% %}

Mitra, Tapan, Efe A. Ok, & Levent Koçkesen (1998) "Popular Support for Progressive Taxation and the Relative Income Hypothesis," *Economics Letters* 58, 69–76.

{% **Dutch book**. They examine de Finetti's subjective expected value $\sum_{j=1}^{n} p_j x_j$. As in Theorem 6.1 of my book Wakker (2010). They use weak ordering, the usual additivity condition, ($x \succcurlyeq y \Rightarrow x+z \succcurlyeq y+z$), and then solvability axioms that sometimes allow for some non-real valued, lexicographic, representations. %}

Mitra, Tapan & Kemal Ozbek (2021) "Ranking by Weighted Sum," *Economic Theory* 72, 511–532.

{% Iowa gambling task is done, trait anxiety (TA) is measured, as are & heart rate & skin conductance. High TA imparies decisions in making subjects distinguish less between favorable and unfavorable options, somewhat reminiscent of likelihood insensitivity which also measures discriminatory power (**inverse S**). %}

Miu, Andrei C. Renata M. Heilman, & Daniel Houser (2008) “Anxiety Impairs Decision-Making: Psychophysiological Evidence,” *Biological Psychology* 77, 353–358.

{% There are N agents, all living countably infinitely many timepoints. They have preferences at every timepoint, over consumption from there one, maximizing discounted expected utility, which, I guess, can depend on past consumption. A social planner has preferences. Proposition 1 shows that weak Pareto, time consistency, and transfer to the worst-off, are incompatible. %}

Miyagishima, Kaname (2023) “Time-Consistent Fair Social Choice,” *Theoretical Economics* 18, 941–964.
https://doi.org/10.3982/TE5220

{% %}

Miyamoto, John M. (1983) “Measurement Foundations for Multiattribute Psychophysical Theories Based on First Order Polynomials,” *Journal of Mathematical Psychology* 27, 152–182.

{% Lemma 1, p. 443, is useful because it gives a powerful tool for characterizing linear-exponential (CARA) and log-power (CRRA) functions. Let U be a continuous strictly increasing function from a subinterval of the positive (positive means 0 is not included) reals to the reals. Let 0.5U(x) + 0.5U(z) = U(y) imply 0.5U(tx) + 0.5U(tz) = U(ty) whenever all arguments are in the domain. Then U is log-power (CRRA). This result is powerful because, first, unlike virtually all statements in the literature it allows for an arbitary interval as domain and, second, it requires only fifty-fifty mixtures. An immediate corollary, through the transformation
x --> ln(x), is: let 0.5U(x) + 0.5U(z) = U(y) imply 0.5U(t+x) + 0.5U(t+z) = U(t+y) whenever all arguments are in the domain. Then U is linear-exponential (CARA). So, this also holds on arbitrary intervals.

This paper corrects a result by Krantz et al. (1971) who in the log-power family overlooked the log function (power 0) and the negative powers. %}

Miyamoto, John M. (1983) "An Axiomatization of the Ratio/Difference Representation," *Journal of Mathematical Psychology* 27, 439–455.

{% %}

Miyamoto, John M. (1987) "Constraints on the Representation of Gambles in Prospect Theory," *Journal of Mathematical Psychology* 31, 410–418.

{% **biseparable utility**; **binary prospects identify U and W** %}

Miyamoto, John M. (1988) "Generic Utility Theory: Measurement Foundations and Applications in Multiattribute Utility Theory," *Journal of Mathematical Psychology* 32, 357–404. https://doi.org/10.1016/0022-2496(88)90019-3

{% %}

Miyamoto, John M. (1991) "Ordinal Independence and Functional Equations in the Theory of Psychological Difference." *In* Jean-Paul Doignon & Jean-Claude Falmagne (eds.) *Mathematical Psychology: Current Developments,* 3–33, Springer, Berlin.

{% P. 203 does not commit to whose preferences should be measured for policy decisions, contrary to the unfortunate suggestions by Gold et al. (1996).

paternalism/Humean-view-of-preference: p. 203: assumes EU to be normative, but assumes also that empirical measurement is descriptive and may deviate. %}

Miyamoto, John M. (1999) "Quality-Adjusted Life Years (QALY) Utility Models under Expected Utility and Rank Dependent Utility Assumptions," *Journal of Mathematical Psychology* 43, 201–237.

{% %}

Miyamoto, John M., Jason N. Doctor, & Michael J. Perry (2004) "Preference Axioms for a Person Tradeoff Representation."

{% Relates PE (if I remember well, they call it SG) to TTO. %}

Miyamoto, John M., & Stephen A. Eraker (1985) "Parameter Estimates for a QALY Utility Model," *Medical Decision Making* 5, 191–213.

{% Test utility independence (of duration from health) and find it mostly confirmed. Only for short durations it's violated, then subjects do not want to trade off any duration for health.

Does utility measurement for nonEU, by restricting stimuli to subdomains where EU is still satisfied, not only for the Miyamoto's generic utility model which is like rank-dependent utility, but also (p. 16) for prospect theory by avoiding distortions due to sign-dependence.

tradeoff method: P. 198 points out that inconsistencies in revealed preferences that, however, distort utility in a linear manner, are of no concern for utility measurement. This is precisely why scale compatibility does not affect the TO utilities.

Distortions in utility measurements that distort utility linearly, are of no concern.

Pp. 17–18: ordering through time tradeoff can be reversed to that in standard gamble. This is a violation of generalized stochastic dominance (i.e., with respect to a subjective underlying preference) and entails: **restrictiveness of monotonicity/weak separability** %}

Miyamoto, John M., & Stephen A. Eraker (1988) "A Multiplicative Model of the Utility of Survival Duration and Health Quality," *Journal of Experimental Psychology: General* 117, 3–20.

{% Investigate utility function for life duration. Find that neither exponential nor power families work well. Do their fitting in John's generic utility model; i.e., that permits probability transformation. %}

Miyamoto, John M. & Stephen A. Eraker (1989) "Parametric Models of the Utility of Survival Duration: Tests of Axioms in a Generic Utility Framework," *Organizational Behavior and Human Decision Processes* 44, 166–202.

{% **state-dependent utility**

Only after publication the authors discovered that Theorem 1 had been obtained

before as Theorem 4 in Ebert (1988, Social Choice and Welfare 5), and Theorem 2 as Ebert's Theorem 3. %}

Miyamoto, John M. & Peter P. Wakker (1996) "Multiattribute Utility Theory without Expected Utility Foundations," *Operations Research* 44, 313–326.
https://doi.org/10.1287/opre.44.2.313
Direct link to paper
Link to comments
(Link does not work for some computers. Then can:
go to Papers and comments; go to paper 96.3 there; see comments there.)

{% %}
Miyamoto, John M., Peter P. Wakker, Han Bleichrodt, & Hans J.M. Peters (1998) "The Zero-Condition: A Simplifying Assumption in QALY Measurement and Multiattribute Utility," *Management Science* 44, 839–849.
https://doi.org/10.1287/mnsc.44.6.839
Direct link to paper

{% %}
Modica, Salvatore (1995) "Expected Utility for Decision Making with Subjective Models," *Theory and Decision* 39, 157–168.

{% Modigliani - Miller view of arbitrage seems to be: drives price to fundamental value as soon as there are some rational investors. %}

{% %}
Modigliani, Franco & Merton H. Miller (1958) "The Cost of Capital, Corporation Finance and the Theory of Investment," *American Economic Review* 68, 261–297.

{% Seems that he measured decision time as index of effort that subjects did. For choices between almost indifferent options it was twice as much as between options with a clear preference between them. This provides some counterevidence against the flat-maximum problem signaled by Harrison (1989) and others. %}

Moffat, Peter G. (2005) "Stochastic Choice and the Allocation of Cognitive Effort," *Experimental Economics* 8, 369–388.

{% Complexity refers to the number of outcomes of a prospect. More people are complexity averse than complexity loving. The authors discuss preference for event splitting (**coalescing**), which goes in the opposite direction. %}

Moffatt, Peter G., Stefania Sitzia, & Daniel John Zizzo (2015) "Heterogeneity in Preferences towards Complexity," *Journal of Risk and Uncertainty* 51, 147–170. https://doi.org/10.1007/s11166-015-9226-3

{% **PT, applications** %}

Mohamed, Rayman (2006) "The Psychology of Residential Developers: Lessons from Behavioral Economics and Additional Explanations for Satisficing," *Journal of Planning Education and Research* 26, 28–37.

{% Probabilistic belief updating with three states. Contrary to two states, no stronger underinference for larger signal sets. %}

Mohrschladt, Hannes, Maren Baars, & Thomas Langer (2024) "Belief Updating beyond the Two-State Setting," *Management Science* 70, 6483–7343. https://doi.org/10.1287/mnsc.2022.00513

{% **anonymity protection**

This was a special issue of Statistica Neerlandica dedicated to Robert J. Mokken. %}

Mokken, Robert J., Peter Kooiman, Jeroen Pannekoek, & Leon C.R.J. Willenborg (1992) "Disclosure Risks for Microdata," *Statistica Neerlandica* 46, 49–67.

{% **anonymity protection** %}

Mokken, Robert J., Jeroen Pannekoek, & Leon C.R.J. Willenborg (1989) "Micro Data and Disclosure Risks," *CBS Select* 5, 181–200; SDU/Publishers, The Hague.

{% **inverse S:** It is well-known that small probabilities are mostly overweighted, but that they are also often underweighted. This paper considers flood insurance, where underweighting is found. It is called the "it won't happen to me" effect.

When subjects are shown images of catastrophes (virtual reality risk communication) they tend to insure more. This can be understood because the risks become more salient then. %}

Mol, Jantsje M., W.J. Wouter Botzen, & Julia E. Blasch (2022) "After the Virtual Flood: Risk Perceptions and Flood Preparedness after Virtual Reality Risk Communication," *Judgment and Decision Making* 17, 189–214.

{% Seems to have the following citation:

"I am inclined to offer Mr. Vieweg from Berlin an epic poem, Herrmann and Dorothea … Concerning the royalty we will proceed as follows: I will hand over to Mt. Counsel Böttiger a sealed note which contains my demand, and I wait for what Mr. Vieweg will suggest to offer for my work. If his offer is lower than my demand, then I take my note back, unopened, and the negotiation is broken. If, however, his offer is higher, then I will not ask for more than what is written in the note to be opened by Mr. Böttiger."

By Johann Wolfgang von Goethe in a letter on January 16, 1797. %}

Moldovanu, Benny & Manfred Tietzel (1998) "Goethe's Second-Price Auction," *Journal of Political Economy* 106, 854–859.

{% %}

Molenaar, Ivo W. (1980) "An Insurance Policy against Unexpected Data," *Kwantitatieve Methoden* 1, 49–74.

{% **foundations of statistics**; discussie in Amsterdam with de Leeuw and Linssen %}

Molenaar, Ivo W. (1984) "Bayesiaanse Statistiek en het Meten van Voorkennis," *Kwantitatieve Methoden* 13, 5–16.

{% %}

Molenaar, Ivo W. (1985) "Statistics in the Social and Behavioral Sciences," *Statistica Neerlandica* 39, 169–179.

{% %}

Molenaar, Ivo W. (1988) "Displaying Statistical Information: Ergonomic Considerations." *In* Gerrit C. van der Veer & Gijsbertus Mulder (eds.) *Human-Computer Interaction: Psychonomic Aspects,* Springer, Berlin.

{% %}

Molenaar, Sjaak, Mirjam A.G. Sprangers, Emiel J.th. Rutgers, Ernest J.T. Luiten, Jan Mulder, Patrick M.M. Bossuyt, Jannes J.E. van Everdingen, Paul Oosterveld, & Hanneke C.J.M. de Haes (2001) "Decision Support for Patients with Early-Stage Breast Cancer: Effects of an Interactive Breast Cancer CDROM on Treatment Decision, Satisfaction, and Quality of Life," *Journal of Clinical Oncology* 19, 1676–1687.

{% P. 2123: "In the absence of survival and major QL [quality of life] differences, the treatment decision can be made according to the patient's preference." P. 2129 discusses to what extent patient decisions can/should be influenced by others, strongly favoring minimal influence. Last para of first column makes a strange claim: "The use of a decision aid did not influence the kind of treatment selected. This is a desirable outcome as the aim of the decision aid is to assist patients in the decision-making process, and not to prescribe a course of action." I guess no influence means no influence on group average, and need not refer to individual level. Anyway, under this token, decision aiding should not influence decisions and only maybe make patients more happy with the decision taken. I think that the primary purpose is to help give better decisions, and the other is only secondary. %}

Molenaar, Sjaak, Frans J. Oort, Mirjam A.G. Sprangers, Emiel J.th. Rutgers, Jan Mulder, Hanneke C.J.M. de Haes (2004) "Predictors of Patients' Choices for Breast-Conserving Therapy or Mastectomy: A Prospective Study," *British Journal of Cancer* 90, 2123–2130.

{% **criticism of monotonicity in Anscombe-Aumann (1963) for ambiguity** This paper, which I like much, criticizes, as did many papers before, the Anscombe-Aumann framework (AA) when applied to ambiguity. It criticizes AA for its monotonicity assumption that, as the authors explain on p. 1022, imposes a weak separability condition on the ambiguous events that does not fit with ambiguity. Wakker (2010 §10.7.3) called it Jaffray's framework and argued that it is more plausible than the AA framework. Unlike the many preceding criticisms, this paper does more: it not only complains about the problem, but also fixes it. That is, it develops an alternative model, with the order of horse and

roulette events reversed (roulette comes first), making it much better suited to analyze ambiguity. Such a basic approach had been done before by the impressive Jaffray (1989), but he used a peculiar framework and an overly extreme complete-ignorance model because of which it was not applicable. This paper instead uses a natural framework with the realistic rank-dependent utility, also known as Choquet expected utility, whose variation is nicely called Expected Choquet Utility, reminiscent of Machina's nice expression of Aumann-Anscombe framework.

The paper provides an axiomatization, essentially by combining Savage's (1954) axioms with Sarin & Wakker's (1992) cumulative dominance.

In the framework of this paper, the relation between ambiguity aversion and preference for probabilistic preference reverses, where the latter now is related to ambiguity *seeking* rather than aversion, which is psychologically more plausible. Wakker (2010 §11.6, p. 328) qualified the AA implication of equating ambiguity aversion with preference for probabilistic mixing as an historical accident.

This paper also links putting up probabilistic (roulette) events first with better incentive compatibility of the random incentive system (RIS). %}

Monet, Benjamin & Vassili Vergopoulos (2024) "Ambiguity, Randomization and the Timing of Resolution of Uncertainty," *Economic Theory* 78, 1021–1045.

{% P. 135 expresses strong preference for belief-function theory over Bayesian approach. %}

Mongin, Philippe (1994) "Some Connections between Epistemic Logic and the Theory of Nonadditive Probability." *In* Patrick C. Humphreys (ed.) *Patrick Suppes: Scientific Philosopher*, Vol. 1, 135–171.

{% %}

Mongin, Philippe (1995) "Consistent Bayesian Aggregation," *Journal of Economic Theory* 66, 313–351.

{% **state-dependent utility** %}

Mongin, Philippe (1998) "The Paradox of the Bayesian Experts and State-Dependent Utility Theory," *Journal of Mathematical Economics* 29, 331–361.

{% %}
Mongin, Philippe (2008) "Factoring out the Impossibility of Logical Aggregation," *Journal of Economic Theory* 141, 100–113.

{% An axiomatization of subjective expected utility taking a stochastic-independence-type preference condition as a primitive. Means that conditioning on an event does not affect preferences regarding another event. Something similar was done before by Bernardo, Ferrándiz, & Smith (1985), cited in this paper. Axiom 12.5.2 in Pfanzagl (1968) also has a bit such an independence concept. %}
Mongin, Philippe (2020) "Bayesian Decision Theory and Stochastic Independence," *Philosophy of Science* 87, 152–178.

{% This paper adds nuances to the normative/descriptive interpretations of the Allais paradox. %}
Mongin, Philippe (2019) "The Allais Paradox: What It Became, What It Really Was, What It now Suggests to Us," *Economics and Philosophy* 35, 423–459. https://doi.org/10.1017/S0266267118000469

{% P. ±372: Jnterpreting utility as measuring: (i) pleasure and pain; (ii) the satisfaction of the individual's actual preferences; (iii) the individual's well-being; (iv) the satisfaction of rational and well informed preferences;

P. 4: welfarism: Jndividual utilities contain all the information required to derive collective evaluation rules.

Teological: do what is "best," so, break promise if it's better to break deontological: follow rules, so, keep promise because that's a rule.

§2.2: utility subjective/objective, as relation between man and object %}
Mongin, Philippe & Claude d'Aspremont (1998) "Utility Theory and Ethics." *In* Salvador Barberà, Peter J. Hammond, & Christian Seidl (eds.) *Handbook of Utility Theory, Vol. I Principles*, 371–481, Kluwer Academic Publishers, Dordrecht.

{% They discuss Bradley, Richard (2017) "*Decision Theory with a Human Face.*" On two topics: R**.C. Jeffrey model**, and his redefinition strategy to defend expected

utility against the Allais and Ellsberg paradoxes. They criticize Bradley's redefinition approach. %}

Mongin, Philippe & Jean Baccelli (2021) "Decision-Making and Hypothetical Reasoning," *Synthese* 199, 695–713.
https://doi.org/10.1007/s11229-020-02691-3

{% An impressive paper giving many valuable preference foundations.

They assume a two-variate product space $\Pi^{i=1,\ldots,n}{}_{j=1,\ldots,m}X^i{}_j$. So, we deal with matrices with m rows and n columns, giving $m \times n$ dimensions. Say there is both time and uncertainty, with n states of nature and m timepoints. One of the components can also refer to persons or commodities or other things. The first basic result, which in itself has been known before as the authors cite, is:

Assume that we only have separability of each row and each column. This, by Gorman's (1968) theorem, is already enough to give full separability and an overall additive representation. This particular form of Gorman's theorem has a long history as the problem of aggregation in economics. (Can we just take aggregate demand of every commodity in the market and only then aggregate over individuals, or should we first aggregate over individuals.) My Rotterdam predecessors Van Daal & Merkies worked on this. The result is so nice because the separability of columns and rows just feels like weak monotonicity. The result is stated in Proposition 1.(b), where a more general result is stated that holds if their domain X is a full product set. The result underscores **restrictiveness of monotonicity/weak separability**.

Then, as the authors show in their Theorem 1 (p. 156), because for every row, for instance, we already have a cardinal representation, requiring ordinal identity of conditional preferences give that these rows have the same representation up to one positive factor. Doing this for columns too, we get a weighted-average representation as with EU and discounted utility while avoiding extra conditions such as bisymmetry, tradeoff consistency, or Savage's (1954) P4. This result is not very new or very deep, but nice and useful, and gives a host of applications and improvements on existing results. It gives a generalized version of Harsanyi (1955) and Anscombe-Aumann (1963), allowing subjective probabilities in the second stage. The authors also handle quite general subsets of product sets, as in Segal (1992) and Chateauneuf & Wakker (1993). %}

Mongin, Philippe & Marcus Pivato (2015) "Ranking Multidimensional Alternatives and Uncertain Prospects," *Journal of Economic Theory* 157, 146–171. https://doi.org/10.1016/j.jet.2014.12.013

{% One can detect state-dependent utility in some NonEU models, e.g., rank-dependent utility, if one assumes that ranking of events goes by utility level. Then, where there is a kink in indifference, there two identical utility levels are involved. For instance, if preferences over have a kink at (E:α, E^c:β), then $U_E(\alpha) = U_{E^c}(\beta)$. %}

Mononen, Lasse (2020) "State Dependent Utility and Ambiguity," lecture at D-TEA conference in Paris on 17 June 2020.

{% %}

Mononen, Lasse Mononen (2023) "State Dependent Utility and Ambiguity," working paper.

{% "Power weighted expected utility" means the separate-probability transformation model (separable prospect theory) with power utility. This can only deviate from expected utility, so power different than 1, if both stochastic dominance and continuity in outcomes are violated. The paper also considers a generalization where EU is linearly combined with Shannon info. To calculate Shannon info, each outcome is taken as a separate signal. %}

Mononen, Lasse (2021) "On Preference for Simplicity, Probability Weighting, and Expected Utility," working paper.

{% **Dutch book**: extend it to many-valued events and infinitesimal probabilities. %}

Montagna, Franco, Martina Fedel, & Giuseppe Scianna (2013) "Non-Standard Probability, Cherence and Conditional Probability on Many-Valued Events," *International Journal of Approximate Reasoning* 54, 573–589.

{% Proves that a quasi-concave separable function on an atomless space is concave. For usual additive separable representations with finite dimensions, $V = V_1 + \cdots + V_n$, we have a state space $S = \{s_1, \ldots, s_n\}$ and a function, act, $x = (x_1,\ldots,x_n)$ and V represents preferences over acts. One can say that S is endowed with the discrete counting measure $\mu(s_j) = 1$ for all j and that V_j is state-dependent utility, and V state-dependent expected utility. When Wakker & Zank (1999) extended this to infinite state spaces S, one unanticipated difficulty was writing the very definition of V, in the absence of a measure μ on S such that V would be absolutely continuous with respect to that measure, so that V could not be written as a kind of integral.

This paper studies state-dependent EU functionals on infinite, even atomless, state spaces that are endowed with a measure μ so that they can be written as an integral. The set of acts is taken as L^p_+. The state-dependent functional is called separable. The state-dependent utility is called kernel. It cites mathematical literature on this, e.g. on continuity results. It shows that for a separable function quasi-concavity implies concavity. %}

Monteiro, Paulo Klinger (1999) “Quasiconcavity and the Kernel of a Separable Utility,” *Economic Theory* 13, 221–227.

{% Title: because responders rather accept lower share than risking being left out. %}

Montero, Maria (2007) “Inequity Aversion May Increase Inequity,” *Economic Journal* 117, C192–C204.

{% Proposes a measure of risk aversion, in addition to Pratt-Arrow, that vanishes locally under expected utility but need not vanish under nonEU. This shows that there can be first-order risk aversion under nonEU, and anticipates somewhat the first-order risk aversion in Segal & Spivak (1990). %}

Montesano, Aldo (1985) “The Ordinal Utility under Uncertainty and the Measure of Risk Aversion in Terms of Preferences,” *Theory and Decision* 18, 73–85.

{% P. 282: Proposes local risk measures of 1st and 2nd order, based on normalized risk premiums, where the 2nd order agrees with Pratt-Arrow if EU and the 1st order is 0 under EU (differentiable utility). 1st order can be nonzero under nonEU.

Proposes global measures by integrating over p over [0,1]. Paper is not easy to read because the mathematical derivations are not separated from their results. Incorporates multivariate measures (also studied by Bob Nau (2003). %}

Montesano, Aldo (1988) “The Risk Aversion Measure without the Independence Axiom,” *Theory and Decision* 24, 269–288.

{% %}

Montesano, Aldo (1991) “Measures of Risk Aversion with Expected and Nonexpected Utility,” *Journal of Risk and Uncertainty* 4, 271–283.

{% Explains how de Finetti (1952) had the Pratt-Arrow risk aversion index –u´´/u´ as index of risk aversion. de Finetti established some local results, but not the nicest result, the one relating to lower certainty equivalents. %}

Montesano, Aldo (2009) “De Finetti and the Arrow-Pratt Measure of Risk Aversion.” *In* Maria Carla Galavotti (ed.) *Bruno de Finetti, Radical Probabilist*, 115–127, College Publications, London.

{% Defines uncertainty aversion as follows: If there EXISTS a subjective probability measure with EU under which all CEs (certainty equivalents) are larger (Def. 1 p. 136). So, this is the same as Ghirardato & Marinacci (2002, JET), taking probabilistic sophistication + EU as ambiguity neutrality. Under CEU (Choquet expected utility) it is equivalent to nonempty CORE. Schmeidler’s condition of preference for probabilistic mixture is called increasing uncertainty aversion (Def. 2 pp. 136-137). They show that the latter implies uncertainty aversion, but not vice versa. Section 4, nicely, proposes to relate uncertainty aversion to the nucleolus of the weighting function. It next proposes some definitions of ambiguity premiums, following up on Hilton. %}

Montesano, Aldo & Francesco Giovannoni (1996) “Uncertainty Aversion and Aversion to Increasing Uncertainty,” *Theory and Decision* 41, 133–148.

{% On his dominance search theory: Jn choice subjects try to (mis)perceive things such that they can claim their choice to be based on dominance. %}

Montgomery, Henry (1983) "Decision Rules and the Search for a Dominance Structure: Towards a Process Model of Decision Making." *In* Patrick C. Humphreys, Ola Svenson, & Anna Vari (eds.) *Analyzing and Aiding Decision Processes*, 343–369, North-Holland, Amsterdam.

{% On his dominance search theory: In choice subjects try to (mis)perceive things such that they can claim their choice to be based on dominance. Unfortunately, he did not publish this in a journal, but only in 1983 & 1989 book chapters. %}
Montgomery, Henry (1989) "From Cognition to Action: The Search for Dominance in Decision Making." *In* Henry Montgomery & Ola Svenson (eds.) *Process and Structure in Human Decision Making*, 23–49, Wiley, Oxford.

{% Recommended to me in August 1992 by Pat Suppes. %}
Moody, Ernest A. & Marshall Clagett (1960, eds.) "*The Medieval Science of Weights.*" University of Wisconsin Press, Madison.

{% %}
Moon, John W. (1968) "*Topics on Tournaments.*" Holt, Rinehart and Winston, New York.

{% Nice reconciliation of 3 kinds of overconfidence: (a) overestimation of one's actual performance, (b) overplacement of one's performance relative to others, and (c) excessive precision in one's beliefs. %}
Moore, Don A. & Paul J. Healy (2008) "The Trouble with Overconfidence," *Psychological Review* 115, 502–517.

{% %}
Moore, Don A, Terri Kurtzberg, Craig R. Fox, & Max H. Bazerman (1999) "Positive Illusions and Forecasting Errors in Mutual Fund Investment Decisions," *Organizational Behavior and Human Decision Processes* 79, 95–114.

{% Stigler (1950, end of §VII, gives a nice citation where Moore nicely formulates how economics aims to become an exact science through utility, albeit in negative terms because Moore does not like it. %}

Moore, Henry L. (1914) "*Economic Cycles: Their Law and Cause.*" MacMillan, New York.

{% Extends the "unit of measurement" method of Wold (1943) to measure cardinal utility, to nonhomothetic preferences. %}

Moore, James C. (1983) "Measurable Triples and Cardinal Measurement," *Journal of Economic Theory* 29, 120–160.

{% %}

Moore, Mike J. & W. Kip Viscusi (1990) "Models for Estimating Discount Rates for Long-term Health Risks Using Labor Market Data," *Journal of Risk and Uncertainty* 3, 381–401.

{% **real incentives/hypothetical choice**: A thorough discussion of the hypothetical bias and its literature, although focusing only on WTP. The authors propose a model where the weighting of attributes is differently for hypothetical than for real. In their data (subjects expressing WTP for apples, real or hypothetical), surprisingly, the hypothetical subjects pay more time to their decision making and ignore fewer attributes. %}

Mørkbak, Morten Raun, Søren Bøye Olsen, & Danny Campbell (2014) "Behavioral Implications of Providing Real Incentives in Stated Choice Experiments," *Journal of Economic Psychology* 45, 102–116.

{% In what is an experienced decision task as in Barron & Erev (2003) and many follow-up pappers (although the authors do not cite this), monkeys and children prefer risky option to its expected value. This is easily explained because the risky choices provide more info (because the monkeys and children do not know the probabilities and have to find out about them) than the safe choices, and the monkeys and children do not only choose for preference value but also for obtaining more info. %}

Moreira, Bruno, Raul Matsushita & Sergio Da Silva (2010) "Risk Seeking Behavior of Preschool Children in a Gambling Task," *Journal of Economic Psychology* 31, 794–801.

{% **updating under ambiguity with sampling**; Subjects sample, with replacement, from risky, compound, and ambiguous urns. They weigh the new observations more (so, the prior info less) for ambiguous than for compound risk. %}

Moreno, Othon M. & Yaroslav Rosokha (2016) "Learning under Compound Risk vs. Learning under Ambiguity – An Experiment," *Journal of Risk and Uncertainty* 53, 137–162.

{% Survey on endowment effect %}

Morewedge, Carey K. & Colleen E. Giblin (2015) "Explanations of the Endowment Effect: An Integrative View," *Trends in Cognitive Science* 19, 339–348.

{% Banks are, because of the nature of their business without physical assets, opaque in their risk; i.e., there are more unknown probabilities and there is more ambiguity as decision theorists would call it. A proxy to measure this degree of ambiguity is the disagreement between raters. Next to insurance, banks indeed have that the highest. %}

Morgan, Donald P. (2002) "Rating Banks: Risk and Uncertainty in an Opaque Industry," *American Economic Review* 92, 874–888.

{% **probability elicitation** for continuous distributions. %}

Morgan, M. Granger & Max Henrion (1990) "*Uncertainty: A Guide to Dealing with Uncertainty in Quantitative Risk and Policy Analysis*." Cambridge University Press, New York.

{% %}

Morgan, John & Martin Sefton (2000) "Funding Public Goods with Lotteries: Experimental Evidence," *Review of Economic Studies* 67, 783–810.

{% %}

Morgan, M. Granger (1993) "Risk Analysis and Management," *Scientific American* 32 (July), 32–41.

{% %}

Morgan, Robert M. & Shelby Hunt (1994) “The Commitment-Trust Theory of Relationship Marketing,” *Journal of Marketing* 58, 20–38.

{% Seems to have said that he and von Neumann never intended EU for **(very) small probabilities**. “For example, the probabilities used must be within certain plausible ranges and not go to .01 or even less to .001, then be compared to other equally tiny numbers such as .02, etc.” %}

Morgenstern, Oskar (1979) “Some Reflections on Utility.” *In* Maurice Allais & Ole Hagen (eds.) *Expected Utility Hypotheses and the Allais Paradox*, 175–183, Reidel, Dordrecht.

{% **real incentives/hypothetical choice**: Consider simple choices between a sure outcome and a prospect. Do it both hypothetically and with real incentives. Find the usual bigger risk aversion for real incentives. But they also do EEG measurements to study neuronal effects. The abstract ends with “A higher N2 component for hypothetical payoffs revealed increased cognitive control for hypothetical decisions. These neuronal underpinnings indicate additional evaluation processes in hypothetical choice paradigms, which can explain the shift in risk attitude toward the expected value of a lottery.” They suggest that hypothetical may be cognitively better! (**cognitive ability related to risk/ambiguity aversion**) On hypothetical choice the authors, appropriately, write: “However, we also have to consider that there are special cases in which a realization of decision outcomes is not possible. For instance, outcomes related to questions of environmental damages, moral conflicts, losses, or very high stakes are often not realizable. In those cases, hypothetical decisions may still provide valuable information as good forecast indicators.” (p. 558; **real incentives/hypothetical choice**) %}

Morgenstern, Ralf, Marcus Heldmann, & Bodo Vogt (2014) “Differences in Cognitive Control between Real and Hypothetical Payoffs,” *Theory and Decision* 77, 557–582.

{% **three-doors problem**: This paper does an experiment on the three door problem. The author investigates to what extent non-Bayesian updating, illusion of control, and status quo bias play a role. (**updating: testing Bayes’ formula**)
The start of the paper is not good. As happens usually, the three door problem is not properly described. Here is the, incomplete, description that the author gives:

> Suppose you’re on a game show, and you’re given the choice of three doors:

behind one door is a car; behind the others, goats. You pick a door, say No. 1, and the host, who knows what's behind the doors, opens another door, say No. 3, which has a goat. He then says to you, 'Do you want to pick door No. 2?' Is it to your advantage to switch your choice?

What is missing in this description is that the host will deliberately always open another door that does not have the car. (For specialists: and, further, that if the host has two doors to choose from, i.e., if "you" initially chose the door with the prize, that then the host randomly chooses the door to be opened. %}

Morone, Andrea (2021) "Three Doors Anomaly, 'Should I Stay, or Should I Go,': An Artefactual Field Experiment," *Theory and Decision* 91, 357–376. https://doi.org/10.1007/s11238-021-09809-0

{% The ambiguity box is software that is convenient for generated ambiguity in the lab, similar to Hey's bingo blower. %}

Morone, Andrea & Rocco Caferra (2024) "The Ambiguity Box: A New Tool to Generate Ambiguity in the Lab," *Journal of Behavioral and Experimental Economics* 113, 102297. doi: https://doi.org/10.1016/j.socec.2024.102299

{% Collect data like Hey & Orme (1994), and fit four functionals: EU, disappointment aversion, RDU with power probability weighting, and RDU with the Tversky & Kahneman one-parameter family (the authors erroneously credit Quiggin 1982 for it). In their first analysis, they do within subject testing, assuming that within-subject choices are statistically independent which I find problematic. Their second test considers for each individual which theory fits best, second-best, and so on. Problem here is that close theories kill each others' chances, in the same way as Nadar made Gore lose to Bush. According to the criteria used, EU is best, disappointment aversion second, RDU with power utility is third, and RDU with T&K weighting is fourth and last. %}

Morone, Andrea & Piergiuseppe Morone (2014) "Estimating Individual and Group Preference Functionals Using Experimental Data," *Theory and Decision* 77, 323–339.

{% %}

Morrell, Darryl R. (1993) "Epistemic Utility Estimation," *IEEE Transactions on Systems, Man, and Cybernetics* 23, 129–140.

{% %}

Morris, Stephen (1994) "Trade with Heterogeneous Prior Beliefs and Asymmetric Information," *Econometrica* 62, 1327–1347.

{% Discusses much literature on the common prior assumption, such as Carnap. %}

Morris, Stephen (1995) "The Common Prior Assumption in Economic Theory," *Economics and Philosophy* 11, 227–253.

{% Generalizes Morris & Shin (1997, ET) to nonEU. %}

Morris, Stephen (1996) "The Logic of Belief and Belief Change: A Decision Theoretic Approach," *Journal of Economic Theory* 69, 1–23.

{% Paper shows that individuals' willingness to bet will exhibit a bid ask spread property in the presence of heterogeneous prior beliefs and asymmetric information. Pp. 236-237: "It is true that it is possible to imagine environments where strategic considerations are ruled out, and our individual nonetheless displays uncertainty aversion. However, it is argued that such situations are unlikely to be economically relevant."

Footnote 24: "It would be interesting to test how sensitive Ellsberg-paradox-type phenomena are to varying emphasis in the experimental designs on the experimenter's incentives." %}

Morris, Stephen (1997) "Risk, Uncertainty and Hidden Information," *Theory and Decision* 42, 235–269.

{% %}

Morris, Stephen (1997) "Alternative Notions of Knowledge." *In* Michael Bacharach, Louis-André Gérard-Varet, Philippe Mongin, & Hyun Song Shin (1997, eds.) *Epistemic Logic and the Theory of Games and Decisions*, 217–234, Kluwer Academic Press, Dordrecht.

{% %}

Morris, Stephen, Andrew Postlewaite, & Hyun Song Shin (1995) "Depth of Knowledge and the Effect of Higher Order Uncertainty," *Economic Theory* 6, 453–467.

{% %}
Morris, Stephen, Rafael Rob, & Hyun Song Shin (1995) "p-Dominance and Belief Potential," *Econometrica* 63, 145–157.

{% **value of information**: Savagean EU maximizer can do decision with or without further info. Info can be favorable, leading to higher EU state, or unfavorable, leading to lower EU state. (This is different thing than Blackwell-like, as authors explain p. 310 bottom.) The authors give conditions for info to be valuable. Generalizations to nonEU by Morris (1996, JET) where essentially the same results hold. Here belief is through a logical operator. %}
Morris, Stephen & Hyun Song Shin (1997) "Rationality and Efficacy of Decisions under Uncertainty," *Economic Theory* 9, 309–324.

{% %}
Morrison, Gwendolyn C. (1997) "HYE and TTO: What Is the Difference?," *Journal of Health Economics* 16, 563–578.

{% %}
Morrison, Gwendolyn C. (1997) "Resolving Differences in Willingness to Pay and Willingness to Accept: Comment," *American Economic Review* 87, 236–240.

{% **PE higher than CE**; **adaptive utility elicitation**; **CE bias towards EV**: not exactly that, but, endowment effect induced bias of CE (certainty equivalent) towards risk seeking.

Seems to find, as do Hershey & Schoemaker (1982), that in standard gamble choices people focus on the sure outcome as their reference point. %}
Morrison, Gwendolyn C. (2000) "The Endowment Effect and Expected Utility," *Scottish Journal of Political Economy* 47, 183–197.

{% **questionnaire versus choice utility**: A metastudy on conversions of introspection-based measurements into revealed-preference based utilities. Impressive! Using strict selection criteria, they were left with 46 empirical studies and 16 further studies shedding light on the topic. One thing they conclude (p. 87 2nd column) is that discrepancies depend more on the domain (which disease) than on the method used. They use the term descriptive measure for introspective-based measures and the term QALY for decision-utility based.

P. 67 top explains that often for practical reasons we cannot get revealed-preference based measurements and have to do with introspective measurements. %}

Mortimer, Duncan & Leonie Segal (2008) "Comparing the Incomparable? A Systematic Review of Competing Techniques for Converting Descriptive Measures of Health Status into QALY-Weights," *Medical Decision Making* 28, 66–89.

{% **risky utility u = strength of preference v (or other riskless cardinal utility, often called value)**: It has been widely understood that cardinality of utility has two different meanings. First, just the mathematical property of uniqueness up to unit and location. Second, that it can be given psychological interpretations. This paper discusses the issue anew, adding new literature. In the beginning of §2, the author writes "In his Manual, Pareto ([1909] 1971: 112 and 396) maintained that utility cannot be measured; i.e., that it is impossible to identify a unit of utility and express the utility of commodities as a multiple of that unit." I regret that the author, as did so many, leaves out the crucial premise that Pareto added. Pareto made his claim only for the case where we only want to explain market demand and equilibrium. %}

Moscati, Ivan (2013) "How Cardinal Utility Entered Economic Analysis, 1909-1944," *European Journal of the History of Economic Thought* 20, 906–939.

{% The most central idea in decision under uncertainty, and the dividing line between Bayesian EU and nonEU, is the sure-thing principle. It was Savage's (1954) main invention. How did the idea come about? I have wondered since my youth. It was mainly in exchanges between Samuelson and Savage, two of the greatest minds ever. This paper carefully documents the history and origin of the idea. It is very valuable to me, answering questions I had since my youth.

independence/sure-thing principle due to mutually exclusive events: The crucial point why the sure-thing principle is normative, is that it concerns separability about mutually exclusive events, between which no physical interaction is possible. (The interaction is only in the, confused, minds of nonEU maximizers.) P. 225 cites a May 11 1950 letter by Marschak who points it out to Samuelson, but Samuelson's reaction is confused. He brings in utility and is confused that utility of tea and pretzles will interact, which is besides the point. P. 227 middle cites Samuelson (1950a) on properly criticizing the Friedman-Savage EU explanation of gambling and insurance with EU. Samuelson (1952 Econometrica) writes that much brooding on "mutually exclusive" in 1950 made him understand the importance of "mutually exclusive." He does not credit Marschak there.

P. 229 cites Sept. 13, 1950 letter by Friedman where Friedman writes that under EU all preferences are completey determined by binary gambles: "Dear Paul: … It has never seemed to me obviously true or necessary that individual's reactions to complicated gambles should be completely predictable from their reactions to two-side ones—which has always seemed to me the fundamental empirical content of the B[ernoulli]–M[arshall] hypothesis"

P. 230 brings up Savage's letter of August 12, 1950, where he first formulates the sure-thing principle as a form of event-wise monotonicity (in the same way that every separability can be written as monotonicity).

On p. 231 this paper suggests that Savage (1954) used the term sure-thing principle only for his P2. But this is not so. It also included P3 (monotonicity w.r.t. outcomes) and P7. Only later it became a tradition in the field to use the term sure-thing principle only for P2, a tradition that I follow.

P. 231 shows that Samuelson had changed his mind on EU, and now considered it normative, in his letter to Friedman of August 25, 1950. It is nowhere stated that the mutual exclusiveness of events played a role in Samuelson's considerations, whereas my memory (I read the relevant letters in the early 1990s) tells it did; but I must have been confused then. Looks like Marschak was the one to bring the argument in in this communication on the sure-thing principle. Note that von Neumann & Morgenstern (1944) repeatedly justify the addition-operation in their EU formula by emphasizing that it is about mutually exclusive events. %}

Moscati, Ivan (2016) "How Economists Came to Accept Expected Utility Theory: The Case of Samuelson and Savage," *Journal of Economic Perspectives* 30, 219–236.

{% The intro argues that Friedman was the first to argue that the vNM cardinal EU utility U can be different than the cardinal economic utility u. The book discusses the historical role of Hölder (1901). It also discusses the mentalist vs. the instrumental view of utility.

A central theme is the distinction between cardinal utility and utility as a ratio scale, but I did not understand it and to me the difference is minor. Well, it becomes substantive if the 0 level of utility has a special meaning as a reference point, separating gains and losses, but this is not the distinction that the book makes.

P. 190, §11.8, writes: "After an initial period characterized by various changes of mind about the validity of EUT, the parties in favor and against stabilized, and the supporters turned out to be significantly both more numerous and more academically prominent than the opponents."
%}

Moscati, Ivan (2019) "*Measuring Utility: From the Marginal Revolution to Behavioral Economics.*" Oxford University Press, Oxford, UK.

{% Surveys recent discussions of empirical status of preferences, mainly mentalism versus behaviorism. Pleas for more attention for recent nonEU theories and heuristics, and more discussions of realism/anti-realism. %}

Moscati, Ivan (2020) "On the Recent Philosophy of Decision Theory," working paper.

{% %}

Moscati, Ivan (2023) "*The History and Methodology of Expected Utility*." Elements in Decision Theory and Philosophy, Cambridge University Press, Cambridge UK.

{% Version of 1 June 2022: Discusses as-if (also called paramorphic) versus process (also called homeomorphic) modeling in behavioral economics. Puts relevant arguments on the table. Comnects decision theory with philosophy (e.g. realism vs. antirealism). Lists many problems for process models: Transitivity is violated; researchers disagreeing. Therefore, goes against processs modeling and pleas for strict as-if. My subjective opinion is opposite: The many problems for process models are not very different from problems for most models. Hold as much for as-if models. Some problems is not enough reasons to entirely discard process insights. Those did, and will, bring many good things. %}

Moscati, Ivan (2024) "Behavioral and Heuristic Models Are as-if Models too—and That's OK," *Economics and Philosophy*, 40, 279–309.
https://doi.org/10.1017/S0266267123000093

{% Explains how Ellsberg (1961) was much influenced by Chipman, his supervisor. %}

Moscati, Ivan (2024) "Ellsberg 1961: Text, Context, Influence," *Decisions in Economics and Finance* 47, 627–653.

{% Seems to find violations of **RCLA**. %}

Moser, Donald V., Jacob G. Birnberg, & Sangho Do (1994) "A Similarity Strategy for Decisions Involving Sequential Events," *Accounting, Organizations and Society* 19, 439–459.

{% Gotten from Ido Erev on 5 sept. 1990.

Tests effects of framing and talking with subjects on their violations of the sure-thing principle. Done before by MacCrimmon (1967) who did it with hypothetical choice. This paper uses real incentives. Those were grades for a statistics course … (I expect that ethical committees would not approve this nowadays, 2020.) All subjects received a simple verbal description. Some received, in addition, a matrix representation that made the common outcome salient, and some in addition received a decision tree figure where the common outcome was not clear. In total, the matrix representation gave most verifications of the sure-thing principle (76%), the just-verbal almost the same (73%), and decision trees the least (65%). So, no spectacular results. The discussion never mentions the possibility that the matrix structure, which makes the role of the s.th.pr. more salient, may lead to more consistent choices not because such is genuine preference, but because this becomes an easy heuristic. %}

Moskowitz, Herbert (1974) "Effects of Problem Representation and Feedback on Rational Behavior in Allais and Morlat-Type Problems," *Decision Sciences* 5, 225–242.

{% EU analysis if probabilities and utilities are not precisely known but are only inferred up to certain limits from observed choices. %}

Moskowitz, Herbert, Paul V. Preckel, & Aynang Yang (1993) "Decision Analysis with Incomplete Utility and Probability Information," *Operations Research* 41, 864–879.

{% %}

Moskowitz, Tobias J. & Annette Vissing-Jorgensen (2002) "The Returns to Entrepreneurial Investment: A Private Equity Premium Puzzle?," *American Economic Review* 92, 745–778.

{% Characterize maxmin choice. %}

Mosquera, Manuel, Peter Borm, M. Gloria Fiestras-Janeiro, Ignacio Garcia-Jurado, & Mark Voorneveld (2008) "Characterizing Cautious Choice," *Mathematical Social Sciences* 55, 55, 143–155.

{% Seems to show that under actuarially unfair coinsurance (loading factor in insurance premium) and EU with concave utility, no complete insurance is taken. %}

Mossin, Jan (1968) "Aspects of Rational Insurance Purchasing," *Journal of Political Economy* 76, 553–568.

{% Seems to show that in a multiplicative growth process, under CRRA utility, preference in one round is equal to preference over any finite number of rounds. This follows trivially from CRRA. It means that one can do myopic optimization. In the same spirit, in an additive growth process (as in Samuelson's "colleague example") one can do myopic optimization under CARA utility. %}

Mossin, Jan (1968) "Optimal Multiperiod Portfolio Policies," *Journal of Business* 41, 215–229.

{% %}

Mossin, Jan (1969) "A Note on Uncertainty and Preferences in a Temporal Context," *American Economic Review* 59, 172–174.

{% Remarkably, Mosteller started as a mathematician, but later turned to psychology. Arrow (1982): first empirical test of EU.

P. 373 seems to argue that PE is difficult because probability is a more difficult concept than money (**PE doesn't do well**)

P. 374 seems to argue against deterministic tests, and to favor probabilistic choice models; they let subjects repeat choices everal times

P. 377: they deceived subjects by giving them more money than said. (**deception when implementing real incentives**)

P. 383 mentions the **utility of gambling**. P. 402 discusses it more. "Indeed, the writers would prefer to defer discussion of this point until a way of testing arguments about it is provided."

P. 385, end of 2nd column: a subject who violates probabilistic reduction (Wakker's (2010) decision under risk assumption 2.1.2) by gambling rather on one hand than the other

Real incentives: repeated gambles for money, all with real incentives. Losses were also implemented. A **losses from prior endowment mechanism** was used although it might in extreme cases not cover all losses. P. 399 mentions that this gives an income effect. P. 400 mentions house money effect, that subjects befome more risk seeking after prior gains.

inverse S: Suggest that their data for probability transf. agree with Preston & Baratta's but this is not much so. Sprowls (1953) says they are more variable. P. 397: For Preston & Baratta probability transformation (assuming linear utility) intersects the diagonal at about 0.2, in this experiment at 0.5 for guardsmen, and not for the students (they are always risk averse). Domain: [–0.05, 5.50]

P. 398 has nice discussion of problem with transforming fixed probabilities, that they must violate transitivity and do not sum to 1. (**biseparable utility**) Then also, nicely, for two-outcome gambles, that subjects focus on a particular outcome, and let the other outcome have rest of unitary decision weight. This would be biseparable utility (RDU for two outcomes) if the particular outcome were always the best, or always the worst. Point out that for more than two

outcomes the formula then is not clear.

SEU = SEU: p. 398 has good discussion, with footnote 16 pointing out that additive subjective probabilities if unequal to objective probabilities cannot be transforms of the latter.

P. 402, §VI.E: **utility of gambling**. %}

Mosteller, Frederick & Philip Nogee (1951) "An Experimental Measurement of Utility," *Journal of Political Economy* 59, 371–404. https://doi.org/10.1086/257106

{% %}

Moulin, Hervé (1985) "Egalitarianism and Utilitarianism in Quasi-Linear Bargaining," *Econometrica* 53, 49–68.

{% %}

Moulin, Hervé (1987) "Equal or Proportional Division of a Surplus, and Other Methods," *International Journal of Game Theory* 16, 161–186.

{% %}

Moulin, Hervé (1988) "*Axioms of Cooperative Decision Making.*" Cambridge University Press, New York.

{% %}

Mowen, John C. & James W. Gentry (1980) "Investigation of the Preference-Reversal Phenomenon in a New Product Introduction Task," *Journal of Applied Psychology* 65, 715–722.

{% %}

Mowrer, O. Hobart & Lawrence N. Solomon (1954) "Contiguity vs Drive-Reduction in Conditioned Fear: The Proximity and Abrubtness of Drive-Reduction," *American Journal of Psychology* 67, 15–25.

{% %}

Moyes, Patrick (2007) "An Extended Gini Approach to Inequality Measurement," *Journal of Economic Inequality* 5, 279–303.

{% Impressive data sets (total N = 17,720!) is used to investigate loss aversion. Throughout, loss aversion is confirmed. Many psychologal factors underlying it are discussed. They cite much literature. Their data set contained over 3,000 millionaires, who also were loss averse for moderate stakes.

Loss aversion due to framing (what I call loss aversion is always due to framing, being reference dependent; genuine utility (reference independent) I call basic utility) is probably what the authors call "loss aversion rooted in preference construction," referring to the constructive view of preference. The authors distinguish it from "rooted in status quo bias" and other factors (p. 408 1st column), but for me those need not be different and they can be one component in combination. In general, it is difficult to see how and to what extent different psychological factors are really distinct or overlapping/joining. The authors distinguish endowment effect from loss aversion, but I take endowment effect to be part of loss aversion.

One problem is that the authors do not consider utility curvature or probability weighting (or other concepts from risk theories) but ascribe all risk aversion to loss aversion. For instance, an indifference (0,.5:–300, 0.5:100) ~ 0 is taken to give loss aversion $\lambda = 3$. They sometimes discuss "rational risk aversion" and suggest to measure it in one study (p. 416), but that only uses an introspective question: "[W]here would your household prefer to put most of its savings and investments?" (1 = very low return/very low risk; 5 = very high return/very high risk)" and it is used as a covariate in regressions (taking away quite some of loss aversion). So, they do not really correct for utility curvature or probability weighting. They also defend by saying that they also find loss aversion for millionaires. It can be argued that, because of the richness of millionaires, utility of small stakes should be linear, but it need not neutralize probability weighting, or other factors from other theories.

For cars taken as multiattribute objects, they measure attributewise loss aversion, finding that it is smaller for attributes better known to subjects (p. 414 1st column). Loss aversion is moderated by being young (p. 414 2nd column discussion has a typo on this; **relation age-risk attitude**), education, knowledge, and experience (**cognitive ability related to risk/ambiguity aversion**).

P. 408 2nd column writes that loss aversion is robust, but I think it is strong but very volatile.

P. 422 1st & 2nd column has the usual enthusiasm: “These results have important implications. … The finding that older people are more loss averse has substantial implications, … extremely important.”

A replication by Zeif & Yechiam (2022) does not find loss aversion for moderate amounts ($40), but of about 1.5 for $100. %}

Mrkva, Kellen, Eric J. Johnson, Simon Gächter, & Andreas Herrmann (2020) “Moderating Loss Aversion: Loss Aversion Has Moderators, but Reports of Its Death Are Greatly Exaggerated,” *Journal of Consumer Psychology* 30, 407–428. https://doi.org/10.1002/jcpy.1156

{% %}

Muermann, Alexander, Olivia S. Mitchell, & Jacqueline M. Volkman (2006) “Regret, Portfolio Choice, and Guarantees in Defined Contribution Schemes,” *Insurance: Mathematics and Economics* 39, 219–229.

{% Application of ambiguity theory;

Measure ambiguity aversion in the traditional way, with choices between gambles on known/unknown urns, some hypothetical and some with real incentives (RIS). Ambiguity aversion is correlated with preference for known brand (not very surprising given that both concern a preference for known versus unknown). The effect is enhanced if ambiguity aversion is enhanced by a lottery choice prior to the brand choice (priming). %}

Muthukrishnan, Analmalal V., Luc Wathieu, & Alison Jing Xu (2009) “Ambiguity Aversion and the Preference for Established Brands,” *Managent Science* 55, 1933–1941.

{% %}

Müller, Werner G., Antonio C.M. Ponce De Leon (1996) “Optimal Design of an Experiment in Economics,” *Economic Journal* 106, 122–127.

{% **free will/determinism**: this whole issue of the journal is on it. %}

Müller, Thomas, Antje Rumberg, & Verena Wagner (2019) "An Introduction to Real Possibilities, Indeterminism, and Free Will: Three Contingencies of the Debate," *Synthese* 196, 1–10.

{% %}
Müller-Peters, Anke (1998) "The Significance of National Pride and National Identity to the Attitude toward the Single European Currency: A Europe-Wide Comparison," *Journal of Economic Psychology* 19, 701–719.

{% **updating: nonadditive measures**: Describes ideas of belief functions; giving new interpretation of Dempster/Shafer updating; **small worlds**: uses incomplete state spaces as argument, adds one catch all state. %}
Mukerji, Sujoy (1997) "Understanding the Nonadditive Probability Decision Model," *Economic Theory* 9, 23–46.

{% Application of ambiguity theory;
PT, applications: nonadditive measures, incomplete markets. Uses Choquet expected utility with convex weighting function. %}
Mukerji, Sujoy (1998) "Ambiguity Aversion and Incompleteness of Contractual Form," *American Economic Review* 88, 1207–1231.

{% %}
Mukerji, Sujoy (2003) Book Review of: Ellsberg, Daniel (2001) "*Risk, Ambiguity and Decision,*" Garland Publishers, New York," *Economic Journal* 113, 187–188.

{% %}
Mukerji, Sujoy (2009) "Foundations of Ambiguity and Economic Modeling," *Economics and Philosophy* 25, 297–302.

{% Application of ambiguity theory;
PT, applications: nonadditive measures, incomplete markets;
equilibrium under nonEU: general equilibrium with incomplete markets explained using Choquet expected utility with convex capacity. %}

Mukerji, Sujoy & Jean-Marc Tallon (2001) "Ambiguity Aversion and Incompleteness of Financial Markets," *Review of Economic Studies* 68, 883–904.

{% Portfolio inertia: There is an interval of prices at which an agent strictly prefers zero position on an asset. This is related to partition-wise preference as in source preference of Tversky & Wakker (1995). As often, the authors throughout equate ambiguity attitude with ambiguity aversion. So, source preference for A over B, in absence of ambiguity seeking for A, must then mean ambiguity aversion for B.

Proposition 3.a shows that, if source preference for $\{A_1,A_2\}$ over $\{B_1,B_2\}$, then $A_1 \cap B_1$ or $A_2 \cap B_2$ must be ambiguous in sense of Epstein & Zhang (2001) by simple natural proof.

Proposition 1 is corrected by Higashi, Mukerji, Takeoka, & Tallon (2008), %}

Mukerji, Sujoy & Jean-Marc Tallon (2003) "Ellsberg's Two-Color Experiment, Portfolio Inertia and Ambiguity," *Journal of Mathematical Economics* 39, 299–315.

{% Absence of indexation of loans is explained through maxmin EU/Choquet expected utility with convex capacity. %}

Mukerji, Sujoy & Jean-Marc Tallon (2004) "Ambiguity Aversion and the Absence of Indexed Debt," *Economic Theory* 24, 665–685.

{% Use Choquet expected utility to analyze the topic of their title. %}

Mukerji, Sujoy & Jean-Marc Tallon (2004) "Ambiguity Aversion and the Absence of Wage Indexation," *Journal of Monetary Economics* 51, 653–670.

{% %}

Mukerji, Sujoy & Jean-Marc Tallon (2004) "An Overview of Economic Applications of David Schmeidler's Models of Decision Making under Uncertainty." *In* Itzhak Gilboa (ed.) *Uncertainty in Economic Theory: Essays in Honor of David Schmeidler's 65th Birthday*, Routledge, London.

{% Cognitive interpretation of inverse S: The more emotionally people think (measured using questionnaires), the more **inverse S** probability weighting

(**cognitive ability related to likelihood insensitivity (= inverse S)**). Although the author several times refers to the relevance of utility curvature, probability weighting is measured assuming linear utility, which is reasonable for moderate amounts but could have been mentioned. The author, rightfully, points out that besides curvature also elevation is relevant. The experiment is always between-subject and thus is not as direct a test of the source method as when it had been within-subject. %}

Mukherjee, Kanchan (2011) "Thinking Styles and Risky Decision-Making: Further Exploration of the Affect–Probability Weighting Link," *Journal of Behavioral Decision Making* 24, 443–455. https://doi.org/10.1002/bdm.700

{% Consider introspective judgments of value of money and relate it to loss aversion. When glancing through the paper I did not see the hypothesis mentioned that loss aversion is due, not to losses being more intense experiences than gains, but losses being weighted more, but I may have missed it. They find no clear results and end the abstract with psychologists' favorite conclusion of context dependence: "Prospect Theory's value function is contextually dependent on magnitudes." %}

Mukherjee, Sumitava, Arvind Sahay, V. S. Chandrasekhar Pammi, & Narayanan Srinivasan (2017) "Is Loss-Aversion Magnitude-Dependent? Measuring Prospective Affective Judgments Regarding Gains and Losses," *Judgment and Decision Making* 12, 81–89.

{% Historical review of early works of de Finetti etc. in the 1920s and 1930s on quasi-linear means and their roles as certainty equivalents under expected utility. %}

Muliere, Pietro & Giovanni Parmigiani (1993) "Utility and Means in the 1930s," *Statistical Science* 8, 421–432.

{% Verbal text book on decision theory %}

Mullen, John D. & Byron M. Roth (1991) "*Decision Making, Its Logic and Practice*." Rowman & Littlefield, Savage Maryland.

{% Do a multivariate generalization of decreasing differences to characterize more concave than. The authors' term loss is not related to reference points or prospect theory or the like. In their terminology, under EU, fear of loss is equivalent to concave utility. %}

Müller, Alfred & Marco Scarsini (2012) "Fear of Loss, Inframodularity, and Transfers," *Journal of Economic Theory* 147, 1490–1500.

{% The authors assume EU with utility u. They introduce an index $0 \le \gamma \le 1$ for a utility function u, an anti-index for the nonconcavity of u. $\gamma = 1$ means complete concavity, and $\gamma = 0$ means strictly increasing and not any restriction otherwise. $0 < \gamma < 1$ means that the function can have convexities, but not too pronounced, and bounded by γ. For u, we take the maximal γ such that

$0 \le \gamma u'(y) \le u'(x)$ for all $y \ge x$.

So, u´ may be increasing, but not by a factor more than 1/γ, so to say. The authors give an extension to nondifferentiable functions through discrete approximations. Besides the definition using derivates, there are also an euivalent integral and an equivalent γ-transfer formulation, and 1+γ stochastic dominance. The conditions are related to greediness and thriftiness conditions of Chateauneuf, Cohen, & Meilijson (2005). The dual definitions for nonconvexity are also given.

§3 explains that the authors' concepts can well capture local convexities, e.g. because of aspiration or other reasons for local jumps in u´. Zank once told me an example: just above the level where you can buy a new house, marginal utility is steep.

§4.2 considers reference dependence and loss aversion. On a bounded interval [–d, d], under concavity for gains and convexity for losses, γ can be determined (both for nonconvexity and nonconcavity), involving loss aversion λ. They show that loss aversion can be reinterpreted as part of utility curvature. %}

Müller, Alfred, Marco Scarsini, Ilia Tsetlin, & Robert L. Winkler (2017) "Between First- and Second-Order Stochastic Dominance," *Management Science* 63, 2933–2947.
https://doi.org/10.1287/mnsc.2016.2486

{% %}

Müller, Dennis C. (2003) "*Public Choice III.*" Cambridge University Press, Cambridge.

{% **foundations of probability** %}

Müller, Thomas (2005) "Probability Theory and Causation: A Branching Space-Times Analysis," *British Journal for the Philosophy of Science* 56, 487–4520.

{% %}

Mulley, Albert G. (1989) "Assessing Patients' Utilities: Can the Ends Justify the Means?," *Medical Care* 27, 269–281.

{% **Dutch book**: discusses extension to multi-valued logic with events that can take more values than true or untrue, following up on work by Jeff Paris. %}

Mundici, Daniele (2006) "Bookmaking over Infinite-Valued Events," *International Journal of Approximate Reasoning* 43, 223–240.

{% **foundations of probability** %}

Munera, Hector A. (1992) "A Deterministic Event Tree Approach to Uncertainty, Randomness and Probability in Individual Chance Processes," *Theory and Decision* 32, 21–55.

{% %}

Munier, Bertrand R. (1988, ed.) "*Risk, Decision and Rationality,*" 545–556, Reidel, Dordrecht.

{% %}

Munier, Bertrand R. (1991) "Nobel Laureate, The Many Other Allais Paradoxes," *Journal of Economic Perspectives* 5 no. 2, 179–199.

{% %}

Munier, Bertrand R. (1991) "Market Uncertainty and the Process of Belief Formation," *Journal of Risk and Uncertainty* 4, 233–250.

{% %}

Munier, Bertrand R. (1992) "Expected Utility versus Anticipated Utility - Where Do We Stand," *Fuzzy Sets and Systems* 49, 55–64.

{% %}

Munier, Bertrand R. & Mohammed Abdellaoui (1991) "Expected Utility Violations: An Appropriate and Intercultural Experiment." *In* Attila Chikàn et al. (eds.) *Progress in Decision, Utility and Risk Theory*, Kluwer Academic Publishers.

{% %}

Munier, Bertrand R. & Mark J. Machina (1994) "*Models and Experiments in Risk and Rationality*." Kluwer Academic Publishers, Dordrecht.

{% Supervisors were Mokken and Saris. March 1998.
Uses generalization of bisymmetry to n dimensions, so, what Chew called event commutativity, to characterize the quasilinear mean. Ch. 2 describes an experimental test of the condition in the context of performances of students. %}

Münnich, Àkos (1998) "Judgement and Choice." Ph.D. Dissertation, University of Rotterdam, the Netherlands.

{% Uses bisymmetry condition, for more than two states of nature, to get expected utility functional. Is formulated in context of aggregation over persons. %}

Münnich, Àkos, Gyula Maksa, & Robert J. Mokken (1999) "Collective Judgement: Combining Individual Value Judgments," *Mathematical Social Sciences* 37, 211–233.

{% Extends the bisymmetry functional equation to n variables. More advanced results can be found in Nakamura (1990 JET, 1992, 1995) and an unpublished Chew (1989) paper. %}

Münnich, Àkos, Gyula Maksa, & Robert J. Mokken (2000) "n-Variable Bisection," *Journal of Mathematical Psychology* 44, 569–581.

{% Test it not for risk but for multi-attribute. %}

Münnich, Àkos, Gyula Maksa, & Robert J. Mokken (2005) "Testing n-Stimuli Bisymmetry," *Journal of Mathematical Psychology* 48, 399–408.

{% Reference dependence in otherwise classical model. Cycles are excluded. %}
Munro, Alistair & Robert Sugden (2003) "On the Theory of Reference-Dependent Preferences," *Journal of Economic Behavior and Organization* 50, 407–428.

{% Risk attitudes in this paper concern uncertainties about own performance. Thus, the uncertain events are not Savagean in the sense of being completely outside of the control of the agent. %}
Murad, Zahra, Martin Sefton, & Chris Starmer (2016) "How Do Risk Attitudes Affect Measured Confidence?," *Journal of Risk and Uncertainty* 52, 21–46.

{% Refer to my Fuzzy Sets and System paper. %}
Murofushi, Toshiaki & Michio Sugeno (1989) "An Interpretation of Fuzzy Measures and the Choquet Integral as an Integral with respect to a Fuzzy Measure," *Fuzzy Sets and Systems* 29, 201–227.

{% %}
Murofushi, Toshiaki & Michio Sugeno (1993) "Some Quantities Represented by the Choquet Integral," *Fuzzy Sets and Systems* 56, 229–235.

{% Extend the Schmeidler (1986) functional representation by considering functions of bounded variation. %}
Murofushi, Toshiaki, Michio Sugeno, & Motoya Machida (1994) "Non-Monotonic Fuzzy Measures and the Choquet Integral," *Fuzzy Sets and Systems* 64, 73–86.

{% **probability elicitation** %}
Murphy, Allan H. & Robert L. Winkler (1970) "Scoring Rules in Probability Assessment and Evaluation," *Acta Psychologica* 34, 917–924.

{% **probability elicitation**. Seem to mention that the U.S. National Weather Service (NWS) required its meteorologists since 1965 to give probability judgments in addition to their categorical forecasts of precipitation. %}

Murphy, Allan H. & Robert L. Winkler (1974) "Subjective Probability Forecasting Experiments in Meteorology: Some Preliminary Results," *Bulletin of the American Meteorological Society* 55, 1206–1216.

{% **probability elicitation** %}
Murphy, Allan H. & Robert L. Winkler (1977) "Reliability of Subjective Probability Forecasts of Precipitation and Temperature," *Applied Statistics* 26, 41–47.

{% Author is also cited as F.P. Murphy.
Small simplification of a point in Vind's demonstration showing that Gorman's theorem holds under connectedness rather than arcconnectedness. %}
Murphy, Barry (1981) "A Note on Weak Separability," *Review of Economic Studies* 48, 671–672.
https://doi.org/10.2307/2297209

{% Describes, a.o., that Bernard (1865) meant to discredit probability theory's applicability to medicine. %}
Murphy, Terence D. (1981) "Medical Knowledge and Statistical Methods in Early Nineteenth Century France," *Medical History* 25, 301–319.

{% Reanalyze the data of a working paper Schulte-Mecklenbeck, Pachur, Murphy, & Hertwig (2018), with N = 142 and 91 choices between risky prospects with at most two nonzero outcomes, with both gains and losses. (§2). Use standard parametrizations of PT to fit data with Prelec's two-parameter family.
P. 309, end of §1.1.2: "Prospect theory is arguably the most important and influential descriptive model of risky choice to date." (**Prospect theory/Rank-Dependent Utility most popular for risk**)
P. 310, beginning of §1.2: "Multiparameter models' estimation methods may be prone to overfitting and in doing so adjust to noise instead of real risk preferences (Roberts and Pashler 2000). This can sometimes be observed when parameter values emerge that are highly atypical and extreme. A common solution to this problem is to set boundaries and limit the range of parameter values that are potentially estimated."
They propose a new hierarchical maximum likelihood estimation method (HML), which the estimates of an individual's parameters are influenced by the

estimates of other individuals. This is also done in hierarchical Bayesian methods. I know too little about it to know where this paper is innovative in this regard. Pp. 310-311: "We therefore address to what degree an estimation method combining group-level information with individual-level information can more reliably represent individual risk preferences compared with using either individual or aggregate information exclusively."

P. 312: Very unfortunately, payments are not what they are said to be, but when incentivized the authors divided all payoffs by 10. I never understood why researchers not just call payoffs what they are.

P. 317: for population fitting, for time 1 choices they find $\alpha = 0.73$ (power of utility; taken the same for gains and losses); $\lambda = 1.11$ (loss aversion); $\delta = 0.88$ (power of weighting function, being index of pessimism), $\gamma = 0.65$ (likelihood-insensitivity index of weighting function), and for time 2 choices they find $\alpha =$ 0.73 (power of utility; taken the same for gains and losses); $\lambda = 1.18$ (loss aversion); $\delta = 0.84$ (power of weighting function, being index of pessimism), $\gamma =$ 0.68 (likelihood-insensitivity index of weighting function).

Pp. 317-318: "On the aggregate, cumulative prospect theory's predictions appear to perform well."

Compared to a classical maximum likelihood estimation (only per individual without using population info), their HML method has, unsurprisingly, somewhat worse within-sample fit, but better out-of-sample prediction and more stability of parameter estimates.

P. 320 bottom: "The benefits of hierarchical modeling may, for example, diminish hen more choice data are available." %}

Murphy, Ryan O., & Robert H.W. ten Brincke (2018) "Hierarchical Maximum Likelihood Parameter Estimation for Cumulative Prospect Theory: Improving the Reliability of Individual Risk Parameter Estimates," *Management Science* 64, 308–326.
https://doi.org/10.1287/mnsc.2016.2591

{% A nice discussion of regret for decisions about prenatal screening for Down syndrome. Many women do not want to do screening so as to avoid regret in case of induced miscarriage, even if by all outcome measures screening is superior. %}

Murray, Rosemary & Jean Beattie (2001) "Decisions about Prenatal Screening." *In* Elke U. Weber, Jonathan Baron & Graham Loomes (eds.) *Conflict and Tradeoffs in Decision Making*, 156–174, Cambridge University Press, Cambridge, UK.

{% %}
Musgrove, Philip (1985) "Why Everything Takes 2.71828 ... Times as Long as Expected," *American Economic Review* 75, 250–252.

{% **conservation of influence**: §34: "Alles, was man fühlt und tut, geschieht irgendwie 'in der Richtung des Lebens,' und die kleinste Bewewgung aus dieser Richtung hinaus ist schwer oder erschreckend." My translation into English: "Everything, which one feels and does, happens somehow 'in the direction of life,' and the smallest movement away from this direction is hard or terrifying". %}
Musil, Robert (1930) "*Der Mann ohne Eigenschaften*." Rohwolt Publisher, Berlin.

{% **Christiane, Veronika & I** %}
Mussweiler, Thomas & Birte Englich (2003) "Adapting to the Euro: Evidence from Bias Reduction," *Journal of Economic Psychology* 24, 285–292.

{% Seems that he introduced rational expectations. %}
Muth, John F. (1961) "Rational Expectations and the Theory of Price Movements," *Econometrica* 29, 315–335.

{% **Prospect theory not cited**: much so. Typical is the sentence on p. 2, ignoring oceans and decades of literature: "We first elicited individuals' preferences towards risk and ambiguity through an elicitation method based on the Multiple Price List (MPL) approach proposed by Holt and Laury (2002) in the context of risk, and extended to ambiguity by Chakravarty and Roy (2009), and on the Becker–DeGroot–Marschak (BDM) method proposed by d'Albis et al. (2020)."

correlation risk & ambiguity attitude: find negative relation. %}
My, Kene Boun, Marielle Brunette, Stephane Couture, & Sarah Van Driessche (2024) "Are Ambiguity Preferences Aligned with Risk Preferences?," *Journal of Behavioral and Experimental Economics* 111, 102237. https://doi.org/10.1016/j.socec.2024.102237

{% **PT, applications**, loss aversion: Supports prospect theory; i.e., implications of reference dependence and diminishing sensitivity. They let subjects exchange money/lotteries in a market setup, when outcomes are losses.

risk averse for gains, risk seeking for losses: Beautiful data supporting this. The resulting equilibria suggest risk seeking for losses, in agreement with prospect theory. When reframed as gains (pp. 818-819), the resulting equilibria suggest risk aversion! The latter was done for only one equilibrium with only 9 subjects.

real incentives/hypothetical choice: Hypothetical questions (called questionnaires) revealed results that nicely agree with real-incentive market behavior. Some more risk aversion for real incentives.

losses from prior endowment mechanism. Done. They must hope that subjects do not integrate the total amounts.

Some results suggest that loss aversion (Conjecture 1, p. 820) and risk-seeking-for-losses (Conjecture 2, p. 820) decrease with experience. The latter nicely suggests that convex utility for losses reflects diminishing sensitivity rather than intrinsic value. I agree much with the interpretations in this paper.

The paper is strange in claiming that learning effects (reducing risk seeking for losses) would violate prospect theory, contrary to writings by Kahneman & Tversky (1986) and others that learning and incentives can make choices more rational.

random incentive system: P. 806 top of 2nd column uses it. Footnote 3 there states that the Holt (1986) compound-prospect argument can be ignored. %}

Myagkov, Mikhail G. & Charles R. Plott (1997) “Exchange Economies and Loss Exposure: Experiments Exploring Prospect Theory and Competitive Equilibria in Market Environments,” *American Economic Review* 87, 801–828.

{% %}

Mycielski, Jan & Stanislaw Swierczkowski (1964) “On the Lebesgue Measurability and the Axiom of Determinateness,” *Fundamentà Mathematicae* 54, 67–71.

{% **time preference**; Seems that they compare exponential to hyperbolic, do not consider increasing impatience; linear utility; hypothetical questions; data fitting on individual level; 12 subjects, no mention that they had problems fitting the data. %}

Myerson, Joel & Leonard Green (1995) "Discounting of Delayed Rewards: Models of Individual Choice," *Journal of the Experimental Analysis of Behavior* 64, 263–276.

{% %}

Myerson, Roger B. (1979) "An Axiomatic Derivation of Subjective Probability, Utility, and Evaluation Functions," *Theory and Decision* 11, 339–352.

{% %}

Myerson, Roger B. (1981) "Utilitarianism, Egalitarianism and the Timing Effect in Social Choice Problems," *Econometrica* 49, 883–897.

{% K is a set of objects to choose from. V is a set of votes available to voters. Votes are to be taken abstractly. For every $v \in V$, $\alpha(v)$ is the number of voters who chose v as t heir vote. For every object $k \in K$ and $v \in V$, $S_k(v)$ is the support that v gives to k. The value of object k is $\sum_{v \in V} S_k(v)\alpha(v)$, and the object k with the highest value is chosen. So, every k is evaluated through a k-dependent repetitions-approach (Wakker 1986) evaluation. %}

Myerson, Roger B. (1995) "Axiomatic Derivation of Scoring Rules without the Ordering Assumption," *Social Choice and Welfare* 12, 59–74.

{% Big Japanese data set is analyzed for relation between discounting, decreasing impatience, and smoking. Novelty is that sign effect (less discounting for losses than for gains) is incorporated. P. 1444 end of 4th para they report that: "hyperbolic discounting estimated from monetary choice questions exhibits neither a predicted nor a stable correlation with smoking." They criticize this measure for being noisy. The measure is derived from intertemporal indifferences (derived from choice list) about receiving in 2 days vs. 9 days, 90 vs. 97 days, and three of 1 month vs. 3 month. So, none considers immediate payoff and present bias.

P. 1448 explains that the authors use hypothetical choice citing three references (footnote 10) that find no differencve. Given hypothetical anyhow, I would have preferred way longer periods because in short term there is little discounting.

They take another question, about whether people did homework fast in their youth (§3.2.2) instead as proxy for discounting. This relates positively with smoking. It can, however, be for reasons different than time attitude. For instance, both smoking and postponing homework are protest attitudes against parents. Sign effect in sense of making discounting less for losses can decrease smoking, which is what the authors claim, but also in sense of making discounting for gains stronger can increase smoking I would say. Opening sentence in §2 strangely connects Becker & Murphy (1988) with forward-looking.

In Table 4, the probability of rain at which one takes an umbrella is index of risk seeking

P. 1453 §3.3 nicely tests time invariance: If time preference changes if both consumption and decision time change, but their difference remains the same. So, whether one can use stopwatch time. They have the longitudinal data for it, and find it violated. %}

Myong-Il Kang and Shinsuke Ikeda (2014) "Time Discounting and Smoking Behavior: Evidence from a Panel Survey, *Health Economics* 23, 1443–1464.

{% %}

Myung, Jae I. (2003) "Tutorial on Maximum Likelihood Estimation," *Journal of Mathematical Psychology* 47, 90–100.

{% Theory is about complexity versus parsimony; it considers not only the number of parameters but also the complexity of the formula. %}

Myung, Jae I. & Mark A. Pitt (1997) "Applying Occam's Razor in Modeling Cognition: A Bayesian Approach," *Psychological Bulletin & Review* 4, 79–95.

{% **error theory for risky choice**; Does what title says. %}

Myung, Jae I., George Karabatsos, & Geoffrey I. Iverson (2005) "A Bayesian Approach to Testing Decision Making Axioms," *Journal of Mathematical Psychology* 40, 205–225.

{% Seems that they point out problems of single-agent/representative-agent assumption in data fitting. %}

Myung, Jae I., Cheongtag Kim, & Mark A. Pitt (2000) "Towards an Explanation of the Power Law Artifact: Insights from Response Surface Analysis," *Memory and Cognition* 28, 832–840.

{% **value of information**; rekenen geloof ik gewoon maar wat dingen uit binnen EU. %}

Nadiminti, Raja, Tridas Mukhopadhyay, & Charles H. Kriebel (1996) "Risk aversion and the Value of Information," *Decision support systems* 16, 241–254.

{% **SPT instead of OPT**: Eq. 1 %}

Nagarajan, Mahesh & Steven Shechter (2014) "Prospect Theory and the Newsvendor Problem," *Management Science* 60, 1057–1062.
https://doi.org/10.1287/mnsc.2013.1804

{% %}

Nagel, Rosemarie (1995) "Unraveling in Guessing Games: An Experimental Study," *American Economic Review* 85, 1313–1326.

{% This paper follows up on Heinemann, Nagel, & Ockenfels (2009 RESTUD), HNO henceforth, adding a competitive entry game and doing neuro measurements. The first of the two games, the stag hunt game, is described in my annotations at HNO.

The second of the two games, the entry game, is as follows.

Imagine the 2-player game where each can choose safe (A) or risky (B), with payoffs, for some parameter $0 < x < 15$.

	A	B
A	x^x	x^{15}
B	15^x	0^0

It is a competitive game. If both go risky, they lose. It is favorable to do what your opponent does not do. If playing against a random member from a big population, and most players do one thing, then it is best to do the other thing.

There are two pure NE (Nash equilibria), (A,B) and (B,A), but none is symmetric so, they cannot arise in a symmetric game. The randomized NE is (x/15: A, (15–x)/15: B) for both players. It has the intuitive property of increasing probability of choosing the safe x as x increases. It is symmetric and stable.

In both games, the authors measure whether players prefer A or B for several values of x, and call the switching value the CE. As with HNO, this is an unconventional CE, and they also measure conventional CEs of lotteries, and by transitivity one can derive matching probabilities of the favorable event, being the opponent's choice B in the stag hunt game and A in the entry game.

In the entry game, a level 2 player always does the opposite of a level-1 player, which in some situations leads to the paradox of less taking the safe option x as x increases. Yet the switching value can still serve as a sort of CE. It does show that the effect of x on behavior is complex and sometimes antimonotonic. Therefore, it is not surprising that in the entry game the authors find more switches of preferences as x increases, what they call more entropy. They put this forward as an argument that the entry game is of a different nature. They use the term threshold strategy if there are no switches. Entry games also require more response time.

game theory can/cannot be viewed as decision under uncertainty (pp. 52-53 discuss it): They compare nature (my term; meaning: generated by nature) uncertainty with strategic uncertainty. The latter is mostly related to higher-level, say level k, thinking. The stag hunt game is simple, requiring little strategic thinking, and the entry game requires much. They find that stag hunt is similar to risk, but entry is different, by neuro measurements (p. 53 4th para; p. 58 last column middle of 2nd para) and also behaviorally based on CEs and correlation. P. 57 2nd column 1st para: CEs of entry games were even uncorrelated with those of risk and stag hunt games.

As do HNO, working with SEU, the authors suggest, following some other economists, that, the moment subjective probabilities have been assigned, the case is (like) decision under risk (abstract ℓ. 3; top of p. 53; p. 58 2nd para ℓ. 3; p. 59 2nd column 1st para last line; p. 59 2nd column lines –4/–6), and any deviation is taken as impossible to involve subjective probabilities. As I write at HNO, in the source method this is not so. Further, in the entry game, subjects can be perfectly Bayesian with subjective probabilities but still have less preference for the safe option x as it increases because they think it increases the probability of the opponent going for safe, so, it improves the risky probability of winning. They would do the same if such probabilities were generated by some natural process rather than a rational opponent, so that it need not necessarily be a difference between natural and strategic uncertainty.

P. 59: "The anterior insula thus reflects risk preferences and guides choice selection both in individual and [in] social settings."

P. 60 penultimate para precludes that the findings are entirely driven by social preferences. It can still be that social preferences do play a role, alongside with other effects. %}

Nagel, Rosemarie, Andrea Brovelli, Frank Heinemann, & Giorgio Coricelli (2018) "Neural Mechanisms Mediating Degrees of Strategic Uncertainty," *Social Cognitive and Affective Neuroscience* 13, 52–62.

{% Considers n-tuples $(x_1,\ldots,x_n)$ in Re^n with n variable. I (not the author) interpret it as 1/n probability prospects. Under EU, certainty equivalents, denoted CE, with utility denoted as φ, is $\varphi^{-1}([\varphi(x_1) + \ldots + \varphi(x_n)]/n)$, with φ endogenous. This paper axiomatizes functions CE for which there exists a continuous strictly monotonic φ. The axioms are (reordered but kept author's numbering):

(i) The function CE is symmetric;

(v) $CE(a,\ldots,a) = a$;

(ii) Write $CE(x_1,\ldots,x_r,x_{r+1},\ldots,x_n) = a$; then $CE(x_1,\ldots,x_r,x_{r+1},\ldots,x_n) = CE(a,\ldots, a, x_{r+1}, \ldots, x_n)$;

(iii) CE is continuous and $a \le CE(x_1,\ldots,x_n) \le b$ if each $a \le x_i \le b$ for all i;

(iv) $x_1 < x_2$ implies $x_1 \le CE(x_1,x_2) \le x_2$.

Condition (ii) is called associativity of the mean. It has a remarkable relation with vNM independence. It is a version of vNM independence: Jf $(x_1,\ldots,x_r) \sim a$ then $[r/n: (x_1,\ldots,x_r), (n-r)/n: (x_{r+1},\ldots,x_n)] \sim [r/n: a, (n-r)/n: (x_{r+1},\ldots,x_n)]$.

So: this can be taken as giving the vNM EU axiomatization for equal-probability prospects, which amounts to all rational-probability prospects, under the restriction of continuous utility!

To excite us even more, the theorem on p. 78 shows that constant absolute risk

aversion is equivalent to linear-exponential utility!! (The theorem only states sufficiency but the text directly preceding states necessity.) %}

Nagumo, Mitio (1930) "Über eine Klasse der Mittelwerte," *Japanese Journal of Mathematics* 7, 71–79.

{% Discuss behavioral theories (social interactions models, self-control models prospect theory in health) in policy applications by three criteria: (1) providing new insights (2) properly applied; (3) corroborated by evidence. Only PT passes the tests. %}

Nakamura, Ryota & Marc Suhrcke (2017) "A Triple Test for Behavioral Economics Models and Public Health Policy," *Theory and Decision* 83, 513–533.

{% %}

Nakamura, Yutaka (1984) "Nonlinear Utility Analysis," Ph.D. Thesis, University of California, Davis, 1984.

{% %}

Nakamura, Yutaka (1988) "Expected Utility with an Interval Ordered Structure," *Journal of Mathematical Psychology* 32, 298–312.

{% %}

Nakamura, Yutaka (1990) "Subjective Expected Utility with Non-Additive Probabilities on Finite State Spaces," *Journal of Economic Theory* 51, 346–366.

{% %}

Nakamura, Yutaka (1990) "Expected Utility with Nonlinear Thresholds," *Annals of Operations Research* 23, 201–212.

{% %}

Nakamura, Yutaka (1990) "Bilinear Utility and Threshold Structures for Nontransitive Preferences," *Mathematical Social Sciences* 19, 1–21.

{% %}

Nakamura, Yutaka (1990) "An Axiomatic Characterization of Quiggin's Anticipated Utility," Discussion paper, Inst. Socio-Econ. Plann., University of Tsukaba.

{% Theorem 1 modifies the results of Nakamura (1990, JET) by giving the rank-dependent weighted-utility representation on a rank-ordered set, not on the whole product set. %}

Nakamura, Yutaka (1992) "Multisymmetric Structures and Non-Expected Utility," *Journal of Mathematical Psychology* 36, 375–395.

{% The published 2009 paper "SSB Preferences: Nonseparable Utilities or Nonseparable Beliefs" gives these results but only for additive measures. The nontransitive nonadditive results have never been published (at least not in 2010). %}

Nakamura, Yutaka (1992) "A Generalization of Subjective Expected Utility without Transitivity and Additivity," paper presented at Sixth FUR conference, Cachan, France.

{% %}

Nakamura, Yutaka (1993) "Subjective Utility with Upper and Lower Probabilities on Finite States," *Journal of Risk and Uncertainty* 6, 33–48.

{% Marvelous theorems, but written in a difficult, mathematical, manner, and several typos. He does not only consider sigma-additive probability measures but, more generally, finitely additive measures. Because of that, he has to deal with ultrafilters, and has to write complex definitions in §2 regarding step probability distributions. On p. 108 last two para's he introduces n-tuples of outcomes and their cumulative probabilities, as Abdellaoui (2002, Econometrica) will do later. Then he, first, considers only three fixed outcomes (so, two-dimensional subspace!) and proves everything there, as he also did in his 1990-JET paper etc. He can, obviously, put his general representations of 1992 for general rank-ordered sets to good use. Axiom 5 is, however, not just multisymmetry but rather it is very similar to act-independence of Gul (1992, Assumption 2), as explained by Köbberling & Wakker (2003 MOR). Here is an explanation. He uses Wakker's (1993, MOR) truncation continuity to obtain an extension to nonsimple

prospects.

P. 104 penultimate para is correct. Nakamura has a rich probability space, and a general consequence space. Wakker (1993) did the extension to nonsimple probability distributions for general consequences, but had no underlying preference foundation of RDU for simple probability distributions for general consequences, but only for continua of outcomes or, at least, solvability for outcomes (Wakker 1991, in Doignon & Falmagne, eds.). %}

Nakamura, Yutaka (1995) "Rank Dependent Utility for Arbitrary Consequence Spaces," *Mathematical Social Sciences* 29, 103–129.

{% Adds a weak independence axiom, his Axiom 2, to the probabilistic sophistication axioms of Machina & Schmeidler (1992), that is necessary and sufficient for the M&S model to be RDU. Section 3 considers the case of unbounded utility, using my 1993 truncation continuity. %}

Nakamura, Yutaka (1995) "Probabilistically Sophisticated Rank Dependent Utility," *Economics Letters* 48, 441–447.

{% **utility families parametric**; characterizes utility that is linear combination of exponential functions. %}

Nakamura, Yutaka (1996) "Sumex Utility Functions," *Mathematical Social Sciences* 31, 39–47.

{% %}

Nakamura, Yutaka (1997) "Lexicographic Additivity for Multi-Attribute Preferences on Finite Sets," *Theory and Decision* 42, 1–19.

{% Generalizes Savage (1954) to nontransitive skew-symmetry, thus extending earlier works by Fishburn and Sugden to nonsimple acts. %}

Nakamura, Yutaka (1998) "Skew-Symmetric Additive Representations of Preferences," *Journal of Mathematical Economics* 30, 367–387.

{% %}

Nakamura, Yutaka (2000) "Finite-Dimensional Utilities," *Economic Theory* 16, 209–218.

{% %}

Nakamura, Yutaka (2000) "Threshold Models for Comparative Probability on Finite Sets," *Journal of Mathematical Psychology* 44, 353–382.

{% Studies convex nontransitive preferences over lotteries. %}

Nakamura, Yutaka (2001) "Totally Convex Preferences for Gambles," *Mathematical Social Sciences* 42, 295–305.

{% Extending Herstein & Milnor (1953) etc. to lexicographic. %}

Nakamura, Yutaka (2002) "Lexicographic Quasilinear Utility," *Journal of Mathematical Economics* 37, 157–178.

{% Additive representation without solvability if there is sufficient denseness. %}

Nakamura, Yutaka (2002) "Additive Utilities on Densely Ordered Sets," *Journal of Mathematical Psychology* 46, 515–530.

{% %}

Nakamura, Yutaka (2004) "Objective Belief Functions as Induced Measures," *Theory and Decision* 55, 71–83.

{% Considers set of lotteries preferred to status quo, equivalent to it, and worse than it, and characterizes it à la vNM. %}

Nakamura, Yutaka (2005) "Trichotomous Preferences for Gambles," *Journal of Mathematical Psychology* 48, 385–398.

{% Does nontransitive generalizations in Aumann-Anscombe setup, but only for additive representations and not for nonadditive. %}

Nakamura, Yutaka (2009) "SSB Preferences: Nonseparable Utilities or Nonseparable Beliefs." *In* Steven J. Brams, William V. Gehrlein, & Fred S. Roberts (eds.) *The Mathematics of Preference, Choice and Order: Essays in Honor of Peter Fishburn*. Springer, Berlin, 39–55.

{% %}

Nakamura, Yutaka (2023) "Subjective Expected Utility with Signed Threshold," *Journal of Mathematical Psychology* 115, 102777. https://doi.org/10.1016/j.jmp.2023.102777

{% About the two-envelope paradox. %}

Nalebuff, Barry J. (1989) "The Other Person´s Envelope is always Greener," *Journal of Economic Perspectives* 3, 171–181.

{% **nonadditive measures are too general**: The authors argue, and I agree, that weighting functions for uncertainty are too general, and introduce a special class after discussing preceding ones. m-separability means that there is a partition $A_1,\ldots,A_m$ such that, for a weighting function (= capacity) W, $W(E) = f(W(E \cap A_1),\ldots,W(E \cap A_n))$ with f strictly increasing in each variable. It is a sort of ordinal additive separability of the elements of the partition. m-separability with respect to every partition will be equivalent to the additivity condition of qualitative probability I guess, and under sufficient richness will be equivalent to being a monotonic transform of an additive probability measure as this is with probabilistic sophistication. %}

Narukawa, Yasuo & Vicenç Torra (2011) "On Distorted Probabilities and m-Separable Fuzzy Measures," *International Journal of Approximate Reasoning* 52, 1325–1336.

{% **criticizing the dangerous role of technical axioms such as continuity**: %}

Narens, Louis (1974) "Measurement without Archimedean Axioms," *Philosophy of Science* 41, 374–393.

{% %}

Narens, Louis (1980) "On Qualitative Axiomatizations of Probability," *Journal of Philosophical Logic* 9, 143–151.

{% Theorems 2.8.2 & 2.8.3 on p. 83 shows that, if the Archimedean axiom is dropped in Hölder's lemma, then the operation need no more be commutative. So, in the lemma of Hölder the Archimedean axiom has empirical content. The example is as follows: X is the set of affine functions ax + b on the reals with a ≥ 1 and b > 0. The operation o is functional composition, the ordering is f ≽ g if f(x) ≥ g(x) for all x sufficiently large (so, lexicographic in a,b). The operation is associative and f ≽ g iff f o h ≽ g o h. The operation is not commutative though, with f = 2x + 1 and g = x + 1 we have fog = 2x + 3 > 2x + 2 = gof.

The violation of commutativity is only infinitesimally small, so I'm not sure if this is really empirical content.

cancellation axioms: Theorems 5.2.1 & 5.2.2 give necessary and sufficient conditions for additive representation of finitely many preferences. Does not need weak ordering. %}

Narens, Louis (1985) "*Abstract Measurement Theory*." MIT Press, Cambridge, MA.

{% %}

Narens, Louis (2002) "*Theories of Meaningfulness*." Lawrence Erlbaum, Mahwah, NJ.

{% **updating: discussing conditional probability and/or updating**; qualitative conditional probability, extended to support theory etc. %}

Narens, Louis (2003) "A Theory of Belief," *Journal of Mathematical Psychology* 47, 1–31.

{% %}

Narens, Louis (2008) "Meaningfulness and Invariance." *In* Lawrence Blume & Steven N. Durlauf (eds.) *The New Palgrave: A Dictionary of Economics*. The MacMillan Press, London.

{% %}

Narens, Louis & R. Duncan Luce (1983) "How We May Have Been Misled into Believing in the Interpersonal Comparability of Utility," *Theory and Decision* 15, 247–260.

{% L & Narens 1986.1. A very good summary of the essence of Krantz et al. (1971), showing how extensive measurement can be used to do conjoint measurement

and so on, specifying priorities of people in this. P. 174 on homogeneity and what follows after is more specialized and interests me less. %}

Narens, Louis & R. Duncan Luce (1986) "Measurement: The Theory of Numerical Assignments," *Psychological Bulletin* 99, 166–180.

{% **equity-versus-efficiency**: seems to be on it. %}

Narloch, Ulf, Unai Pascual, & Adam G. Drucker (2011) "Cost-Effectiveness Targeting under Multiple Conservation Goals and Equity Considerations in the Andes," *Environmental Conservation* 38, 417–425.

{% Ch. 17, p. 172: Nash made a **Dutch book**, well, not a Dutch book but arbitrage, against his students for the 1952 election Stevenson-Eisenhower. %}

Nasar, Sylvia (1998) "*A Beautiful Mind. The Life of Mathematical Genius and Nobel Laureate John Nash*." Simon & Schuster, New York.

{% %}

Nascimento, Arnaldo, Che Tat Ng, & Rich Gonzalez (2022) "Measuring Attractiveness and Discriminability," working paper.

{% The authors provide numerical analyses of (source) preference and insensitivity for various parametric families of weighting functions w. As local index of source reference they take $w(p) - p$. For a subset S of [0,1], the index is the integral of $w(p) - p$. Over the whole [0,1] it, thus, is $\int w(p) - ½$. For an interval [q,r], the discriminability (opposite of insensitivity) is w(r)–w(q) – (r–q). This is equivalent to the integral of $w' - 1$ over the interval. The authors consider w's of bounded variation, then, I guess, am not sure, write $w' - 1$ as the sum of an increasing and decreasing function, and whichever gives the bigger discriminability, that they take. They then numerically analyze the effects of parameters of parametric families on their measures. %}

Nascimento, Arnaldo, Che Tat Ng, & Richard Gonzalez (2025) "Measuring Probabilistic Risk Attitude," *Management Science*, forthcoming.

{% This paper is the first to axiomatize the Goldstein-Einhorn probability weighting family. It corrects Gonzalez & Wu (1999), who claimed to have it but made a mistake. In the rest of this annotation, I present the maths in my own words.

Assume PT throughout. Consider the following preferences, which I, coincidentally, used in the tradeoff method, with X_pY denoting the lottery (p:X, 1−p:Y):

$X_pY \sim X'_pY'$ &

$X_pY' \sim X'_pY''$

It implies that Y´ is the utility-midpoint between Y and Y´´, as I often used. Here another implication is important: the first indifference means that the oddsratio of w at p is a utility-difference ratio. That is,

$$\frac{w(p)}{1-w(p)} = \frac{U(Y)-U(Y')}{U(X)-U(X')}$$

The second indifference gives, similarly, identical ratios

$$\frac{w(p)}{1-w(p)} = \frac{U(Y')-U(Y'')}{U(X)-U(X')}$$

Similarly,

$X_qY \sim X'_qY''$ gives a double ratio:

$$\frac{w(q)}{1-w(q)} = \frac{U(Y')-U(Y'')}{U(X)-U(X')} = 2\frac{U(Y)-U(Y')}{U(X)-U(X')} = 2\frac{w(p)}{1-w(p)}$$

Thus, the oddsratio of w at q is twice that at p.

Gonzalez & Wu (1999) formulated a preference condition that this remain the same if we replace p and q by p´ and q´ where w has oddsratios t times those at p and q for any t´>0. If f denotes how the oddsratio of w depends on that at p, we get

$$f(y) = 2f(x) \Rightarrow f(ty) = 2f(tx). \qquad (*)$$

Gonzalez & Wu erroneously thought that this implies linearity of f. But it does not. To wit, assuming f strictly increasing and continuous. Its domain and range are $\mathbb{R}^{++}$. Take any y and then x<y with f(y) = 2f(x). Write y = dx for d>1, where d abbreviates doubling. On [x,dx] one defines f arbitrarily given the preceding constraints.

LEMMA. For every integer n, f is uniquely determined on $[d^nx, d^{n+1}x]$ and, further, f is uniquely determined on its whole domain.

PROOF. We have $f(d^nx)=2^nf(x)$ (Eq. * with y = dx and t = d^n and induction, similarly for negative integers n).

Further, take any z in [x, dx] and write it as tx. Then dz in [dx, d^2x]. f(dz)/f(z) = f(dx)/f(x) = 2. Inductively, $f(t^nz) = 2^nf(z)$, similarly for negative integers n. f is uniquely determined on its whole domain. □

One sees that the construction in the lemma is not only necessary, but also sufficient, for Eq. (*), and f need not be linear. It is a sort of periodicity. A special case is if f(2x) = 2f(x).

My first hunch to get a sufficient condition would be to add an indifference $X_pY'' \sim X'_pY'''$ to the above ones, set

$X_rY \sim X'_rY'''$ to get

$$\frac{w(r)}{1-w(r)} = 3\frac{w(p)}{1-w(p)}$$

and then treat it as above to get f(z) = 3f(x) ⇒ f(tz) = 3f(tx). I conjecture that this 3-fold periodicity of f, together with the 2-fold periodicity, implies linearity, as desired.

This paper takes a somewhat different, and more appealing, approach. It uses three indifferences

$X_pY \sim X'_pY'$ &

$X_sY' \sim X'_sY''$

$X_qY \sim X'_qY''$

Note that the only change is that the second indifference has s instead of p. Similar algebra as above shows that the w odds ratio at q is the sum of those at p and s. The authors then require that indifferences are maintained if we replace p,s,q by p´, s´, q´ that have odds ratios t times those of p, s, r. This gives a functional equation strong enough to imply linearity of f.

This paper pp. 3-6 before §5 gives didactical account of the underlying functional equations. %}

Nascimento, Arnaldo & Che Tat Ng (2022) “An Axiomatization of the Goldstein–Einhorn Weighting Functions,” *Journal of Mathematical Psychology* 109, 102669.
https://doi.org/10.1016/j.jmp.2022.102669

{% Expert aggregation under ambiguity. Adopts Anscombe-Aumann framework and assumes identical risk attitudes. Two-stage reduction (p. 545) considers replacing the 2nd-stage lotteries by their CEs, to escape from violations of RCLA. Cites the advanced Domotor (1979), showing good knowledge of the literature. %}

Nascimento, Leandro (2012) "The Ex-Ante Aggregation of Opinions under Uncertainty," *Theoretical Economics* 7, 535–570.

{% Characterize the general functional that satisfies certainty independence, and that is the point of departure of the variational model, maxmin EU, and Chateauneuf & Faro's (2009) appealing variation on variational (not cited here). They do, nicely, cite Chateauneuf on his 91 foundation of maxmin EU. %}

Nascimento, Leandro & Gil Riella (2010) "On the Uses of the Monotonicity and Independence Axioms in Models of Ambiguity Aversion," *Mathematical Social Sciences* 59, 326–329.

{% Axiomatizes a common generalization of maxmin EU and incompleteness-via-unanimity multiple priors, by considering a set of sets M of multiple priors, where for each M maxmin is done, and then preference holds if and only if it is unanimous over all sets M considered. Does it also for the variational model. Uses three-stage Anscombe-Aumann. %}

Nascimento, Leandro & Gil Riella (2011) "A Class of Incomplete and Ambiguity Averse Preferences," *Journal of Economic Theory* 146, 728–750.

{% Generalizes the recursive utility model by not having one second-order probability, but having maxmin EU there. So, it is like their 2011 JET paper, but not going for Bewley (1986, 2002)-type incompleteness but instead for maxmin. Figure 1 in this paper is a very small variation of Figure 1 of the 2011 JET paper. Strangely enough, they do not cite their 2011 JET paper. %}

Nascimento, Leandro & Gil Riella (2013) "Second-Order Ambiguous Beliefs," *Economic Theory* 52, 1005–1037.

{% %}

Nash, John F. (1950) "Non-Cooperative Games." Ph.D. Thesis, Princeton University, Princeton.

{% Axiom 3 is IIA, not in the Arrow-social-choice sense, but in the revealed-preference sense, for multivalued choice functions. So, again, Nash was the first to have written it, preceding Arrow (1959).

Shubik's 1982 book writes: "This section by John F. Nash, jr., was written as an informal note dated August 8, 1950; it is reproduced here with the permission of the author." %}

Nash, John F. (1950) "Rational Nonlinear Utility." *In* Shubik, Martin (1982) "*Game Theory in the Social Sciences,*" Appendix A2, The MIT Press, Cambridge, MA.

{% The author considers bargaining situations where all probability distributions over outcomes are available. Each individual maximizes expected utility over probability distributions with utility function U. It is an interval scale, i.e., is unique up to scale and location.

I disagree with p. 158, last sentence of penultimate para: "Of course, the graph is only determined up to changes of scale since the utility functions are not completely determined." U is an interval scale when representing risky preferences through the expected utility formula, but nothing in the world requires it to be that when an input to the bargaining solution. An example: assume that player 1 maximizes expected value for risk. Then changing the unit of payment from cent to dollar, i.e., multiplying all outcomes by 100, does not matter for his risk attitude. But it may still matter much for his bargaining attitude. He may be willing to do many concessions if all outcomes are below $1000, but change much if the outcomes exceed $1000. Nothing in the world precludes this. One may counter that the bargaining solution depending only on U means that the info on what the underlying outcomes are should be forgotten but this is entirely unrealistic. In any application, one knows the outcomes better than their utility values. I have a similar problem with Ghirardato, Maccheroni, & Marinacci (2005); see my annotations there. %}

Nash, John F. (1950) "The Bargaining Problem," *Econometrica* 18, 155–162.

{% His famous Nobel-awarded paper proving equilibrium using Kakutani's theorem. %}

Nash, John F. (1950) "Equilibrium Points in n-Person Games," *Proceedings of the National Academy of Sciences* 36, 48–49.

{% He gives an improved proof of equilibrium existence using Brouwer's fixed-point theorem rather than Kakutani's. He applies it to some games such as poker. %}

Nash, John F. (1951) "Non-Cooperative Games," *Annals of Mathematics* 54, 286–295.

{% Assume preferences over matrices. They have an additive representation if and only if every row and every column is separable, under usual continuity and monotonicity assumptions. Nataf shows it under differentiability assumptions. It is known as the problem of aggregation, answering a question posed by Klein (1946).

Although Nataf's theorem is correct, several authors complained that his proof is obscure. Clarifications are in van Daal & Merkies (1988). Gorman (1968) is useful here. %}

Nataf, André (1948) "Sur la Possibilité de Construction de Certain Macromodèles," *Econometrica* 16, 232–244.

{% %}

Natenzon, Paulo (2019) "Random Choice and Learning," *Journal of Political Economy* 127, 419–457.

{% (NICE): in 2012 one QALY may cost £30,000 in the UK. In Holland, €80,000 has been mentioned informaly. %}

National Institute for Health and Clinical. Excellence

{% Responsible government agency for damage assessments in connection with oil spills (NOAA) appointed panel of economic experts to evaulate use of contingent valuation. Panel was co-chaired by Arrow and Robert Solow. Panel published a report containing a number of recommendations for contingent valuation.

They recommend binary contingent valuation ("referendum approach") instead of open-ended questions.

Discussed by Johannesson, Jönsson, & Karlsson (1995)

Hypothetical WTP exceeds real WTP. %}

National Oceanic and Atmospheric Administration (1993) "Report of the NOAA Panel on Contingent Valuation," *Federal Register* 58, 4602–4614.

{% **paternalism/Humean-view-of-preference**, & **real incentives/hypothetical choice**: Seem to write: "The survey instrument of analysis method shall provide a mechanism for calibrating hypothetical WTP to actual WTP. The trustee(s) shall document the rationale for the selected calibration mechanism. If the survey instrument or analysis method fails to provide such a mechanism or the trustee(s) fails to document the rationale for the selected calibration mechanism, actual WTP shall be presumed to be one-half of stated WTP." %}

National Oceanic and Atmospheric Administration (1994) "Natural Resource Damage Assessments: Proposed Rules," *Federal Register* 59, 1062–1191.

{% **probability elicitation**; Rasmussen rapport %}

National Research Council Governing Board Committee on the Assessment of Risk (1981) "The Handling of Risk in NRC Reports." Washington, DC: National Research Council.

{% No author is specified. It is the main editor Andrea Taroni. This editorial supports Peters (2019). It starts criticizing economics for assuming infinite growth whereas this cannot be because our resources are finite. ??? It may not be clear at first where this strange claim comes from, or what it would serve for. It gets clearer if one has read Peters & Gell-Mann (2016). That paper has weird and incorrect claims about all of economics making wrong assumptions about (un)bounded utility. Probably this was lingering in the editor's mind one way or the other. Strange is then still that Peters & Gell-Mann, erroneously, claim that all of economics assumes that utility must be bounded, whereas this editorial criticizes economics for assuming no upper bound. Oh well. Strange is also that this beginning has nothing clear to do with the rest of the text, or it should be "just throw out anything negative about economists coming to mind." The editors sentence

"Still, as the issue of climate change becomes ever more urgent, it is notable that natural scientists' argument that economists ignore the limits of growth is, essentially, the basis upon which the case for action put forward by environmental activists such as Greta Thunberg rests."

illustrates that he is going for the grand picture, not hindered by knowledge.

The sentence

"For example, we now instinctively calculate expectation values with the implicit belief that they reflect what happens over time."

further ilustrates that he/she is just buying all the erroneous marketing of Peters. It also appears from the final text of the editoral:

"It may sound obvious to say that what matters to one's wealth is how it evolves over time, not how it averages over many parallel states of the same individual. Yet that is the conceptual mistake we continue to make in our economic models. By correcting for this error when studying aggregate systems, it also becomes possible to make a statement that is pertinent to the issue Murphy was concerned with in 2012: a measure such as gross domestic product, an ensemble average, does not reflect individual wellbeing, a time average. There is therefore no need to optimize it blindly.

Another mindset is possible: it requires moving beyond average thinking."

Sounds like, in my words: "Economics should stop taking averages." %}

Nature Physics Editorial (2019) "Time to Move beyond Average Thinking," *Nature Physics* 15, 1207.
https://doi.org/10.1038/s41567-019-0758-3

{% %}

Nau, Robert F. (1985) "Should Scoring Rules be "Effective"?," *Management Science* 31, 527–535.

{% %}

Nau, Robert F. (1992) "Joint Coherence in Games of Incomplete Information," *Management Science* 38, 374–387.

{% A very interesting paper. A subject may take 1:2 bets on an event if his subjective probability of the event exceeds 1/3 as long as the stakes are moderate. But if the stakes are large then the subject does not do this anymore, because he starts doubting his own info (especially if the bet is with an opponent who, if setting large stakes, must be self-assured). So, the maximal stake that is still accepted is an index of the value of info. One of the very rare papers where a behavioral foundation is given to degree of confidence in subjective probability. %}

Nau, Robert F. (1992) "Indeterminate Probabilities on Finite Sets," *Annals of Statistics* 20, 1737–1767.

{% **state-dependent utility** %}

Nau, Robert F. (1995) "Coherent Decision Analysis with Inseparable Probabilities and Utilities," *Journal of Risk and Uncertainty* 10, 71–91.

{% %}

Nau, Robert F. (1995) "The Incoherene of Agreeing to Disagree," *Theory and Decision* 39, 219–239.

{% %}

Nau, Robert F. (1995) "Arbitrage-Free Correlated Equilibria,"

{% %}

Nau, Robert F. (1999) "Arbitrage, Incomplete Models, and Other People's Brains." *In* Bertrand R. Munier & Mark J. Machina (eds.) *Preferences, Beliefs, and Attributes in Decision Making*, Kluwer, Dordrecht.

{% **criticisms of Savage's basic framework**: argues that states and acts are naturally given, consequences not but the consequence set is product set of acts and states. %}

Nau, Robert F. (2001) "De Finetti Was Right: Probability Does not Exist," *Theory and Decision* 51, 89–124.

{% %}

Nau, Robert F. (2002) "The Aggregation of Imprecise Probabilities," *Journal of Statistical Planning and Inference* 105, 265–282.

{% %}

Nau, Robert F. (2003) "A Generalization of Pratt-Arrow Measure to Non-Expected-Utility Preferences and Inseparable Probability and Utility," *Management Science* 49, 1089–1104.

{% %}

Nau, Robert F. (2004) "Phd Seminar on Choice Theory. Lecture Notes and Readings." available at: https://faculty.fuqua.duke.edu/~rnau/choice/choice04.pdf

{% %}

Nau, Robert F. (2006) "The Shape of Incomplete Preferences," *Annals of Statistics* 34, 2430–2448.

{% **tradeoff method**: Axiom 4 on p. 143;

event/outcome driven ambiguity model: outcome driven

This paper does not provide proofs but uses the formula "proof available from the author upon request." It was done, as the author explained to me in an email of March 22, 2006, because the proofs were deemed simple, and not merely to save space. He uploaded proofs and explanations on internet in Sept. 06 on his homepage.

source-dependent utility: uses the Kreps-Porteus (1978) two-stage-expectation representation,

$\mathrm{EXP_T}\big[\varphi\big(\mathrm{EXP_S}[U(f(s))d\pi]\big)d\mu\big]$,

where $\mathrm{EXP_S}[\ldots]$ denotes expectation over S, etc. The model is EU iff φ is linear. It reinterprets the model for ambiguity, where T does not reflect uncertainty at a different time as it does for Kreps & Porteus, but uncertainty from a different source of uncertainty for which there can be more ambiguity. Ambiguity aversion then results if φ is concave, so that here we find smaller certainty equivalents. This paper generalizes the model to **state-dependent utility**, and considers local measures of risk/ambiguity aversion being matrix-generalizations of the Pratt-Arrow measure.

biseparable utility violated %}

Nau, Robert F. (2006) "Uncertainty Aversion with Second-Order Utilities and Probabilities," *Management Science* 52, 136–145.

{% State-dependent extensions of smooth ambiguity models. %}

Nau, Robert F. (2011) "Risk, Ambiguity, and State-Preference Theory," *Economic Theory* 48, 437–467.

{% **games with incomplete information**, correlated equilibrium %}
Nau, Robert F. & Kevin F. McCardle (1990) "Coherent Behavior in Noncooperative Games," *Journal of Economic Theory* 50, 424–444.

{% %}
Nau, Robert F. & Kevin F. McCardle (1991) "Arbitrage, Rationality, and Equilibrium," *Theory and Decision* 31, 199–240.

{% **measure of similarity** %}
Navarro, Daniel J. (2007) "On the Interaction between Exemplar-Based Concepts and a Response Scaling Process," *Journal of Mathematical Psychology* 51, 85–98.

{% **measure of similarity;** One point of discussion is the pros and cons of fitting individual or group-average data if there is much noise in the data. %}
Navarro, Daniel J., Thomas L. Griffiths, Mark Steyvers, & Michael D. Lee (2006) "Modeling Individual Differences Using Dirichlet Processes," *Journal of Mathematical Psychology* 50, 101–122.

{% %}
Navarro, Daniel J. & Michael D. Lee (2003) "Combining Dimensions and Features in Similarity-Based Representations," *Advances in Neural Information Processing Systems* 15, 59–66.
Also appeared as book:
Navarro, Daniel J. & Michael D. Lee (2003) "Combining Dimensions and Features in Similarity-Based Representations." *In* Suzanne Becker, Sebastian Thrun, & Klaus Obermayer (eds.) *Advances in Neural Information Processing Systems* 15, 59–66.

{% Discuss that decisions have often ignored the input of patients' preferences and argue for it. Consider this issue, however, only in the context of planning clinical trials with the emphasis on the sample size that must be incorporated in a clinical test, and only for the probability tradeoff test. %}
Naylor, C. David & Hilary A. Llewellyn-Thomas (1994) "Can There Be a More Patient-Centred Approach to Determining Clinically Important Effect Sizes for Randomized Treatment Trials?," *Journal of Clinical Epidemiology* 47, 787–795.

{% **utility families parametric**: gives 1−exp(−c(p^S)/t) as family of **inverse S**-curves, is utility functions of Ron Howard. %}

Nease, Robert F. (1994) "Risk Attitudes in Gambles Involving Length of Life," *Medical Decision Making* 14, 201–203.

{% %}

Nease, Robert F. (1996) "Do Violations of the Axioms of Expected Utility Theory Threaten Decision Analysis?," *Medical Decision Making* 16, 399–403.

{% Considers welfarism through choice functions that need not be representable by a transitive preference relation. %}

Nebel, Jacob M. (2024) "A Choice-Functional Characterization of Welfarism," *Journal of Economic Theory* 222, 105918. https://doi.org/10.1016/j.jet.2024.105918

{% **dynamic consistency**

Several subjects satisfy independence but then violate two or more of the dynamic axioms that imply independence. %}

Nebout, Antoine & Dimitri Dubois (2014) "When Allais Meets Ulysses: Dynamic Axioms and the Common Ratio Effect," *Journal of Risk and Uncertainty* 48, 19–49.

{% %}

Nehring, Klaus D.O. (1992) "Foundations for the Theory of Rational Choice with Vague Priors." *In* John F. Geweke (ed.) *Decision Making under risk and Uncertainty: New Models and Empirical Findings*, Kluwer Academic Publishers, Dordrecht.

{% It will not be surprising that I disagree with the criticism in this note. My 2010 book explains the case in §7.6. In short, the main problem with this note is that under RDU, w cannot just be applied to any probability as the author does, but only to goodnews probabilities. If we transform badnews probabilities, then the

dual of w should be taken. All confusions would have been avoided had the field used the more proper term rank-transformation or goodnews-probability transformation rather than probability transformation. %}

Nehring, Klaus D.O. (1994) "On the Interpretation of Sarin and Wakker's "A Simple Axiomatization of Nonadditive Expected Utility" ," *Econometrica* 62, 935–938.

{% **preference for flexibility** ; P. 106 ℓ. 5 has typo: the last ≥ should be ≠.

The model axiomatized: Every act f assigns to every state θ a nonempty set f(θ) of outcomes, an opportunity set (or menu). The agent has to choose between acts today. Then from f(θ) she has to choose one element (an outcome) tomorrow, and that is the outcome she ends up with. If her utility function tomorrow is v_ω, then she will choose the v_ω maximum from any opportunity set f(θ) tomorrow. Today she is uncertain about her preference and utility function tomorrow, an uncertainty expressed by a subjecive probability distribution λ. So, for each state θ she takes the λ weighted average of those maxima. Next, of those she takes the μ weighted average, where μ is the subjective probability measure over the states of nature. %}

Nehring, Klaus D.O. (1999) "Preference for Flexibility in a Savage Framework," *Econometrica* 67, 101–119.

Elementary explanation of preference for flexibility

{% Assumes CEU (Choquet expected utility) with linear utility function. Under CEU, unambiguous events are meant to be those for which the capacity is additive. If on a collection of events the capacity satisfies additivity, then it need not be possible to extend it to the algebra generated by the collection while preserving additivity. This point is reminiscent of the definition of additive probability measures in probability theory, where these are first defined on subcollections and then extended to sigma-algebras, and the subcollections must be appropriate. Def. 4 defines unambiguous event as rank-independence of the total decision weight of such an event, so, the capacity being additively separable as regards that event. It does so in an Anscombe-Aumann type setting with linear utility. I think that this definition implicitly assumes that we have expected utility for risk,

also if it were formulated without committing to the Anscombe-Aumann framework. %}

Nehring, Klaus D.O. (1999) "Capacities and Probabilistic Beliefs: A Precarious Coexistence," *Mathematical Social Sciences* 38, 197–213.

{% %}

Nehring, Klaus D.O. (2000) "A Theory of Rational Choice under Ignorance," *Theory and Decision* 48, 205–240.

{% %}

Nehring, Klaus D.O. (2001) "Ambiguity in the Context of Probabilistic Beliefs," working paper.

{% %}

Nehring, Klaus (2002) "Imprecise Probabilistic Beliefs as a Context for Decision-Making under Ambiguity," working paper.

{% %}

Nehring, Klaus D.O. (2003) "Ellsberg without Allais: A Theory of Utility-Sophisticated Preferences under Ambiguity; working paper."

{% Harsanyi-like aggregation, an existence result iff common prior %}

Nehring, Klaus (2004) "The Veil of Public Ignorance," *Journal of Economic Theory* 119, 247–270.

{% %}

Nehring, Klaus (2006) "Is it Possible to Define Subjective Probabilities in Purely Behavioral Terms? A Comment on Epstein-Zhang (2001)," Working Paper.

{% **ordering of subsets**: The author considers a qualitative probability relation that need not be complete and represents it by a set of priors through unanimous representation (known way to get incompleteness). Gives preference axioms for it. The main axiom is the adaptation of the usual additivity. It here claims that for two equally likely events, each can be partitioned into two equally likely smaller

events, and then that the four resulting smaller events are equally likely again (it is formulated somewhat differently and less transparently, as splitting in Axiom 8 p. 1062, but the text following states that it is only used as I just described). Richness is through equidivisibility: Each set can be split up into two equally likely subsets. Further continuity. A 1/k event is such that, in the terminology of Wakker (1981) the vacuous event and the universal event differ by at least k times that event. It is used to define convergence, and then continuity. By equidivisibility, we can divide the universal event into 2^n equally likely events for each n. A very restrictive implication follows: All probability measures in the set of priors must agree on these events and assign the same probability 2^{-n} to them. Thus, they all agree on a rich set of events, and we in fact have a rich set of events with known probabilities, something like Anscombe & Aumann (1963) but, fortunately, without multistage setup, so, more like the hybrid models of Wakker (2010).

The proof is to split the universal event up into always more refined 2^n equally likely partitions, where the probabilities are 2^{-n} and then all dyadic numbers. All other events can then be calibrated. Abdellaoui used this method in several empirical papers.

In several places the author claims, and I disagree, that the aforementioned restrictive assumption (all priors agreeing on rich set of dyadic events) can hardly be avoided if one wants uniqueness (of convex closure). He only puts forward Example 1 on p. 1065, but this is only one example showing that without equidivisibility and with nonatomicity instead it does not work. There is much between equidivisibility and nonatomicity, and much besides nonatomicity too. (He also puts forward that any structure can be embedded in a larger structure that has equidivisibility, by adding objective-probability events, on p. 1057 penultimate para and p. 1066 last para) but, again, the same kind of argument can be used to defend virtually any richness assumption in any model whatsoever.)

In several places (e.g. p. 1055 next-to-last para, p. 1058 ℓ. 5) the author writes that his model is to be taken as rational.

questionnaire versus choice utility: The author interprets the likelihood relation as a cognitive primitive, not based on observable preference and not uniquely related to betting-on but only through a one-sided implication (called likelihood compatibility on p. 1056). He has been sympathetic to such interpretations since his youth, often referring to it in personal communications. He argues that taking the ordering as primitive is more convincing than taking the set of priors as primitive. He does not impose many restrictions on the likelihood relation and preferences over event-contingent prospects (acts), only a kind of stochastic dominance relation. He argues for the desirability of not having many such relations.

There is some rhetorics: P. 1056 penultimate para incorrectly suggests that the model advanced here is "the" formalization of verbal statements by Ellsberg (1961) and Schmeidler (1989), suggesting words from their mouths about incomplete cognitive likelihood ordering that they did not write themselves. A second example is p. 1057 top on models that relax the onesided implication of likelihood compatibility where the author writes that this "severs radically the connection between belief and preference" but has no argument to offer other than restating definitions.

P. 1070 has a mysterious suggestion that belief not just be cognitive likelihood relation but also corresponding behavior. It may reflect other suggestions elsewhere in the paper, also hard to understand for me, that the cognitive relation be only part of the belief and that there be more to belief.

End of paper considers utility-sophistication (preferences depend only on utilities of outcomes through some functional) and in terms of this derives results that multiple-prior preferences have the exact same set of priors as resulting from the likelihood ordering, with a central role for the dyadic events where all priors agree. %}

Nehring, Klaus (2009) "Imprecise Probabilistic Beliefs as a Context for Decision-Making under Ambiguity," *Journal of Economic Theory* 144, 1054–1091.

{% **ordering of subsets** %}

Nehring, Klaus D.O. & Clemens Puppe (1996) "Continuous Extensions of an Order on a Set to the Power Set," *Journal of Economic Theory* 68, 456–479.

{% %}

Nehring, Klaus D.O. & Clemens Puppe (2003) "A Theory of Diversity," *Econometrica* 70, 1155–1198.

https://doi.org/10.1111/1468-0262.00321

{% %}

Neil Yu, Ning & Thorsten Chmura (2013) “Belief-Ordering Identification of Ambiguity Attitudes with Application to Partnership Dissolving Experiments,”

{% **coalescing**. Proposes a generalization of expected utility where the utility function depends on the number of outcomes. He assumes complexity aversion for gains (U for gains gets smaller as it relates to a lottery with more outcomes) and the opposite for losses. He shows that it can accommodate several violations of expected utility. %}

Neilson, William S. (1992) “Some Mixed Results on Boundary Effects,” *Economics Letters* 39, 275–278.
https://doi.org/10.1016/0165-1765(92)90260-6

{% %}

Neilson, William S. (1992) “A Mixed Fan Hypothesis and Its Implications for Behavior towards Risk,” *Journal of Economic Behavior and Organization* 19, 197–211.

{% Published as Neilson (2010, JRU). %}

Neilson, William S. (1993) “Ambiguity Aversion: An Axiomatic Approach Using Second Order Probabilities,” working paper, Dept. of Economics, University of Tennessee, Knoxville, TN.

{% **game theory for nonexpected utility** %}

Neilson, William S. (1994) “Second Price Auctions without Expected Utility,” *Journal of Economic Theory* 62, 136–151.

{% If a person does RDU, and turns down a gamble (p, 125; 1–p, –100) at every level of wealth, where w(p) = 1/2, then we get the same phenomena as Rabin (2000, Econometrica) got for the special case of w(1/2) = 1/2 (this is EU). Of course, under common assumptions on w, such gambles have to be more extreme and the

examples are not empirically realistic anymore, so I think that this is no paradox for RDU. %}

Neilson, William S. (2001) "Calibration Results for Rank-Dependent Expected Utility," *Economics Bulletin* 4, 1–5.

{% %}

Neilson, William S. (2002) "Comparative Risk Sensitivity with Reference-Dependent Preferences," *Journal of Risk and Uncertainty* 24, 131–142.

{% This paper considers a structure that is isomorphic to an additively decomposable structure, where the isomorphism (from the additively representable space to our structure) is $(x_0,x_1,\ldots,x_n)$ --> $(x_0,x_1-x_0,\ldots,x_n-x_0)$. It translates axioms that characterize additively decomposable representations through this isomorphism. That is, with $x_{-i}c_i$ denoting x with x_i replaced by c_i, for all i not equal to 0, $x_{-i}c_i > y_{-i}c_i$ if and only if $x_{-i}(c_i+\varepsilon) > y_{-i}(c_i+\varepsilon)$, for all variables in question, which is as usual. For the 0th coordinate, however, we now have $(c_0,x_1,\ldots,x_n) >(c_0,y_1,\ldots,y_n)$ if and only if $(c_0+\varepsilon,x_1+\varepsilon,\ldots,x_n+\varepsilon) >(c_0+\varepsilon,y_1+\varepsilon,\ldots,y_n+\varepsilon)$. The condition just stated is equivalent to the author's self-referent separability. The additive representation maps, through the isomorphism, into $u_0(x_0) + u_1(x_1-x_0) + \ldots + u_n(x_n - x_0)$. It means that the x_js designate final wealth.

The Fehr & Schmidt (1999) model is a special case of this model. I do not agree with the author's suggestion, on top of p. 687 and in the abstract, that he has now axiomatized the Fehr-Schmidt model. One reason is that an axiomatization of a special case of a general model can be way different than the general model (e.g. all quantitative models are special cases of the general quantitative representation that is characterized by transitivity, completeness, and countable-denseness, which does not mean that the latter result can claim all existing axiomatizations).

The model gives a nice point of departure for reference dependence through differences, which can be useful in welfare evaluations and risky choice (prospect theory), etc. A difficulty with prospect theory is that under prospect theory it is natural to compare different options only if they have the same reference level.

The author defines constant absolute risk aversion by relating it to a common increase of reference level x_0 and the other final wealth levels x_j, so that changes w.r.t. x_0 ($x_i - x_0$) are unaffected. This implies separability w.r.t. the 0^{th} coordinate and implies that the model depends only on the deviations w.r.t. x_0, $x_1-x_0,\ldots,x_n-x_0$, and not on x_0 itself. It does not imply exponential utility. %}

Neilson, William S. (2006) "Axiomatic Reference-Dependence in Behavior toward Others and toward Risk," *Economic Theory* 28, 681–692.

{% **biseparable utility violated; source-dependent utility**; **event/outcome driven ambiguity model: outcome driven**:

This is the published version of Neilson (1993). Nothing essential was changed. The paper considers a two-stage setup as in Anscombe-Aumann with known probabilities and vNM EU in the second stage, but unknown (so, then subjective) probabilities and Savage-EU in the first stage. So, uses richness of state space. The utility functions in the two stages can be different, so that RCLA is violated. So, it is the smooth model of KMM, but with the two stages exogenously given, meaning that it is in fact the Kreps & Porteus (1978) model only with the first-stage probabilities subjective instead of objective.

The first-stage (first here refers to left stage, the one resolved first temporarily) utility is more concave than the second-stage (interpreted as ambiguity aversion) if and only if weak risk aversion in the first stage holds in terms of second-stage utility units. This condition has a drawback. Using second-stage utility as inputs is not a big problem because these can readily be expressed as second-stage probabilities. However, using the first-stage subjective probabilities needed to define first-stage expectations in weak risk aversion is problematic because these are not given as empirical primitives, unlike in Kreps & Porteus where the first-stage probabilities were objective and not subjective. %}

Neilson, William S. (2010) "A Simplified Axiomatic Approach to Ambiguity Aversion," *Journal of Risk and Uncertainty* 41, 113–124. https://doi.org/10.1007/s11166-010-9099-4

{% **PT falsified**: a useful paper putting PT to new tests and demonstrating that we need better parametric families.

The defenses of PT demonstrating that it accommodates the Allais paradox,

gambling, insurance, etc., have usually focused on only one of these phenomena. Parametric fittings of PT have not been checked yet for what they say about these known phenomena. This paper is the first, to my knowledge, to see if the parameters found for PT can do more and explain known patterns of choices jointly, and if the parameters found give plausible behavior outside the immediate paradoxes. The current parametric families don't perform well. For example, the T&K families, if explaining the Allais paradox, must be very risk averse, too much to give much gambling for low probabilities. Similar observations apply to coexistence of gambling and insurance. Risk premia are calculated and often are not very plausible. %}

Neilson, William S. & C. Jill Stowe (2001) "A Further Examination of Cumulative Prospect Theory Parameterizations," *Journal of Risk and Uncertainty* 24, 31–46.

{% %}

Neilson, William S. & C. Jill Stowe (2003) "A Theory of Other-Regarding Preferences with Rank-Dependence,"

{% **foundations of probability**: Argues that reasoning should be based on conditional probabilities, which can exist in a deterministic world if the conditioning statement need not be a complete description. Seems to assume, à la Carnap's logical probability, that such conditional probability is objective. Then many philosophical problems can be solved. %}

Nelson, Kevin (2009) "On Background: Using Two-Argument Chance," *Synthese* 166, 165–186.

{% Do belief measurement in games for continuum of events, by assuming parameteric family. Over strategies of each individual opponent: A unimodal beta distribution, a triangular distribution, the union of two or three triangular distributions, or the union of a unimodal beta and a triangular distribution, depending on what best fits. Joint distributions are probably obtained by assuming stochastic independence. %}

Neri, Claudia (2015) "Eliciting Beliefs in Continuous-Choice Games: A Double Auction Experiment," *Experimental Economics* 18, 569–608.

{% %}

Nestle, Frank O., Hannes Speidel, & Markus O. Speidel (2002) "High Nickel Release from 1- and 2-Euro Coins," *Nature* 419, 132.

{% Can measure gravity at quantum level better than done before. So, they can better than before test the equivalence principle: Gravitational mass (how much a body of mass attracts other bodies; in Dutch "zware massa") and inertial mass (how much a body of mass itself is attracted by other bodies; in Dutch "trage massa") are the same. %}

Nesvizhevsky, Valery V., Hans G. Börner, Alexander K. Petukhov, Hartmut Abele, Stefan Baeler, Frank J. Rue, Thilo Stöferle, Alexander Westphal, Alexei M. Gagarski, Guennady A. Petrov, & Alexander V. Strelkov (2002) "Quantum States of Neutrons in the Earth's Gravitational Field," *Nature* 415 (January 17) 297–299.

{% **concave utility for gains, convex utility for losses**: Gives an evolutionary explanation. Considers repeated-decisions problems from evolutionary perspective, building on Robson (2001). Takes utility as rewarding system optimized by individual, and sees when it best serves evolutionary survival. Then utility should be steepest in regions met most frequently, and where mistakes have most serious consequences. For intertemporal it can generate violations of stationarity. For risk it leads to a utility function convex below some point, concave above, where the point is the status quo that occurs most frequently. So, quite like prospect theory has it. %}

Netzer, Nick (2009) "Evolution of Time Preferences and Attitudes toward Risk," *American Economic Review* 99, 937–955.

{% %}

Netzer, Nick, Arthur Robson, Jakub Steiner, & Pavel Kocourek (2021) "Endogenous Risk Attitudes," Working paper.

{% **Dutch book** %}

Neuefeind, Wilhelm & Walter Trockel (1995) "Continuous Linear Representability of Binary Relations," *Economic Theory* 6, 351–356.

{% lecture of Jan 2009 %}

Neugebauer, Tibor (2009) "The Petersburg Paradox: 300 Years of Introspection and Experimental Evidence at Last,"

{% This paper axiomatizes discounted expected utility (DEU) in the Keeney & Raiffa (1976) multiattribute utility framework with probability distributions over n-tuples, where n-tuples are streams over time. Thus, all uncertainty is resolved at time 0. The authors use, besides standard axioms giving expected utility (Axiom 3 is von-Neumann-Morgenstern independence), two special axioms. Axiom 6 allows to replace any sure outcome α at time t by an equivalent standard gamble (p:I_+, 1−p: I_-) where I_+ is the best outcome and I_- the worst. It is a weakened version of Keeney-Raiffa utility independence. Axiom 7 is a weakened version of time separability. For it, sets of timepoints are identified with indicator functions assigning the maximal outcome to that set and the minimal outcome to its complement, utility is normalized to be 0 at the worst outcome and 1 at the best, and then the time measure of a set of timepoints is the expected utility of its indicator function. The latter axiom I haven't seen before in the context of multiattribute utility, and it may be quite new. It amounts to additivity of the time measure over disjoint sets of timepoints. %}

Neumann, Berenice Anne & Marc Oliver Rieger (2023) "A New Axiomatization of Discounted Expected Utility," *Theory and Decision* 95, 515–537. https://doi.org/10.1007/s11238-023-09932-0

{% Seems to be: meta-analysis of 109 estimates of loss aversion from 33 studies about consumer brand choice. Find loss aversion of $\lambda = 1.49$ or 1.73 depending on method of analysis. %}

Neumann, Nico & Ulf Böckenholt (2014) "A Meta-Analysis of Loss Aversion in Product Choice," *Journal of Retailing* 90, 182–197.

{% A nice new preference reversal:

A: 6 month free entrance at Rockefreller museum at $5 [26.1%]

or

B: 18 month free entrance at Rockefreller museum at $5.50 [73.9%]

A´: Single entry at Rockefreller museum at $5 [66.7%]
or
B´: 18 month free entrance at Rockefreller museum at $5.50 [33.3%]
even though A dominates A´. This violates dominance-transitivity of Diecidue & Somasundaram (2017). %}

Neunhoeffer, Frieder (2021) “On Subscription Traps and Preference Reversals: The Pigeonholing Effect,”

{% **information aversion**!! Demonstrates a.o. that prospect theory can sometimes in special circumstances lead to information aversion; i.e., that there exists an example. %}

Newman, D. Paul (1980) “Prospect Theory: Implications for Information Evaluation,” *Accounting Organizations and Society* 5, 217–230.

{% Seems to have written: “I can calculate the motion of heavenly bodies, but not the madness of people.” %}

Newton, Isaac (1687) “Philosophiae Naturalis Principia Mathematica.”

{% **value of information**: seems to argue that receiving info is always good in game theory, as long as opponents are not aware of it. %}

Neyman, Abraham (1991) “The Positive Value of Information,” *Games and Economic Behavior* 3, 350–355.

{% The first section gives several characterizations of preferences over infinite income streams, assumed bounded with linear utility. Next parts of the paper provide robustness results, if data are imprecise. %}

Neyman, Abraham (2023) “Additive Valuations of Streams of Payoffs That Satisfy the Time Value of Money Principle: A Characterization and Robust Optimization,” *Theoretical Economics* 18, 303–340.

{% Studies critical regions based on maximal likelihood ratio from point of view of posterior probability, as Neyman & Pearson (1933) formulate it. %}

Neyman, Jerzy (1928) "Contribution to the Theory of Certain Test Criteria," *Bulletin de l'Institut International de Statistique* 24, 44–86.

{% Seems to argue that the performance of a statistical procedure is only relevant in the repeated use and that it is a mistake to think in terms of learning about a particular θ. %}

Neyman, Jerzy (1977) "Frequentist Probability and Frequentist Statistics," *Synthese* 36, 97–131.

{% Introduce "principle of likelihood." For simple hypotheses that means going by the likelihood ration which is Bayesian. For composite hypotheses, you take quotient of upper bound likelihood over H_0 and upper bound likelihood over H_1.

I think that they did not use size of test as criterion here because in a later paper they will present that as new. %}

Neyman, Jerzy & Egon S. Pearson (1928) "On the Use and Interpretation of Certain Test Criteria for Purposes of Statistical Inference: Part I," *Biometrika* 20A, 175–240.

{% %}

Neyman, Jerzy, & Egon S. Pearson (1928) "On the Use and Interpretation of Certain Test Criteria for Purposes of Statistical Inference: Part II," *Biometrika* 20A, 263–294.

{% **foundations of statistics**; This paper introduces their classical Neyman-Pearson model. In earlier paper they had introduced "principle of likelihood" which for simple hypotheses amounts to likelihood ratio and Bayesianism. (For composite hypotheses it does some, more or less ad hoc, upper bound taking of likelihoods before taking quotient.) Three things make NP take power and size, rather than likelihood ratio, as the basis of statistics. (1) Their desire for not using prior probabilities. (2) The frequentist interpretation that can be given to size and power. (3) The nice extension to composite hypotheses of size and power through uniformly most powerful tests in some important cases.

P. 293 and several other places refer to earlier Biometrika paper for

introduction of “principle of likelihood” (see at that reference).

This paper may have been the first that relates it to the size and, thus, makes all of humanity go wrong for a whole century, in my (Bayesian) opinion. They explicitly motivate their approach by the desire of not using prior probability.

Introductory, p. 291, chooses words to go towards where they want to go:

“Without hoping to know whether each separate hypothesis is true of false, we may search for rules to govern our behaviour with regard to them, in following which we insure that, in the long run of experience, we shall not be too often wrong. Here, for example, would be such a “rule of behavior”: to decide whether a hypothesis, H, of a given type be rejected or not, calculate a specified character, x, of the observed facts; if $x > x_0$ reject H, if $x \le x_0$ accept H. Such a rule tells us nothing as to whether in a particular case H is true when $x \le x_0$ or false when $x > x_0$. But it may often be proven that if we behave according to such a rule, then in the long run we shall reject H when it is true not more, say, than once in a hundred times, and in addition we may have evidence that we shall reject H sufficiently often when it is false.”

End of introductory, p. 293, on the principle of likelihood:

“It was clear, however, in using it that we were still handling a tool not fully understood, and it is the purpose of the present investigation to widen, and we believe simplify, certain of the conceptions previously introduced.”

P. 295, around Eq. 11: “Principle of likelihood.”

For simple hypotheses that means going by the likelihood ration which is Bayesian. For composite hypotheses, you take quotient of upper bound likelihood over H_0 and upper bound likelihood over H_1.

P. 296, again talking towards where they want to go:

“From the point of view of mathematical theory all that we can do is to show how the risk of the errors may be controlled and minimised.

The principle upon which the choice of the critical region is determined so that the two sources of errors may be controlled is of first importance.”

P. 296 explains, on the two errors in statistics: “in determining just how the balance should be struck, must be left to the investigator.”

P. 297, 1st paragraph (last 1.5 page of §II), then says that the probability of incorrectly rejecting H_0 can be controlled to be what they denote by ε (that’s the level of significance), and rest of paper then takes that as criterion. So, here is the dramatic moment when the 20th century statistics went the wrong way. P. 298, Eq. (15), displays the significance level criterion formally.

The same page says “as far as our judgment on the truth or falsehood of H_0 is concerned, if an error cannot be avoided it does not matter on which sample we make it." I disagree. First, the more extreme the sample, the more one will believe the incorrect hypothesis. Further, if there are several alternative hypotheses, I can imagine that the error of kind I (false rejection of H_0) is more serious as the sample suggests more that an alternative far remote from H_0 is true. I do not understand the footnote added by NP there. NP continue with "It is the frequency that matters" which is of course where they are heading for, so which may explain their assumption. They argue for the same point more explicitly in their 1933 paper in Proceedings of the Cambridge Philosophical Society 29, p. 497, where they write that errors of type I (incorrect rejection of H_0) are essentially different than of type II. They write that all incorrect rejections of H_0 are equivalent, no matter what the sample, but not so all incorrect acceptances of H_0 (then it will depend on alternative hypothesis that is true they say). They probably write this to justify their consideration of frequency of incorrect rejections of H_0. It seems quite implausible to me. The more extreme the sample is, the more one, incorrectly, believes in the alternative and, if there are more alternatives, the more remote is the alternative hypothesis now incorrectly assumed instead of H_0 so, the worse it seems to me.

P. 300, Eq. 24 derives lemma of Neyman-Pearson as it is called nowadays (1980-2023), that, for simple hypotheses, to have most powerful test at given significance level, one should maximize likelihood ratio. Then later it is extended to composite hypotheses. P. 301 points out, in the context of simple hypotheses, that also Bayesian approach would go by likelihood ratio: "In this case even if we had precise information as to the a priori probabilities of the alternatives H_1, H_2, ... we could not obtain an improved test."

P. 308 second paragraph discusses prior probabilities. "But in general, we are doubtful of the value of attempts to combine measures of the probability of an event if a hypothesis be true, with measures of the a priori probability of that hypothesis. The difficulty seems to vanish in this as in the other cases, if we regard the λ [λ is likelihood ratio criterion] surfaces as providing (1) a control by the choice of ε of the first source of error (the rejection of H_0 when true); and (2) a good compromise in the control of the second source of error (the acceptance of H_0 when some H_1 is true). The vague a priori grounds on which we are intuitively more confident in some alternatives than in others must be taken into account in the final judgment, but cannot be introduced into the test to give a single probability measure."

P. 313, on prior probabilities over composite hypothesis to take some average of size etc.: "We have, in fact, no hesitation in preferring to retain the simple conception of control of the first source of error (rejection of H_0 when it is true) by the choice of ε, which follows from the use of similar regions. This course seems necessary as a matter of practical policy, apart from any theoretical objections to the introduction of measure of a priori probability."

Rest of paper elaborates on many cases and examples.

Summary repeats criterion of first fixing level of significance and then optimizing power, calling it "A new basis has been introduced" %}

Neyman, Jerzy & Egon S. Pearson (1933) "On the Problem of the Most Efficient Tests of Statistical Hypotheses," *Philosophical Transactions of the Royal Society of London A* 231, 289–337.

{% **foundations of statistics**; This paper comes after the 1933 one in "Philosophical"

P. 493 is explicit on their desire not to use prior probability and also on them being seduced by the unfortunate coincidence of size having a long-run meaning: "Yet if it is important to take into account probabilities a priori in drawing a final inference from the observations, the practical statistician is nevertheless forced to recognize that the values of φ_i [the prior probabilities of the hypotheses] can only rarely be expressed in precise numerical form. It is therefore inevitable from the practical point of view that he should consider in what sense, if any, tests can be employed which are independent of probabilities a priori. Further, the statistical aspect of the problem will appeal to him. If he makes repeated use of the same statistical tools when faced with a similar set of admissible hypothees, in what sense can he be sure of certain long run properties?"

P. 502/503 points out that sometimes numerical measures can be assigned to the consequences of both types of error and then expectation of those measures should be taken.

P. 507, Definition D, in definition of most powerful test given significance level, uses explicitly the words "independent of the probabilities a priori." %}

Neyman, Jerzy & Egon S. Pearson (1933) "The Testing of Statistical Hypotheses in Relation to Probabilities A Priori," *Proceedings of the Cambridge Philosophical Society* 29, 492–510.

{% **foundations of statistics** %}

Neyman, Jerzy & Egon S. Pearson (1936) "Contributions to the Theory of Testing Statistical Hypotheses," *Statistical Research Memoirs* 1, June 1936.

{% The paper studies what its title says, using prospect theory rather than expected utility, but has a negative finding: no relations. %}

Neyse, Levent, Ferdinand M. Vieider, Patrick Ring, Catharina Probst, Christian Kaernbach, Thilo van Eimeren, & Ulrich Schmidt (2020) "Risk Attitudes and Digit Ratio (2D:4D): Evidence from Prospect Theory," *Journal of Risk and Uncertainty* 60, 29–51. https://doi.org/10.1007/s11166-020-09321-w

{% **cancellation axioms** %}

Ng, Che Tat (2016) "On Fishburn's Questions about Finite Two-Dimensional Additive Measurement," *Journal of Mathematical Psychology* 75, 118–126.

{% **cancellation axioms**: Consider for finite two-dimensional set $X_1 \times X_2$ with $|X_1| = m$, $|X_2| = n$, how many cancellation axioms are needed to imply all cancellation axioms. $m = 4$ and $n =$ needs cancellation axioms up to order 6. %}

Ng, Che Tat (2018) "On Fishburn's Questions about Finite Two-Dimensional Additive Measurement, II," *Journal of Mathematical Psychology* 64, 409–447.

{% **utility of gambling** %}

Ng, Che-Tat, R. Duncan Luce, Anthony A.J. Marley (2009) "Utility of Gambling when Events are Valued: An Application of Inset Entropy," *Theory and Decision* 67, 23–63.

{% **risky utility u = strength of preference v (or other riskless cardinal utility, often called value),** is based on **just noticeable difference. %**}

Ng, Yew-Kwang (1984) "Expected Subjective Utility: Is the von Neumann-Morgenstern Utility the Same as the Neoclassical's?," *Social Choice and Welfare* 1, 177–186.

{% **total utility theory**;

P. 1848, on ordinalistic revolution: "In a very important sense, these changes represent an important methodological advance, making economic analysis based on more objective grounds. However, the change or correction has been carried to an excess, making economics unable to tackle many important problems, divorced from fundamental concepts, and even misleading."

P. 1848 also describes the similar behaviorist/cognitive (citing Chomsky on latter) revolutions in psychology.

P. 1848 and 1854 mention that Arrow's impossibility theorem shows that social choice without cardinal utility doesn't work. (**Arrow's voting paradox ==> ordinality does not work**)

P. 1851 cites many hostile references against [**risky utility u = strength of preference v (or other riskless cardinal utility, often called value)**]

P. 1851 and further assume as given a cardinal index of happiness and suggest that as basis of cardinal utility, also: **risky utility u = strength of preference v (or other riskless cardinal utility, often called value),** based on **just noticeable difference**. %}

Ng, Yew-Kwang (1997) "A Case for Happiness, Cardinalism, and Interpersonal Comparability," *Economic Journal* 107, 1848–1858.

{% **risky utility u = strength of preference v (or other riskless cardinal utility, often called value)**; p. 213: "Thus, these subjective cardinal utility functions exist *before* the vNM construction is used." [italics from original] Gives many nice refs. %}

Ng, Yew-Kwang (1999) "Utility, Informed Preference, or Happiness: Following Harsanyi's Argument to Its Logical Conclusion," *Social Choice and Welfare* 16, 197–216.

{% **tradeoff method**: Assumption 2 is an analogue of TO consistency, stated directly in quantitative terms. %}

Ng, Yew-Kwang (2000) "From Separabilility to Unweighted Sum: A Case for Utilitarianism," *Theory and Decision* 49, 299–312.

{% C-E analyses for public funding etc. from happiness perspective. %}

Ng, Yew-Kwang (2003) "From Preference to Happiness: Towards a More Complete Welfare Economics," *Social Choice and Welfare* 20, 307–350.

{% **updating under ambiguity with sampling**: Ambiguity with learning has more heterogeneity than without. Learning is in a bid-ask context, with a maxmin EU. %}

Ngangoué, M. Kathleen (2021) "Learning under Ambiguity: An Experiment in Gradual Information Processing," *Journal of Economic Theory* 195, 105282.

{% %}

Nguyen, Hung T. (1978) "On Random Sets and Belief Functions," *Journal of Mathematical Analysis and Applications* 65, 531–542.

{% Consider distortion functions as coherent risk measures. Those distortion functions are nothing but Quiggin's (1982) RDU for risk, but there is no cross reference, although they do cite Schmeidler for the Choquet integral. Consider transformation functions derived from probability distribution functions and their roles in Black-Scholes, for instance. Under realistic generalizations of B-S, risk neutral probabilities are less convincing. %}

Nguyen, Hung T., Uyen H. Pham & Hien D. Tran (2012) "On Some Claims Related to Choquet Integral Risk Measures," *Annals of Operations Research* 195, 5–31.

{% Measure prospect theory for Vietnamese fishermens. %}

Nguyen, Quang D. & Pingsun Leung (2009) "Do Fishermen Have Different Attitudes toward Risk? An Application of Prospect Theory to the Study of Vietnamese Fishermen," *Journal of Agricultural and Resource Economics* 34, 518–538.

{% Seems to have given a nice example of purported violation of transitivity: "Nothing is better than eternal happiness. A ham sandwich is better than nothing. Therefore, a ham sandwich is better than eternal happiness." %}

Nickerson, Raymond S. (1986) "*Reflections on Reasoning.*" Erlbaum, Hisdale, NJ.

{% **foundations of statistics** %}

Nickerson, Raymond S. (1999) "Statistical Significance Testing: Useful Tool or Bone-Headedly Misguided Procedure?," Book Review of: Lisa L. Harlow, Stanley A. Mulaik, & James H. Steiger (1997, eds.) What if there Were No Significance-Tests?, Erlbaum, Mahwah, N.J.; *Journal of Mathematical Psychology* 43, 455–471.

{% **foundations of probability**; **foundations of statistics** %}

Nickerson, Raymond S. (2004) "*Cognition and Chance—The Psychology of Probabilistic Reasoning*." Lawrence Erlbaum Associates, Mahwah, New Jersey.

{% Give statistical arguments that gains and losses cannot be combined just like that and better be treated separately, in a large-scale study of some 6,0000 patients. %}

Nichol, Michael B. & Joshua D. Epstein (2008) "Separating Gains and Losses in Health when Calculating the Minimum Important Difference for Mapped Utility," *Quality of Life Research* 17, 955–961.

{% **updating under ambiguity with sampling**; JRU misspelled the name Aylit Tina Romm, but here it is done correctly.

Subjects repeatedly gamble on drawings with replacement from an unknown Ellsberg urn, where the sure-thing principle is tested each time. In one treatment, subjects are informed about the result of the drawing each time, so that they get to know the composition of the urn, and in the other treatment they are not. The latter is called "learning through mere thought," and the former is called "statistical learning." Learning through mere thought reduced violations of the sure-thing principle, but statistical learning does not. The latter is surprising and the authors write that they have no explanation for it. %}

Nicholls, Nicky, Aylit Tina Romm, & Alexander Zimper (2015) "The Impact of Statistical Learning on Violations of the Sure-Thing Principle," *Journal of Risk and Uncertainty* 50, 97–115.

{% ISBN 0-324-27086-0 %; ISBN for non-USA: 0-324-22505-9 %}

Nicholson, Walter (2005) "*Microeconomic Theory; Basic Principles and Extensions*" 9th edn. South-Western, Thomson Learning, London.

{% %}

Niederée, Reinhard (1992) "What Do Numbers Measure? A New Approach to Fundamental Measurement," *Mathematical Social Sciences* 24, 237–276.

{% In 1943, Niebuhr wrote the following prayer, often cited and called the Serenity Prayer:

"God, give us grace to accept with serenity the things that cannot be changed,
courage to change the things that should be changed,
and the wisdom to distinguish the one from the other."

He wrote it for the Congregational church in the hill village of Heath, Massachusetts. It is quoted as an epigraph in the beginning of the 1976 book, on the page preceding the preface. This book contains sermons etc. by him, edited by his wife Ursula M. Niebuhr after his death. She explains about the serenity prayer on p. 5.

Two Dutch translations are:

Geef mij de kalmte om te aanvaarden
wat ik niet kan veranderen
de kracht om te veranderen wat ik kan
de wijsheid om het onderscheid te zien.
(Amnesty International, 1999)

and

Geef mij de innerlijke rust om de dingen, die ik niet kan veranderen, te aanvaarden, de moed om datgene te veranderen waartoe ik bij machte ben, en de wijsheid om te zien waar het verschil ligt (source unknown).

A variation of the prayer is cited in Vonnegut, Kurt (Jr.) (1969).

The prayer was formalized by Savage (1954) in his acts, states, and consequences. %}

Niebuhr, Reinhold (1976) "*Justice and Mercy.*" Harper and Row, New York.

{% Life expectancy cannot be an ultimate criterion because the utility of life duration can be nonlinear. %}

Nielsen, Jytte Seested, Susan Chilton, Michael Jones-Lee, & Hugh Metcalf (2010) "How Would You Like Your Gain in Life Expectancy to Be Provided? An Experimental Approach," *Journal of Risk and Uncertainty* 41, 195–218.

{% **dynamic consistency**; **value of information**

What the author calls compound lottery concerns uncertainty to be resolved about future events. What she calls information structure refers to past (unknown) events. The information is carefully arranged to be noninstrumental. This means that by any rational theory it should be worthless. Subjects prefer to receive info

about past events early on, but prefer not to receive such info early on for future events. Because by rational theories, the info is worthless, minor psychological effects to select from indifference could drive the results. However, subjects are willing to pay for their preference. Experimenter demand? %}

Nielsen, Kirby (2020) "Preferences for the Resolution of Uncertainty and the Timing of Information," *Journal of Economic Theory* 189, 105090.

{% %}

Nielsen, Kirby & John Rehbeck (2022) "When Choices Are Mistakes," *American Economic Review* 112, 2237–2268.
https://doi.org/10.1257/aer.20201550

{% P. 205 nicely points out that analyses by DeGroot (1970) and Ledyard (1971) seek to characterize (finite, real-valued) expected utility maximization while the utility function is unbounded, but use that utility function itself to define the domain of prospects with finite expected utility, which does not count as a preference axiom. The latter should only use preferences as the empirical primitive. Wakker (1993 MOR) solved this problem with his truncation-continuity. %}

Nielsen, Lars Tyge (1984) "Unbounded Expected Utility and Continuity," *Mathematical Social Sciences* 8, 201–216. (See also Nielsen, Lars Tyge (1987) "Corrigenda," *Mathematical Social Sciences* 14, 193–194.)
https://doi.org/10.1016/0165-4896(84)90096-9

{% This paper assumes EU with risk aversion, implying concave utility. Then we are close to differentiability. Given concave utility, necessary and sufficient conditions are given for differentiability that amount to excluding first-order risk aversion, by requiring risk premia and probability-risk-premia to vanish when stakes get small. Such a preference condition involving limits has the same observability status as continuity. %}

Nielsen, Lars Tyge (1999) "Differentiable von Neumann-Morgenstern Utility," *Economic Theory* 14, 285–296.

{% **common knowledge** %}

Nielsen, Lars Tyge, Adam Brandenburger, John Geanakoplos, Richard McKelvey, & Talbot Page (1990) “Common Knowledge of an Aggregate of Expectations,” *Econometrica* 58, 1235–1239.

{% **Dutch book**: Studies de Finetti’s ideas about finite versus countable additivity. I must say that I find these ideas very *un*interesting, and they illustrate for me the limitedness of de Finetti. The paper shows that de Finetti’s ideas lead not only to finite additivity but also to the use of nonconstructive concepts (for me, from the country of Brouwer, further reason to find it uninteresting), and relates it to Hahn-Banach’s theorem. %}

Nielsen, Michael (2021) “The Strength of de Finetti’s Coherence Theorem,” *Synthese* 198, 11713–11724.
https://doi.org/10.1007/s11229-020-02825-7

{% Measure risk attitudes in a number of ways. One is by the choice list. Others are by introspective and hypothetical questions N = 300 households. They have significant but small correlations. Associated with age (**relation age-risk attitude**), gender (**gender differences in risk attitude**), education, but not with wealth. %}

Nielsen, Thea, Alwin Keil, & Manfred Zeller (2013) “Assessing Farmers’ Risk Preferences and Their Determinants in a Marginal Upland Area of Vietnam: A Comparison of Multiple Elicitation Techniques,” *Agricultural Economics* 44, 255–273.
https://doi.org/10.1111/agec.12009

{% %}

Nielsen, Thomas D. & Jean-Yves Jaffray (2001) “An Operational Approach to Rational Decision Making Based on Rank-Dependent Utility,”

{% %}

Nielsen, Thomas D. & Jean-Yves Jaffray (2006) “Dynamic Decision Making without Expected Utility: An Operational Approach,” *European Journal of Operational Research* 169, 226–246.

{% Nice first sentence in abstract: "This paper draws some bold conclusions from modest premises." %}
Nieswandt, Katharina (2024) "Instrumental Rationality in the Social Sciences," *Philosophy of the Social Sciences* 54, 46–68.
https://doi.org/10.1177/00483931231181930

{% Seems to have written: "For believe me the secret for harvesting from existence the greatest fruitfulness and the greatest enjoyment is to live dangerously! Build your cities on the slopes of Vesuvius! Send your ships into unchartered seas! Live at war with your peers and yourselves! Be robbers and conquerors as long as you cannot be rulers and possessors, you seekers of knowledge!" %}
Nietzsche, Friedrich (1882) "*Die Fröhliche Wissenschaft*." Translated into English by Walter Kaufmann (1974) "*The Gay Science*." Vintage Books, New York.

{% CPB %}
Nieuwenhuis, Ate (1994) "Simultaneous Maximization, the Nash Noncooperative Equilibrium, and Economic Model Building," Central Planning Bureau, The Hague, the Netherlands.

{% **intuitive versus analytical decisions**: A meta-analysis of the hypothesis of unconscious thought, which claims that decisions improve if you distract people before so that they cannot give it conscious thought and have to do purely, in lack of a better term, intuitively. The hypothesis had been advanced by Dijksterhuis et al. (2004) and many others. The paper is negative on this hypothesis. %}
Nieuwenstein, Mark R., Tjardie Wierenga, Richard D. Morey, Jelte M. Wicherts, Tesse N. Blom, Eric-Jan Wagenmakers, Hedderik van Rijn (2015) "On Making the Right Choice: A Meta-Analysis and Large-Scale Replication Attempt of the Unconscious Thought Advantage," *Judgment and Decision Making* 10, 1–17.

{% **ordering of subsets** %}
Niiniluoto, Ilkka (1972) "A Note on Fine and Tight Qualitative Probabilities," *Annals of Mathematical Statistics* 43, 1581–1591.

{% %}

Nilsson, Nils J. (1986) “Probabilistic Logic,” *Artificial Intelligence* 28, 71–87.

{% Their 2020 paper provides a correction.

Nice explanation of hierarchical Bayesian estimation, done for PT. The authors use exactly the same parametric family as T&K’92 and as in Example 9.3.1 of Wakker (2010). They run into big numerical problems for estimating loss aversion and discuss it extensively but do not pin down the mathematical reason. That mathematical reason is described in §9.6 of Wakker (2010). P. 89 2/3 at 1st column: The authors recommend using the same power for gains and losses so as to fix utility and disentangle utility from loss aversion, and use this as $\alpha = \beta$ restricted PT in the rest of the paper. That this restriction avoids all kinds of numerical problems is explained in §9.6 of Wakker (2010). %}

Nilsson, Håkan, Jörg Rieskamp, & Eric-Jan Wagenmakers (2011) “Hierarchical Bayesian Parameter Estimation for Cumulative Prospect Theory,” *Journal of Mathematical Psychology* 55, 84–93. https://doi.org/10.1016/j.jmp.2010.08.006

{% **SPT instead of OPT**: In their 2011 paper they did probability weighting incorrectly, using the Edwards-type separate-outcome weighting (separable prospect theory). They now discovered it and, taking a principled stance, went public with correcting it. Nothing substantial changes in the results. %}

Nilsson, Håkan, Jörg Rieskamp, & Eric-Jan Wagenmakers (2020) “Commentary: Hierarchical Bayesian Parameter Estimation for Cumulative Prospect Theory,” *Journal of Mathematical Psychology* 98, 102429. https://doi.org/10.1016/j.jmp.2020.102429

{% %}

Ninio, Anat, & Daniel Kahneman (1974) “Reaction Time in Focused and in Divided Attention,” *Journal of Experimental Psychology* 103, 393–399.

{% How people develop awareness of probability/statistics, and how that is also matter of evolution of awareness. %}

Nisbett, Richard E., David H. Krantz, Christopher Jepson, & Ziva Kunda (1983) "The Use of Statistical Heuristics in Everyday Inductive Reasoning," *Psychological Review* 90, 339–363.

{% %}

Nisbett, Richard E. & Lee Ross (1980) "*Human Inference: Strategies and Shortcomings of Social Judgment*." Prentice-Hall, London.

{% %}

Nisbett, Richard E. & Timothy D. Wilson (1977) "Telling More than We Can Know: Verbal Reports on Mental Processes," *Psychological Review* 84, 231–259.

{% **revealed preference**: on compact path-connected space, a single-valued choice function defined on all finite subsets cannot be continuous. %}

Nishimura, Hiroki & Efe A. Ok (2014) "Non-Existence of Continuous Choice Functions," *Journal of Economic Theory* 153, 376–391.

{% Shows that every (continuous and) reflexive binary relation on a (compact) metric space can be represented by means of the maxmin, or dually, minmax, of a (compact) set of (compact) sets of continuous utility functions.

Maxmin utility representation: $x \succcurlyeq y$ $\sup_{S \in \mathcal{S}} \sup_{u \in S}(u(x) - u(y)) \geq 0$. Here $\mathcal{S}$ is a collection of sets of utility functions, and S is a set of utility functions. This can be done with u continuous for every reflexive $\succcurlyeq$. One can also take, dually, a minmax representation. There is no clear uniqueness result for the sets to be chosen. Because there is much richness in the sets to be chosen, one can always choose the utility functions continuous. %}

Nishimura, Hiroki & Efe A. Ok (2016) "Utility Representation of an Incomplete and Nontransitive Preference Relation," *Journal of Economic Theory* 166, 164–185.

{% **revealed preference**: A variation of Afriat's theorem that allows for general choice domains. It considers a one-dimensional representation, defining rationalizability (this formal term is common in this field, which I regret) as the choice set being a SUBSET of the preference-best elements but, and this is the central issue of this paper, the preference relation should satisfy a dominance relation. Richter (1966) gave completely general (for general choice domains) necessary and sufficient conditions when rationalizability is defined in the more common sense of a choice set being identical to the preference-best elements. Further results are given, including continuity and intertemporal properties. %}

Nishimura, Hiroki, Efe A. Ok, & John K.-H. Quah (2017) "A Comprehensive Approach to Revealed Preference Theory," *American Economic Review* 107, 1239–1263.

{% Define more uncertainty averse under CEU (Choquet expected utility) as one capacity dominating the other. Show then that more uncertainty averse makes laborers search shorter for new job, whereas more risk averse makes them search longer. %}

Nishimura, Kiyohiko G. & Hiroyuki Ozaki (2004) "Search and Knightian Uncertainty," *Journal of Economic Theory* 119, 299–333.

{% **EU+a*sup+b*inf**; they do it with $a = 0$, so, only with overweighting of worst outcome and not of best, in the Anscombe-Aumann framework, using the Schmeidler axioms with the needed further restriction. They do not cite predecessors such as Gilboa (1988) or Jaffray (1988). %}

Nishimura, Kiyohiko G. & Hiroyuki Ozaki (2006) "An Axiomatic Approach to ε-Contamination," *Economic Theory* 27, 333–340.

{% Whereas an increase in risk increases the value of irreversible investment, an increase of ambiguity (equated with maxmin EU here) decreases it. %}

Nishimura, Kiyohiko G. & Hiroyuki Ozaki (2007) "Irreversible Investment and Knightian Uncertainty," *Journal of Economic Theory* 136, 668–694.

{% Sally Carck lost two children in a row because of cot (in Dutch: "wiegendood") or SIDS. A judge judged that this, twice in a row, was so unlikely that he convicted her for murder. Many statisticians and others protested. She was later acquited. The case is often used to illustrate deficiencies of p-values as opposed to Bayes factors (**foundations of statistics**). %}

Nobles, Richard & David Schiff (2005) "Misleading Statistics within Criminal Trials: The Sally Clark Case," *Significance* 2, 17–19.

{% %}
Noël, Marie-Pascale & Xavier Serron (1997) "On the Existence of Intermediate Representations in Numerical Processing," *Journal of Experimental Psychology: Learning, Memory, and Cognition* 23, 697–720.

{% **conservation of influence**: Proved that in every situation of symmetry there is a concept subject to a conservation law. She proved that symmetry w.r.t. time translations imply the law of conservation of energy, a useful result for relativity theory. %}
Noether, Emmy A. (1918) "Invariante Variationsprobleme," *Nachr. König. Gesellsch. Wissen. Göttingen, Math-Phys. Klasse*, 235–257; translated into English by M. A. Travel (1971), *Transport Theory and Statistical Physics* 1, 183–207.

{% **updating under ambiguity** %}
Noguchi, Yuichi (2015) "Merging with a Set of Probability Measures: A Characterization," *Theoretical Economics* 10, 411–444.

{% Does what title says. High-level construal contexts (so, enhancing abstract rather than concrete thinking) give more loss aversion. %}
Noh, Hwan-Ho, Hye Bin Rim, Byung-Kwan Lee (2025) "Risk Preferences in Decision-Making: A Construal Level Perspective," *Acta Psychologica* 252, 104675.
https://doi.org/10.1016/j.actpsy.2024.104675

{% Explains immediacy effect and decreasing impatience by a model with constant discounting but time-dependent utility (as the author puts it: No constant marginal utility over time), including time-dependent background consumption. Reminds me of the hidden stakes for decision under uncertainty by Kadane & Winkler (1988). Has numerical illustration with power utility.
DC = stationarity: P. 2082 comes close but ascribes it to others: "… various experiments reject exponential discounting on the basis of dynamic choice data finding violations

of *dynamic consistency*.” [Italics from original] He then argues that it may instead be due to an optimistic bias in the expectation of future marginal utility, but I am not sure I understand. %}

Noor, Jawwad (2009) “Hyperbolic Discounting and the Standard Model: Eliciting Discount Functions,” *Journal of Economic Theory* 144, 2077–2083.

{% In his JET 2009 paper he took a discounting model with time-dependent utility. Here he takes outcome-dependent discounting. This is, of course, very unidentifiable, where we can always redefine a new outcome-dependent discount function as simply the product of utility and discounting, with then utility constant 1. He then observes that timed outcomes (only at one timepoint a nonzero outcome) do not identify discounting. Even if discounting is outcome independent then such a multiplicative representation indeed gives the utility and discount functions up to a joint power only, leaving power unidentifiable. Standard measurement theorems show that with more than one nonzero outcome, the power and the whole model become identifiable. The author shows how we can derive functional equations from preference, basically by translating into present value. He uses a variation of the Thomsen axiom to get discounting outcome-independent. %}

Noor, Jawwad (2010) “Time Preference Data and Functional Equations,”

{% %}

Noor, Jawwad (2011) “Temptation and Revealed Preference,” *Econometrica* 79, 601–644.

{% Axiomatizes a model $V(x,t) = \delta(x)^t U(x)$, so, constant discounting but with outcome-dependent discount factor. Using my tradeoff technique (writing ~* instead of $\sim^t$), the main axiom, weak stationarity, requires that $[0,\tau] \sim^* [t,T+\tau]$ implies that these are ~* with respect to the $\lambda/1-\lambda$ mixture, being $[\lambda t, \lambda T+\tau]$. Indeed, $\delta(s)^0/\delta(l)^\tau = \delta(s)^t/\delta(l)^{T+\tau}$ requires that these ratios equal $\delta(s)^{\lambda t}/\delta(l)^{\lambda T+\tau}$. In all of this, the outcomes s and l are used as gauges, so, the axiom is necessary. %}

Noor, Jawwad (2011) “Intertemporal Choice and the Magnitude Effect,” *Games and Economic Behavior* 72, 255–270.

{% Current self reckons with future selfs. The model incorporates self-control and a magnitude effect: magnitude-decreasing impatience. %}

Noor, Jawwad & Norio Takeoka (2022) “Optimal Discounting,” *Econometrica* 90, 585–623.

{% %}

Norberg, Tommy (1986) “Random Capacities and Their Distributions,” *Probab. Th. Rel. Fields* 73, 281–297.

{% %}

Norberg, Tommy & Wilhelmus Vervaat (1989) “Capacities on Non-Hausforff Spaces.” Working paper no. 1989-11 ISSN 0347-2809, Dept. of Mathematics, Chalmers University of Technology, The University of Göteborg, Sweden.

{% **utility elicitation**; p. 560: domain and framing effects for direct scaling; p. 565 discusses **reflective equilibrium. %**}

Nord, Erik (1992) “Methods for Quality Adjustment of Life Years,” *Social Sciences and Medicin* 34, 559–569.

{% **utility elicitation** %}

Nord, Erik (1994) “The QALY—A Measure of Social Value rather than Individual Utility?,” *Health Economics* 3, 89–93.

{% Seems to argue that life duration cannot be traded for quality of life. %}

Nord, Erik (2001) “The Desirability of a Condition versus the Well-Being and Worth of a Person,” *Health Economics* 10, 579–581.

{% **foundations of statistics**: Plead for using likelihood ratio as strength of evidence, without committing to Bayesianism. So, they are pleaing for the likelihood principle; but seem not to cite this principle. Discussions follow in the same issue. %}

Nordgaard, Anders & Birgitta Rasmusson (2012) "The Likelihood Ratio as Value of Evidence—More than a Question of Numbers," *Law, Probability and Risk* 11, 303–315.

{% **intuitive versus analytical decisions**; They show that deliberation for complex choices reduces consistency. For simple choices it does nothing. %}

Nordgren, Loran F. & Ap Dijksterhuis (2008) "The Devil is in the Deliberation: Thinking too Much Reduces Preference Consistency," *Journal of Consumer Research* 36, 39–46.

{% Use PE (if I remember well, they call it SG) to measure SF-6D. Mention the floor effect of PE that other methods do not have (**PE doesn't do well**). Find health states that affect utility most. 5% of health states is valued below 0 (death). Argue that this is for Australian health states. Why it would not be for other countries I do not understand. Do not compare to other (such as not PE) methods, but mention this as topic for future research. %}

Norman, Richard, Rosalie Viney, John Brazier, Leonie Burgess, Paula Cronin, Madeleine King, Julie Ratcliffe, & Deborah Street (2014) "Valuing SF-6D Health States Using a Discrete Choice Experiment," *Medical Decision Making* 34, 773–786.

{% %}

Norris, Nilan (1976) "General Means and Statistical Theory," *American Statistician* 30, 8–13.

{% **preference for flexibility** %}

Norwood, Franklin B. (2006) "Less Choice Is Better, Sometimes," *Journal of Agricultural & Food Industrial Organization* 4, 1–21.

{% **foundations of statistics**: This paper argues for pregesistration of statistical analyses, and of all of them it seems. The authors nicely write nine challenges for preregistration, the main point being that, especially in exploratory research, often unforeseeable things happen at unforeseeable times during the study. They suggest solutions but those I usually found weak. A challenge not mentioned for preregistration combined with pre-journal-commitment is that for many studies they are only of high interest under particular results, and not under all. If a paper finds that a medicine against a disease (e.g., corona) works then that paper deserves wide attenion. However, if it finds that the medicine does not work, then the value of that finding is not zero but positive, but it is only slightly positive and needs to be known only to a few specialists.

For most studies, preregistration cannot be. Without it, it is unverifiable to what extent a researcher used prior or post prediction. This may explain why, for virtually all researchers who did not preregister, they do not even try to explain what was pre- or post-prediction. This is a problem for p-values, but not for Bayesian statistics reporting Bayes factors. I, as a Bayesian, think that the blame for these problems goes to the unsound concepts of classical statistics.

The term "revolution" is heavy and people should not just use it. I feel that here in this title it is overblown. %}

Nosek, Brian A. Charles R. Ebersole, Alexander C. DeHaven, & David T. Mellor (2018) "The Preregistration Revolution," *Proceedings of the National Academy of Sciences* 115, 2600–2606.

{% Vickrey does better than BDM (Becker-DeGroot-Marschak). %}

Noussair, Charles, Stephane Robin, & Bernard Ruffieux (2004) "Revealing Consumers' Willingness-to-Pay: A Comparison of the BDM Mechanism and the Vickrey Auction," *Journal of Economic Psychology* 25, 725–741.

{% **real incentives/hypothetical choice**: p. 335 reports no differences.

Measure risk attitude, prudence, temperance, in LISS representative sample of Dutch population (assuming EU), finding these phenomena confirmed. Prudence is positively related with saving, and temperance is negatively related with risky portfolio choices.

decreasing ARA/increasing RRA: p. 355. Their hypothetical choices suggest increasing relative risk aversion.

Have nice discussions of the pros and cons of adding control variables. %}

Noussair, Charles, Stefan T. Trautmann, & Gijs van de Kuilen (2014) "Higher Order Risk Attitudes, Demographics, and Financial Decisions," *Review of Economic Studies* 81, 325–355.

https://doi.org/10.1093/restud/rdt032

{% **real incentives/hypothetical choice**: find no difference (p. 169).
Use LISS data panel. Risk aversion was measured by five choices between a sure option and a lottery. Religious people are more risk averse. Driven by their different social life more than by religion. %}

Noussair, Charles N., Stefan T. Trautmann, Gijs van de Kuilen, & Nathanael Vellekoop (2013) "Risk Aversion and Religion," *Journal of Risk and Uncertainty* 47, 165–183.

{% Finds that people are more risk averse for present payment than for future payment. Focuses on literature from experimental economics, and does not cite works by Prelec & Loewenstein, Keren & Roelofsma, Read, or others. (**Prospect theory not cited**) %}

Noussair, Charles & Ping Wu (2006) "Risk Tolerance in the Present and the Future: An Experimental Study," *Managerial and Decision Economics* 27, 401–412.

{% Argue that reference point depends on intentions. If you decided before to buy something, you don't perceive the payment of money as a loss. %}

Novemsky, Nathan & Daniel Kahneman (2005) "The Boundaries of Loss Aversion," *Journal of Marketing Research* 42, 119–128.

{% %}

Novemsky, Nathan & Daniel Kahneman (2005) "How Do Intentions Affect Loss Aversion?," *Journal of Marketing Research* 42, 139–140.

{% This paper presents the Pasadena game:
As in St. Petersburg game, a fair coin is tossed until the first heads shows up. If it is on the nth toss, you receive $(-1)^{n-1}2^n/n$, in utility units. So, the payments are 2, –2, 2⅔, and so on. A first attempt to calculate EU may concern the limit

$$\lim_{n\to\infty} 2^{-n} \times (-1)^{n-1} 2^n/n = 1/2 - 1/3 + 1/4 - 1/5 \cdots = ln2.$$

But it is debatable, because both the positive and the negative part have expectation ∞. Hence, according to the most common Lebesgue integration, EU is undefined. It can be turned into anything by re-ordering terms. This paper, and several follow-ups by the authors, discuss it. A later paper is Hájek & Nover (2012 *Synthese*.) %}

Nover, Harris & Alan Hájek (2004) "Vexing Expectations," *Mind* 113, 237–249.

{% %}

Novick, Melvin R. & Dennis V. Lindley (1978) "The Use of More Realistic Utility Functions in Educational Applications," *Journal of Educational Measurement* 15, 181–191.

{% Discusses vNM utility measurement in a prescriptive vein, recommending interactively. Fixed-state means probability equivalent. %}

Novick, Melvin R. & Dennis V. Lindley (1979) "Fixed-State Assessment of Utility Functions," *Journal of the American Statistical Association* 74, 306–311.

{% On bipolar scales. %}

Nowlis, Vincent & Helen H. Nowlis (1956) "The Description and Analysis of Mood," *Annals of the New York Academy of Science* 65, 345–355.

{% Seems to have been the first who published Newcomb's problem, says that the physicist William Newcomb first formulated it. %}

Nozick, Robert (1969) "Newcomb's Problem and Two Principles of Choice." *In* Nicholas Rescher (ed.) *Essays in Honor of Carl S. Hempel*, 114–146, Reidel, Dordrecht.

{% **probability elicitation** %}

Nuclear Regulatory Commission, 1975. Reactor Safety Study—An Assessment of Accident Risks in U.S. Commercial Nuclear Power Plants, Report WASH-1400 (NUREG-75/014) NTIS, October.

{% **methoden & technieken** %}

Nunnally, Jum C. (1967) "*Psychometric Theory*." McGraw-Hill, New York (2nd edn. 1978).

{% **methoden & technieken** %}

Nunnally, Jum C. & Ira H. Bernstein (1994) "*Psychometric Theory*;" 9th edn. McGraw-Hill, New York

{% Mathematical results on optimizing EU with power (CRRA) utility. %}

Nutz, Marcel (2012) "Risk Aversion Asymptotics for Power Utility Maximization," *Probability Theory and Related Fields* 152, 703–749.

{% Information Technology (IT) project escalation can result from the deaf effect: If the agent fails to heed risk warnings communicated by others. This paper investigates how the MRR (messenger (= auditor)-receiver-relation) impacts the deaf effect. If the messenger is collaborative then the deaf effect is smaller than if she is an opponent. They test such things in experiments. I wonder if this could be corrected for trust and selective-reporting-by-the-messenger. For prospect theory, their hypothesis H3a matters. It predicts that the influence of MRR on the deaf effect is weaker for losses than for gains. The idea is that losses give more risk seeking and, hence, more willingness to pursue. I wonder how it is in not considering risk seeking/aversion, but the CHANGE of risk seeking/aversion. Even one level more, the deaf effect itself already is not about the absolute level of risk seeking, but about a CHANGE in risk seeking.

P. 5 1st para: In escalation situations, people rather add resources to a project after losses so as to recover. Let me add that this is a 2nd order effect because 1st order is that things with losses are bad and, hence, are avoided henceforth.

P. 7 1st column last para: "Student subjects were deemed to be appropriate for this exeriment because framing is a cognitive bias that should not be a function of work experience." %}

Nuijten, Arno, Mark Keij, & Harry Commandeur (2016) "Collaborative Partner or Opponent: How the Messenger Influences the Deaf Effect in IT Projects," *European Journal of Information Systems* 1–19.

{% **foundations of statistics**: criticizes hypothesis testing. %}

Nuzzo, Regina (2014) "Scientific Method: Statistical Errors," *Nature* 506, 150–152. Available at

http://www.nature.com/news/scientific-methodstatistical-errors-1.14700
[129]

{% **foundations of probability**: broad-audience explanation of the central issues. %}
Nuzzo, Regina (2015) "Chance: Peace Talks in the Probability Wars," *NewScientist Physics & Math* issue 3012 (March 16 2015) 1–5.

{% **probability elicitation**: applied to experimental economics; **proper scoring rules-correction**: Elicit subjective probabilities of beliefs about opponents' strategy choices in a 2 by 2 game. They also estimate such probabilities based on (recency-overweighted) observed choice frequencies of opponent's choices (fictitious-play beliefs). The subjective probability expressed by a player better predicts his strategy choice than the other probability. Although the authors emphasize this finding much, it is in fact trivial! (The authors mention it on p. 992, beginning of §3.1.6, but I disagree with their defenses.)

The subjective probabilities, depicted for instance in Figure 2 on p. 980, are too extreme and variable (and remain so, see top of p. 981), and often are 0 or 1. This suggests that subjects took these as proxies/justifications of what their own strategy choices would be (as per the referee's/editor's suggestion in footnote 20 on p. 986), and did not understand the **proper scoring rules**.

The subjective probability judgments predict the opponent's strategy choices worse than the observed-frequency estimations (§3.1.3 at pp. 985 ff) according to Brier scores. The linear distance, advanced by the authors in defense of subjective probabilities at the end of §3.1.3, is not proper and should not be considered. For instance, it favors always estimating a probability as 1 as soon as the true probability exceeds 0.5 and, thus, favors extreme judgments rather than true judgments.

Abstract 1st sentence claims novelty on something done before (elicitng beliefs from choices, well, in context of learning). Abstract $\ell\ell$. -5/-4 repeats it. The uninformative 3rd sentence of the abstract is characteristic of the self-enthusiasms of this paper: "What we find is interesting." (This sentence is repeated at the end of the first para of the conclusion, p. 1003.) P. 972 ℓ. -15: "Our original research plan …"

P. 976 writes that the quadratic soring rules formulas were given to subjects just like that. %}

Nyarko, Yaw & Andrew Schotter (2002) “An Experimental Study of Belief Learning Using Elicited Beliefs,” *Econometrica* 70, 971–1005.

{% Empirical tests of bargaining solutions %}

Nydegger, Rudy V. & Guillermo Owen (1975) “Two-Person Bargaining: An Experimental Test of the Nash Axioms,” *International Journal of Game Theory* 3, 239–249.

{% %}

Nygren, Thomas E. (1986) “A Two-stage Algorithm for Assessing Violations of Additivity via Axiomatic and Numerical Conjoint Analysis,” *Psychometrika* 51, 483–491.

{% %}

Nygren, Thomas E., Alice M. Isen, Pamela J. Taylor, & Jessica Dulin (1996) “The Influence of Positive Affect on the Decision Rule in Risk Situations: Focus on Outcome (and Especially Avoidance of Loss) rather than Probability,” *Organizational Behavior and Human Decision Processes* 66, 59–72.

{% %}

O’Brien, Bernie J., Michael F. Drummond, Roberta J. Labelle, & Andrew Willan (1994) “In Search of Power and Significance: Issues in the Design and Analysis of Stochastic Cost-Effectiveness Studies in Health Care,” *Medical Care* 32, 150–163.

{% %}

O’Brien, George L. & Wilhelmus Vervaat (1991) “Capacities, Large Deviations and LogLog Laws.” *In* Stamatis Cambanis, Gennady Samorodnitsky, & Murad S. Taqqu (eds.) *Stable Processes*, 43–83.

{% Show that framing matters. %}

O'Connor, Annette M., Norman F. Boyd, David L. Tritchler, Yuri Kriukov, Heather J. Sutherland, & James E. Till (1985) "Eliciting Preferences for Alternative Cancer Drug Treatments: The Influence of Framing, Medium and Rater Variables," *Medical Decision Making* 5, 453–463.

{% **dynamic consistency**; Paper deals with **sophisticated choice** and naive choice, so it does not consider resolute choice and assumes that dynamic consistency in the strong sense is violated. It assumes constant zero discounting with one exception: The presence, the current period, receives higher weight (present-biased preference). It assumes that one action has to be chosen only one time (e.g. write a report), yielding a cost at some later time and a reward at some, possibly different, later time. §IV considers what the authors call welfare considerations, meaning the undiscounted total utility. This terminology suggests that the authors view zero discounting as normative, an assumption to which I am sympathetic.

For costs, sophistication counters the overweighting of the presence which is always good from the zero-**discounting normative** perspective (Proposition 3). For current reward, sophistication can do anything, also exacerbate the present-bias (Example 2). For example, the sophisticated person foresees that he will exhibit presence-bias in the future and therefore consume "too" soon, which decrease in future utility is just enough to make him completely give in to current presence-bias and consume immediately. He thereby lowers the normative undiscounted total utility.

P. 103 defines time consistency in the usual ambiguous way. (**time consistency stated ambiguously** %}

O'Donoghue, Ted & Matthew Rabin (1999) "Doing It now or later," *American Economic Review* 89, 103–124.

{% %}

O'Donoghue, Ted & Matthew Rabin (1999) "Incentives for Procrastinators," *Quarterly Journal of Economics* 114, 769–816.

{% %}

O'Donoghue, Ted & Matthew Rabin (1999) "Risky Behavior among Youths: Some Issues from Behavioral Economics."

{% %}

O'Donoghue, Ted & Matthew Rabin (1999) "Addiction and Self Control." *In* Jon Elster (ed.) *Addiction: Entries and Exits,* Russel Sage Foundation.

{% %}

O'Donoghue, Ted & Matthew Rabin (1999) "Procrastination in Preparing for Retirement." *In* Henry Aaron (ed.) *Behavioral Dimensions of Retirement Economics,* The Brookings Institution, New York.

{% %}

O'Donoghue, Ted & Matthew Rabin, (2000) "The Economics of Immediate Gratification," *Journal of Behavioral Decision Making* 13, 233–250.

{% %}

O'Donoghue, Ted & Matthew Rabin (2001) "Choice and Procrastination," *Quarterly Journal of Economics* 116, 121–160.

{% %}

O'Donoghue, Ted & Matthew Rabin (2003) "Studying Optimal Paternalism, Illustrated by a Model of Sin Taxes," *American Economic Review, Papers and Proceedings* 93, 186–191.

{% A didactical paper on EU, loss aversion, probability weighting, giving much attention to Bordalo, Gennaioli, & Shleifer's (2012) salience theory. It is very accessible and, therefore, without depth. %}

O'Donoghue, Ted & Jason Somerville (2018) "Modeling Risk Aversion in Economics," *Journal of Economic Perspectives* 32, 91–114.

{% %}

O'Hagan, Anthony, Caitlin E. Buck, Alireza Daneshkhah, J. Riochard Eiser, Paul H. Garthwaite, David J. Jenkinson, Jeremy E. Oakly, & Tim Rakow (2006) "*Uncertainty Judgements: Eliciting Experts' Probabilities*." Wiley, Chichester, England.

{% **foundations of probability**; **foundations of statistics**; %}

Oaksford, Mike & Nick Chater (2007) "*Bayesian Rationality: The Probabilistic Approach to Human Reasoning*." Oxford University Press, Oxford, UK.

{% The authors study complexity aversion for risky choice, where they take number of outcomes in a lottery as complexity. This interpretation was criticized by Wakker (2023 JBEE), who argued that attribute splitting plays a big role here and not just complexity perception. The authors consider simple, two-outcome lotteries, and for each a corresponding seven-outcome lottery, corresponding in the sense of having same expectation, variance, and skewness. In Experiment 1, subjects have to estimate the mean (getting awarded for being close) for each, and express Willingness to pay (WTP), incentivized by Becker-DeGroot-Marschak (BDM). In Experiment 2, subjects have to do the same, but also do choice - making, each time between a simple and corresponding "complex" seven-outcome lottery.

In Experiment 1, the authors do not find complexity aversion. In Experiment 2, they do, and more for binary choice than for WTP evaluation.

My main criticism of the experiments is that the outcomes of lotteries were not listed naturally from high to low or low to high, but were listed in randomized order. For simple lotteries this does not matter much, but for complex it brings inconvenient extra complexity, and I think annoyance because of perception of either bad organization or deliberately making life unnecessarily difficult. A further drawback in the WTP measurements, surely in Exeriment 1 but maybe not done in Experiment 2, is that subjects were also asked to estimate mean, which is just more unpleasant for the complex lottery and, thus, negatively affects the WTP assessment. Thus, I think that the authors did not find complexity aversion in the sense of many outcomes, but in the sense of poor unnecessary complex presentation. Experiment 1 found no complexity aversion despite the handicapped presentation for complex gambles, which may be taken to suggest complexity seeking.

I disagree with some citations of the literature. On p. 2 ℓ. 5, Oberholzer et al. cite Sonsino et al. (2002) as supportive of *their* complexity aversion. However, Sonsino et al. (2002) was mostly about other concepts. Only their first experiment

speaks to number of outcomes (via event splitting), and they have only one, one!, data point on it, a switching that is only marginally significant. This is why Wakker's (2023) survey did not include this paper. Further, Mador et al. (2000), also cited by Oberholzer et al. there, considered other versions of complexity, as pointed out by Wakker (2003). Wakker's (2003) survey cites many other papers, mostly finding the opposite, complexity seeking, but those papers are not cited by Oberholzer et al. In particular the most advanced work on this topic, by Birnbaum, is not cited.

A further criticism is that subjects were paid in numbers whose unit was revealed only after the choices made. %}

Oberholzer, Yvonne, Sebastian Olschewski, & Benjamin Scheibehenne (2024) "Complexity Aversion in Risky Choices and Valuations: Moderators and Possible Causes," *Journal of Economic Psychology* 100, 102681.

{% Name is also spelled as Occam. Lived between 1285 and 1349, "What can be done with fewer (assumptions) is done in vain with more." See Paul Edwards (ed. 1967) "*The Encyclopedia of Philosophy*" 8, MacMillan, New York. %}

Ockham, William of (1285–1347/49)

{% Seems to find loss aversion and reference dependence, and the disposition effect. %}

Odean, Terrance (1998) "Are Investors Reluctant to Realize their Losses?," *Journal of Finance*, 1775–1798.

{% With hypothetical choices they find that people discount more with food than with money, both for small and high stakes. %}

Odum, Amy L., Ana A.L. Baumann, & Delores D. Rimington (2006) "Discounting of Delayed Hypothetical Money and Food: Effects of Amount," *Behavioural Processes* 73, 278–284.

{% %}

Oechssler, Jörg & Alex Roomets (2014) "Unintended Hedging in Ambiguity Experiments," *Economics Letters* 122, 243–246.

{% In a careful experiment, ambiguity is generated by balls falling through an irregular Galton box, just created by volunteer students hammering nails in it not knowing for what purpose. This box was used to determine the composition of Ellsberg urns. It is called mechanical ambiguity because it results from a process with no deliberate human beings involved (probably meant: No human beings who can rig the urn), and the experimenters not able to know. They compare with ambiguity that is generated by a human being which they call strategic (probably having in mind that this can involve rigging the urn and, hence, they do not control for suspicion and do not allow subjects to choose the color to bet on; **suspicion under ambiguity**), finding a null hypothesis of no difference (the choice percentages of 37.7% and 45.5% are not significantly different in a between-subject treatment of 53 subjects versus 121 subjects, suffering from the small power of between-subjects designs).

Each subject did only one choice, so as to have no income effects and no need for RIS (which is especially problematic for ambiguity because the risk involved in RIS interferes with ambiguity). The authors also correct for indifference, by letting the ambiguous option being slightly better (to be sure that unambiguous option chosen is really ambiguity aversion) and in another choice situation letting it be slightly worse (to be sure that ambiguous option chosen is really ambiguity seeking). They find some 40% ambiguity aversion but 25% ambiguity seeking (**ambiguity seeking**). The authors review many studies, showing that their finding is consistent with other findings. They find a null hypothesis of mechanical ambiguity being similar to strategic (human-generated) ambiguity. %}

Oechssler, Jörg & Alex Roomets (2015) “A Test of Mechanical Ambiguity,” *Journal of Economic Behavior and Organization* 119, 243–246.

{% **criticism of monotonicity in Anscombe-Aumann (1963) for ambiguity**: They provide so. There are a two-color ellsberg urn (B or Y), and a fair coin (H or T). It is made clear to subjects that first the color is determined and only then the coin is tossed, so that the order of events is properly as in the Anscombe-Aumann (AA) framework. Subjects can choose between two-stage options, where γ denotes a “good” positive prize that can depend on the act, not expressed in my notation. Subjects can either gamble on the color (BH: γ, BT: γ, YH:0 , YT:0), or on the coin, (BH: γ, BT:0, YH: γ , YT:0), or hedge (BH: γ, BT:0, YH: 0, YT: γ). The authors use better displays to make clear the ordering of events. According to AA we should have indifference between gambling on the coin or hedging, and under ambiguity aversion we should prefer gambling on the color strictly less. In reality, subjects had a clear preference for the coin gamble against hedging for instance. The authors had γ depend on the gamble in a way to confirm those strict preferences and rule out indifference. They argue that the preferences found are too strong to be due to random choice. %}

Oechssler, Jörg & Alex Roomets (2021) "Savage vs. Anscombe-Aumann: An Experimental Investigation of Ambiguity Frameworks," *Theory and Decision* 90, 405–416.
https://doi.org/10.1007/s11238-020-09778-w

{% Test reversal of order axiom of Anscombe & Aumann, and do not reject null of equality. Also find no ambiguity hedging in the Anscombe-Aumann setting. I take this as evidence against multi-stage acts: Those are complex and give noise. (**criticism of monotonicity in Anscombe-Aumann (1963) for ambiguity**: only against nulti-stage). The authors assume particular dynamic optimization principles for nonEU in their analyses, similar to Raiffa (1961). They interpret it as evidence supporting isolation and the RIS for ambiguity. %}

Oechssler, Jörg, Hannes Rau, & Alex Roomets (2019) "Hedging, Ambiguity, and the Reversal of Order Axiom," *Games and Economic Behavior* 117, 380–387.
https://doi.org/10.1016/j.geb.2019.07.007

{% Loss aversion could be an additional factor for the finding of this paper. %}

Offerman, Theo (2002) "Hurting Hurts More than Helping Helps," *European Economic Review* 46, 1423–1437.

{% **probability elicitation**

The authors show how to correct for loss aversion in proper scoring rules. They assume that the reference point is a generalized expected value. Loss aversion is

measured empirically. Next the scoring rule is adjusted for loss aversion. An experiment shows good performance. %}

Offerman, Theo & Asa B. Palley (2016) “Lossed in Translation: An Off-the-Shelf Method to Recover Probabilistic Beliefs from Loss-Averse Agents,” *Experimental Economics* 19, 1–30.

{% %}

Offerman, Theo, Jan Potters, & Joep Sonnemans (2002) “Imitation and Belief Learning in an Oligopoly Experiment,” *Review of Economic Studies* 69, 973–997.

{% **proper scoring rules**

The paper reports a control experiment finding H_0 of no difference whether or not subjects are told that the experiment serves to measure beliefs. This was done reluctantly because I only find the approach natural where this is told to the subjects. But a referee required that we add the control experiment and the editor backed him up saying that the paper would be rejected otherwise. Hence, we had to add this treatment, which I consider a dilution of the paper. %}

Offerman, Theo, Joep Sonnemans, Gijs van de Kuilen, & Peter P. Wakker (2009) “A Truth Serum for Non-Bayesians: Correcting Proper Scoring Rules for Risk Attitudes,” *Review of Economic Studies* 76, 1461–1489.

https://doi.org/10.1111/j.1467-937X.2009.00557.x

Direct link to paper

{% **decreasing ARA/increasing RRA**: Find increasing RRA in data set on Pakistani and Indian households. **utility concave near ruin**: the authors argue that for low-income decreasing RRA is plausible which it, near ruin, indeed is. %}

Ogaki, Masao & Qiang Zhang (2001) “Decreasing Relative Risk Aversion and Tests of Risk Sharing,” *Econometrica* 69, 515–526.

{% **total utility theory**; show that pleasure centers in brain can be directly stimulated. %}

Olds, James & Peter Milner (1954) “Positive Reinforcement Produced by Electrical Stimulation of Septal Area and Other Regions of the Rat Brain,” *Journal of Comparative Physiological Psychology* 47, 419–427.

{% **conservation of influence**: Takes issue with having agent outside of and above the physical world. The big point of the paper is to have the agent as part of the physical world, with all his wishes and decisions generated by the laws of the physical world. Section 3.1.1 defines cellular systems, basically a state of the world making transitions to next states. Then it considers the probability of these transitions maximizing some individual utility functions. The paper writes formulas of Bayes to modify these probabilities, but does not go much beyond that. %}

Oesterheld, Caspar (2016) "Formalizing Preference Utilitarianism in Physical World Models," *Synthese* 193, 2247–2759.

{% **utility elicitation**

p. 270: PE ("N-M") method does worst (**PE doesn't do well**); CE ("modified N-M") and Ramsey method (lottery equivalent with .5 probabilities, similar to Davidson, Siegel, & Suppes, 1957) give similar results;

P. 272: Ramsey method was superior in utility analysis;

utility of gambling: p. 259 argues that comparing risky to riskles gambles induces biases (due to utility or disutility of gambling)

P. 260 argues for CE (certainty equivalent) method and against PE method because subjects may not fully understand concept of probability (**PE doesn't do well**)

P. 263: "By keeping the number of participants small and by casting the study in a realistic and important decision context, we found it possible to evaluate the hypotheses of the study in greater depth."

P. 264, footnote 3: "Any obviously inconsistent answers were returned to the subject and ... were usually corrected"

P. 268, Table 2, gives five utility functions measured through PE (probability equivalents), CE, and SP (strength of preference), on interval [0, 3500]. These numbers are costs, not gains. The authors don't analyze it much. When I did, I found:

PE higher than others

1st subject: U_{PE}: inconsistent (decreasing after 2000). U_{CE}: convex; U_{SP}: concave

2nd subject: U_{PE}: linear. U_{CE}: linear; U_{SP}: concave

3rd subject: U_{PE}: convex. U_{CE}: concave;

U_{SP}: convex on [0,1800] and concave

on[1800,3500] (I drew the graph)

4th d subject: U_{PE}: concave. U_{CE}: convex; U_{SP}: concave

5th subject: U_{PE}: concave-convex. U_{CE}: convex; U_{SP}: convex; after normalization, U_{PE} dominates U_{CE} almost everywhere (on [0, 3100], except near 3500. %}

Officer, Robert R. & Alfred N. Halter (1968) "Utility Analysis in a Practical Setting," *American Journal of Agricultural Economics* 50, 257–277.

{% Adapts Schmeidler (1989) by basing additive probabilities on Savage axioms. %}

Oginuma, Takashi (1994) "A Theory of Expected Utility with Nonadditive Probability," *Journal of Mathematical Economics* 23, 451–473.

{% %}

Ok, Efe A. (1994) "On the Approximation of Fuzzy Preferences by Exact Relations," *Fuzzy Sets and Systems* 67, 173–179.

{% %}

Ok, Efe A. (1995) "Fuzzy Income Inequality Measurement: A Class of Fuzzy Inequality Measures," *Social Choice and Welfare* 12, 111–136.

{% %}

Ok, Efe A. (1995) "On the Principle of Equal Sacrifice in Income Taxation," *Journal of Public Economics* 58, 453–467.

{% %}

Ok, Efe A. (1996) "Fuzzy Measurement of Income Inequality: Some Possibility Results on the Fuzzification of the Lorenz Ordering," *Economic Theory* 7, 513–530.

{% %}

Ok, Efe A. (1997) "A Note on the Existence of Progressive Tax Structures," *Social Choice and Welfare* 14, 527–543.

{% %}

Ok, Efe A. (1997) "On Opportunity Inequality Measurement," *Journal of Economic Theory* 77, 300–329.

{% %}

Ok, Efe A. (1997) "Inequality Averse Collective Choice," *Journal of Mathematical Economics* 30, 301–321.

{% **completeness criticisms**; Preference representations for **one-dimensional utility** with incomplete preferences; incompleteness is due to indecisiveness. %}

Ok, Efe A. (2002) "Utility Representation of an Incomplete Preference Relation," *Journal of Economic Theory* 104, 429–449.

{% %}

Ok, Efe A. & Levent Koçkesen (2000) "Negatively Interdependent Preferences," *Social Choice and Welfare* 17, 533–558.

{% %}

Ok, Efe A., Levent Koçkesen, & Rajiv Sethi (2000) "Evolution of Interdependent Preferences in Aggregative Games," *Games and Economic Behavior* 31, 303–310.

{% %}

Ok, Efe A. & Laurence Kranich (1998) "The Measurement of Opportunity Inequality: A Cardinality-Based Approach," *Social Choice and Welfare* 15, 263–287.

{% %}

Ok, Efe A. & Peter J. Lambert (1999) "On Evaluating Social Welfare by Sequential Generalized Lorenz Dominance," *Economics Letters* 63, 45–53.

{% **time preference**; Pp. 216-217 gives an example where, even if a priori choice between some alternative consumption paths are not determined if intransitivity, the choices are determined if it can be done using backward induction where at each timepoint there are only two choice options. However, the authors suggest

that this may mean that intransitivity in general is no problem in case of backward induction.

They axiomatize (x,t) > (y,s) iff U(x) > eta(s,t)U(y). This allows intransitivities. They do this by imposing the Reidemeister condition on the 2nd coordinate while giving up transitivity. Their domain is in Re x Re, so, it is real-valued. They interpret the first coordinate as money and the second as time. Such intransitive additive representability reminds me of Vind's work. %}

Ok, Efe A. & Yusufcan Masatlioglu (2007) "A Theory of (Relative) Discounting," *Journal of Economic Theory* 137, 214–245.

{% **revealed preference**: A choice function is given on a general set of choice alternatives. The authors formulate revealed preference conditions (mostly acyclity conditions) that hold if and only if there exist a reference dependent model as follows: For each choice set, either one of the choice alternatives serves as reference point, or not. If not, then a utility function is maximized. If yes, then the utility function is only maximized over the choice alternatives that dominate the reference point for every attribute. Here both the reference point and the attributes (can also take as utility functions) are derived endogenously. The paper is targeted to/motivated by the attraction effect, where adding a dominated choice alternative makes the dominating choice alternative more attractive (the other one is ruled out here by taking the added alternative as reference point), and it reviews the literature on it.

The paper confines attention to two-point interactions, where the value of an alternative x chosen is increased by the presence in the choice-menu of one other alternative z (z is a potential reference for x), and not by bigger sets of other alternatives through multiple interaction.

The possibility to define attributes endogenously joint with the lexicographic processing gives much flexibility. If we want to rule out one alternative everywhere then we introduce an extra attribute where this alternative has value 0, all others in the set have value 1, and some proper reference point is chosen if needed. Contrary to what p. 301 ℓ. −1 writes, this is not parsimonious but increases fit rather than parsimonity. It reminds me of Suck (1990) who also derived attributes endogenously, and Epstein, Marinacci, & Seo (2007), who derive a state space endogenously (**state space derived endogeously**). %}

Ok, Efe A., Pietro Ortoleva, & Gil Riella (2015) "Revealed (P)Reference Theory," *American Economic Review* 105, 299–231. https://doi.org/10.1257/aer.20111046

{% A nice unification of two forms of incompleteness: Bewley (1986, 2002) kind with set of probability measures and preference only if unanymous EU, and Dubra-Maccheroni-Ok kind with set of utility functions and preference only if unanymous EU. The idea is that at the beginning, with your first preference, you are just free to choose indecisiveness one way or the other and they are on the same footing. However, once chosen indecisiveness one way you can no more have any in the other direction because the mix of the two will violate the independence-like axiom imposed. Do it in an Anscombe-Aumann setup.

P. 1794 concisely presents Bewley's theorem, with indecisiveness in beliefs.

P. 1795 has the Dubra, Maccheroni, & Ok (2004) dual, of indecisiveness in tastes (Theorem 1). The main axiom is reduction: it is a kind of local probabilistic sophistication, where the subjective probability can depend on the act.

P. 1796 Theorem 2 is the main result, with weak reduction as the main axiom. Now there need not exists act-dependent probabilistic sophistication yielding indifference, but only weak preference. %}

Ok, Efe A., Pietro Ortoleva, & Gil Riella (2012) "Incomplete Preferences under Uncertainty: Indecisiveness in Beliefs versus Tastes," *Econometrica* 80, 1791–1808.

{% This theoretical paper considers three reasons for probabilistic choice: Indifference, indecisiveness, and trying out for learning. As they write, these reasons are neither mutually exclusive nor exhaustive. For each of the three, it can be considered fully rational (although indecisiveness is debatable). They give theoretical tools for detecting the reasons and an underlying rational preference relation. %}

Ok, Efe A. & Gerelt Tserenjigmid (2022) "Indifference, Indecisiveness, Experimentation, and Stochastic Choice," *Theoretical Economics* 17, 651–686. https://doi.org/10.3982/TE4216

{% %}

Ok, Efe A. & Fernando Vega-Redondo (2001) "On the Evolution of Individualistic Preferences: Complete versus Incomplete Information Scenarios," *Journal of Economic Theory* 97, 231–254.

{% %}

Ok, Efe A. & Lin Zhou (1999) "Revealed Group Preferences on Non-Convex Choice Problems," *Economic Theory* 13, 671–687.

{% %}

Ok, Efe A. & Lin Zhou (2000) "The Choquet Bargaining Solutions," *Games and Economic Behavior* 33, 249–264.

{% **coherentism**: Nice text on p. 421, intended only for descriptive applications:

"Though Savage insisted on the behaviouristic interpretation, from a modern vantage point this looks untenable. Almost all sciences introduce theoretical posits that go beyond, and are meant to explain, the data; few philosophers today are tempted by an instrumentalist or fictionalist attitude towards such posits. This is as true in psychology as anywhere else; since the 'first cognitive revolution', psychologists have been happy to posit unobservable mental states and processes, many of them inaccessible to consciousness, that are meant to explain behaviour. And in philosophy of mind, it is a commonplace to regard an agent's intentional attitudes, such as beliefs and desires, as internal causes of the agent's behaviour."

ubiquity fallacy: In the opening the paper, nicely, points out that many philosophers equate all of decision theory with EU: "Indeed many philosophers appear to use 'decision theory' simply to mean EU theory." (p. 410 $\ell\ell$. 2-3)

The author favors the mentalist approach, as I do, for descriptive applications. For me it is the same normatively, but for the author it is not and for normative he favors the behaviourist/representational view. This is because he, while he like me assumes that EU axioms are necessary for rationality, he, unlike me, also assumes that they are sufficient (**coherentism**). Pfff! After working 8 years in a hospital I have come to understand that there is more to rationality than the EU axioms. Anyway, this makes the author strongly criticize any author who does not leave the choice of utility completely free. P.425 2nd para: "But it is quite wrong to view the normative content of the theory as saying that an agent should maximize expected

utility relative to a psychologically real utility and credence function." P. 429 ℓℓ. 1-3: "It is evident that Briggs construes decision theory as telling the agent to maximize expected utility with respect to some independently defined utility function; which as I have argued is a misconception."

p. 421 penultimate para: "psychologist have been happy to posit unobservable mental states and processes, many of them inaccessible to consciousness, that are meant to explain behaviour."

P. 422 1st para about as if calculations:

"but this is quite standard in cognitive psychology." %}

Okasha, Samir (2016) "On the Interpretation of Decision Theory," *Economics and Philosophy* 32, 409–433.
https://doi.org/10.1017/s0266267115000346

{% A problem in the famous Asian disease example (now in 2024 I find this term politically incorrect) of Tversky & Kahneman (1981) is that, with number of people dying given, it may not be clear how many then survive, and that this is meant to be all others. This study makes the latter explicit and then the framing effect disappears. %}

Okder, Hidetaka (2012) "The Illusion of the Framing Effect in Risky Decision Making," *Journal of Behavioral Decision Making* 25, 63–73.

{% r**eal incentives/hypothetical choice**: seems to be on it %}

Okouchi, Hiroto (2023) "Real, Potentially Real, and Hypothetical Monetary Rewards in Probability Discounting," *Journal of the Experimental Analysis of Behavior* 120, 406–415.
https://doi.org/10.1002/jeab.882

{% Different agents use different prediction models and have *subjective* expectations about whether their model is best. For small samples, models with few parameters are best. For large samples, models with many parameters. In the latter case, it is not bad to add worthess predictors, but it is bad to leave out predictors that capture any part of the variance. Very unfortunately, QJE publishes proofs only in online appendixes, meaning that maths published in this journal is unreliable. For a good view on this point, see Spiegler (2023). %}

Olea, José Luis Montiel, Pietro Ortoleva, Mallesh M. Pai, & Andrea Prat (2022) "Competing Models," *Quarterly Journal of Economics* 137, 1–39. https://doi.org/10.1093/qje/qjac015

{% **DC = stationarity**: Does not happen here, and the authors state the point carefully: "Present bias may lead to violations of dynamic consistency when choices at later points in time are also part of the analysis;" (p. 1450-1451).

tradeoff method: p. 1459 Axiom 11 is the tradeoff consistency axiom, which I introduced in Wakker (1984) and used in 2/3 of my papers, e.g. Köbberling & Wakker (2003), where my later papers also used that name tradeoff consistency. But, ☹, they do not cite me there. Fortunately, they do cite more of my papers (☺) than the average researcher does today, so I am still in a good mood.

The technique of measuring discounting without measuring utility by subjectively matching time intervals, used in this paper to identify β and δ, was introduced by Attema, Bleichrodt, & Wakker (2012 MDM) for the general measurement of discounting (from a different field; not cited) and was also used by Attema, Bleichrodt, Gao, Huang, & Wakker (2016 American Economic Review p. 1490).

P. 1462 footnote 9 cites Ramsey on pointing out a relation between time and belief. Ramsey apparently wrote: "the degree of belief is like a time interval; it has no precise meaning unless we specify how it is to be measured." But I conjecture that Ramsey did not think of subjective discounting here, but only of time as objective unit, and the analogy only concerned measurement of equal sets in general. Attema, Bleichrodt, & Wakker (2012 MDM p. 585) did point out the analogy between measuring subjective discounting without involving utility through matching time intervals and measuring subjective probabilities, a point reiterared by Attema, Bleichrodt, Gao, Huang, & Wakker (2016 American Economic Review p. 1490). %}

Olea, José Luis Montiel & Tomasz Strzalecki (2014) "Axiomatization and Measurement of Quasi-Hyperbolic Discounting," *Quarterly Journal of Economics* 129, 1449–1499.

{% **concave utility for gains, convex utility for losses**: Do this w.r.t. number of human lives lost in tragic events, showing diminishing sensitivity. The authors use the decision-by-sampling model by Neil Stewart and others. They argue, in my terminology, that it is more numerical perception than intrinsic value that drives judgement. The more one's country has large catastrophes, the more one can "handle" large numbers and the less the diminishing sensitivity/convexity are. %}

Olivola, Christpoher Y. & Namika Sagara (2009) "Distributions of Observed Death Tolls Govern Sensitivity to Human Fatalities," *Proceedings of the National Academy of Sciences* 106, 22151–22156.

{% **correct for probability distortion** Modifies the PE (if I remember well, they call it SG), similarly to Bleichrodt, Pinto, & Wakker. Finds that loss aversion increases the internal consistency of the PE, probability transformation does not. %}

Oliver, Adam J. (2003) "The Internal Consistency of the Standard Gamble: Tests after Adjusting for Prospect Theory," *Journal of Health Economics* 22, 659–674.

{% %}

Oliver, Adam J. (2003) "A Quantitative and Qualitative Test of the Allais Paradox Using Health Outcomes," *Journal of Economic Psychology* 24, 35–48. https://doi.org/10.1016/S0167-4870(02)00153-8

{% **utility measurement**: c**orrect for probability distortion** %}

Oliver, Adam J. (2005) "Testing the Internal Consistency of the Lottery Equivalents Method Using Health Outcomes," *Health Economics* 14, 149–159.

{% Shows that ranking can reduce preference reversals. %}

Oliver, Adam J. (2006) "Further Evidence of Preference Reversals: Choice, Valuation and Ranking over Distributions of Life Expectancy," *Journal of Health Economics* 25, 803–820.

{% Finds usual preference reversals but now for health stimuli. Although not very systematic direction (although still sgnificant), about 35% reversals. The intro

nicely summarizes the main findings on preference reversals. Last para of §1.2:

> Thus, to sum up current thinking on the causes of preference reversals, based on two [three] decades of research, we can say that the rate of preference reversal is hardly affected by the payoff scheme and therefore cannot be attributed to a failure of independence, that intransitivity accounts for quite a small proportion of preference reversals, and that the principal cause of the phenomenon is a failure of procedural invariance, particularly the overpricing of the $-bet in the valuation task, which in turn suggests that preferences are often constructed, not fixed.

The second experiment uses real incentives, but not the health states given to the subjects. Instead, subjects are told that the heath states will be converted to money, but they are not told how. %}

Oliver, Adam J. (2013) "Testing Procedural Invariance in the Context of Health," *Health Economics* 22, 272–288.

{% Short comment arguing that behavioral economics may be used to improve behavior also if it cannot be along the lines of nudge, and it cannot be libertarian. %}

Oliver, Adam J. (2013) "Should Behavioural Economic Policy Be Anti-Regulatory?," *Health Economics* 22, 373–375.

{% Argues that nudging, with no coercion used, often is not enough, and discusses work of British nudge dept. BIT and others. %}

Oliver, Adam J. (2015) "Nudging, Shoving, and Budgeting: Behavioural Economic-Informed Policy," *Public Administration* 93, 700–714.
https://doi.org/10.1111/padm.12165

{% Tests fourfold pattern for money and life duration. Finds qualified support for money, and strong support for life duration, in open valuation, and all of this moderated in binary choice. Open evaluation uses WTA for gains and WTP for losses. It would be interesting to see how the biases known for WTA vs. WTP, biasing the elicited certainty equivalents upwards or downwards, affect the reflection effect found. %}

Oliver, Adam J. (2018) “Your Money and Your Life: Risk Attitudes,” *Journal of Risk and Uncertainty* 57, 29–50.

{% Do PE (if I remember well, they call it SG) for life duration (N = 30) and find risk aversion, in agreement with many preceding studies. Surprisingly, the lottery equivalent (N = 40) does not reduce the risk aversion. %}
Oliver, Adam & Richard Cookson (2010) “Analysing Risk Attitudes to Time,” *Health Economics* 19, 644–655.

{% **time preference**: finds that discounting is not constant. %}
Olsen, Jan A. (1993) “Time Preference for Health Gains: An Empirical Investigation,” *Health Economics* 2, 257–265.

{% That discounting of money must be equally strong as discounting of health states. %}
Olsen, Jan A. (1993) “On What Basis Should Health Be Discounted,” *Journal of Health Economics* 12, 39–53.

{% %}
Olsen, Jan A. (1994) “Person vs Years: Two Ways of Eliciting Implicit Weights,” *Health Economics* 3, 39–46.

{% The term “common curency” in the title nicely expresses that we should not have QALY depending on everything, like the context-dependence that psychologists like so much, but we should get some measures that can be compared across different contexts.

EQ-5D-5L from Canada, Englan, Netherlands, Spain are very similar, e.g. regarding importance weights of dimensions and utility decrements. A common scale is developed. %}
Olsen, Jan Abel, Admassu N. Lamu, & John Cairns (2018) “In Search of a Common Currency: A Comparison of Seven EQ-5D-5L Value Sets,” *Health Economics* 27, 39–49.

{% P. 20 **DC = stationarity**? Person prefers consuming 4/5 of his possession today, 3/25th tomorrow, 2/25 third day. He exhibits time inconsistency if myopic; Distinguish between diminishing marginal utility and pure **time preference**;

P. 1 (**discounting normative**):

"the case for positive time preference is absolutely compelling."

Several things they write are debatable.

P. 13: one need not have a "what-has-posterity-ever-done-for-me" attitude. %}

Olson, Mancur & Martin J. Bailey (1981) "Positive Time Preference," *Journal of Political Economy* 89, 1–25.

{% **risk averse for gains, risk seeking for losses**: surveys among professional investors confirms loss aversion, risk aversion for gains, and risk seeking for losses. %}

Olsen, Robert A. (1997) "Prospect Theory as an Explanation of Risky Choice by Professional Investors: Some Evidence," *Review of Financial Economics* 6, 225–232.

{% **coherentism**: Argues against coherentism. Coherentism means that internal coherence of a set of beliefs is the only criterion for truth. There is no debatable link with external reality otherwise. %}

Olsson, Erik (2005) "*Against Coherence. Truth, Probability and Justification*." Oxford University Press, Oxford.

{% **biseparable utility violated**; **ordering of subsets**; Preferences over sets of lotteries, where nature next chooses one, but does so in a nonprobabilized manner: Ambiguity à la Jaffray (cited by the author) and others. As in Jaffray's model, the evaluation is through a mixture of the inf and sup of the utility (which is EU here) of the prospects. Axioms include a set-version of the independence condition, and set-continuity. If set A c B, agent 1 prefers A to B more than agent 2 does, whereas they have same (EU) preference over singletons, then agent 1 is more ambiguity averse. (Seems to use betweenness-like axioms.) Holds (Corollary 2, p. 575) iff the mixture-weight of the inf is bigger for agent 1.

In a way this paper is to multiple priors what decision under uncertainty is to decision under risk. %}

Olszewski, Wojciech (2007) "Preferences over Sets of Lotteries," *Review of Economic Studies* 74, 567–595.

{% Show using simulations that high correlations between different EQ-5D measurements are to a large extent spurious, casting more doubt upon their validity. %}

Ombler, Franz, Michael Albert, & Paul Hansen (2018) "How Significant Are "High" Correlations between EQ-5D Value Sets?," *Medical Decision Making* 38, 635–645.

{% Assume a fixed prize, and t the time at which you receive it. This paper considers the case where, with the prize fixed, t is uncertain. Under the classical discounted EU, the commonly found convex discounting function would imply risk seeking w.r.t. t. Empirically, however, we find risk aversion. (The authors show it systematically, citing Chesson & Viscusi 2003 as the first finding of this kind.) As the authors point out, their finding gives nice evidence for risk aversion not being outcome driven but probability driven. An original idea! The finding supports rank-dependent utility. An alternative explanation is that the discounting function would be concave, with increasing rather than the commonly assumed decreasing impatience, but the authors do not favor this explanation. The authors cite Kacelnik & Bateson (1996) who find risk seeking instead for animal foraging behavior. Redelmeier & Heller (1993 MDM) also find risk aversion in an experiment very similar to the one here, but with aversive health outcomes instead of money. Then convex discounting is multiplied by a negative outcome meaning that the resulting function is concave, and common positive discounting gives risk aversion. Hence, what Redelmeier & Heller find is in agreement with common findings and not the paradox that this paper provides. %}

Onay, Selçuk & Ayse Öncüler (2007) "Intertemporal Choice under Timing Risk: An Experimental Approach," *Journal of Risk and Uncertainty* 34, 99–121.

{% %}

Onay, Selçuk & Ayse Öncüler (2009) "How Do We Evaluate Future Gambles? Experimental Evidence on Path Dependency in Risky Intertemporal Choice," *Journal of Behavioral Decision Making* 22, 280–300.

{% Ambiguity attitudes for future payments. Distinguish ambiguity about probabilities from ambiguity about outcomes. Table 1 cites many papers making the same distinction (**ambiguous outcomes vs. ambiguous probabilities**). Refer to construal level theory, from which they derive the prediction that the future moderates ambiguity attitudes towards probabilities but amplifies them towards outcomes. They find that future moderates ambiguity aversion for probabilities and amplifies **ambiguity seeking** towards outcomes. %}

Onay, Selcuk, Dolchai La-Ornual, & Ayse Öncüler (2013) "The Effect of Temporal Distance on Attitudes toward Imprecise Probabilities and Imprecise Outcomes," *Journal of Behavioral Decision Making* 26, 362–374. http://dx.doi.org/10.1002/bdm.1763

{% **completeness criticisms; quasi-concave so deliberate randomization**; In an ultimatum game experiment, receivers are allowed to randomize their choice. They do so, and are even willing to pay for it. A theoretical model is used to give predictions. %}

Ong, Qiyan & Jianying Qiu (2023) "Paying for Randomization and Indecisiveness," *Journal of Risk and Uncertainty* 67, 45–72. https://doi.org/10.1007/s11166-023-09407-1

{% %}

Ontario Ministry of Health (1991) "Guidelines for the Preparation of Economic Analysis to Be Included in Submission to Drug Programs Branch for Listing in the Ontario Drug Benefit Formulary/Comparative Drug Index," Ministry of Health, Toronto.

{% %}

Oostenbrink, Rianne, Ronald de Groot, & Henriette A. Moll (1999) "Het Jonge Kind met Koorts zonder Focus; Diagnostiek en Beleid," *Nederlands Tijdschrift voor de Geneeskunde* 23, 185–190.

{% %}

Oosterbeek, Hessel, Randolph Sloof, & Gijs van der Kuilen (2004) "Cultural Differences in Ultimatum Game Experiments: Evidence from a Meta-Analysis," *Experimental Economics* 7, 171–188.

{% special issue, dedicated to decision analysis. %}
Operations Research 28, no. 1.

{% %}
Opp, Marcus M. & John Y. Zhu (2015) "Impatience vs. Incentives," *Econometrica* 83, 1601–1617.

{% They propose to add questions (instruction manipulation checks) like "Please do not answer the next question" in an experiment (especially online) to check if subjects read the instructions well. Now when I write this, in 2021, there have been numerous applications with many refinements and good and bad experiences. %}
Oppenheimer, Daniel M., Tom Meyvis, & Nicolas Davidenko (2009) "Instructional Manipulation Checks: Detecting Satisficing to Increase Statistical Power," *Journal of Experimental Social Psychology* 45, 867–872.

{% The paper was previously entitled "Simplicity Equivalents." It was later published as Oprea (2024 *American Economic Review*). The comments below concern the version of 4 June 2023 and were written in my annotated bibliography of 16 March 2024.

Prospect theory/Rank-Dependent Utility most popular for risk: beginning of §1.2 writes it.

GENERAL JUDGMENT

This paper has a very nice "mirror" treatment for lottery choices. It shows more clearly than before that risk attitudes are to a large extent driven by general principles of perception also found in other domains rather than by things typical of risk. Unfortunately, the author uses many terms differently than the literature does. In particular, he uses separative interpretations rather than Kahneman & Tversky's and also my integrative interpretations (explained below). In the integrative interpretation, his findings do not criticize risk attitude and probability

weighting, but give new insights into them, be it that those isights deviate less from what was known before than the author suggests. His deviating terms include preference, risk attitude, probability weighting, and loss aversion. The author gets carried away too much with claims such as "probability weighting is a misnamed phenomenon" (p. 29). The author's alternative explanation of complexity attitude, fashionable nowadays (2023), is noninformative for being too broad/unspecific, but on the other hand too narrow because factors other than complexity perception play a role.

SUMMARY

This paper lets subjects consider options concerning 100 boxes, such as

25 Boxes	75 Boxes
\$25	\$0

For the nonmixed cases, the outcomes are \$25 and \$0 or –\$25 and \$0. The number of nonzero-outcome boxes is 10, 25, 75, or 90 for nonmixed lotteries. One treatment concerns probabilistic mixing: one of the 100 boxes of an option is selected randomly, and its content is given to the subject. These options are called lotteries. The other treatment concerns physical mixing: the content of the 100 boxes is summed, divided by 100, and that amount is paid. In other words, under physical mixing subjects receive the average of the boxes for sure. These options are called deterministic mirrors of lotteries, mirrors for short. In the latter treatment, subjects have calculators available to facilitate calculating. The two treatments were within-subject with order randomized.

For the nonmixed cases, the paper elicits indifferences such as

25 Boxes	75 Boxes		100 Boxes
\$25	\$0	~	\$X

Under probabilistic mixing, this gives certainty equivalents. The results of physical mixing are called simplicity equivalents.

For the mixed case, the paper elicits equivalences such as

50 Boxes	50 Boxes		100 Boxes
–\$10	\$X	~	\$0

taking 10/X as loss aversion (recommended and justified by Wakker 2010 Example 9.4.2). And, similarly with –\$15 instead of –\$10.

Further, all indifferences are elicited using either choice lists (n = 184) or the

Becker-Degroot-Marschak (BDM) mechanism (n = 100). (For the mixed case, BDM is done a bit differently than described above.) This is between-subjects. For implementing losses, the author did the usual **losses from prior endowment mechanism**. There were N = 487 online subjects. They received $6 showup fee and for 1/5 of them the RIS was used. The experiment took some 26 minutes for subjects and they gained about $6.60 in total for choice lists, $7.50 for BDM. Means very little performance-contingent! The experiment being online adds to low motivation.

In the physical treatment, if we can ignore calculation costs, then everyone should calculate average and go purely by that. This did not happen at all. In both treatments, the usual four-fold evaluation pattern of prospect theory (PT) was found, to a similar extent, for group averages and medians. Subjects were more risk seeking for mirrors than for lotteries, something not discussed in the paper. Between-subject within-treatment heterogeneity was big, but between-treatment within-subject heterogeneity was small, the latter appearing from strong correlations between probabilistic and physical mixing (0.7). The differences between choice lists and BDM exceeded those between physical and probabilistic mixing.

AUTHOR'S INTERPRETATION:

The findings of PT do not reflect risk attitude (such as probability weighting), but a different thing: complexity attitude.

MY DEVIATING INTERPRETATION:

To prepare, I first note that risk attitude consists of (1) general perception phenomena plus (2) typical-of-risk-phenomena. Physical-mixing-attitude also consists of (1) general perception phenomena, plus (3) things typical of physical mixing. The latter, (3), can consist of dislike of the artificiality of not putting all money in one box for no reason that one can think of. The common (1) is large. But there are differences in the data still, with more pesssimism for gains under risk than for mirrors and large confidence intervals that do not reject considerable differences still. So, no good statistical support for the claimed identical results. (A small aside: further, the effects by (3) can happen to be similar to those by (2).)

My *main difference in interpretation with the author*: whenever things concern general perception in (1) above, the author writes that it is NOT risk attitude. I call this the separative view. I disagree: it is PART OF risk attitude still. I call this the integrative view. For example, that humans share 97% of their genes with (“other”) ape species, does not imply that our behavior would not be human.

Kahneman and Tversky, more than anyone else, brought the insight to the field that much of risk attitude concerns (1), i.e., general perception. The author cites them for it in Footnote 12 on p. 24 and p. 27, but other than that writes by the separative view. Typical is the author’s writing on p. 27: “Prospect-theoretic behavior can be interpreted, in large part, as an outgrowth of just this sort of insensitivity, an observation that goes back at least to Tversky & Kahneman (1992). *However*, as results like ours suggest, this kind of insensitivity is not special to risky choice but applies to complex problems more generally (e.g., in deterministic mirrors).” [italics added] He first acknowledges Tversky & Kahneman but then, by the word “however,” suggests that he deviates, which he does not at all.

My second difference in interpretation with the author: now (2023) it is fashionable in the literature to use the term complexity for many things. However, complexity plays a role in everything we do, but in million different ways, and it is commonly used in a completely vague unspecified manner, giving no predictive power. Hence, I find his interpretation by complexity attitude and his term “simplicity equivalent” not informative.

For the stakes in this experiment, the performance-contingent payments being lower than common in experiments, and Prolific adding noise, the effects of (2) and (3) above are similar. But for very large stakes, say 1000 fold, as in finance and health decisions, I predict that (3) almost entirely disappears and subjects will get very close to average maximization, but a considerable part of (2) (probability weighing and for large stakes also concave utility) will remain because it involves cognitive inability of people not understanding probability. Online Appendix A2 has a student group with probability of choice-contingent behavior being implemented being equal 1 rather than 1/5, but this is not enough of an increase in incentives. The author there claims similar findings but the lower half of Figure 6 displays big differences. He does acknowledge that loss aversion for mirrors was only half of that for lotteries.

FURTHER DETAILED COMMENTS FOR VERSION OF 4 June 2023

That the BDM is problematic has often been observed, so not very surprising that it deviates much. In general, that framing effects, preference reversals, violations of transitivity, and noise and factors unknown to us are strong, and stronger than the systematic deviations from EU, has been known long time. I agree with the author in calling the PT effects second-order. However, no other theory has as yet (2023) done better.

Fields similar to risk, such as intertemporal choice and welfare, are known to exhibit many phenomena similar to risk, sharing (1) above, general perceptual phenomena.

The last sentence of the abstract: "These findings suggest that much of the behavior described by prospect theory may be driven by the complexity of evaluating lotteries *rather than* by risk or risk preferences." [Italics added] It is again the separative view that I disagree with.

Intro: the author writes that the only difference between lotteries and their deterministic mirrors are that the former have stochasticity, i.e., (2) above. However, (3) above can also play a role: the deterministic mirrors can cause annoyance for the artificial inefficient disaggregated info for no good reason that one can think of.

P. 12: Whereas economists usually use the term preference to encompass everything, tastes, beliefs, discounting, and so on, the author apparently often uses the term preference for only taste and disjoint from, for instance, beliefs, a terminology common in finance for instance, unlike in economics. This leads to confusions and incorrect interpretations of other authors who used the terms differently. For instance, p. 12 writes: "Probability weighting, for instance, is classically interpreted as a description of how *taste* for risk changes as probabilities change.[6][Here footnote 6] However some recent treatments (e.g., Wakker 2010) have interpreted probability weighting *instead* as consisting of one component that is due to *preferences* ("optimism/pessimism," the elevation of the probability weighting function) and another that is driven by cognitive misunderstandings or misperceptions of the differences between probabilities ("likelihood insensitivity," the flatness of the probability weighting function)." [italics added] The author incorrectly ascribes the term taste to Kahneman and Tverksy (where footnote 6 cites their text that used the term "preference" in the general economic meaning rather than in the author's "taste" meaning) suggesting that they would preclude cognitive interpretations, which is really the last thing they would do. It then goes on to, incorrectly, suggest that my interpretation would be any different than

K&T's, by using a term preference for what I instead call motivational.

Something similar happens with loss aversion. Kahneman and Tversky, myself, and many others think that two factors contribute to loss aversion: (a) feeling; (b) attention. Regarding (a), losses are more felt than corresponding gains. Regarding (b), more attention is paid to losses than to gains (irrespective of what is felt). The author, however, takes it to comprise only (a), when writing on p. 12: "Loss aversion, likewise, is generally interpreted as a description of subjects' taste for losses relative to gains." Wakker (2010 p. 239 penultimate para) discusses (a) and (b).

Loss aversion in mirrors is 80% of loss aversion in lotteries.

P. 15, Figure 2, gives data on group averages. A difference displayed by the data is that for gains subjects are more optimistic (risk seeking) for mirrors than for lotteries, and for the mixed case also. For losses they may be a bit more pessimistic for mirrors, but now much. The author does not discuss these differences.

Results section: medians are the same for lotteries and mirrors.

P. 18, §3.1 2-to-last para: "our finding that lottery valuations *fail to* reveal risk preferences" [italics added] Again the separative view.

P. 18, §3.1 2-to-last para: Differences between choice lists and BDM are four times larger than between lotteries and mirrors.

P. 21: "Our experiment was designed to identify the relative roles risk and complexity play in generating lottery anomalies, but it was not designed to sharply identify exactly how complexity induces these anomalies." This sentence at the same time suggests an exact treatment of complexity and acknowledges that the paper does not do so. One of my main criticims concerns the latter. Footnote 1 on p.2 opens up with referring to complexity as defined in computer science, suggesting a specified treatment to come, but the paper does not do it.

P. 22, §3.3 provides much evidence such as relatedness with noisy behavor etc, supporting the view that subjects just did not want to do the effort of using proper calculations.

P. 22: "This strongly reinforces our conclusion that prospect-theoretic behavior in lotteries and mirrors derive from the same behavioral mechanism, and suggests that this mechanism has little to do with risk or risk preferences." The author uses the separative terminology.

P. 23, end of §3, cites much literature giving noisy processing models implying the PT patterns. Again, this need not be taken separatively but can be taken integratively.

P. 24, §4 2nd para: "This literature has, to a great extent, interpreted prospect theory as a description of risk preferences, encouraged by the *preference-based* interpretation advanced in the paper that introduced the theory (Kahneman & Tversky 1979). However the literature has long been ambivalent in this interpretation, and boundedly rational interpretations of some or all of prospect theory's components have been openly entertained as an *alternative possibility*." Again, the author takes the separative rather than the integrative perspective, again misunderstanding the term preference of K&T.

P. 25: "driven largely by constraints on information processing rather than preferences." Here, the author again uses the term preference differently than Kahneman & Tversky do.

All the phenomena in §4 (pp. 23-28) do not refute risk attitude, but give background to risk attitude.

P. 25, still §4, cites Benheim & Sprenger (2020) affirmatively on their, in my opinion incorrect, ideas on complexity aversion. Wakker (2023 JBEE §6) criticizes them, citing literature on event splitting. The author's Footnote 13 mentions event splitting but gives no references and does not explain why that would not be counterevidence.

P. 26: "We find similar elicitation effects in both lotteries and mirrors, indicating that elicitation effects themselves are phenomena of complexity, not risk. This result suggests that these effects have little to do with risk or risk preferences, but instead are likely expressions of the poorly adapted procedures subjects use when evaluating complex things." Again, the separative view, with again the unspecified "complex."

P. 27: "meaning loss aversion may be a species of a more general mechanism for processing positive relative to negative information." This is not a deviating insight but it is the very reason why Kahneman introduced loss aversion into prospect theory!

P. 28, end of §4, writes: "These results underscore and expand upon our interpretation of our results by suggesting that the patterns of insensitivity described by prospect theory may be generic to the evaluation of complex things — a mechanism that may unify a great number of anomalies in behavioral economics." This has been well understood by Tversky, Kahneman, and many others.

Pp. 28-30, in the discussion section, the author gets carried away in his separative perspective. He, for instance, goes overboard on p. 29: "This suggests, most importantly, that probability weighting is a *misnamed* phenomenon and is not, as in traditional interpretations, a description of the way tastes and preferences for risk change with probabilities." [Italics added] The italicized word "misnamed" is too much and very incorrect. Agsain, if human beings share 97% of their genes with apes, then "human being" is not a misnamed phenomonon.

cognitive ability related to likelihood insensitivity (= inverse S): that "complexity" contributes to inverse S supports it. %}

Oprea, Ryan (2023, 4 June) "Decisions under Risk are Decisions under Complexity," working paper.

{% Subjects express preferences between lotteries, displayed as 100 boxes containing monetary prizes, with one randomly selected and paid. Subjects also express preferences between "mirrors". Mirrors are displayed using the same 100 boxes as with lotteries, but now subjects get the average amount with certainty. That is, they get the expected value of the corresponding lottery with certainty.

For lottery preferences, probability weighting and loss aversion are found as usual and as predicted by prospect theory of Kahneman and Tversky (KT henceforth). Oprea calls this the common pattern CP, and I here use that term too. Remarkably though, mirror preferences don't go by expected value as they should normatively, but display the CP similarly. Two observations follow: The mirror preferences are clearly irrational, so that probably:

(1) CP in lottery preferences is irrational.

Further:

(2) Many phenomena for risky preferences, such as CP, occur similarly in other contexts, so are not very typical of risky-preferences-only but are based on more general principles of perception.

The two observations are not new but have been observed before, by Kahneman & Tversky (1979), Tversky & Kahneman (1981, 1986, 1992), and also by Wakker (2010) and many others. I repeat, emphasizing: all these works qualify CP as irrational and as much based on general perceptual properties. The contribution of Oprea is to show them with ingenious stimuli, prettier and clearer than ever before. So much that it deserves everybody's attention and a top publication.

Unfortunately, many misunderstanding have arisen. Many (if not all …!?) readers of Oprea's paper erroneously took it as a falsification and invalidation of

CP and prospect theory, rather than the corroboration that it is. Four causes of these misunderstandings follow:

(1) In Oprea's intro and §§I-II, he presents the above two observations without citing KT or any other predecessor, making readers erroneously believe that these are new insights. And, then, that KT must have missed them and hence must be wrong. Oprea's citation of KT on related material, only at the end of his §IV, does not convey their precedence:

> "… complexity: that it causes decision-makers to be insensitive to features of decision problems that matter for optimal choice. The classical pattern can be interpreted, in large part, as an outgrowth of just this sort of insensitivity, an observation that goes back at least to *Tversky and Kahneman (1992)*." [italics added] (p. 3808)

Intros should position the novelty of a paper, not the end of §IV. The text is confusingly surrounded by modern work on complexity as if contributing to only that, and uses vague words "outgrowth … just … at least". No reader will get from this text that the two above observations of the intro, put central throughout Oprea's paper, had long and thoroughly been presented before by KT and many others.

(2) Oprea's intro and §§I-II only emphasize similarities or even quantitative equalities between CP for risky and riskless preferences. They suggest complexity as the only relevant factor, suggesting that it can replace everything known before. Only his §§III-IV deviate and put things right. They acknowledge differences, sometimes even dramatic, between risky and riskless preferences, and that factors other than complexity can play a role. With that understood, the contribution of the paper becomes quite less sensational.

(3) Oprea uses the terms "preference" and "taste" in an unconventional manner. In his Footnote 1 he explains that in his terminology, these terms only refer to the rational ("welfare-relevant") part of preference, and that deviations from rationality are called mistakes and not preferences. This terminology deviates from the common convention in decision theory where preference refers to observed, revealed, choices so that preferences can be irrational. Sometimes Oprea adds "true" or "reliable" to the term preference. Now confusions arise from texts such as:

> "much of the behavior motivating our most important behavioral theories of risk

> derive from complexity-driven mistakes rather than *true risk preferences*." [iutalics added] (p. 3789; abstract):

By Oprea's footnote 1, "true risk preference" should be taken as rational. Then this text is just a restatement of the above first observation, made many times before by KT and many others. It then is strange that such claims are repeated throughout the paper, given that they are not new. If one, however, takes "true risk preference" in its usual meaning, as empirical, revealed, and comprising the usual irrationalities, then the text would amount to a refutation of "our most important behavioral theories", including prospect theory with CP (were it not that it then would be incorrect: that risky preferences share properties with other preferences does not mean they are not risky preferences), and be a sensational novelty rather than something well-known. Virtually all readers of Oprea's paper have, understandably, fallen victim to this misunderstanding, including Simonsohn (14 March 2025).

(4) Following up on (3), readers thinking that CP is falsified, think it must be in for replacement. And then the above cited text, and many such texts repeated throughout the paper, make them erroneously believe that complexity replaces CP. This is not so. CP is not in for replacement. Complexity is an important factor explaining and supporting CP (Armantier & Treich 2016; Spiliopoulos & Hertwig 2023; Zilker, Hertwig, & Pachur 2020), rather than replacing it.

Those were four causes of misunderstandings. Most papers assume that decision costs and bounded rationality are small enough to be ignored. If they are given a nontrivial role, then some of the terms above should be modified. Then "mistakes" in Oprea's paper may not be mistakes. Then the CP can even be rationalized sometimes (Enke & Graeber 2023). These changes do not affect the above analysis. Still (1) CP is not welfare-relevant and (2) risky and riskless preferences are related. Still, KT gave much attention to bounded rationality.

Banki et al. (2025) criticized Oprea's experiment. However, there has already been much evidence supporting the above two observations. I believe they can be done with stimuli as pretty as Oprea's, in experiments with good instructions, good incentives, and the right level of complexity of stimuli. My point is that such findings corroborate, rather than falsify, CP, prospect theory, and KT's

work.

P. 3739 Footnote 3: **losses from prior endowment mechanism** %}

Oprea, Ryan (2024) "Decisions under Risk are Decisions under Complexity," *American Economic Review* 114, 3789–3811. https://doi.org/10.1257/aer.20221227

{% %}

Oprea, Ryan & Ferdinand M. Vieider (2023) "Closing the Gap," working paper.

{% %}

Oresme, Nicolas (1968) "Tractatus de Configurationibus Qualitatum et Motuum." *In* Marshall Clagett (ed.) *Nicole Oresme and the Medieval Geometry of Qualities and Motions,* University of Wisconsin Press, Madison.

{% %}

Orlovski, Sergei A. (1994) "Calculus of Decomposable Properties, Fuzzy Sets, and Decisions." Allerton Press, New York.

{% %}

Ordonez, Lisa & Lehman Benson (1997) "Decisions under Time Pressure: How Time Constraint Affects Risky Decision Making," *Organizational Behavior and Human Decision Processes* 71, 121–140.

{% A review of Plotts work. It is negative on the biases and heuristics literature by Kahneman and others, with very critical remarks on Rabin for instance on p. 569. It, accordingly, argues that, besides Smith, Plott rather than Kahneman should have gotten the Nobel prize. %}

Ortmann, Andreas (2003) "Charles R. Plott's Collected Papers on the Experimental Foundations of Economic and Political Science," *Journal of Economic Psychology* 24, 555–575.

{% **foundations of statistics**

Discusses controversies about hypothesis testing in organization studies (OS)

which, according to the abstract, refers to all management-related journals and disciplines, including but not limited to organizational behavior, strategy, human resource management, and organization theory. %}

Orlitzky, Marc (2012) "How Can Significance Tests Be Deinstitutionalized?," *Organizational Research Methods* 15, 199–228.

{% In an Anscombe-Aumann framework, assumes a preference relation $\succcurlyeq_0$ if there is no status quo, and for all acts f a preference relation $\succcurlyeq_f$ which is preference if f is status quo. $\succcurlyeq_f$ is such that there is a set of priors such that only acts g are $\succcurlyeq_f$ preferred to f if they are so unanimously for the whole set of priors. Among those acts preferences $\succcurlyeq_f$ are as $\succcurlyeq_0$, so as if there was no status quo. So, the status quo does not affect preference between acts preferred to the status quo. Other than that $\succcurlyeq_0$ can be anything in Theorem 1. Theorem 2 adds axioms that make $\succcurlyeq_0$ maxmin. %}

Ortoleva, Pietro (2010) "Status Quo Bias, Multiple Priors and Uncertainty Aversion," *Games and Economic Behavior* 69, 411–424.

{% **updating under ambiguity**: in the Anscombe-Aumann framework, the author imposes standard Anscombe-Aumann axioms (continuity, weak ordering, independence). He further considers updating and assumes consequentialism, event-collapsing (**coalescing**) (implicitly), and a weakened version of **dynamic consistency**: dynamic coherence. The latter means that if a set of events is informationally equivalent in the sense that given one, the complement of any other is null, then their updated preferences should be identical. He proves that these axioms hold iff: Bayesian updating for all events whose subjective probability exceeds a threshold ε. An observation less likely than ε is not trusted. Then the agent imposes a second-order probability distribution on his priors, updates that, and takes the most likely prior as new prior. How restrictive the last part, of maximizing likelihood, is, depends on how restricted the choice of prior is. What it is beyond preserving null I did not study.

Remarkable that American Economic Review took this purely axiomatic paper. %}

Ortoleva, Pietro (2012) "Modeling the Change of Paradigm: Non-Bayesian Reactions to Unexpected News," *American Economic Review* 102, 2410–2436.

{% Abstract: "Overconfidence is a substantively and statistically important predictor of ideological extremeness, voter turnout, and partisan identification."

P. 507: "This work contributes to the emerging literature on behavioral political economy, which applies findings from behavioral economics to understand the causes and consequences of political behavior. This approach promises to allow political economists to integrate the insights of a half-century of psychology-based political behavior studies."

Derive their conclusion from a dataset nationwide of over 3000 adults. P. 505: "Citizens passively learn about a state variable through their experiences (signals). However, to varying degrees, citizens underestimate how correlated these experiences are, and thus, have different levels of overconfidence about their information. This underestimation—which we call correlational neglect"

The authors thus give a behavioral interpretation to data and derive new insights from that. %}

Ortoleva, Pietro & Erik Snowberg (2015) "Overconfidence in Political Behavior," *American Economic Review* 105, 504–535.

{% %}

Ortona, Guido (1994) "Examining Risk Preferences under High Monetary Incentives: Comment," *American Economic Review* 84, 1104.

{% %}

Osborne, Martin J. & Ariel Rubinstein (1994) "*A Course in Game Theory*." MIT Press, Cambridge, MA.

{% **paternalism/Humean-view-of-preference**: they propose heuristic but clever manner for correcting quantitatively for incoherencies in probability judgments. P. 1 and 2 give many refs to people trying to correct for incoherencies in probability judgments.

They ask subjects for judgments of probabilities of elementary statements and the set E of their logical combinations. These of course contain incoherencies. They then take state space S with 10 equally probable states.

STAGE 1. They stretch all probabilities of elementary statements by a random factor towards, randomly chosen, either 0 or 1.

STAGE 2. To each elementary statement they assign a, randomly chosen, subset E of S with ||E||/10 as close as possible to the "stretched" probability of the elementary statement. Thus, a probability distribution over E results.

STAGE 3. They calculate the absolute deviation between the probability over E of stage 2 and the direct judgments of probability

STAGE 4. They do the whole above process 30 times, and of these 30 times choose the one that has the minimal distance in Stage 3.

The probability distributions obtained like this better fit to objective probabilities, known to experimenters but not to subjects, than the direct judgements do. %}

Osherson, Daniel, Eldar Shafir, David H. Krantz, & Edward E. Smith (1997) "Probability Bootstrapping: Improving Prediction by Fitting Extensional Models to Knowledgeable but Incoherent Probability Judgments," *Organizational Behavior and Human Decision Processes* 69, 1–8.

{% Best known study showing overconfidence %}

Oskamp, Stuart (1965) "Overconfidence in Case-Study Judgments," *Journal of Consulting Psychology* 29, 261–265.

{% Adolescents take more risks because they are worse at learning from experience. %}

Osmont, Anaïs, Sylvain Moutier, Grégory Simon, Lison Bouhours, Olivier Houdé, & Mathieu Cassotti (2017) "How Does Explicit versus Implicit Risk Information Influence Adolescent Risk-Taking Engagement?," *Journal of Behavioral Decision Making* 30, 1093–1103.

{% **CBDT**; Students repeatedly guess colors from balls drawn from urns with unknown compositions, where they learn from repeated drawings. Get points, the total sum of which is turned into money later. CBDT is implemented with particular similarity functions, and utility linear. It accommodates observations better than maxmin, maxmax, α maxmin, and some learning models.

Subjects got points and were paid, besides €5 showup fee, €0.05 per point if the number of points was positive, but did not have to pay if the sum was negative. %}

Ossadnik, Wolfgang, Dirk Wilmsmann, & Benedikt Niemann (2013) "Experimental Evidence on Case-Based Decision Theory," *Theory and Decision* 75, 211–232.

{% Hypothetical choice. Consider choice between a sure gain and a gain-loss prospect, and between a sure loss and a gain-loss prospect. Seem to assume linear utility, and fit probability weighting using the Goldstein & Einhorn (1987) transformation family. Investigate interactions between payments and probability weighting (**probability weighting depends on outcomes**). Do not refer to prospect theory or the vast risky-choice literature, but only to intertemporal choice as analog of risky choice. %}

Ostaszewski, Pawel & Wojciech Bialaszek (2010) "Probabilistic Discounting in "Certain Gain–Uncertain Loss" and "Certain Loss–Uncertain Gain" Conditions," *Behavioural Processes* 83, 344–348.

{% Independently obtained the Goldstein & Einhorn (1987, Eqs. 22–24) family by applying a hyperbolic function—often used in intertemporal choice—to the odds ratio p/(1–p). %}

Ostaszewski, Pawel, Leonard Green, & Joel Myerson (1998) "Effects of Inflation on the Subjective Value of Delayed and Probabilistic Rewards," *Psychonomic Bulletin & Review* 5, 324–333.

{% **information aversion** %}

Oster, Emily, Ira Shoulson, & E. Ray Dorsey (2013) "Optimal Expectations and Limited Medical Testing: Evidence from Huntington Disease," *American Economic Review* 103, 804–830.

{% The paper considers evaluations of

$(a_1,t_1, ..., a_n,t_n)$.

There are n individuals, and this is health state a_i (abstract, with dead as worst and perfect heath as best) during time t_i (positive reals) for individual i.

The paper assumes separability giving evaluation

$V_1(a_1,t_1) + \cdots + V_n(a_n,t_n)$

and then adds axioms to give linearity in t, power functions in t, and particular multiplicative decompositions that follow mostly from utility independence. An important step in proofs is to replace pairs (a_i,t_i) by an equivalent (a^*,t_i^*), where a* is perfect health and (a^*,t_i^*) is the healthy years equivalent. %}

Østerdal, Lars-Peter, Jens Hougard, & Juan Moreno-Ternero (2012) "A New Axiomatic Approach to the Evaluation of Population Health," *Journal of Health Economics* 32, 515–523.

{% **free will/determinism** %}

Otterström, Göran Duus (2009) "Almost Pregnant: On Probabilism and its Moral Uses in the Social Sciences," *Philosophy of the Social Sciences* 39, 572–594.

{% **probability communication** %}

Oudhoff, Jurriaan P. & Daniëlle R. M. Timmermans (2015) "The Effect of Different Graphical and Numerical Likelihood Formats on Perception of Likelihood and Choice," *Medical Decision Making* 35, 487–500.

{% Theorem A.1, presented as an elaboration of an exercise of Bourbaki, gives a topological version of Hölder's lemma, with a connected topology. %}

Ovchinnikov, Sergei (2001) "On Ordered Structures of Scale Type (*N,N*)," *Journal of Mathematical Psychology* 45, 913–916.

{% Seems to point out that randomization is only to let opponent be uncertain about which (possibly pure) strategy is chosen. %}

Owen, Guillermo (1974) "A Discussion of Minimax," *Management Science* 20, 1316–1317.

{% A theoretical model on how in ambiguity learning affects/converges to risk aversion. %}

Oyarzun, Carlos & Rajiv Sarin (2013) "Learning and Risk Aversion," *Journal of Economic Theory* 148, 196–225.

{% Theorems on generalized quasilinear means and other topics. There are results on **information aversion** in §5, relating it to low sensitivity to probabilities. Iterated integrals are analogous to associativity and axiomatize the implicit means that are in fact quasilinear. %}

Ozaki, Hiroyuki (2009) "Conditional Implicit Mean and the Law of Iterated Integrals," *Journal of Mathematical Economics* 45, 1–15.

{% Shows some ways of weakening independence or continuity in the vNM axiomatization by reinforcing the other. %}

Ozbek, Kemal (2024) "Expected Utility, Independence, and Continuity," *Theory and Decision* 97, 1–22.
https://doi.org/10.1007/s11238-023-09964-6

{% **conservation of influence**: Paper is about something different, being unknown states of nature. But many of its sentences, especially in the beginning, suggest related thoughts. Reading this paper gives good feelings. Nice conclusion: "There are occasions when even if an alternative has a high priority relative to other alternatives that priority is questionable because there may be other criteria that need to be identified and used that can change the ranks obtained for the alternatives. In that case "other" would not be of help. One needs to be fairly sure that all the important criteria have been used and the priorities of the alternatives are close, in which case "other" would be useful to determine the stability of the best alternative." %}

Ozdemir, Mujgan S. & Thomas L. Saaty (2006) "The Unknown in Decision Making: What to Do about It," *European Journal of Operational Research* 174, 349–359.

{% %}

Ozdenoren, Emre (2002) "Completing the State Space with Subjective States," *Journal of Economic Theory* 105, 531–539.

{% **dynamic consistency**; Consider, for instance, Ellsberg 3-color with conditioning and the paradoxical implications of ambiguity aversion. %}

Ozdenoren, Emre & James Peck (2008) "Ambiguity Aversion, Games against Nature, and Dynamic Consistency," *Games and Economic Behavior* 62, 106–115.

{% Measure for present, and taking place in two weeks: individual risks, social risks (trust), ambiguity aversion, all get reduced by temporal distance, in agreement with Construal Level Theory, but the effects are weak. %}

Özgümüs, Asri, Holger A. Rau, & Stefan T. Trautmann (2024) "Delayed Risk in Individual and Social Decisions," *Journal of Economic Psychology* 102, 102710. https://doi.org/10.11588/data/QGKGSN

{% **Prospect theory not cited**: Cash transfer program and a community development package in rural Lesotho decrease risk aversion, mediating impact on investment decisions in real life. %}

Pace, Noemi & Silvio Daidone (2024) "Impact of Development Interventions on Individual Risk Preferences: Evidence from a Field-Lab Experiment and Survey Data," *Journal of Behavioral and Experimental Economics* 111, 102238. https://doi.org/10.1016/j.socec.2024.102238

{% N = 1047 subjects from the US and Germany answered hypothetical choice questions. There were affect-poor choices (lotteries over money) and affect-rich choices (lotteries over medical outcomes). Numeracy measures of the subjects were available. High numeracy and US give more EV maximization. (**cognitive ability related to risk/ambiguity aversion**) Remarkably, although the Americans on average had lower numeracy scores, they still did more EV maximization. Study 2 (N = 118 from Germany) shows that with affect-rich outcomes there is more neglect of probability (I guess, then more inverse S). %}

Pachur, Thorsten & Mirta Galesic (2013) "Strategy Selection in Risky Choice: The Impact of Numeracy, Affect, and Cross-Cultural Differences," *Journal of Behavioral Decision Making* 26, 260–271.

{% **PT falsified; probability weighting depends on outcomes**: They investigate this. Several studies have shown that affect-rich outcomes can affect probability weighting, the electric shocks versus moviestar kisses of Rottenstreich & Hsee (2001) being most well known. This paper shows the effect very thoroughly, also within-subject, and is the first to do so. The main finding is that affect-rich outcomes make people less, or even completely, insensitive to probabilities.

Process data with eye tracking support this claim. The authors interpret disregarding probabilities as something fundamentally different than bigger insensitivity (p. 75 last para of 1st column and p. 76 2nd column 2nd para), and follow that same interpretation in other papers. I disagree. It is an extreme case of insensitivity. Thus, what the authors take as evidence against inverse S, in my opinion is strong support. %}

Pachur, Thorsten, Ralph Hertwig, & Roland Wolkewitz (2014) "The Affect Gap in Risky Choice: Affect-Rich Outcomes Attenuate Attention to Probability Information," *Decision* 1, 64–78.

{% **cognitive ability related to risk/ambiguity aversion**: They measure PT and use real incentives. Subjects with high probabilistic insensitivity pay little time looking at probabilities, supporing the cognitive interpretation of inverse S.

P. 148: "Arguably the most influential descriptive model in the expectation tradition is cumulative prospect theory (CPT; Kahneman & Tversky, 1979; Tversky & Kahneman, 1992)."

(**Prospect theory/Rank-Dependent Utility most popular for risk**) They assume power utility with the same power for gains and losses, which, as explained by Wakker (2010, end of §9.6.1): "Thus, there is no clear way to define loss aversion for power utility unless the powers for gains and losses agree. Tversky & Kahneman (1992) coincidentally found such an agreement." Table 1 shows a strange finding: $\lambda < 1$, gain seeking.

P. 155: "CPT has a previously overlooked capacity to reflect aspects of the cognitive processing of specific attribute information."

Experiment 2 manipulates attention to gains and losses, and, unsurprisingly, more attention to losses increases loss aversion. %}

Pachur, Thorsten, Michael Schulte-Mecklenbeck, Ryan O. Murphy, & Ralph Hertwig (2018) "Prospect Theory Reflects Selective Allocation of Attention," *Journal of Experimental Psychology: General* 147, 147–169.
https://doi.org/10.1037/xge0000406

{% Consider how PT can accommodate five heuristics: Maxmin (maximize minimal outcome; the authors call it minimax), maxmax (maximize maximal outcome), least likely (identify the worst outcome of each prospect; take the one that assigns the lowest probability to its worst outcome; so, (0.1: -10^7, 0.9:-10^6) is preferred to 10^6 because the latter assigns probability 1 to its worst outcome, and the former only probability 0.1), most likely (equate each prospect with its most likely outcome, and choose according to those, which also readily leads to violations of stochastic dominance), and the priority heuristic (described in my comments to the Brandstätter, Gigerenzer, & Hertwig 2006 paper). A nice attempt at reconciliation!

They do not solve the problem mathematically, but by taking the parametric families of T&K'92 and fitting those to two-, three-, and five-outcome prospects.

Here are my mathematical speculations: For gains, maxmin (or maxmax) can be perfectly accommodated by a weighting function that is 0 (or 1) everywhere outside 0 (or 1), see my Wakker (2010) book Exercise 10.4.3. For losses this goes dually. Least likely and most likely are so far from any traditional theory satisfying stochastic dominance that it will depend entirely on the data set considered. The priority heuristic is more interesting but also more involved. Its overweighting of worst gain and best loss, and ignorance of intermediate outcomes supports pessimism + inverse S for gains and optimism + inverse S for losses.

I did not find clearly what stimuli were used in the simulations and experiments.

The authors consider hypothetical risky choices with monetary outcomes and with health outcomes. With health the probability weighting is more pessimistic and also more inverse S.

The heuristics models all have a context dependence that means they will violate transitivity. All the ones considered here are non-compensatory. Although algebraic models could be equipped with speculations on underlying cognitive processes and heuristics could be used without, mostly it is the other way around and this the authors write. The abstract takes diminishing sensitivity to outcomes and probabilities as psychophysical and not as cognitive. I like to take insensitivity (inverse S) probability weighting as (also) cognitive. The abstract calls risk aversion "and loss aversion" psychological.

P. 62 §8.1.1: "Algebraic models, with their focus on describing preference patterns, are mute about the cognitive processes underlying choice." P. 62 §8.1.2: "Prospect theory has psychophysical roots that Kahneman and Tversky (1979) highlighted, for instance, in the context of diminishing sensitivity" Again, the case of probability

weighting, I like to take that as (also) cognitive. I emailed with Thorsten Pachur on 23Feb.2018 and I think we converged on the following: The term prospect theory is used in different senses in the literature. Some economists prefer to take it Friedman-style purely as revealed-preference without any interpretation. Their claim of muteness refers to those. However, others, including Kahneman, Tversky, Rich Gonzalez (I would like to join in this group), like to speculate on cognitive interpretations and are not mute.

Nice is that the paper tries to relate and compare PT and heuristics in neutral terms. %}

Pachur, Thorsten, Renata Suter, & Ralph Hertwig (2017) "How the Twain Can Meet: Prospect Theory and Models of Heuristics in Risky Choice," *Cognitive Psychology* 93, 44–73.
https://doi.org/10.1016/j.cogpsych.2017.01.001

{% **ratio bias** %}

Pacini, Rosemary & Seymour Epstein (1999) "The Relation of Rational and Experiental Information Processing Styles to Personality, Basic Beliefs, and the Ratio-Bias Phenomenon, *Journal of Personality and Social Psychology* 76, 972–987.

{% **measure of similarity** %}

Paclík, Pavel, Jana Novovicová, & Robert P. W. Duin (2006) "Building Road-Sign Classifiers Using a Trainable Similarity Measure," *IEEE Transactions on Intelligent Transportation Systems* 7, 309–321.

{% Voice means that victims may speak in court. Students in lab are told hypothetically how much time they get and then scale it introspectively for fairness. The resulting function has a shape like the value function of prospect theory. %}

Paddock, E. Layne, Jaewon Ko, Russell Cropanzano, Jessica Bagger, Assâad El Akremi, Julie Camerman, Gary J. Greguras, Antonio Mladinic, Carolina Moliner, Kidok Nam, Kjell Törnblom and Kees Van den Bos (2015) "Voice and Culture: A Prospect Theory Approach," *Journal of Behavioral Decision Making* 28, 167–175.

{% **coherentism**: neurons in the OFC (orbitofrontal cortex) are proposed as a good "candidate network" for economic value (so, utility). %}

Padoa-Schioppa, Camillo & John A. Assad (2006) "Neurons in the Orbitofroonal Cortex Encode Economic Value," *Nature* 441, 11 May 06, 223–226.

{% %}

Page, Frank H. Jr. (1996) "Arbitrage and Asset Prices," *Mathematical Social Sciences* 31, 183–208.

{% My endorsement of the book:

"Rationality, central in economics and empirically abandoned in the "behavioral revolution," is, unfortunately, rarely discussed because of its slippery nature. This monograph, very very well building up, captures its essence, as of behavioral economics. Nuanced and in-depth. It thus serves two methodological purposes—a fortunate combination because one cannot be understood well without the other."

This, personal, monograph discusses rationality. It is not a collection of papers. It is one build-up of something that only a book can do. It is very well organized. Every chapter starts with some good citations, followed by a summary. Part I sets the stage, on homo economicus (Ch. 1), psychology (Ch. 2), scientific revolution (Ch. 3), and evolution (Ch. 4). Then follow 10 chapters on biases in behavioral economics. Finally, Ch. 15, called epilogue, brings all threads together and discusses arguments about rationality, without drawing clear conclusions, but this is OK for the slippery topic of rationality.

The preface ends with overblown language: "My aim is to get you to see the underlying meaning to the often mysterious ways we seem to live our lives." Well, to sell a book such quasi-nicely sounding sentences may be good and so be it. See the last sentence of Hawking (1988) and his comment on it, elsewhere in these annotations. Strictly speaking, it deserves the keyword: **ubiquity fallacy**.

Ch. 1: homo economicus

P. 2: "Analyses of citation flows show that economists export their results to other social sciences more than they import from them (Fourcade et al. 2015)." This can mean that economists are less open, or even more haughty, than others …

Pp. 3-5 discuss economic's simplifying rationality assumptions

Pp. 5-6 take Stigler & Becker (1977) “De Gustibus non Est Disputandum” more seriously than I do.

P. 10 writes, and I agree much: “Whenever we criticise the homo economicus, we should not ignore all the contributions of this “standard model” to economics and other social sciences. I will argue in this book that the way beyond the homo economicus is not to throw away the past insights and just state that people are “irrational”. On the contrary, it is the enrichment of this model which often offers the best insights into the rich and complicated patterns of human behaviour.”

Ch. 2 is on psychology of biases

P. 12 has nice texts on Ward Edwards, a pioneer with his impressive 1954 paper.

p. 13 nicely discusses Grether & Plott (1979).

Ch 3: Scientific revolution

P. 20 writes that behavioral economics lacks a unifying theory, but that evolution can provide such. Even that that is a central theme of the book. I would put it less central. Even though evolution is something like a religion to me, I think it is too abstract and complex to give concrete insights. Evolution can take place at every level, not only individuals but also habits (memes), genes, groups, language, and so on.

Ch. 4, pp. 22-34 is on evolution.

Then comes part II, on individual decisions.

Ch. 5 is on heuristics.

Ch. 6 on reference dependence and loss aversion.

§6.1.1 is on what Nobel-prize winner Kahneman calls Bernoulli’s error. That: Bernoulli did not incorporate reference dependence. I find calling this an error to be overblown and misplaced, and regret here as elsewhere that the author does not often take issue with ideas of high status but low value. §6.1.2 nicely points out that violation of asset integration is crucial.

§6.2.1 seeks to explain/rationalize reference dependence through limited perception, and §6.2.2 through motivation. Loss aversion is also discussed. I like to distinguish between basic and overall utility, and whether or not asset integration is violated, but did not find a central role for this in the text (may have missed it).

Ch. 7 is on probabilistic sensitivity.

§7.1 is on EU debates.

§7.2 is on probability weighting to give second-best solutions.

Ch. 8 is on random choice.

§8.1 discusses completeness from the indecisivenes perspective.

§8.2 discusses optimal sampling.

Ch. 9 is on intertemporal choice (impatience).

E.g., that we are always uncertain about the future.

Ch. 10 is on reciprocity.

On altruism, norms, rules.

Ch. 11 is on emotions and commitment.

Ch. 12 is on social identity.

§12.3.2 discusses group selection.

Ch. 13 is on imprecision.

§13.2 is on second-order beliefs, but this is to be taken between-persons and not for individual choice.

Ch. 14 is on delusion including overconfidence.

Part IV brings everything together in the final Ch. 15 entitled “Rationality”

Although this Part IV is called epilogue, it is the most important part of the book.

§15.1 discusses maximization. Is it rational to maximize happiness, instant pleasure, fitness, and there are citations by Socrates, Plato, Aristotle.

§15.2 discusses rationality as consistency (**coherentism**), and how the ordinal revolution contributed to bringing this about. Then pp. 227-228 discuss completeness, defending incompleteness due to indecisiveness. I never like such criticism, and more like criticisms of completeness due to unrealistic infinite continuum models, but never saw that discussed in the book. Pp. 229-230 discuss transitivity, with useful references, and leaving open if even that is rational. Pp. 230-233 discuss independence, taking history on for instance Samuelson from the valuable Moscati (2016). Pp. 233 ff. discuss independence of irrelevant alternatives. To me that is about the same as transitivity, but the book never seems to connect the two. Then a text has “Bayesianism” as its heading.

§15.3 is on rationality after the behavioral revolution. Pp. 240-241 is more optimistic than me on neuroscience by suggesting that it could make subjective experience observable.

I think Broome (1991), one of the biggest influences on my academic thinking, would have been a useful reference for this book. Broome in his discussion of rationality went further and argued that we may rather take the axioms as a choice of paradigm. So, if someone violates transitivity and take only the second-largest cake, we say that utility must be redefined. Broome discussed follow-up arguments on circularity and so on. %}

Page, Lionel (2022) "*Optimally Irrational: The Good Reasons We Behave the Way We Do.*" Academic Press, New York.

-

{% %}

Page, Lionel & Robert T. Clemen (2013) "Do Prediction Markets Produce well Calibrated Probability Forecasts?," *Economic Journal* 491–513.

{% **risk seeking for small-probability gains**: well, this is risk aversion for small-probability losses.

"Overprotection stems partly from the skewed incentives for reviewing committees … are held accountable for failure but not rewarded for success. … the possible risks loom larger than the cost savings. This is because of the disproportionate weighting of rare extreme events — for instance, a risk increase of 0% to 1% may be seen as more alarming than one from 40% to 41%. Institutions may therefore opt to play safe, despite the low probability of such events. … As such, the costs of overprotection raise ethical concerns of their own." %}

Page, Lionel & Katie Page (2017) "Reforms Overdue for Ethical Reviewing," *Nature* 544 (13 April 2017) 161.
https://doi.org/10.1038/544161d

{% **decreasing ARA/increasing RRA**: Shortly after 2011 Australian floods (Brisbane) interviewed home owners. They could choose payment of $10 for sure, or a scratch card costing $10 (sort of lottery game, well-known, and giving very high prize with small probability). People with serious damage to their house chose the scratch card more often. So, looks like they are more risk seeking. Well, probabilities of scratch card are unknown, so, then they are more uncertainty seeking. %}

Page, Lionel, David A. Savage, & Benno Torgler (2014) "Variation in Risk Seeking Behaviour Following Large Losses: A Natural Experiment," *European Economic Review* 71, 121–131.

{% Uses loss aversion as in Köszegi & Rabin (2006) to explain life-cycle consumption: (1) excess smoothness and sensitivity—consumption responds to income shocks with a lag (delay losses for expectation-adjustment.) (2) low consumption early in life (precautionary savings). Next, as uncertainty resolves, time-inconsistent overconsumption. Last, declining consumption. (3) At retirement, absent uncertainty, overconsumption drops, being associated with a sure loss in future consumption. Provides estimates from macro-data. %}

Pagel, Michaela (2017) "Expectations-Based Reference-Dependent Life-Cycle Consumption," *Review of Economic Studies* 84, 885–934. https://doi.org/10.1093/restud/rdx003

{% %}

Pahlke, Julius, Sebastian Strasser, & Ferdinand M. Vieider (2012) "Risk-Taking for Others under Accountability," *Economics Letters* 114, 102–105.

{% **losses from prior endowment mechanism**: This was NOT done. Losses were really implemented and subjects could really lose money, which they could either pay on the spot or work off (€5 per half hour). Every subject was paid three choices, which may generate some income effect, but which was done to minimize the risk for a subject of really losing. Two of 144 lost, €3.50 and €2.00.

inverse S: When people have to decide not only for themselves, but also for the outcomes of someone else, then this accentuates the fourfold pattern. The authors show this by considering gains and losses for 50-50 prospects, and then also for small probabilities.

decreasing ARA/increasing RRA: p. 131: For gains they find INCREASING absolute risk aversion, for losses H_0 of constant. For gains, the common finding is decreasing absolute risk aversion. The discussion section p. 138 cites increasing risk aversion as the common finding, but the references cited find increasing RELATIVE risk aversion, whereas this paper tests absolute risk aversion (in the chart on p. 129, a constant b/2 is ADDED to all outcomes in the positive shift). %}

Pahlke, Julius, Sebastian Strasser, & Ferdinand M. Vieider (2015) "Responsibility Effects in Decision Making under Risk," *Journal of Risk and Uncertainty* 51, 125–146.

{% %}

Palacios-Huerta, Ignacio (1999) "The Aversion to the Sequential Resolution of Uncertainty," *Journal of Risk and Uncertainty* 18, 249–269.

{% **dynamic consistency**; Writes that Adam Smith and David Hume already pointed out that we can have, besides instant utility, also utility from anticipated and remembered consumption. Suggests that Smith and Hume meant these concepts to be an internal reward system to avoid dynamic inconsistency. This would be reminiscent of the Machina-McClennen view on dynamic consistency without extraneous commitment device. It may also be that Smith and Hume only meant these emotions to serve good purposes in a general sense, without particularly thinking of dynamic inconsistency. D**C = stationarity** on p. 242, 248. %}

Palacios-Huerta, Ignacio (2003) "Time-Inconsistent Preferences in Adam Smith and David Hume," *History of Political Economy* 35, 241–268.

{% **decreasing ARA/increasing RRA**: many refs on power utility and the average power found, in the economics literature.

The paper is strange, incorrectly trying to criticize Rabin's (2000) paradox. Looking at the implausible implication of EU when combined with Rabin's plausible empirical assumption of $11_{0.5}$–10 $\prec$ 0 at various wealth levels, the idea to give up EU does not occur to the authors. Instead they, first, add evidence of the same kind as Rabin. That is, they cite many empirical estimations of power utility in the literature *that are all based on the EU assumption*, and then point out that these findings cannot be reconciled with Rabin's assumption of the above preference for a range of wealth levels. They do not conclude from this evidence, as does Rabin, that EU is in trouble, but, unable or unwilling to give up EU, they instead turn against Rabin's assumed preference and conclude that it must not be plausible after all.

This paper is typical of many economists' thinking. Rabin & Thaler show that, for a plausible assumption denoted PA here ($11_{0.5}$–10 ≺ 0 at various wealth levels), [EU & PA] $\Rightarrow$ implausible implications. They, correctly, conclude that EU is implausible. But many economists are just not able to make this step; they are not able to abandon EU. Instead, they enter their common way of thinking and come out with the conclusion that PA must be implausible.

It is also strange that, in citing findings on powers of utility from the literature, the point so crucial in Rabin's argument about how large the stakes are, is never mentioned by the authors. %}

Palacios-Huerta, Ignacio & Roberto Serrano (2006) "Rejecting Small Gambles under Expected Utility," *Economics Letters* 91, 250–259.

{% **ranking economists** %}

Palacios-Huerta, Ignacio & Oscar Volij (2004) "The Measurement of Intellectual Influence," *Econometrica* 72, 963–977.

{% %}

Palfrey, Thomas R. & Robert Porter (1991) "Guidelines for Submission of Manuscripts on Experimental Economics," *Econometrica* 59, 1197–1198.

{% **probability elicitation**: applied to experimental economics; **proper scoring rules** %}

Palfrey, Thomas R. & Stephanie W. Wang (2009) "On Eliciting Beliefs in Strategic Games," *Journal of Economic Behavior and Organization* 71, 98–109.

{% %}

Palley, Asa (2012) "Great Expectations: Prospect Theory with a Consistent Reference Point"

{% **free will/determinism** %}

Palmer, David (2021) "Free Will and Control: A Noncausal Approach," *Synthese* 198, 10043–10062.

https://doi.org/10.1007/s11229-020-02701-4

{% %}
Palmer, Tim N. & Renate Hagedorn (2006, eds.) "*Predictability of Weather and Climate*." Cambridge University Press, Cambridge.

{% **decreasing ARA/increasing RRA**: seems to finds no relation between RRA and income, which suggests constant RRA. %}
Pälsson, Anne-Marie (1996) "Does the Degree of Relative Risk Aversion Vary with Household Characteristics?," *Journal of Economic Psychology* 17, 771–787.

{% Extend quasi-hyperbolic discounting to the continuous case.
Axiomatize a discount model with constant discounting before some timepoint, and after, but the two periods having different discount rates. The switching point can be taken endogenously. %}
Pan, Jinrui, Craig S. Webb, & Horst Zank (2015) "An Extension of Quasi-Hyperbolic Discounting to the Continuous Case," *Games and Economic Behavior* 89, 43–55. https://doi.org/10.1016/j.geb.2014.11.003

{% They consider risky choices at different timepoints. They use prospect theory with a probability weighting family of Abdellaoui et al. (2010), where the insensitivity parameter is time dependent. Thus, aversion/pessimism remain the same but cognitive understanding is affected by time. There is an application to bargaining. %}
Pan, Jinrui, Craig S. Webb, & Horst Zank (2019) "Delayed Probabilistic Risk Attitude: A Parametric Approach," *Theory and Decision* 87, 201–232. https://doi.org/10.1007/s11238-019-09712-9

{% %}
Pan, Jun (2002) "The Jump-Risk Premia Implicit in Options: Evidence from an Integrated Time-Series Study," *Journal of Financial Economics* 63, 3–50.

{% **questionnaire versus choice utility**: argues for introspective psychological data in economics. %}

Pantaleoni, Mafio (1913) "Definizione dell'Economia. Una Prolusione," *Erotemi di Economia* I, 1–66, Laterza, Bari, Italy.

{% Denneberg gaf aan (ik geloof over symmetric integral); alleen ter inzage Koninklijke bib Den Haag. %}
Pap, Endre (1995) "Null-Additive Set Functions;" Mathematics and its Applications: Vol. 337. Kluwer Academic, Dordrecht.

{% %}
Papamarcou, Adrianos & Terrence L. Fine (1986) "A Note on Undominated Lower Probabilities," *Annals of Probability* 14, 710–723.

{% http://dx.doi.org/10.1016/j.geb.2013.06.010
CBDT: Assume functional forms of CBDT and derive, through simulations, properties from that. It is a sort of reversed revealed preference (explained p. 53 1st para). %}
Pape, Andreas Duus & Kenneth J. Kurtz (2013) "Evaluating Case-Based Decision Theory: Predicting Empirical Patterns of Human Classification Learning," *Games and Economic Behavior* 82, 52–65.

{% Their functions on, say, [0,1], are strictly increasing and continous, so that they are almost everywhere differentiable, but they are singular meaning that the derivative is 0 almost everywhere. They are Cantoir-type. Even more, whenever the derivative is defined, it is 0. It can also be infinite if we count that as "being defined." See Theorem 3.1. %}
Paradís, Jaumnine, Pelegri Viader, & Lluis Bibiloni (2001) "The Derivative of Minkowski's ?(x) Function," *Journal of Mathematical Analysis and Applications* 253, 107–125.
https://doi.org/10.1006/jmaa.2000.7064

{% **dynamic consistency**
People are willing to pay considerably for NOT precommitting. %}
Paradiso, Massimo & John D. Hey (2004) "Strategies vs Backward Induction in Dynamic Decision-Making: An Experimental Investigation," discussion paper.

{% Discusses implications of loss aversion for marketing, with a detailed discussion of the conative (action-linked) and other components of loss aversion. %}

Paraschiv, Corina & Olivier l'Haridon, (2008) "Loss Aversion: Origin, Components and Marketing Implications," *Recherche & Applications en Marketing* 23, 67–83.

{% Range-frequency model: Assume that you are exposed to a set of stimuli $x_0,\ldots,x_n$, which are real numbers with, for convenience, $x_0 < \ldots < x_n$. Define the absolute position of x_i as $(x_i-x_0)/(x_n-x_0)$, and the relative position as i/n (my terms). The perceived size of x_i is a weighted average of these two positions.. The absolute position can incorporate differences, but the relative position can only observe orderings, and suggests insensitivity. The model is a mix of an ordinal and a cardinal model. The model implies that we are extra sensitive, and our sensation function is extra steep, in regions where there are many x_js, and we are little senstive in regions with few x_js. The ordinal term pushes our perceptions in the direction of uniformly distributed locations. Makes sense that we are extra sensitive in regions where we have much experience. %}

Parducci, Allen (1965) "Category Judgment: A Range-Frequency Model," *Psychological Review* 72, 407–418.

{% %}

Parducci, Allen (1968) "The Relativism of Absolute Judgments," *Scientific American* 219 (n. 6, Dec), 84–90.

{% Good reference on his range-frequency theory. %}

Parducci, Allen (1995) "*Happiness, Pleasure, and Judgment: The Contextual Theory and its Applications*." Lawrence Erlbaum Associates, Hillsdale, NJ.

{% %}

Pareto, Vilfredo (1892) "Considerazioni sui Principii Fondamentali dell'Economia Politica Pura," *Giornalie degli Economisti*, Series 2, Vol. V, Aug. 1892.

{% Stigler (1950) says that on p. 307 (or p. 119 ff. says Stigler, 1950 in Footnote 201): First person in history to give empirical implication of additive decomposability it seems (according to Stigler, 1950). Mentioned that increase in price of any commodity then implies decrease in demand. Then says that demand is observable, that we can infer the implication just mentioned, and that therefore the utility of a commodity may be assumed to depend, approximately, only on the quantity of the commodity in question.

Seems to have noted problem of existence of utility function; i.e., seed of ordinalism.

Schumpeter (1954), §5 of Appendix to Ch. 7, suggests that Pareto turned to ordinalism only in 1890, and that “Wieser” preceded him. %}

Pareto, Vilfredo (1893) “Considerazioni sui Principii Fondamentali dell’Economia Politica Pura,” *Giornalie degli Economisti*, series 2, Vol. VII.

{% P. 47−48 (I think of Vol. I) used interpersonal comparison of utility for welfare purposes.

Distinguishes between utility bringing usefulness and fulfilling needs (in principle objective and observable), and utility fulfilling desires (ophelimity, subjective). Pareto seems to say that the two concepts should be identical for a rational person. So, then ophelimity is descriptive and usefulness is normative? Cooter & Rappoport, footnote 23, say that Pareto (1896 Vol. I) says that the two concepts should coincide for a rational person, don’t say where. Just before, they referred to p. 3 of Pareto’s work.) %}

Pareto, Vilfredo (1896/7) “*Cours d’Economie Politique*, Vol. I and II.” Rouge, Lausanne.

{% Seems to write: “It is an empirical fact that the natural sciences have progressed only when they have taken secondary principles as their point of departure, instead of trying to discover the essence of things … Pure political economy has therefore a great interest in relying as little as possible on the domain of psychology.” (I got this from Bruni & Sugden (2007), who cite Businо (1964) for it on their p. 154.) %}

Pareto, Vilfredo (1896/7) letter to Adrien Naville.

{% P. 214 (I guess of 1982 Reprinted text) seems to claim, as one of his main achievements, that "every psychological analysis is eliminated."

Seems to write:

"When, in order to establish the fundamental equations of pure economics, we start from the notion of pleasure and of its measurement, we come up against an insurmountable difficulty right from the start: there is no practical means of measuring this pleasure directly. We have just seen that such measurement is superfluous for attaining our end, which is the determination of economic equilibrium."

Pareto seems to assume that utility in a cardinal sense "exists" but is often unmeasurable. %}

Pareto, Vilfredo (1900) "Sunto di Alcuni Capitoli di un Nuovo Trattato di Economia Politica del Prof. Pareto," *Giornale degli Economisti* 10, 216–235; 511–549. Reprinted in 1982, "Oeuvres Complètes of V. Pareto," Droz, Geneva.

{% Seems that both the first article in Econometrica and in Review of Economic Studies was an article on Pareto.

Showed some implications of additive decomposability of utility, mentioned some economic phenomena that contradict those implications, but still defended it as an approximation.

Ch. 3, paragraph 29, utility is relation between man and thing. Paragraph 36b points out that only indifference curves matter, not anything of utility (called ophelimity, meaning it's what the subject chooses, so what apparently pleases him most, but need not be useful in some rational sense, e.g. such as taking heroine.

1927 translation in French seems to be first to define strength of preference on p. 19, according to Fishburn (1970 p. 81).

1971 translation seems to write, on p. 191, that strength of preference judgments by introspection are possible, though not with great precision.

Seems that in Ch. 3, §1, he writes on preferences only after learning:

"A man who buys a certain food for the first time may buy more of it than is necessary to satisfy his tastes, price taken into account. But in a second purchase he will correct his error, in part at least, and thus, little by little, will end up by procuring exactly what he needs. W*e will examine this action at the time when he has reached this state.* Similarly, if at first he makes a mistake in his reasoning about what he desires, he will rectify it in repeating the reasoning and will end up by making it completely logical." [italics added here]

conservation of influence: Seems to have written, on man maximizing something with us researchers being conspicuously vague on what is maximized: "to compare the sensations of a man in different situations, and to determine which of these he would chose. … [S]ince it is customary to assume that man will be guided in his choice exclusively by consideration of his own advantage, of his self-interest, we say that this class is made up of theories of egotism. But it could be made up of theories of *altruism* (if the meaning of that term could be defined rigorously), or, in general, of theories which rest on any rule which man follows in comparing his sensations. It is not an essential characteristic of this class of theories that a man choosing between two sensations choose the most agreeable; he could choose a different one, following a rule which could be fixed arbitrarily." (Ch.3, §11) %}

Pareto, Vilfredo (1906) "*Manuele di Economia Politica.*" Piccolo Biblioteca Scientifica, Milan. Translated into English by Ann S. Schwier (1971) "*Manuel of Political Economy,*" MacMillan, London.
Translated into French in 1927 as "*Manuel d'Economie Politique*; 2nd edn." Giard, Paris.
Seems to be in "*Oeuvres Complètes*," 12, Droz, Genève, 1964.

{% **discounting normative**: Ch. 14 argues for positive discounting because your identity changes over time, and criticizes six arguments for constant discounting. If those do not apply, then he favors zero discounting. This is taken as the most standard reference for this viewpoint. Seems that he introduced the silly term of the repugnant conclusion for an Archinedean axiom. %}

Parfit, Derek (1984) "*Reasons and Persons.*" Clarendon Press, Oxford, UK.

{% **Dutch book** %}

Paris, Jeff B. (2000) "A Note on the Dutch Book Method."

{% Provide easier ways to analyze data from balloon task. %}

Park, Harhim, Jaeyeong Yang, Jasmin Vassileva, & Woo-Young Ahn (2021) "Development of a Novel Computational Model for the Balloon Analogue Risk Task: The Exponential-Weight Mean–Variance Model," *Journal of Mathematical Psychology* 102, 102532.
https://doi.org/10.1016/j.jmp.2021.102532

{% Says Rabin is due to loss aversion. %}

Park, Hyeon (2016) “Loss Aversion and Consumption Plans with Stochastic Reference Points,” *B.E. Journal of Theoretical Economics* 16, 303–336.

{% Extends Green & Osband (1991) to weighted utility. %}

Park, In-Uck (1998) “A Revealed-Preference Implication of Weighted Utility Decisions under Uncertainty,” *Economic Theory* 11, 413–426.

{% %}

Park, Joo Heon & Douglas L. MacLachlan (2008) “Estimating Willingness to Pay with Exaggeration Bias-Corrected Contingent Valuation Method,” *Marketing Science* 27, 691–698.

{% **utility elicitation**: Subjects choose between 2-dimensional alternatives where the first coordinate describes an amount of money, the second some good such as a new compact disk player or a tennis outfit. They find that double cancellation is rather well satisfied and conclude that an additive representation must hold. P. 280: “Krantz et al. (1971) have shown that, for all effective purposes, if double cancellation is not violated, the system is additive.” That is, they make the well-known mistake of not understanding the empirical implications of restricted solvability, clearly explained in Krantz et al. (1971, §9.1). (**criticizing the dangerous role of technical axioms such as continuity**: these authors are not aware of it.) They get the additive value function for money as x to the power .64.

IMPORTANT, on **risky utility u = strength of preference v (or other riskless cardinal utility, often called value)** or **risky utility u = transform of strength of preference v**: !!!Nice example of cardinal utility obtained from additive conjoint measurement. Give many references to the usefulness of the power family to fit utility.!!! %}

Parker, Scott & Bruce Schneider (1988) “Conjoint Scaling of the Scaling of the Utility of Money Using Paired Comparisons,” *Social Science Research* 17, 277–286.

{% Review implications of Keeney (1992). %}

Parnell, Gregory S., David W. Hughes, Roger Chapman Burk, Patrick J. Driscoll, Paul D. Kucik, Benjamin L. Morales, & Lawrence R. Nunn (2013) “Invited

Review—Survey of Value-Focused Thinking: Applications, Research Developments and Areas for Future Research," *Journal of Multi-Criteria Decision Analysis* 20, 49–60.

{% **proper scoring rules**: Extend locality to also allow dependence on some higher-order derivatives of the score at the event observed. Then more than just the logarithmic function can do it. %}
Parry, Matthew, A. Philip Dawid, & Steffen Lauritzen (2012) "Proper Local Scoring Rules," *Annals of Statistics* 40, 561–592.
https://doi.org/10.1214/12-aos971

{% **decision under stress**: This paper examines the impact of stress on risk attitudes. Many papers have done this, and Table 1 gives several. The keyword "**decision under stress"** in this annotated bibliography, no more updated since about 2005, gives some others. The novelty here is that this paper considers the number of switches in choice lists ("noise"), and how that is related to other things. Besides classical analyses, they add nice Bayesian statistical analyses. Cognitive ability is negatively related to switches in choice lists. No other significant results are found. In particular, the, for decision under stress new, number of switches in choice lists does not impact anything. **Prospect theory not cited**: also here. %}
Parslow, Elle & Julia Rose (2022) "Stress and Risk— Preferences versus Noise," *Judgment and Decision Making* 17, 883–936.

{% **time preference**; referaat of Anne op 15 mei 1996. Argue against Keeler-Cretin idea that benefits must be discounted as strongly as money because one would defer projects for ever otherwise. %}
Parsonage, Michael & Henry Neuburger (1992) "Discounting and Health Benefits" (with discussion), *Health Economics* 1, 71–79.

{% %}
Parthasarathy, Koduvayur R. (1967) "*Probability Measures on Metric Spaces.*" Academic Press, New York.

{% no. 233: Pascal's wager. Seems to be discussed by Hacking (1975). %}

Pascal, Blaise (1660), *Pensées*.

{% **PT, applications**: §3.2.2 points out that they have no closed form for equilibrium. §4 describes PT as a descriptive theory. %}

Pasquariello, Paolo (2014) "Prospect Theory and Market quality," *Journal of Economic Theory* 149, 276–310.

{% **cognitive ability related to risk/ambiguity aversion**: seems that they find more probability weighting and framing-dependence for low numerate subjects. %}

Patalano, Andrea L., Jason R. Saltiel, Laura Machlin, & Hillary C. Barth (2015) "The Role of Numeracy and Approximate Number System Acuity in Predicting Value and Probability Distortion," *Psychonomic Bulletin & Review* 22, 1820–1829. https://doi.org/10.3758/s13423-015-0849-9

{% I thought for some time that they introduced QALYs, together with Torrance, Sackett & Thomas (1973). Later I found that Fanshel & Bush (1970, p. 1050) preceded them. %}

Patrick, Donald L., James W. Bush, & Milton M. Chen (1973) "Toward an Operational Definition of Health," *J. Health Soc. Behavior* 14, 6–23.

{% survey of QALYs; use MAUT techniques to combine dimensions in Health utilities index (vision, hearing, speech, dexterity, mobility, cognition, emotion, pain) and others into a QALY index. %}

Patrick, Donald L. & Pennifer Erickson (1993) "*Health Status and Health Policy: Allocating Resources to Health Care*." Oxford University Press, New York.

{% A strange paper. It discusses the publication process from a sort of meta-philosophical perspective, such as what kind of general communication system it is. I did not find concrete suggestions for any of the involved parties on how they could improve their performance. %}

Patriotta, Gerardo (2017) "Crafting Papers for Publication: Novelty and Convention in Academic Writing," *Journal of Management Studies* 54, 747–759.

{% %}

Pauker, Stephen G. (1976) “Coronary Artery Surgery: The Use of Decision Analysis,” *Annals of Internal Medicine* 85, 8–18.

{% **simple decision analysis cases using EU** %}
Pauker, Stephen G. & Jerome P. Kassirer (1980) “The Threshold Approach to Clinical Decision Making,” *New England Journal of Medicine* 302, 1109–1117.

{% %}
Pauker, Stephen G. & Jerome P. Kassirer (1987) “Decision Analysis,” *New England Journal of Medicine* 316, 250–258.

{% **inverse S:** N = 16 subjects, CEs (certainty equivalents) elicited for seven one nonzero-outcome prospects. No real incentives (p. 676 last para). The authors then find the best-fitting power utility function and 2-parameter CI family of Prelec (1998) (minimizing squared distance). Find $U(x) = x^{0.66}$ as best fitting, and usual w. However, for one-nonzero outcomes the joint power of utility and probability weighting is unidentifiable. Looks like they make a classical mistake here. Find that degree of inverse S (which is not affected by indeterminacy of power, as in Wakker 2004 Psychological Review) corresponds with lack of controlled processing by the anterior cingulate cortex (do not know what that means, copying it from the abstract). %}
Paulus, Martin P. & Lawrence R. Frank (2006) “Anterior Cingulate Activity Modulates Nonlinear Decision Weight Function of Uncertain Prospects,” *Neuroimage* 30, 668–677.

{% **Z&Z** %}
Pauly, Mark V. (1968) “The Economics of Moral Hazard: Comment,” *American Economic Review* 58, 531–537.

{% **Z&Z** %}
Pauly, Mark V. (1968) “Overinsurance and Public Provision of Insurance: The Role of Moral Hazard and Adverse Selection,” *Quarterly Journal of Economics* 88, 44–62.

{% Theoretically study predictions of prospect theory on higher-order risk preferences such as prudence and temperance, showing that the choice of reference point matters much. Many numerical results and graphs. They do not clearly relate prudence to inverse S probability weighting. %}

Paya, Ivan, David A. Peel, & Konstantinos Georgalos (2023) "On the Predictions of Cumulative Prospect Theory for Third and Fourth Order Risk Preferences," *Theory and Decision* 95, 337–359. https://doi.org/10.1007/s11238-022-09920-w

{% %}

Payne, John W. (1973) "Alternative Approaches to Decision Making under Risk: Moments versus Risk Dimensions," *Psychological Bulletin* 80, 439–453.

{% **PT falsified** %}

Payne, John W. (2005) "It Is whether You Win or Lose: The Importance of the Overall Probabilities of Winning or Losing in Risky Choice," *Journal of Risk and Uncertainty* 30, 5–19.

{% %}

Payne, John W., James R. Bettman, Eloise Coupey, & Eric J. Johnson (1992) "A Constructive Process View of Decision Making: Multiple Strategies and Choice," *Acta Psychologica* 80, 107–141.

{% Beginning distinguishes compensatory and noncompensatory strategies. P. 536 3rd para discusses attribute-based versus alternative-based evaluations. (Terms explained in annotations at Scholten et al. (2024 Psychological Review).

This paper uses simulations to see to what extent decision heuristics, with or without time limitation, work well and are close to normative procedures. Then experiments are done with subjects, seeing what strategies they use. %}

Payne, John W., James R. Bettman, & Eric J. Johnson (1988) "Adaptive Strategy Selection in Decision Making," *Journal of Experimental Psychology: Learning, Memory and Cognition* 14, 534–552. https://doi.org/10.1037/0278-7393.14.3.534

{% a review %}

Payne, John W., James R. Bettman, & Eric J. Johnson (1992) "Behavioral Decision Research: A Constructive Processing Perspective," *Annual Review of Psychology* 43, 87–131.

{% %}

Payne, John W., James R. Bettman, & Mary-Frances Luce (1996) "When Time Is Money: Decision Behavior under Opportunity-Cost Time Pressure," *Organizational Behavior and Human Decision Processes* 66, 131–152.

{% This paper does not only describe things going wrong in preference theory but it is constructive in nature: it seeks to offer remedies and make preference measurement function again.

Schkade during SPUDM '97 lecture:

"Get more out of fewer subjects."

The paper is less focused on the issue of interacting with clients but gives a broad survey of the many biases that can occur during preference measurement.

P. 249: "The procedures often involve greater work in the measurement of preferences, with a focus on doing more tasks with fewer respondents."

Paper uses term "design purposes" for prescriptive.

P. 247: they argue for using coherence conditions for improving preference elicitation, adding to it that also the process leading to preference should be judged.

P. 257, §3.3.1 gives reasons for why people may want to avoid making tradeoffs.

P. 259 recommends that anchors be made explicit rather than have them be made by implicit/random factors

P. 265: "Nevertheless, we believe that providing procedures and tools that help individuals discover their own preferences is in the best interest of those individuals, even though this may also influence those preferences." %}

Payne, John W., James R. Bettman, & David A. Schkade (1999) "Measuring Constructed Preferences: Towards a Building Code," *Journal of Risk and Uncertainty* 19, 243–270.

{% %}
Payne, John W. & Myron L. Braunstein (1971) "Preferences among Gambles with Equal Underlying Distributions," *Journal of Experimental Psychology* 87, 13–18.

{% N = 30 & N = 42 & N = 84; hypothetical choice;
reflection at individual level for risk: they don't give data detailed enough to see this.
Translating gambles (adding up a constant to all outcomes) through the origin evokes sharp changes in risk attitude, in agreement with the predictions of loss aversion. Gives many refs to early aspiration-level and reference-level ideas.
paternalism/Humean-view-of-preference: p. 1055 suggests that utility should not be concavitized but should be left convex for losses if that is what is measured. Criticize Keeney & Raiffa (1976) for such concavitization. %}
Payne, John W., Dan J. Laughhunn, & Roy L. Crum (1980) "Translation of Gambles and Aspiration Level Effects in Risky Choice Behavior," *Management Science* 26, 1039–1060.

{% Supplement findings of their 1980 paper. They now manipulate the reference level, not the outcomes.
P. 1054 writes: "The prevailing view about risk attitude in management science research, for both normative and positive models, ignores the aspiration level concept and assumes that decision makers are uniformly risk averse." %}
Payne, John W., Dan J. Laughhunn, & Roy L. Crum (1981) "Further Tests of Aspiration Level Effects in Risky Behavior," *Management Science* 27, 953–958.

{% Study multiattribute risk aversion; **risk averse for gains, risk seeking for losses** %}
Payne, John W., Dan J. Laughhunn, & Roy L. Crum (1984) "An Experimental Study of Multiattribute Risky Choice," *Management Science* 30, 1350–1361.

{% **CBDT** Players do CBDT optimization in repeated games. %}
Pazgal, Amit (1997) "Satisficing Leads to Cooperation in Mutual Interests Games," *International Journal of Game Theory* 26, 439–453.

{% %}
Pazner, Elisa A. (1979) "Equity, Nonfeasible Alternatives and Social Choice: A Reconsideration of the Concepts of Social Welfare." *In* Jean-Jacques Laffont (ed.) *Aggregation and Revelation of Preferences*, Ch. 9, 161–173, North-Holland, Amsterdam.

{% Argues against reasonableness of Nash equilibrium; T00032 %}
Pearce, David (1984) "Rationalizable Strategic Behavior and the Problem of Perfection," *Econometrica* 52, 1029–1050.

{% %}
Pearl, Judea (1986) "Fusion, Propagation, and Structuring in Belief Networks," *Artificial Intelligence* 29, 241–288.

{% Book is pro-Bayesian. Reviewed by Dubois & Prade (1990, JMP). %}
Pearl, Judea (1988) "*Probabilistic Reasoning in Intelligent Systems: Networks of Plausible Inference*." Morgan Kaufmann, San Mateo CA.

{% %}
Pearl, Judea (1990) "Reasoning with Belief Functions: An Analysis of Compatibility," *International Journal of Approximate Reasoning* 4, 363–389.

{% %}
Pearl, Judea (1992) "Probabilistic Semantics for Nonmonotonic Reasoning." *In* Robert G. Cummins & John Pollock (eds.) *Philosophy and AI, Essays at the Interface*, 157–187, MIT Press, Cambridge, MA.

{% This book is considered a classic. Imagine that we observe only correlations, and find one between C and A. We don't know if C has causal influence on A or vice versa, because of symmetry. If we also get temporal info, and know that C preceded A, then it seems plausible that C has causal influence on A. (There is always problem of hidden common causes for C and A; soit.) For long time it was believed that with only info on correlations, and not for instance on temporal ordering, we cannot speculate on causal directions because of symmetry. It seems that Pearl discovered a way to speculate nevertheless: if C and B are mutually independent but both are correlated with A, then it is plausible that B and C have causal influence on A and not the other way around. Seems that he started writing on it at end of 1980s. This book collects several of his papers. %}

Pearl, Judea (2000) "*Causality. Models, Reasoning, and Inference.*" Cambridge University Press, New York.

{% Measured prior probability for binomial parameter experimentally, e.g., one day he goes out on the street and observes the proportion of women that wear red hats. Collected data over four years. P. 389 describes Venn's rule of succession.

P. 397: "Casual Observations in London Streets and elsewhere" Under this heading: "From a window in Gower street I observe how many vehicles out of the first 20 that pass below are drawn by horses, and then how many of a later sample of 15." %}

Pearson, Egon S. (1925) "Bayes Theorem, Examined in the Light of Experimental Sampling," *Biometrika* 17, 388–442.

{% Seems to have argued that each scientist should search for "self-elimination in his judgements, to provide an argument which is true for each individual mind as for his own." This spirit contributes to inclination to take statistics in a non-Bayesian way, such as in the theory of Neyman and Egon Pearson (Karl's son). %}

Pearson, Karl (1892) "*Grammar of Science*."

{% Explains that Hutton (known for work on geological time), preceding Darwin (1831), had a chapter explaining the principles of selection of the fittest, though maybe not the development of new species. Hutton taught in Edinburgh, where besides Darwin also Patrick Matthew and William Wells lived, two people credited before for having preceded Darwin on the idea of evolution. All these three came after Hutton. %}

Pearson, Paul N. (2003) "In Retrospect of: James Hutton (1794) An Investigation of the Principles of Knowledge and of the Progress of Reason, from Sense to Science and Philosophy," *Nature* 425, 16 October 2003, p. 665.

{% Seems to discuss −f´´/f´ as a measure for curvature, and to give references to preceding literature, as was told to me by Rich Gonzalez in August 1994. %}

Pecaric, Josip E., Frak Proschan, & Yung Liang Tong (1992) "*Convex Functions, Partial Orderings, and Statistical Applications*." Academic Press, San Diego.

{% RDU version of de Finetti's coherence, containing generalizations of things of Diecidue & Wakker (2002). %}

Pedersen, A. Paul (2014) "Comparative Expectations," *Studia Logica* 102, 811–848.

{% %}

Pedersen, A. Paul & Gregory Wheeler (2014) "Demystifying Dilation," *Erkenntnis* 79, 1305–1342.

https://doi.org/10.1073/pnas.2401229121

{% A nice didactical text on general measurement. The topic is treated more heavily by Krantz et al. (1971).

Prospect theory/Rank-Dependent Utility most popular for risk: not quite. P. 3, 2nd column,middle, writes:

"Prospect Theory is often found to underperform relative to rival theories that do not include loss aversion as an attribute (e.g., ref. 50)"

Here ref. 50 is Birnbaum (2008 Psych. Rev.) who often wrote similarly negatively on prospect theory, also using emotionally charged terms such as the "underperform" used here. The authors were influenced (I also say: misled) by Birnbaum. %}

Pedersen, A. Paul, David Kellen, Conor Mayo-Wilson, Clintin P. Davis-Stober John C. Dunn, M. Ali Khan, Maxwell B. Stinchcombe, Michael L. Kalish, Katya Tentori , and Julia Haaf (2025) "Discourse on Measurement," *Proceedings of the National Academy of Sciences* 122(5) e2401229121.

https://doi.org/10.1073/pnas.2401229121

{% An impressive study. For 1,507 (!) subjects, six elicitation methods were used to measure risk attitudes, taking essentially a whole day of each subject. Very little consistency was found, both between raw measures of risk aversion (only that; no raw measure of insensitivity) and between fitted parameters of expected utility or prospect theory. The authors conclude very negatively (P. 807 2nd column end of 1st para):

“What is clear, however, is that scientists’ common practice, namely, measuring risk preferences with one simple behavioural EM (for example, lotteries) and thus creating the fiction that they can capture consistent risk preferences, should stop.” They several times express the constructive view of preference. For example, abstract last sentence: “Instead, we interpret the results as suggesting that risk preferences may be constructed when they are elicited, and different cognitive processes can lead to varying preferences.”

My reaction: I will continue to work on finding consistent risk preferences. One reason is based on normative thoughts: There exists a normative proper risk attitude in every person, e.g. though utility in expected utility. We should do all we can to find it as much as possible. The more so as finding it is something like finding the holy grail. One can then take best decisions for people. This is also why the decision-theory concepts of risk attitude are way more interesting than introspective measures. Another point in my reaction: Subjects had to spend almost a day doing the experiment. My experience is that individual choice experiments can last no more than 45 minutes. After that subjects get bored. The subjects here may have gotten bored, so that almost only noise was measured.

The literature references in the paper are impressive.

P. 803, 2nd para: “Surprisingly, there is no consensus across science and industry on how risk preferences should be measured.”

P. 803: end of 1st para of 2nd column: many references that compare different measurement methods.

P. 804 penultimate para: The BART measurement deviated most from the others, and this is because, unike the other tasks, it had unknown probabilities, to be learned from sampling (DFE). P. 806 1st para: BART has very weird results, with risk seeking and loss aversion $\lambda = 0.43$, so, much gain seeking.

P. 804 2nd column 3rd para: They related choice inconsistencies to a cognitive intelligence measure, but found no relation. Report it only in online appendix (“Supplementary Information”).

P. 806, 2nd para: “However, numerous studies have demonstrated that individuals’ risk preferences often deviate from EUT and that CPT is often the best model for fitting aggregate choices even if some people are not best described by EUT and even though there may not be a single best model for fitting individual choices." (**Prospect theory/Rank-Dependent Utility most popular for risk**)

P. 806, 4th para: "Although on average CPT describes the choices better than EUT"

P. 807, 4th para: "Second, capturing risk preferences in terms of the non-normative components of risky choice (for example, probability weighting and loss aversion)". That is, the authors take expected utility as normative.

P. 807 para starting at bottom of 1st column is only one with a bit of positive results, although not much.

P. 807 2nd column 1st para reports the only positive result: "Second, the fact that all levels of analysis reveal exclusively positive correlations may hint at the existence of a general underlying construct."

P. 807 2nd column 1st para expresses the other constructive view of preference. It is not the view that all is arbitrary ad hoc construction and here is nothing down there. The second is that experimenters should influence subjects and construct their risk attitude together with subjects, as architects ("getting more out of fewer subjects"), when the authors write: "In addition, it may be of interest to examine whether decision aids, such as expert advice on how to approach specific decisions, may increase consistency in observed risk preferences." %}

Pedroni, Andreas, Renato Frey, Adrian Bruhin, Gilles Dutilh, Ralph Hertwig, & Jörg Rieskamp (2017) "The Risk Elicitation Puzzle," *Nature Human Behaviour* 1, 803–809.
https://doi.org/10.1038/s41562-017-0219-x

{% Propose to use expo-power in PT, and show some properties. %}

Peel, David A. & Jie Zhang (2009) "The Expo-Power Value Function as a Candidate for the Work-Horse Specification in Parametric Versions of Cumulative Prospect Theory," *Economics Letters* 105, 326–329.

{% I enjoyed this discussion, given to me by Gideon Keren, of the psychological factors underlying positive versus negative outcomes, distinguishing several biases or functional weightings. The authors separate affective from informational, and relate to approach-avoidance. It interested me because if gives psychological background to loss aversion. But sometimes it was hard to follow. For instance, on p. 37: "the tendency to expect the positive is allied with a strongly marked

sensivitity for aversive stimuli," if any part of this claim had been reversed it would have been just as plausible to me.

P. 54 middle: negativity effect (overweighting of negative outcomes, both affectively and informationally) is independent of probability at that negative outcome.

Yechiam & Hochman (2013) present a sophisticated model explaining loss aversion by attention rather than to utility, with a followup in Yechiam, Retzer, Telpaz, & Hochman (2015). Bilgin (2012) is also relevant, and so is Huber, Ariely, & Fischer (2001), who rule out any role of utility but still find loss aversion induced by weighting. Tversky & Kahneman (1981 p. 454 1st column penultimate para) explains loss aversion merely through utility.

Baumeister, Bratslavsky, Finkenauer, & Vohs (2001) is cited more than this paper but I like this paper more. %}

Peeters, Guido & Janusz Czapinski (1990) "Positive-Negative Asymmetry in Evaluations: The Distinction between Affective and Informational Negative Effects." *In* Wolfgang Stroebe & Miles Hewstone (eds.) *European Review of Social Psychology* 1, 33–60.

{% **updating under ambiguity with sampling**; %}

Peijnenburg, Kim (2018) "Life-Cycle Asset Allocation with Ambiguity Aversion and Learning," *Journal of Financial and Quantitative Analysis* 53, 1963–1994.

{% Complete first name is Charles Sanders.

information aversion: Nonaversion to information (also for nonexpected utility??); note clearly thinks that value of additional knowledge is always positive. See for instance, in Reprinted version, note.7.159, p. 86, ll 6-8.

Note 142, p. 77 in Reprinted version, says that the utility of knowledge consists in its capability of being combined with other knowledge so as to enable us to calculate how we should act. %}

Peirce, Charles S. (1876) "Note on the Theory of the Economy of Research." Reprinted in Arthur W. Burks (1978, ed.) "C*ollected Papers of Charles Sanders Peirce*," Volume 7, Science and Philosophy, 7, 140–161, Harvard University Press.

{% **foundations of statistics**: Proposes an expected utility criterion to assess the value of a test, say the prediction of a tornado. This value is

(p.aa – l.ab)/(aa + ab + ba + bb)

where: p is profit (extra relative to not predicting) gained by correctly predicting it, aa the frequency of correct predictions, l the loss (relative to not predicting) of incorrectly predicting it, ab the frequency of incorrect predictions, and ba + bb the frequency of not predicting the tornado (wrong or right, respectively). So, the true Bayesian solution to evaluate a statistical hypothesis test. %}

Peirce, Charles S. (1884) “The Numerical Measure of the Success of Predictions,” *Science* 4 (Nov. 14) 453–454.

{% P. 421 seems to write:

“to express the proper state of belief, not *one* number but *two* are required, the first depending on the inferred probability, the second on the amount of knowledge on which that probability is based.” %}

Peirce, Charles S. (1932) “*Collected Papers.*” Charles Hartstone & Paul Weiss (eds.) Belknap Press, Cambridge, MA.

{% There is an incomplete pref. rel. over lotteries satisfing independence and continuity. The paper also considers choices between menus, and investigates cautiousness: Defer choice whenever in doubt. Then there must be preference for flexibility. Thus, preference for self-control is distinguished from indecisiveness. %}

Pejsachowicz, Leonardo & Séverine Toussaert (2017) “Choice Deferral, Indecisiveness and Preference for Flexibility,” *Journal of Economic Theory* 170, 417–425.

{% **ordering of subsets**: %}

Pekec, Sasa (2023) “A Characterization of the Existence of Succinct Linear Representation of Subset-Valuations,” *Journal of Mathematical Psychology* 115, 102779.
https://doi.org/10.1016/j.jmp.2023.102779

{% Fit EU, RDU, en PT (they write CPT) for 8 macaques, 5 capuchins, and 4 orang-utans, by letting them choose between a sure cookie or a risky-size cookie. Fit power utility under EU (which fitted better than exponential, under EU by p. 157), power utility under RDU (which fitted better than exponential; p. 159), and piecewise linear, with kink at 0, for PT (can't have more parameters for then unidentifiable; see footnote 8 p. 157). For RDU and PT use 1-parameter T&K'92 family. When fitting PT, they assume linear utility because otherwise nonidentifiable (footnote 8 p. 157) apart from loss aversion. Find mixed results. %}

Pelé, Marie, Marie-Hélène Broihanne & Bernard Thierry, Joseph Call, & Valérie Dufour (2014) "To Bet or not to Bet? Decision-Making under Risk in Non-Human Primates," *Journal of Risk and Uncertainty* 49, 141–166.

{% %}

Peleg, Bezalel & Hans J.M. Peters (2009) "Nash Consistent Representation of Effectivity Functions through Lottery Models," *Games and Economic Behavior* 65, 503–515.

{% **dynamic consistency**? %}

Peleg, Bezalel & Stef H. Tijs (1996) "The Consistency Principle for Games in Strategic Form," *International Journal of Game Theory* 25, 13–34.

{% **dynamic consistency**; reviewed by Shefrin (1998); Goldman (1979, 1980) seems to be an important follow-up.

Paper first points out that for Strotz-Pollak solution (so, **sophisticated choice**; forgone-branch independence [often called consequentialism] is assumed for utility at time t) solution need not always exist. The counterexample is, if I understand right, based on the observation that the consumption chosen at time t is the result of a maximization and need not be continuous, therefore at time t–1 a noncontinuous function has to be maximized, if I understand right. Then one can approximate the optimal utility within each distance ε but the maximum need not exist. (This is in my opinion a technical complication that does not lead me to reject sophisticated choice intuitively.) The authors next proceed to study different approaches than Strotz-Pollak, and propose that the solution should be a subgame perfect equilibrium for the players which makes sense. They point out that being an equilibrium is necessary (I agree given sophisticated choice) but surely not sufficient, e.g., equilibria can violate Pareto. Note that sophisticated choice leads to equilibria. I'm not sure if the authors point that out.

P. 391 states the common assumption in economics that preference is not different than choice, but that preference is just binary choice: "An agent's preference ordering is nothing more than a summary of choices, when confronted with dichotomous alternatives."

P. 392, assumption that utility function at time t does not depend on past consumption, considered in §II, is like forgone-branch independence. I do not understand their claim, at the end of §III, that their definition of stationarity would preclude changing tastes. For example, let $U_1(x_1,x_2,x_3, \ldots)$ be $x_1 + x_2/2 + x_3 + x_4/2 + \cdots$. then I think that their stationarity leads to dynamic inconsistency and changing tastes; I didn't study it in much detail.

DC = stationarity: 2nd to last sentence of §III is on that topic. It defines stationarity as utility U_t at t being independent of past consumption and $U_t(a,b, \ldots) = U_1(a,b, \ldots)$. So, it is what I would call forgone-act independence (often called consequentialism) plus a sort of invariance (that DUR automatically has but DUU not) different than stationarity. They are wrong in suggesting that their stationarity would preclude changing tastes, there they seem to confuse things with DC (dynamic consistency). For example, let $U_1(a,b,c,d, \ldots) = a + b/2 + c + d/2 + + \cdots$, then DC is violated, at time 1 I may prefer (0,0,1,0, ...) to (0,0,0,1,0, ...) but at time 2 my preference reverses. %}

Peleg, Bezalel & Menahem E. Yaari (1973) "On the Existence of a Consistent Course of Action when Tastes are Changing," *Review of Economic Studies* 40, 391–401.

{% %}

Pelham, Brett W. & William B. Swann, Jr. (1989) "From Self-Conceptions to Self-Worth: On the Sources and Structure of Golbal Self-Esteem," *Journal of Personality and Social Psychology* 57, 672–680.

{% %}

Pelham, Brett W., Tin Tin Sumarta, & Laura Myaskovsky (1994) "The Easy Path from Many to Much: The Numerosity Heuristic," *Cognitive Psychology* 26, 103–133.

{% An Italian author propagating the ideas of de Finetti. He favors giving more importance to de Finetti's influence on Friedman, giving many discussion of Mach etc. on observability. %}

Pelloni, Gianluigi (1996) "De Finetti, Friedman, and the Methodology of Positive Economics," *Journal of Econometrics* 75, 33–50.

{% Axiomatize ways of market evaluations, satisfying the conditions in the title.

P. 26 4th para: they use utility indifference, meaning CE (certainty equivalents) under EU.

P. 38: Time consistency (other terms: recursiveness or tower property) means that if you do two-step evaluation over two consecutive periods, or do the two one-blow, should give the same result. Under some conditions it is equivalent to the usual dynamic consistency or time consistency. %}

Pelsser, Antoon & Mitja Stadje (2014) "Time-Consistent and Market-Consistent Evaluations," *Mathematical Finance* 24, 25–65.

{% **real incentives/hypothetical choice, for time preferences**: seems to be. %}

Pender, John L. (1996) "Discount Rates and Credit Markets: Theory and Evidence from Rural India," *Journal of Development Economics* 50, 257–296.

{% Test house money effect and find it confirmed. Use hypothetical choice, with questions of the type "Suppose you had just won such a gamble. Would you play it again?" %}

Peng, Jiaxi, Danmin Miao, & Wei Xiao (2013) "Why are Gainers More Risk Seeking," *Judgment and Decision Making* 8, 150–160.

{% He introduced the Penney game, with intransitivity. Imagine a fair coin is tossed repeatedly, independently, giving H or T each time. Two players can choose a pattern of three results. Say Player 1 chooses THH and player 2 chooses HHH. If a pattern of a player shows up, before the pattern of the opponent did, the player

can claim victory. With the patterns chosen, 7 out of 8 times player 1 will win, so THH $\succ$ HHH. It turns ut that there are intransitivities, and there is not one optimal pattern. So, you can propose this game to someone, let that other first choose a pattern, and then you can always choose a pattern with the bigger chance of winning. %}

Penney, Walter (1969), "Penney-Ante," *Journal of Recreational Mathematics* 2, 241.

{% **questionnaire versus choice utility**;

Outcomes were monetary. Data were collected from 346 managers from small and medium size hog farms.

Risk attitude was measured by

(1) psychometric questionnaires regarding whether they would be open to new products etc.

(2) hypothetical CE (certainty equivalent), fifty-fifty, questions.

(3) same as (2) but corrected by taking it w.r.t. underlying scale that was derived from strength of preference (as they call it but it is direct assessment such as what is called VAS (visual analog scale) in the health domain; see p. 1341 beginning of §3.3.2), so, it was risk attitude à la Dyer & Sarin.

CE bias towards EV: most (60%) were risk seeking!

Risk attitude from questionnaire correlated significantly with (2) and (3), not with str. of pr. value scale.

Exponential utility fitted data better than power.

Attitude questions were best predicted by (1); i.e., psychometric questionnaire results. Actual behavior was, however, best predicted by (2) and (3). There was no relation between actual behavior and psychometric scales. This is a remarkable result, because most recent studies (this sentence is written June 2021; e.g. by Dohmen and co-authors) find that psychometric scales better predict behavior than decision-model quantities.

P. 1340 beginning of §3.3.1: Utility is measured of the price for slaughter hogs. Strictly speaking, a price is a different thing than money. P. 1341 beginning of §3.3.2: what the authors call strength of preference is in fact only a subjective intrinsic absolute evaluation ("VAS"), and not really a strength of preference between objects. %}

Pennings, Joost M.E. & Ale Smidts (2000) “Assessing the Construct Validity of Risk Attitude,” *Management Science* 46, 1337–1348.

{% **PT, applications**, loss aversion, buying strategy of hog farmers; **CE bias towards EV**: p. 1254 reports only 55% risk averse in CE (certainty equivalent) questions.

50-50 CE questions were asked to 332 Dutch hog farmers. 149 had an “open” production system, where piglets and feeds are bought, piglets are raised to slaughter hogs in three months, and then sold. 183 had a closed system that is similar, only do they breed the piglets themselves instead of buying them. In the open system where people buy the piglets, the buying price provides a natural reference point. Of these 149 people, 83 indeed show the S-shaped utility function of PT around that price, with convexity below, and 66 have concave utility. Of the other group of 183, 163 have concave utility without reference point or convex part, and 20 have ref/point concavity. An exceptionally nice illustration of how reference points come about because of small psychological aspects of framing.

In the open group with the natural reference point, for gains we have c = 3.53, and for losses c = –0.77 (Pennings, personal communication, email of Friday 23 July 2004.)

P. 1261: with log-IPT fitting (contrary to what the paper writes, it is not the IPT family but the log-IPT family, as Smidts, November 2003, personal communication, let me know), the inflection point (reference point!?) of utility is endogenous

P. 1272: argue that farmers may not transform 50/50 probabilities because they know them very well from everyday experience.

There are many elaborate details on parametric fittings. When the authors write global shape, they refer to the extent to which the function exhibits an S-shape. When they write local shape, they refer to the extent to which the function is concave or not. When they say organizational (strategic) behavior, they mean whether or not the production is open or closed and they relate it to whether or not utility is S-shaped. When they say trading behavior they mean other actions studied in another of their papers, and they relate it to risk aversion/concavity.

Given that the choice of production must be complex, and driven by many factors, risk attitude can at most be a minor causal factor. Therefore, I think that the choice of production is the cause of the utility function measured, and not what the authors suggest throughout, that it would be the other way around. I interpret this paper, therefore, as a nice illustration of how framing can drive utility measurement. %}

Pennings, Joost M.E. & Ale Smidts (2003) "The Shape of Utility Functions and Organizational Behavior," *Management Science* 49, 1251–1263.

{% %}

Pennock, David M., Steve Lawrence, C. Lee Giles, & Finn Årup Nielsen (2001) "The Real Power of Artificial Markets," *Science* 291 (5506; February 9) 987–988.

{% **free will/determinism**: Seems to suggest that indeterminacy at level of elementary particles may suffice to have uncertainty in the world and this making free will possible. So, the author overestimates the implications of physics. %}

Penrose, Roger (1997) "*The Large, the Small, and the Human Mind*." Cambridge University Press, Cambridge.

{% **Christiane, Veronika & I** %}

Pepermans, Ronald, Carole B. Burgoyne, & Anke Müller-Peters (1998) "European Integration, Psychology and the Euro," *Journal of Economic Psychology* 19, 657–661.

{% **Christiane, Veronika & I** %}

Pepermans, Ronald, Gino Verleye (1998) "A Unified Europe? How Euro-Attitudes Relate to the Psychological Differences between Countries," *Journal of Economic Psychology* 19, 681–699.

{% %}

Perakis, Georgia & Guillaume Roels (2008) "Regret in the Newsvendor Model with Partial Information," *Operations Research* 56, 188–203.

{% %}

Percoco, Marco & Peter Nijkamp (2009) "Estimating Individual Rates of Discount: A Meta-Analysis," *Applied Economics Letters* 16, 1235–1239. https://doi.org/10.1080/13504850701367189

{% %}
Perea, Andrés (2007) "Proper Belief Revision and Equilibrium in Dynamic Games," *Journal of Economic Theory* 136, 572–586.

{% %}
Perea, Andrés (2008) "Minimal Belief Revision Leads to Backward Induction," *Mathematical Social Sciences* 56, 1–26.

{% %}
Perea, Andrés (2007) "A One-Person Doxastic Characterization of Nash Strategies," *Synthese* 158, 251–271.

{% %}
Perea, Andrés (2009) "A Model of Minimal Probabilistic Belief Revision," *Theory and Decision* 67, 163–222.

{% %}
Perea, Andrés (2012) "*Epistemic Game Theory: Reasoning and Choice*." Cambridge University Press, New York.

{% %}
Perea, Andrés (2014) "Belief in the Opponents' Future Rationality," *Games and Economic Behavior* 83, 231–254.

{% **game theory can/cannot be viewed as decision under uncertainty**: (see also: Game theory as ambiguity). Applying usual revealed-preference techniques in game theory has a problem. Imagine we want to derive preferences over and utilities of strategies for player 1. We do the typical revealed-preference measurement: Assume player 1 has has only actions 1 and 2 available, and not strategy 3. What will he prefer, strategy 1 or strategy 2? Problem is that removing strategy 3 and possibly other strategies changes the whole game, including the behavior of the other players, so that an essential ceteris paribus assumption is violated. Aumann & Drèze (2009) used the following thought experiment: "imagine player 1 does not have strategy 3 but the others don't know so and think that he has, and player 1 knows this." Such thought experiments are far-fetched and not very satisfactory. This paper proposes an alternative approch: "do not change the available strategies. Instead change the conceivabe beliefs." Then still utilities can be derived. A nice new approach. (Although I do not know to what extent this already was in Gilboa & Schmeidler 2003 GEB, a paper cited by the authors.) It uses techniques similar to case-based decision theory (CBDT) of Gilboa & Schmeidler, where preferences depend linearly on memories, much like here preferences depend linearly on beliefs.

This paper considers preference relations conditioned on subjective probability measures, denoted small p. It considers how variations in those subjective probabilities lead to variations in preferences, and derives utilities and so on from that. This is similar to Gilboa & Schmeidler's case-based decision theory (CBDT), where memories play roles similar to the subjective probability measures considered here. The author, indeed, cites a Gilboa & Schmeidler (2003) paper as very close. That paper did not use CBDT but related techniques. This is an interesting alternative approach to decision under risk, taking different empirical inputs.

Assume a finite state space S, and a finite set of (choice) alternatives C. (The paper uses different symbols and the unfortunate term choice for alternative.) In Savage's (1954) framework, states and so-called outcomes are primitives, and alternatives, called acts, are derived from those, as functions from S to outcomes. This is not the only way. The keyword "**criticisms of Savage's basic framework**" in this bibliography gives discussions of it. One can also take states and alternatives as primitive, and derive outcomes as pairs (s,a), so that the outcome set is a product set of the state space and the alternative space., and this is in fact what the paper does, more or less implicitly. The aforementioned set of (subjective) probability measures is the set of all probability distributions over S.

The paper considers expected utility, defined as maximizing

$a \mapsto \sum_{s \in S} p(s)u(a,s)$

over alternatives a given the probability measure p. First assume only two alternatives, C = {a, b}. Define by $\mathcal{P}^+$ the set of probability measures giving strict preference for a, and $\mathcal{P}^-$ and $\mathcal{P}^0$ similar. Only utility differences u(a,s)–u(b,s) are meaningful, and $\mathcal{P}^+$ is the set of p's with

$\sum_{s\in S} p(s)\big(u(a,s)-u(b,s)\big) > 0.$

Given that a and b are fixed, we can reinterpret this as preferences over the p's, where we only know which p's (the set $\mathcal{P}^+$) are strictly preferred to a neutral q with EU(q) = 0, which are indifferent to q, and which are preferred strictly less. Assuming usual weak ordering and continuity, independence is still necessary and sufficient for EU, where independence here is never more than betweenness. This is the first result of the paper.

When we have three or more alternatives, and C = {a,b,c,…}, then we need more than betweenness. Betweenness only implies linear indifference sets, but they need not be parallel as needed for EU. The paper imposes a "uniform preference increase" axiom, which involves assumptions about parallel hyperplanes. If there are no weakly dominated alternatives, then strong transitivity and a line property, referring to a particular line, can replace the uniform preference increase axiom. The extra axiom is similar in a mathematical sense to the diversity axiom of CBDT, as the author points out. It is also similar to the decomposition of independence in Burghart (2020, *Theory and Decision*), where homotheticity is used to get the indifference sets parallel and is similar to the uniform preference increase axiom. %}

Perea, Andrés (2020) "A Foundation for Expected Utility in Decision Problems and Games," working paper.

{% They analyze choice errors in test-retest for four risk elicitation tasks. Find that about 50% of the variance is explained by noise. They measure from data, and use simulations to analyze. Also consider the technique of Gillen et al. (2019 JPE). Helps, but does not solve all. %}

Perez, Fabien, Guillaume Hollard, & Radu Vranceanu (2021) "How Serious is the Measurement-Error Problem in Risk-Aversion Tasks?," *Journal of Risk and Uncertainty* 63, 319–342.
https://doi.org/10.1007/s11166-021-09366-5

{% %}

Perlman, Michael D. & Lang Wu (1999) "A Defense of the Likelihood Ratio Criterion for Testing One Sided and Order Restricted Alternatives," submitted to *Journal of Statistical Planning and Inference*.

{% **foundations of statistics**; §9 gives many citations arguing against Neyman-Pearson hypothesis testing.

Conclusion: "it is better to have no universal criterion than cling to an inappropriate one."

%}

Perlman, Michael D. & Lang Wu (1999) "The Emperor's New Tests" (with discussion), *Statistical Science* 14, 355–381.

{% %}

Perlman, Michael D. & Lang Wu (2000) "On the Validity of the Likelihood Ratio and Maximum Likelihood Methods.".

{% %}

Perold, André F. (2004) "The Capital Asset Pricing Model," *Journal of Economic Perspectives* 18, 3–24.

{% %}

Perraillon, Marcelo Coca, Ya-Chen Tina Shih, & Ronald A. Thisted (2015) "Predicting the EQ-5D-3L Preference Index from the SF-12 Health Survey in a National US Sample: A Finite Mixture Approach," *Medical Decision Making* 35, 888–901.

{% Data of households. They also asked for subjective assessment of own risk attitude ("I am willing to take above-average risks" etc.) and related it to investments in stocks. Seems that they found some trivial (p. 136) and some nonintuitive (p. 131) results. %}

Perraudin, William R.M. & Bent E. Sorensen (2000) "The Demand for Risky Assets: Sample Selection and Household Portfolios," *Journal of Econometrics* 97, 117–144.

{% Body length during adolescence (I think age 16) predicts future wage, and not body length during adulthood. %}

Persico, Nicola, Andrew Postlewaite, & Dan Silverman (2004) "The Effect of Adolescence Experience on Labor Market Outcomes: The Case of Height," *Journal of Political Economy* 112, 1019–1053.

{% History of term "ceteris paribus;" earliest use 1311 after Christ; so, not used by Romans or Greecs themselves. %}

Persky, Joseph (1990) "Retrospectives: Ceteris Paribus," *Journal of Economic Perspectives* 4 no. 2, 187–193.

{% %}

Pesendorfer, Wolfgang (2006) "Behavioral Economics Comes of Age: A Review Essay on Advances in Behavioral Economics," *Journal of Economic Literature* 44, 712–721.

{% %}

Peski, Marcin (2011) "Prior Symmetry, Similarity-Based Reasoning, and Endogenous Categorization," *Journal of Economic Theory* 146, 111–140.

{% People who score bad on measurements of elementary numerical skills, are also subject to many confusions such as to interpreting numbers or percentages as probabilities; etc. In particular, if Bowl A contains 9 red beans and 91 white, and Bowl B contains 1 red bean and 9 white, they prefer to gamble on red from A because it "gives more chances to win" (**ratio bias**). A similar finding, called ratio bias, is in Kirkpatrick & Epstein (1992), and in Denes-Raj & Epstein (1994), as the authors indicate. They investigate how these effects are affected by numeracy. Also do Asian-disease-like (now in 2024 I find this term politically incorrect) questions with their usual weakness (20% died need not mean that 80% survived; there may be missing data etc.). Whereas their numeracy score predicts things, more general intelligence scores do not. (**cognitive ability related to risk/ambiguity aversion**) %}

Peters, Ellen, Daniel Västfjäll, Paul Slovic, C.K. Mertz, Ketti Mazzocco, & Stephan Dickert (2006) "Numeracy and Decision Making," *Psychological Science* 17, 407–413.
https://doi.org/10.1111/j.1467-9280.2006.01720.x

{% %}

Peters, Hans J.M. (1986) "*Bargaining Game Theory*." Ph.D. dissertation, University of Nijmegen, Department of Mathematics.

{% %}

Peters, Hans J.M. (1986) "Simultaneity of Issues and Additivity in Bargaining," *Econometrica* 54, 153–169.

{% **strength-of-preference representation**: through stengths of prefs if one function is concave transform of other. %}

Peters, Hans J.M. (1992) "A Criterion for Comparing Strength of Preference with an Application to Bargaining," *Operations Research* 40, 1018–1022.

{% %}

Peters, Hans J.M. (1992) "*Axiomatic Bargaining Theory*." Kluwer Academic Publishers, Dordrecht.

{% This great paper analyzes Shalev's model of loss aversion. It does not incorporate probability weighting. Note that the symbol λ used in this paper corresponds with λ–1 of Tversky & Kahneman (1992) and Wakker (2010, Ch. 8). So, in the notation of this paper, λ>0 means loss aversion.

As several authors have pointed out (Currim & Sarin 1989 p. 24 point ii), the Shalev model cannot accommodate utility being concave for gains and convex for losses. Despite this problem, this paper is still the best presently available in the literature to show what loss aversion means, because it considers variable reference points (the desirability of that latter was pointed out by Wakker 2010, p. 247, §8.8, end of Problem 1). Its conciseness and mathematical style may make it, unfortunately, hard to read for nonmathematicians. %}

Peters, Hans J.M. (2012) "A Preference Foundation for Constant Loss Aversion," *Journal of Mathematical Economics* 48, 21–25.

{% ISBN 978-3-662-46949-1; ISBN 978-3-662-46950-7 (eBook); %}

Peters, Hans J.M. (2015) "*Game Theory; A Multi-Leveled Approach*: (2nd edn)." Springer, Berlin. https://doi.org/10.1007/978-3-662-46950-7

{% A new axiomatization of the Nash bargainng solution using risk aversion for losses combined with variations in reference points + proper variation of disagreement outcome. %}

Peters, Hans J.M. (2022) "Risk Aversion for Losses and the Nash Bargaining Solution," *Theory and Decision* 92, 703–715. https://doi.org/10.1007/s11238-021-09837-w

{% Consider the incomplete preference model of Dubra et al. (2004). Add a bad-outcome aversion axiom: After canceling all the common worst outcomes with the same prob, the worst one decides: The prospect assigning the biggest probability to it is dispreferred. It can be modeled by a set of utility functions that more and more overweigh the low outcome relative to the good one. That is, that tend to the nonstandard function that at every lower outcome makes a jump down greater than any before, a sort of extreme lexicographic. %}

Peters, Hans J.M., Tim Schulteis & Dries Vermeulen (2010) "Generalized Stochastic Dominance and Bad Outcome Aversion," *Social Choice and Welfare* 35, 285–290.

{% %}

Peters, Hans J.M. & Eric van Damme (1991) "Characterizing the Nash and Raiffa Bargaining Solutions by disagreement Point Axioms," *Mathematics of Operations Research* 16, 447–461.

{% %}

Peters, Hans J.M. & Koos J. Vrieze (1987) "Surveys in Game Theory and Related Topics," CWI-Tract 39, Center for Mathematics and Computer Science, Amsterdam.

{% Show that Yaari's (1969 result of first agent's u being a concave transform of a second iff first's certainty equivalents are always smaller, formulated by Yaari only for Euclidean spaces and, if I remember right, differentiability, can easily be extended to general outcomes.

The main step in the proof is to show that a convex function on a nonconvex domain can be extended to a convex function on the convex hull of its domain. %}

Peters, Hans J.M. & Peter P. Wakker (1987) "Convex Functions on Non-Convex Domains," *Economics Letters* 22, 251–255.
https://doi.org/10.1016/0165-1765(86)90242-9
Direct link to paper

{% **revealed preference** %}

Peters, Hans J.M. & Peter P. Wakker (1990) "Independence of Irrelevant Alternatives and Revealed Group Preferences" (Extended abstract). *In* Tatsuro Ichiishi, Abraham Neyman, & Yair Tauman (eds.) *Game Theory and Applications*, 404–406, Academic Press, New York.
Direct link to paper

{% **revealed preference** %}

Peters, Hans J.M. & Peter P. Wakker (1991) "Independence of Irrelevant Alternatives and Revealed Group Preferences," *Econometrica* 59, 1787–1801.
Reprinted in William Thomson (2010, ed.) "*Bargaining and the Theory of Cooperative Games: John Nash and beyond*," Ch. 4, Edward Elgar Publisher, Northampton, MA.
https://doi.org/10.2307/2938291
Direct link to paper

{% **revealed preference**; A follow-up paper with a simpler counterexample is John (1995, JET). %}

Peters, Hans J.M. & Peter P. Wakker (1994) "WARP Does not Imply SARP for More than Two Commodities," *Journal of Economic Theory* 62, 152–160.
https://doi.org/10.1006/jeth.1994.1008
Direct link to paper

{% **revealed preference** %}

Peters, Hans J.M. & Peter P. Wakker (1996) "Cycle-Preserving Extension of Demand Functions to New Commodities," *Journal of Mathematical Economics* 25, 281–290.
https://doi.org/10.1016/0304-4068(95)00733-4
Direct link to paper

{% %}

Peters, Hans J.M. & Horst Zank (2005) "The Egalitarian Solution for Multichoice Games," *Annals of Operations Research* 137, 399–409.

{% A detailed general criticism of the author's work is given at his 2019 Nature Physics paper. It is a case of **ubiquity fallacy**, where the author's expertise is ergodic theory. The author argues for his expected growth rate criterion for intertemporal choice. It implies, *under several assumptions*, maximization of expected logarithm of wealth. Bernoulli also argued for such maximizationn, be it for very different reasons. The author argues that his justification is superior to Bernoulli's, completely unfounded. As explained in my annotations at Peters (2019), it is because this author is not aboe to think of anything other existing than ergodic processes.

Pp. 4914-1915: The author argues that expected utility/value is an "ensemble average." How he comes to this claim is explained by Doctor, Wakker, & Wang (2020b). There are only two kinds of averages that can have any meaning to this author, and those are averages over time or averages over ensemble, which is often taken to reflect only persons. Other averages he cannot imagine. He then thinks that averages, such as expected value/utility, must be interpreted as one of these two averages, where ensemble refers to an average over people, because otherwise he cannot relate to them so he thinks they must make no sense. Because for expected utility, different outcomes may arise, the author reasons that the several (?) persons involved in it must be replicas of the agent, and that this requires a belief in parallel universes. He then blames Bernoulli, and then all economists, for not seeing things his way, for instance on p. 4918 3rd para: "these behavioural regularities have a physical reason that Bernoulli failed to point out." Note that no economist or decision theorist ever wrote such things, and that it is only the author's imagination from which all this comes. Typical is the 1st para of §5 (p. 4918): "Fermat and Pascal (P. Fermat & B. Pascal 1654, personal communication between themselves) chose to embed within parallel universes, but alternatively—and often more meaningfully—we can embed within time."

P. 4918, §5 1st para: the author cannot relate to single decisions, and argues that we should consider everything as a process over time.

Pp. 4919-4920: "Conceptually, however, the *arbitrary* utility (*arbitrary in the sense that it depends on personal characteristics*) is replaced by an argument based on the physical reality of the passing of time and the fact that no communication or transfer of resources is possible between the parallel universes introduced by Fermat." [italics added] Illustrates that the author finds the study of interpersonal dependence a waste of time, and instead we should all only be studying intertemporal variations as in ergodic theory. His strange idea of parallel universes, and incapability to relate to averages other than if over time or persons, is described in his §5a, p. 4920, and beginning of §6.

P. 4926: "Inadvertently, by postulating logarithmic utility (left-hand side of equation (7.1)), Bernoulli replaced the ensemble-average winnings with the time-average exponential growth rate in a multiplicative non-ergodic stochastic process (right-hand side of equation (7.1)). Bernoulli did not make the time argument," shows again the author's way of thinking: As everyone should always do only ergodic theory, so should Bernoulli, and if he didn't it was his mistake and he must have been doing it inadvertently.

P. 4929, penultimate para, explains why the author often calls utility circular: "The framework is self-referential in that it can only translate a given utility function into actions that are optimal with respect to that same utility function."

P. 4930 ℓ. 2: "For example, some fraction of $w may already be earmarked for other vital use." This sentence shows some awareness that we do not only optimize entire wealth at the end of our life, but that intermediate consumptions play a role. However, the author treats this as a little aside and not as what it should be: something that severly restricts his analyses. Here, in his early papers, he would still sometimes bring in some nuancces. But his apparent marketing successes rewarded him for dropping nuances, and they disappear in later writings. %}

Peters, Ole (2011) "The Time Resolution of the St Petersburg Paradox," *Philosophical Transactions of the Royal Society A* 369, 4913–4931.

{% The opening sentence "This study focuses on the simple setup of self-financing investments, that is, investments whose gains and losses are reinvested without consumption or deposits of fresh funds, in assets whose prices are undergoing geometric Brownian motion." shows that the author understands that intermediate consumption should be ruled out to make his criterion of expected growth factor relevant. It implies that his criterion can only refer to longterm investment decisions. In later papers he will omit these restrictions, and claim relevance for all of economics, getting more and more the taste of overselling.

P. 1593 2nd column writes: "While in the terminology of modern portfolio theory, the latter ansatz can be interpreted as the assumption of logarithmic utility, in section 1.1 the Kelly result is shown to be equivalent, in the present setup, to an application of Ito's formula of stochastic calculus. In this sense it is not the reflection of a particular investor's risk preferences, but a generic null hypothesis. Considerations of personal risk preferences can improve upon this hypothesis but they must not obscure the crucial role of time." It shows that he already has his preoccupation with time, thinking that ergodic properties are more important than anything else. But here at least he still acknowledges that considerations of interpersonal variations, e.g. regarding risk attitude, may also be of use, be it secondary to ergodic theory. Such relatively "positive" views on the value of risk theory will disappear from his later papers.

P. 1594 1st column seems to acknowledge that in finance not only returns (or their ln, which is equivalent to expected growth factor, the sole criterion of Peters' ergodic economics) but also volatility and even higher moments can matter.

P. 1596 1st column argues again that risk is in a way irrelevant because not all possible outcomes will actually be realized, whereas all outcomes over time will be.

Pp. 1596-1597 writes: "This is different from Bernoulli's treatment, where the logarithm is a utility function and would be inside the sample average, obscuring the conceptual failure of the ensemble average. It was Kelly (1956) who first pointed out that the time average should be considered instead." The author is suggesting here that Kelly is with him in arguing that time is more important than risk and that Bernoulli was just confused, but I cannot believe that Kelly would ever have suggested something so silly.

P. 1601 2nd para writes: "The use of leverage is not fundamentally constrained by the prevailing framework of portfolio selection, which relies on a necessarily and explicitly subjective notion of optimality, dependent on utility, or risk preferences. This has become problematic because asymmetric reward structures have encouraged excessive leveraging." Here he is also criticizing finance.

P. 1601 last para of 1st column opens with: "In conclusion, utility functions were introduced in the early 18th century to solve a problem that arose from using ensemble averages where time averages seem more appropriate." Showing again that for him time is more important than risk.

In several papers, Peters' imagination fabricated a history that from the 17th to the 19th century people worked with expectation, should have made the ergodicity assumption, but ergodic theory did not exist yet and, therefore, mankind was in a state of confusion, not able to distinguish averages over time from averages of uncertainty, and always confusing them. Only then ergodic theory came along and only then mankind was able to properly distinguish averages over time from averages over uncertainty. Needless to say, such fantasies have nothing to do with reality. %}

Peters, Ole (2011) "Optimal Leverage from Non-Ergodicity," *Quantitative Finance* 11, 1593–1602.
https://doi.org/10.1080/14697688.2010.513338

{% I am not neutral in the sense that I co-authered a criticism of this paper: Doctor, Wakker, & Wang (2020, *Nature Physics;* link). My views can best be inferred from my 12-minutes lecture for nonspecialists at
https://www.youtube.com/watch?v=FDvBrcytU7Q&t=52s.
Here is a link to many citations from this paper and criticisms of those:
http://personal.eur.nl/Wakker/refs//pdf/citations.eee18jan2021.pdf
I add some observations below.
The author is supported by Nassim Nicholas Taleb (who also supported president Trump). Furher, this journal wrote a supporting editorial, Nature Physics Editorial (2019).

The author has two basic problems:

(1) [economics by imagination] He knows little of economics, picks a few points from the economic literature, adds many details based only on his imagination, this leads to unsound frameworks, and then he starts blaming economics for that unsoundness. But the unsoundness came only from his own wrong imaginations, and not from economics.
(2) [**ubiquity fallacy**] The author's expertise is ergodic theory and he thinks it is the only thing existing. It is a subfield of measure theory, which is a subfield of mathematics, about the dynamic development of systems over time. It is a subfield in mathematics among dozens of other subfields.
Just some examples of decisions where time is not central (Peters is not aware of such):

> (1) [Choice of applicant] If we choose one from some similarly aged Ph.D. students, then we weigh the pros and cons of their high and low grades, the uncertainties about their motives/qualities, and their strategic interests E.G. when putting deadlines. All these ubiquitous aspects are relevant. But progression in time, while present (ubiquitous), is not considered or analyzed because it gives no insights into the choice to be made. It does not distinguish between candidates. P.s.: this could be considered a situation where a kind of generalized ergodicity holds in the sense that growth over time goes similarly for all candidates.
> (2) [Choice of restaurant] I don't just maximize entire wealth over my life, but think for the salary received this month, where I want to spend one evening in a fancy restaurant, which restaurant to choose. There are pros and cons such as service and travel time, uncertainties, impact for my company that evening, but progression over time plays no role in my decision.
> (3) [Choice of travel mode] If commuting to my work, I consider cycling or walking, where I prefer walking if there turns out to be black ice, and cycling otherwise. I think about probabilities of black ice and severeness of inconveniences, but not of growth of consequences over time.
> (4) [etc]

The author's mistake of thinking that growth over time can answer all questions is what I call the **ubiquity fallacy**. It is closely related to what Kaplan (1964) called the "law of the instrument." Kaplan seems to write

"I call it the law of the instrument, and it may be formulated as follows: Give a small boy a hammer, and he will find that everything he encounters needs pounding." (p. 28)

He also seems to write: "It comes as no particular surprise to discover that a scientist formulates problems in a way which requires for their solution just those techniques in which he himself is especially skilled." (p. 28)

Carrel (1939) seems to write: "Every specialist, owing to a well-known professional bias, believes that he understands the entire human being, while in reality he only grasps a tiny part of him." (§2.2)

I sometimes use the example of a dietician who thinks that all problems can be solved, no more wars etc., if we have a good diet.

P. 1221 presents ergodic economics as an, in the author's terminology, null model. I did not know this term, but from other papers by Peters inferred that it is a kind of first-approximation model, capturing the main characteristics, but open to refinements to capture things of secondary importance. So, here Peters seems to be more permissive to the rest of economics apart from ergodic phenomena: they are not completely useless, but can have secondary importance as long as it is understood that anything ergodic should be of primary importance.

The author, strangely, thinks that expected utility for one-time decisions requires belief in multiverses. David (1986) has a theory assuming this. %}

Peters, Ole (2019) "The Ergodicity Problem in Economics," *Nature Physics* 15, 1216–1221.

{% I am not neutral I the sense that I criticized this author. I find this reply weak. I take his "I'm not sure where the disagreement lies" literally: He does not understand any of our criticisms, does not react to any, but just repeats some of his views. He then goes into his ergodic model as if it captures all of life. His "Classical economics puts forward a different decision theory. Here, expectation value maximization is declared a natural aim" ignores the justifications, e.g. through normative preference foundations and/or empirical evidence, that economists give and that our paper mentions. His "Declaring expectation value maximization an a priori natural aim is, simply put, an error in the foundations of economics." is haughty.

His "From this perspective, the simplest decision theory is this: entities will often act to maximize the long-term growth rate of their wealth (or other resources)." commits the **ubiquity fallacy** w.r.t. time, of saying that everyone should always study time.

His "Declaring expectation value maximization an a priori natural aim is, simply put, an error in the foundations of economics. The error occurred because economics began working with mathematical models of randomness long before the ergodicity problem was discovered." makes the error of thinking that EU needs ergodicity. %}

Peters, Ole (2020) "Reply to: Economists' Views on the Ergodicity Problem," *Nature Physics* 16, 1169 (2020). https://doi.org/10.1038/s41567-020-01108-9

{% My comments concern version of January 12, 2018.

The abstract takes utility curvature as irrational

P. 2 writes: "We ask precisely how the failures of neoclassical economics may be interpreted as a flaw in the formalism that can be corrected. Such a flaw indeed exists, buried deep in the foundations of formal economics: often expectation values are taken where time averages would be appropriate. Such a flaw indeed exists, buried deep in the foundations of formal economics: often expectation values are taken where time averages would be appropriate. In this sense, formal economics has missed perhaps the most important property of decisions: they are made in time and affect the future." Showing the state of mind of the authors.

P. 3 "Secondly, we postulate a specific form of rationality, that is, we state an axiom. Our axiom is that humans make decisions in a manner that would optimise the timeaverage growth rate of wealth, were those decisions to be repeated indefinitely."

The authors then give theorems showing how maximization of EU w.r.t. a utility function U arises as maximizing expected growth rate w.r.t. a particular infinite stochastic process.

P. 9: "A well-established but false belief in the economics literature, due to Karl Menger [16, 17], is that permissible utility functions must be bounded."

P. 9 Discussion: "Expected utility theory is an 18th-century patch, applied to a flawed conceptual framework established in the 17th century that made blatantly wrong predictions of human behavior." %}

Peters, Ole & Alexander Adamou (2018) "The Time Interpretation of Expected Utility Theory," London Mathematical Laboratory, London, UK.

{% A nice family of weighting functions: Take the normal distribution function Φ. Take the inverse $\Phi^{-1}(p)$. Translate it, say by multiplying by a positive τ and adding a real λ, into $\tau(\Phi^{-1}(s)+\lambda)$. Then go back: $\Phi\big(\tau(\Phi^{-1}(s)+\lambda)\big)$. This way we transform mean and variance. This idea also appeared in Hou & Wang (2019).

They discuss probability weighting. Argue that we should bring in time and that it is a mistake not to do so, as always argued by Ole Peters. %}

Peters, Ole, Alexander Adamou, Mark Kirstein, & Yonatan Berman (2020) "What Are We Weighting for? A Mechanistic Model for Probability Weighting," working paper.

{% Here is a link to many citations from this paper and criticisms of those: http://personal.eur.nl/Wakker/refs//pdf/citations.eee18jan2021.pdf

Here are some further comments.

P. 5 2nd column: "In modern terms, Huygens suggested to maximize the ergodic growth rate assuming additive dynamics." I am pretty sure that Huygens did not think anything in the direction of ergodic growth.

P. 7 bottom of 1st para writes: "However, based on formal arguments, Menger drew conclusions for the structure of the permissible formalism, namely, he ruled out linear and logarithmic functions as models of behavior, and, equivalently, additive and multiplicative processes as models of wealth. Because of the central role of these dynamical models, the development of decision theory suffered from this restriction, and it is satisfying to see that formal arguments against these important models are invalid, as intuition would suggest." Shows one more time how far the author's imagination can lead him astray, as to claim that Menger would deny the existence of additive or multiplicative growth processes!?

P. 7 §D 1st sentence, and then p. 8 3rd para of 1st column: "Karl Menger revisited Bernoulli's 1738 study, and came to the incorrect conclusion that only bounded utility functions are permissible. … Despite a persisting intuitive discomfort, renowned economists accepted Menger's conclusions [that utility has to b bounded] and considered them an important milestone in the development of utility theory." The author continues in his imaginatory world about economics.

P. 8 1st column: "To implement this notion in the formalism of decision theory, it was decided to make utility functions bounded." The author continues in his imaginatory world about economics, erroneously thinking that they require bounded utility. %}

Peters, Ole & Murray Gell-Mann (2016) "Evaluating Gambles Using Dynamics," *Chaos* 26, 023103.
https://doi.org/10.1063/1.4940236

{% Replicate Fehr-Tyran (2001) and argue that money illusion is less important, rather being a second-order effect. Fehr & Tyran (2014) argue that the authors misinterpret their data. %}

Petersen, Luba & Abel Winn (2014) "Does Money Illusion Matter?: Comment," *American Economic Review* 104, 1047–1062.

{% %}

Peterson, Daniel (2011) "Qeauty and the Books: A Response to Lewis's Quantum Sleeping Beauty Problem," *Synthese* 181, 367–374.

{% INTRO

It is impressive that computers with machine learning can already develop theories, and this general direction shown by this paper (more clearly than predecessors) is valuable and impressive, making this one of the most valuable papers I read for a long time. Yet, on the negative side, the concrete conclusions they draw on risk theories have, I think, value 0, because of a big mistake in the experiment (not implementing losses) and, I guess (being nonexpert), that prediction exercises with large calibration sets too much favor high numbers of parameters and overfitting. Thus, the main and very simple finding of the paper is: the more parameters the better.

SPT instead of OPT: p. 1210 2nd column ℓ. 1. What the authors call 1979 prospect theory in fact is not that, but is separable prospect theory (Wakker 2023 Theory and Decision). I will nevertheless use the abbreviation OPT for it. For new 1992 prospect theory I use the authors' abbreviation CPT, although I would prefer the abbreviation PT.

The authors collected a very large set of experimental choices between risky lotteries, being 14,711 subjects each making 20 choices randomly selected from 13,000 choice pairs, totalling 294,220 choices. Well, if I understand right, then for each individual each choice pair was repeated five times. Then it would amount to 1,47,100 risky choices. They used choice pairs from Erev, Ert, Plonsky, Cohen, & Cohen (2017). These are mostly lotteries with few outcomes, but some have more like 6 or 8 or so outcomes. They involve most of the well-known paradoxes so that in this sense the stimuli are not relevant for general choices but have paradoxes overrepresented. Then prediction exercises were done, taking a calibration ("training") set to next do out-of-sample prediction for a prediction set. Although the paper does not write it clearly, the authors combined all choices into a representative agent model. (One modification, an individual replication is discussed below.) They used a Luce-type probabilistic choice model, with dominating choices treated separately.

When the authors call a model neural, such as neural EU, they mean that they selected the best utility function from a very large class, using splining techniques. They also considered many parametric families. Because in this paper the more parameters the better, neural models are found to work best.

PROBLEMS REGARDING RISKY CHOICES:

(1) The authors use the random incentive system but if the outcome is a loss, the subject need not pay (their Figure 1, left upper panel). This is very unfortunate. First, it means that choices between loss lotteries were hypothetical. In general, I am not against hypothetical choice, but in an experiment where other choices are incentivized, by contrast effect hypothetical choice is no good. Second, and more seriously, mixed lotteries (giving both gain- and loss-outcomes) are warped and destroyed. Subjects are willing to risk just any loss just for optimizing a chance at a gain. Thus, the estimates on loss aversion in this paper have no validity, and many other results are distorted by it.

(2) Supposedly, a prediction task corrects for number of parameters, as often claimed, and the authors claim so on p. 1210 left column 2/3 ("All theories are evaluated on their cross-validated generalization performance, meaning that model complexity is already implicitly accounted for in our analyses") They resolutely take predictive power as the almost only and absolute criterion, although they do reckon some with psychological interpretability, but not much. However, in my only experience with prediction exercises, Kothiyal, Spinu, & Wakker (2014), it came out clearly that the more data, the higher the nr. of parameters give the optimal prediction. Makes sense because even with the most silly parameter, capturing a heuristic adopted by only 1/1000 of subjects, given enough data, errors will cancel out (usually) and something systematic, no matter how small and silly, will be picked up. Looks to me that prediction exercises do not sufficiently correct for overfitting. Overfitting gets a bigger problem as the calibration set gets bigger. I think that this is also a big problem in this paper, where more parameters are

always better. A model with almost everything depending on almost everything (using the term that psychologists like so much: Context dependence, implying that transitivity is violated) is found to be best in this paper. The model is too complex, with too many parameters with too little meaning, to be of much interest.

(3) In Figure 4B, lower panel (Figures S4-S6 in Online Appendix p. 24 for probability weighting), the common findings of utility and probability weighting are reproduced miraculously well, although the authors use the PT formula and not the CPT formula, but this is only because the authors used parametric families that do not allow for other patterns. Figure 1B the right lower figure gives probability weighting optimized under PT "neurally," i.e., without parametric restrictions and then, strangely enough, almost get the identity function. This is strange but is not discussed by the authors. It suggests that the parameters of PT beyond EU do nothing. Then how can PT predict so much better than EU? I do not understand. Figure S7 in Online Appendix p. 25 gives the best-fitting probability weighting function under CPT, but strangely enough it only gives light underweighting, mostly for small (one would expect more for large) probabilities. These figures are extra-hard to interpret for me because it is not clear to me to what extent they come from gains or losses or, maybe, both?

SMALLER PROBLEMS:

Something unavoidable here as in most experiments: we are not so much observing preferences but rather heuristics of subjects to get the experiment done easily. In this big study it is very central though: The winning model in this study has numerously many parameters, but they are mostly picking up and predicting every silly heuristic that subjects may adopt. They mostly measure coherent arbitrariness (Ariely, Loewenstein, & Prelec 2001).

I regret that the authors did not really pay the outcomes stated, but only 10% of it (their Figure 1, left upper panel, and Online Appendix p. 24 Figure S5).

In Figure 1, left lower panel, the authors erroneously let EU and EV NOT be a subset of CPT. EU and EV should have been in the (nonempty!) intersection of PT and CPT. The online appendix, p. 14, does write that CPT contains EU and EV.

The authors focus on differentiable theories, but provide no definition in the paper. Rank-dependent theories such as CPT are not differentiable in usual meanings, and several others considered will neither be. OPT is not even continuous, neither in probabilities (at $p = 0$) nor in outcomes (when collapsing). The authors mean differentiable in the sense of how the error measure depends on parameters chosen, as used for finding optimal fit. Peterson (19 Sep 2022; personal communication) explained: "that we could take derivatives with respect to model parameters, which is helpful for fitting models, large neural networks in particular. This perhaps only works if one can tolerate mapping gamble values to choice probabilities, as opposed to focusing on hard decision preferences, because doing so allows us to maintain a smooth (differentiable) error function when we fit models to human behavior."

Swollen language: end of p. 1212, and some other places, writes on "human ingenuity" for nothing other than theory building.

They claim several times that Erev et al. (2017) is the largest data set on risky choice to date, where they then have > 30 times more data. But this is not so, and they miss relevant literature. From the top of my head, l'Haridon & Vieider (2019) have 3000 subjects, certainty equivalents for 28 lotteries of risky choice, with about 25 choices per certainty equivalent, amounting to a total of 2939*44*25 = 3,232,900 risky choices. Over twice as much as this study! There have been several metastudies on risk attitudes that will also have had more. For instance, Brown, Imai, Vieider, & Camerer (2022), in their mata-analysis of loss aversion, counting only the papers reporting the number of subjects, have 305,514 SUBJECTS in the meta-analysis. Estimating loss aversion will involve several choices. Thus, their data set is similar in size to this paper. There will be other such studies. I think, frankly, that the authors should have anticipated that their unfounded claim has little chance of survival.

GENERAL COMMENTS

As for OPT versus CPT, for limited calibration sets as common in experiments, CPT clearly outperforms OPT (Figure 2B left part, yellow vs. red curve). For larger calibration sets they are very similar but OPT is somewhat better. This may be explained by overfitting: in CPT, weights should add to 1 but in OPT they need not, giving some more flexibility to OPT. (E.g., Loehmann, 1998, p. 299 last line: "Thus, the assumption that subjective probabilities sum to one has a strong effect on subjective probability estimates.") As written, for large data sets there is

no good correction for overfitting and it is the more parameters the better, the more so as we are getting heuristics of subjects more than true preferences here.

There was a replication study of 300 subjects each doing 300 choices (60 choice pairs, each repeated five times) and then separate fitting for each individual, so that heterogeneity between individuals can be inspected. I am afraid that this was much with boredom and fatigue. Heterogeneity is not reported, but only predictive performance. They replicated the main findings although, unfortunately, they did not consider an analysis of CPT but only of PT. I regret this and expect that with this more limited set, CPT would do much better.

The authors played with mix-models, where either a first or a second model is used, and it depends on features of the lottery which one, and they performed well.

It is interesting that Erev et al.'s (2017) BEAST model clearly outperforms all other standard models in predicting (Figure 3), and to have this confirmed by an independent team. I expect that the model winning in this (Peterson et al.) paper is not at all stable w.r.t. stimuli set chosen, and had they chosen a somewhat different set of 13,000 choice pairs to choose from, the parameters of the winning model would have been quite different. %}

Peterson, Joshua C., David D. Bourgin, Mayank Agrawal, Daniel Reichman, & Thomas L. Griffiths (2021) "Using Large-Scale Experiments and Machine Learning to Discover Theories of Human Decision-Making," *Science* 372, 1209–1214.
https://www.science.org/doi/10.1126/science.abe2629

{% Survey of St. Petersburg paradox. %}

Peterson, Martin (2019) "The St. Petersburg Paradox." *In* Edward N. Zalta (ed.), *The Stanford Encyclopedia of Philosophy*, Fall 2019 edition, URL = <https://plato.stanford.edu/archives/fall2019/entries/paradox-stpetersburg/>

{% statistics: c lassification in data analysis. %}

Petit-Renaud, Simon & Thierry Denoeux (2004) "Nonparametric Regression Analysis of Uncertain and Imprecise Data Using Belief Functions," *International Journal of Approximate Reasoning* 35, 1–28.

{% A variation of variational preferences. Uses Fréchet derivatives and Wasserstein metric on probability measures, with a central role for a probability measure closest to the priors in the set of priors. Mathematically advanced and no direct preference conditions. %}

Petracou, Electra V., Anastasios Xepapadeas, & Athanasios N. Yannacopoulos (2022) "Decision Making under Model Uncertainty: Fréchet–Wasserstein Mean Preferences," *Management Science* 68, 1195–1211. https://doi.org/10.1287/mnsc.2021.3961

{% %}

Petri, Henrik (2019) "Asymptotic Properties of Welfare Relations," *Economic Theory* 67, 853–874.

{% Use hypothetical choice. Study relation between inverse S and cognitive ability (**cognitive ability related to likelihood insensitivity (= inverse S) & inverse S (= likelihood insensitivity) related to emotions**).

With affect-rich outcomes (voucher for romantic dinner) there is more likelihood insensitivity than with affect-poor outcomes (reduction of electricity bill). (**PT falsified**: see also **probability weighting depends on outcomes;**) Numerosity (Berlin number task) also seems to reduce likelihood insensitivity (in re-appraisal task.). These results, however, seem to hold only for small probabilities, and not for large.

To calculate probability weighting, they assume linear utility, which for moderate stakes is fine. Data-fitting is by minimizing quadratic distance. They confirm inverse S. %}

Petrova, Dafina G., Joop van der Pligt, & Rocio Garcia-Retamero (2014) "Feeling the Numbers: On the Interplay between Risk, Affect, and Numeracy," *Journal of Behavioral Decision Making* 27, 191–199. https://doi.org/10.1111/j.1467-9280.2006.01720.x

{% Hedden (2013) argued for using nonadditive probabilities, with fixed-probability transformation. This paper follows up, e.g., arguing that we may allow decision makers to choose to either follow the classical book argument or Hedden's version. I did not try to really understand. %}

Pettigrew, Richard (2012) "On the Expected Utility Objection to the Dutch Book Argument for Probabilism," *Nous* 47, 23–28. https://doi.org/10.1111/nous.12286

{% Seems that he already wrote on identifiability and ceteris paribus in economics. %}

Petty, William (1899) "A Treatise of Taxes and Contributions." *In* Charles Henry Hull (ed.) *Economic Writings of Sir William Petty*, 1–92. Cambridge University Press, London.

{% **loss aversion: erroneously thinking it is reflection**: P. 2170 top line discusses a potential role of loss aversion in an experiment with purely losses. This is reiterated on p. 2177: "Experiment 3 suggests that even while favorable information is being overweighted, individuals in our ambiguity task show risk-seeking behavior consistent with loss aversion." (The authors use the term risk seeking also under pure ambiguity.)

Did Ellsberg experiments, where probability intervals are given to subjects, and maxmin EU is used. Consider both gains and losses. Providing extra info that is favorable has much positive effect, not only through its favorableness but also through reducing ambiguity. Providing extra info that is unfavorable has just a bit negative effect, because its unfavorableness is counterbalanced by its reduction of ambiguity.

Experiment 4B does not take Ellsberg urns, but guesses on naturally occurring quantities (say temperature). Events concerned whether the quantity was below or above some threshold. Whether the winning event was above or below the threshold was randomly determined, and this was told to subjects. It means that objective risk comes in. Further, subjects can have extra info about such events so that there is no control for beliefs. The central question, what the effect of info provision is, is a comparative question that is not much affected by the aforementioned complications.

The authors are enthusiastic about their findings and conclude the paper with: "Thus, our results have the potential to enhance both a psychological understanding of behavior as well as economics models with importance at the micro and macro levels." %}

Peysakhovich, Alexander & Uma R. Karmarkar (2016) "Asymmetric Effects of Favorable and Unfavorable Information on Decision Making under Ambiguity," *Management Science* 62, 2163–2178. http://dx.doi.org/10.1287/mnsc.2015.2233

{% %}

Pfanzagl, Johann (1959) "*Die Axiomatischen Grundlagen einer Allgemeinen Theorie des Messens.*" Physica-Verlag, Vienna. Elaborated in Pfanzagl, Johann (1968) "*Theory of Measurement.*" Physica-Verlag, Vienna.

{% Pfanzagl is absolutely brilliant, and so is this paper, with mature and deep writing on measurement. Advanced results on the bisymmetry axiom, how that axiomatizes subjective expected utility etc. Everything is then restricted to two-outcome acts.

When reading p. 284 on the operation o in a o b (also denoted as F(a,b)): imagine an event E is given. a o b then denotes a certainty equivalent, being the sure amount equivalent to the prospect (E:a; not-E:b). So,

a o b = F(a,b) = CE(E:a; not-E:b)

a o b ~ (E:a; not-E:b)

Then Theorem 1 is a characterizations of subjective expected utility. a --> a* denotes the utility function. More precisely, it is Theorem 1 together with the assumption of reflexivity on p. 285 3rd para (to normalize probabilities). So, Pfanzagl was one of the first to characterize subjective expected utility, and the first to do it with continuity of utility, which in economics is natural!

For intertemporal choice: imagine two fixed timepoints, say today and tomorrow. a o b relates to the consumption of a today and b tomorrow and is, more precisely, the constant consumption c such that c today and c tomorrow is equivalent to a today and b tomorrow. It is the constant-consumption-equivalent. Then the theorems you see there amount to characterizations of discounted utility.

Pfanzagl in his 1968 book only uses topological connectedness, not top. separability, so, immediately understood that top. separability can be dispensed with. This insight was lost for some time after, because of Debreu (1960) and Gorman (1968) and others who did assume topological separability, but it was rediscovered by Krantz et al. (1971), and was propagated by people including me.

Theorem 2 considers bisymmetry (event-commutativity as Chew (1989) called it) for two-outcome acts with different events involved, characterizing that they have the same utility function so that it really is RDU-with-symmetry (SEU for fixed event but additivity of probability need not hold otherwise) when restricted to only binary acts that may relate to different events.

Pp. 287-288 discuss what I consider most interesting, DUU, where Pfanzagl then essentially is giving Savage's (1954) SEU for two states of nature, even for all binary acts.

biseparable utility: P. 287 has it, but (see end of 3rd para) only for symmetric nonadditive measures and probability transformations, (w(p) = 1−w(1−p)), so that no rank-dependent restriction needs to be added. He calls w(p) subjective probability. **binary prospects identify U and W**: writes: "In spite of that, they permit us to derive all relevant results concerning the scale of utility." Then he goes on to do biseparable utility for uncertainty, for the special case of a symmetric maybe nonadditive measure although he does not say this explicitly. P. 287 bottom goes on to do the same thing done before for probabilities, now doing it for an event. P. 288 gives all the axioms that axiomatize biseparable utility with a nonadditive symmetric measure. He does not write the model itself, but it is evident from replacing probabilities on the previous page by events. The bottom of the page shows that a violation of symmetry, discussed only for a fifty-fifty event, violates his axioms.

Pfanzagl is overly pessimistic in claiming that the construction of utility then is impossible. Nowadays (1996 and after) we know that comonotonic versions of axioms will still hold. Wakker & Deneffe (1996) showed that the construction of utility then can still be done.

P. 288 already describes the nice dynamic interpretation of bisymmetry if the events can be repeated independently that is also in Segal (1993, JME, "order indifference"), Luce (1988, JRU 1, Eqs. 22 and 23), and Luce (1998, JRU, "event commutativity").

Pp. 289-290 discuss constant absolute risk aversion (called consistency) and the crucial role of what is taken as a fixed or variable status quo (he uses this term status quo). There are several discussions of empirical and psychological studies, Mosteller & Nogee (1951), Stevens, etc.

Para on pp. 289-290: Pfanzagl tries to discuss the role of initial wealth or, maybe, reference dependence. Unfortunately, the text is incomprehensible because of the many undefined terms such as “money in front of the subject,” “available amount of money,” “money held by the subject,” “money in his pocket,” “money immediately involved in playing,” and in next para: “status quo,” “net outcomes.” In general, we have

W = R+ c

where W denotes final wealth, R denotes reference outcome, and c change w.r.t. reference outcome. Usually R is taken as a real number, as I will do, and not as a random variable or anything. Usually, in one choice situation, R is fixed there but c and W can take several values within and between lotteries, but I will write singular W and c mostly. If one investigates dependency on one of these variables, say c, by varying c, one has to specify which of the other two variables covaries and which is kept constant (if any). Authors commonly do not do that, leading to many ambiguous texts. Reference independence means that changes in R with c covarying and W kept fixed do not affect preferences, i.e., preferences depend only on W. Kahneman & Tversky (1979) assumed that changes in R and W, keeping c fixed, do not affect preferences (but only approximately so if the changes in R are not big, as they point out). Then preferences depend only on c. The para also discusses whether utility (curvature) changes, but then it is relevant to know if c or something else is argument, and if c is, whether W (mostly) or R covaries with c, and which of W and R is constant. Pfanzagl discusses the role of constant absolute risk aversion, or consistency as he calls it. I assume that he assumes here that preferences depend only on final wealth, i.e., reference independence. Then it means that adding constants to W, R, and c (keeping the equality) do not affect preferences. In particular, if we know only c and not R/W, then that is fine.

Theorem 3, p. 290, characterizes linear/exponential (CARA) family through constant absolute risk aversion. This was done before in mathematics, not related to decision theory, by Nagumo (1930 p. 78, stating sufficiency, but proof also stating necessity) and Hardy, Littlewood, & Pòlya (1934, Theorem 84, for log-power utility). %}

Pfanzagl, Johann (1959) “A General Theory of Measurement—Applications to Utility,” *Naval Research Logistics Quarterly* 6, 283–294.

{% Characterizes a functional as being a conditional expected value, with no utility involved ("linear utility"). %}

Pfanzagl, Johann (1967) "Characterizations of Conditional Expectations," *Annals of Mathematical Statistics* 38, 415–421.

{% I could only see the abstract, but it suggests the following. First, he points out that to measure subjective probabilities people usually use objective probabilities. Either to derive utility for instance using standard gambles, or to use matching probabilities. But Pfanzagl can do it using the bisymmetry technique of his 1959 paper, without assuming objective probabilities. %}

Pfanzagl, Johann (1967) "Subjective Probability Derived from the Morgenstern-von Neumann Utility Concept." *In* Martin Shubik (1967, ed.) "*Essays in Mathematical Economics in Honor of Oskar Morgenstern*," Princeton University Press, Princeton, NJ, 237–251.

{% An elaborated version of his 1959 book, translated by himself, with help (also in content) by Volker Baumann and H. Huber.

§1.10 distinguishes between fundamental and derived measurement: "… we can define fundamental measurement as the construction of scales by mapping an empirical relational system isomorphically into a numerical relational system. Derived measurement, on the other hand, derives a new scale from other given scales."

Lemma 3.5.9: an ordered set is connected w.r.t. order topology iff it has no gaps (a ≺ b but (a,b) is empty) and is order-complete (each nonempty subset with lower bound has infimum, or, equivalently, each nonempty subset with upper bound has supremum).

Corollary 5.4.2: if X is connected and an operation * is cancelable and continuous, then autodistributivity ((a*b)*c = (a*c) * (b*c)) implies bisymmetry. Cancelability is something like antisymmetry plus strict monotonicity. Formally, it means that a*b is 1-1 (injective) in each of its variables, at whatever level the other variable is fixed.

P. 107: the only weak point I discovered in this phantastic book so far: he writes Archimedian instead of Archimedean.

criticizing the dangerous role of technical axioms such as continuity: §6.6

(pp. 107-108) has a good discussion of, and even formal theorems on, the dangerous empirical status of technical (Pfanzagl says objectionable if finite observations cannot falsify) axioms such as continuity and solvability, often overlooked. (Remark on p. 111 gives another nice statement.) Definition 6.6.3 gives a definition of "technical" as Pfanzagl calls it. In the presence of other axioms, they do have empirical content but it may not be clear what that content is. See also §9.1 of Krantz et al. (1971). A strengthening of Adams, Fagot, & Robinson (1970, at the time of Pfanzagl's book unpublished) is given. §9.5 will explain that continuity is dangerous in adding empirical implications. Theorem 9.5.5 suggests that continuity w.r.t. connected topology does not add further dangerous implications to strong solvability.

tradeoff method: Def. 8.6.8 is in fact a version of the $\succcurlyeq^*$ relation defined in my book Wakker (1989) and used in what I call TO consistency nowadays (after 2005). The definition of F_{12} implies that

$(c_1, F_{12}(c_1)) \sim (d_1, F_{12}(d_1))$, and this together with $(a_1, F_{12}(c_1)) \leq' (b_1, F_{12}(d_1))$ ($\leq'$ denoting reversed preference) makes Pfanzagl write $a_1b_1 \leq' c_1d_1$, where I would write $a_1b_1 \leq'^* c_1d_1$ in my 1989 book and $a_1b_1 \leq'^{t} c_1d_1$ in my 2010 book (were it not that in the latter I only consider indifferences $\sim'^{t}$). Note that Pfanzagl's solution condition entails a strong solvability condition.

Pfanzagl pleas for this approach with tradeoffs (called distances in his terminology). Remark 9.4.5 ends with: "We are of the opinion that the indirect way over distances makes the whole approach more intuitive." (**tradeoff method**)

Ch. 12 does DUU in a multistage setup. Sure-thing principle is formulated as monotonicity, together with a "lack of illusion" condition that apparently entails **RCLA**, it entails the known things.

Axiom 12.5.2 assumes that for each event there exists another independent event, where independence means that conditioning does not affect preference.

biseparable utility: Corollary 12.5.8 (p. 211) has it only for additive measures S, with additivity proved in Theorem 12.5.9, and later conditions given that subjective probability agree with objective if existing. The text is restricted to repeatable events and compound gambles, although it could have been restricted to static gambles and certainty-equivalent substitution. %}

Pfanzagl, Johann (1968) "*Theory of Measurement*." Physica-Verlag, Vienna.

{% If w has infinite derivative at 0, then prospects with finite expected value can have infinite PT value. This paper proposes weighting functions that avoid this problem. %}

Pfiffelmann, Marie (2011) "Solving the St. Petersburg Paradox in Cumulative Prospect Theory: The Right Amount of Probability Weighting," *Theory and Decision* 71, 325–341.

{% **one-dimensional utility**: Surveys many families. Gives criteria for when third derivatives (prudence) and fourth derivatives (temperance) become important. %}

Phelps, Charles E. (2024) "A User's Guide to Economic Utility Functions," *Journal of Risk and Uncertainty* 69, 235–280.
https://doi.org/10.1007/s11166-024-09443-5

{% **Z&Z**; survey on effects of coinsurance etc. on demand for health care %}

Phelps, Charles E. & Joseph P. Newhouse (1974) "Co-Insurance, the Price of Time, and the Demand for Medical Services," *Review of Economics and Statistics* 66, 334–342.

{% Seems to say on p. 43, on uncertainty with unknown probabilities, that there "is where the 'genuine uncertainty' lies". In the spirit of Knight. %}

Phelps, Edmund (2023) "*My Journeys in Economic Theory*." Columbia University Press, New York.

{% They introduced quasi-hyperbolic. %}

Phelps, Edmund S. & Robert A. Pollak (1968) "On Second-Best National Saving and Game-Equilibrium Growth," *Review of Economic Studies* 35, 185–199.

{% %}

Philippe, Fabrice (2000) "Cumulative Prospect Theory and Imprecise Risk," *Mathematical Social Sciences* 40, 237–263.

{% This paper adds several results to the model of Jaffray & Philippe (1997), for belief functions, Polish outcome spaces, and so on. %}

Philippe, Fabrice, Gabriel Debs, & Jean-Yves Jaffray (1999) "Decision Making with Monotone Lower Probabilities of Infinite Order," *Mathematics of Operations Research* 24, 767–784.

{% %}

Phillips, J.P.N. (1969) "A Further Procedure for Determining Slater's i and All Nearest Adjoining Orders," *British Journal of Mathematical and Statistical Psychology* 22, 97–101.

{% **updating: testing Bayes' formula**: seem to find that people reply best when in log odds units. %}

Phillips, Lawrence D. & Ward Edwards (1966) "Conservatism in a Simple Probability Inference Task," *Journal of Experimental Psychology* 72, 346–354.

{% This paper axiomatizes a generalization of utilitarianism, with separability maintained. For every welfare allocation, a set of opportunities plays a role. I did not come to full understanding. The author discussed interpersonal comparability of utility, and whether to use ordinal or cardinal inputs. %}

Piacquadio, Paolo Giovanni (2017) "A Fairness Justification of Utilitarianism," *Econometrica* 85, 1261–1276.

{% Assumes event tree structure. Reference dependence (resource constraint) but smooth.) Full separability. %}

Piacquadio, Paolo G. (2020) "The Ethics of Intergenerational Risk," *Journal of Economic Theory* 186, 104999.
https://doi.org/10.1016/j.jet.2020.104999

{% My comments concern the 1957 English translation. Funny examples of "conservation errors" in physics. Suppose liquid is poured from one form into another. Children under 7 will not recognize that the amount was unchanged.

conservation of influence: p. 213 2nd para: "without conservation of totalities" (about children up to seven years of age). Throughout the book, the term irreversibility is used as something crucial for randomness, but I hardly understood more of the term than that it means randomness. First children have to get a concept of implication, then that implication does not work 100%, so there is unpredictability, then they can get some awareness of chance. §X.2, p. 216 etc., argues that in many ways babies, like even the most primitive animals, can exhibit behavior adapted to chance, but this is animal spirit not real awareness. P. 217 2nd para: “But it would be idle to draw from these functional analogies a structural identity and to attribute to the nursing infant operative structures, whether deductive or probabilistic.”

Stage I is from 4 to 7, stage 2 from 7 to 11, stage/level 3 after 11. Stage I is subdivided into level I A and I B. Stage I consists of levels I A and I B, stage II also consists of levels II A and II B, stage III/level III is not subdivided I guess.

Ch. VI (pp 131-160):
“The Quantification of Probabilities.”

P. 131: “On the other hand, the progress supposes the gradual ability to establish a relationship between the individual cases and the whole distribution;” For the frequentist understanding of probability, the heads coming up on different tosses of a coin, different individual events, must indeed be grouped together and the child must be able to do that mentally.

P. 132 2nd para gives a nice description of the growing awareness of numerical probability. Also on p. 133 last para (on level I B: “or there is an intuitive comparison deriving from the perception of striking disproportionalities”).

Level I A understands that things can be unpredictable (“chance”). See, for example, §X.2, p. 218, “From the functional point of view, there is certainly at this time a notion which performs the function of the possible, and this is precisely the idea that the near future is made up of events which one is not certain that he can anticipate.” P. 138 last para, on level I A: “If the child had the least bit of quantified probabilistic intuition,” I think that somewhere else there is a text that the child neither distinguishes quantitatively nor qualitatively. A little bit of differentiation between different levels of likelihood arises at level I B, see p. 133 last para (on level I B: “or there is an intuitive comparison deriving from the perception of striking disproportionalities”). Level II knows that 4 out of 7 is more likely than 3 out of seven or 4 out of 8, but cannot compare 4 out of 7 to 2 out of 6. Note that the perception is not just a function of objective probability because 1/2 = 5/10 need not be understood. P. 228, 2nd para, on level II: “This again is easily explained as a function of operative development.”

Level III can distinguish numerical probabilities well. So, level I A is **principle of complete ignorance** (three-valued logic) where there is, in the terminology of decision theory, true, untrue, or possible.

My claim seems to be contradicted by several writings by Piaget & Inhelder that children at stage I cannot differentiate between the possible and the necessary. For example, this is the title of §X.2 on p. 216. However, the second half of the second para on p. 218 shows that Piaget & Inhelder consider possibility only understood if some logical operations like complementarity and their interaction with possible are also understood. So, he uses the term possible in a more restrictive sense. See also third para of p. 214 and the last para of §X.3, on p. 230. %}

Piaget, Jean & Bärbel Inhelder (1951) "*La Genèse de l'Idée de Hasard chez l'Enfant*." Presses Universitaires de France, Paris. Translated into English by Lowell Leake, Jr., Paul Burrell, & Harold D. Fishbein:

Piaget, Jean & Bärbel Inhelder (1975) "*The Origin of the Idea of Chance in Children.*" Norton, New York.

{% absentminded driver; seems that they introduced the beautiful sleeping beauty paradox. %}

Piccione, Michele & Ariel Rubinstein (1997) "On the Interpretation of Decision Problems with Imperfect Recall," *Games and Economic Behavior* 20, 3–24.

{% Seems to have nicely expressed experimenter's demand: "It is to the highest degree probable that the subject['s] . . . general attitude of mind is that of ready complacency and cheerful willingness to assist the investigator in every possible way by reporting to him those very things which he is most eager to find, and that the very questions of the experimenter . . . suggest the shade of reply expected. . . . Indeed . . . it seems too often as if the subject were now regarded as a stupid automaton." %}

Pierce, Artur H. (1908) "The Subconscious Again," *Journal of Philosophy, Psychology, & Scientific Methods* 5, 264–271.

{% **foundations of statistics**; Ancillary statistics, nuisance parameters, that this is not very nice for classical frequentist statistics. %}

Pierce, David A. & Dawn Peters (1994) "Higher-Order Asymptotics and the Likelihood Principle: One-Parameter Models," *Biometrika* 81, 1–10.

{% Extends the Savage framework by a mapping that maps events into perceived events. This is quite like support theory of Tversky & Koehler (1994). This paper provides preference axiomatizations. %}

Piermont, Evan (2021) “Hypothetical Expected Utility,” working paper.

{% **risk averse for gains, risk seeking for losses**: The energy-budget rule from biology (also found by Caraco 1981) says that optimal foraging should be risk averse when above energy requirements, and risk seeking when below. The authors verify this finding for risky monetary choices by humans, with repeated choices with repeated real payments, and find it confirmed. Of course, in full agreement with prospect theory! %}

Pietras, Cynthia J., Gabriel D. Searcy, Brad E. Huitema, & Andrew E. Brandt (2008) “Effects of Monetary Reserves and Rate of Gain on Human Risky Choice under Budget Constraints,” *Behavioural Processes* 78, 358–373.

{% **probability communication** %}

Pighin, Stefania, Michel Gonzalez, Lucia Savadori, & Vittorio Girotto (2015) “Improving Public Interpretation of Probabilistic Test Results Distributive Evaluations,” *Medical Decision Making* 35, 12–15.

{% **probability communication**: they reanalyze existing data and report new data suggesting that natural frequencies are NOT better ways to report probabilities. %}

Pighin, Stefania, Michel Gonzalez, Lucia Savadori, & Vittorio Girotto (2016) “Natural Frequencies Do not Foster Public Understanding of Medical Test Results,” *Medical Decision Making* 36, 686–691.

{% **probability communication** & **ratio bias**: Compare perceptions of 1:100 versus 5:500 and so on. Find, unlike other studies, that the latter is weighted less than the former. Maybe because for health outcomes are losses? Study also other forms of probability communication. %}

Pighin, Stefania, Lucia Savadori, Elisa Barilli, Laura Cremonesi, Maurizio Ferrari, & Jean-François Bonnefon (2011) “The 1-in-X Effect on the Subjective Assessment of Medical Probabilities,” *Medical Decision Making* 31, 721–729.

{% **discounting normative**: p. 25 argues that discounting is irrational; a vague citation by Strotz (1956, p. 172) suggests that Pigou considered discounting to be a defect of our telescope.

marginal utility is diminishing; r.av. = dim.marg.utility;

P. 729 of 1924 edn. seems to write on **decreasing ARA/increasing RRA** (well, third derivative instead of RRA)

Appendix XI is on utility, which is taken as satisfaction ≠ normative maximandum

P. 785 seems to write, on **linear utility for small stakes**: "a small change in the consumption of any ordinary commodity ... cannot involve any appreciable change in the marginal desiredness of money."

P. 847: Marshall said that economics has advantage over other social sciences because it has money as a measuring rod.

P. 849: says that strength of pref. comparisons are possible as judgments, i.e., "comparable in principle," but not through measurement, so, they are not comparable "in fact."

§V of Appendix XI, p. 850, is nice. It says that interpersonal comparability of utility cannot be proved, but that the burden of evidence is on the other side. %}

Pigou, Arthur C. (1920) "*The Economics of Welfare.*" (edn. 1952: MacMillan, London.)

{% **linear utility for small stakes**: a central accepted point in a debate about mathematical correctness of some formulas. %}

Pigou, Arthur C., Milton Friedman, & Nicholas Georgescu-Roegen (1936) "Marginal Utility of Money and Elasticities of Demand," *Quarterly Journal of Economics* 50, 532–539.

{% §3.1: utility is ordinal; §3.5: **marginal utility is diminishing**! %}

Pindyck, Robert S. & Daniel L. Rubinfeld (2001) "*Microeconomics.*" Prentice Hall International, London.

{% **three-doors problem**: The author tries to discuss it but, ironically, does not understand it himself. Here is his incorrect description of the problem in his

opening para:

“One of the most famous television game shows from the heyday of the genre from the 1950s to the 1980s was Let’s Make a Deal. Its host, Monty Hall, achieved a second kind of fame when a dilemma in probability theory, loosely based on the show, was named after him. A contestant is faced with three doors. Behind one of them is a sleek new car. Behind the other two are goats. The contestant picks a door, say Door 1. To build suspense, Monty opens one of the other two doors, say Door 3, revealing a goat. To build the suspense still further, he gives the contestant an opportunity either to stick with their original choice or to switch to the unopened door. You are the contestant. What should you do?”

People well-versed in probability theory and statistics know that to determine a conditional probability one should not only be informed about the value observed, but also about what information one would have received in other, counterfactual, events. That is, one should know the whole random variable one is informed about. In this case, one should know the strategy of the quizmaster Monty. In particular, in the counterfactual event that the prize (car) had been behind door 3, could Monty have opened that door still? As a first and strongest counterexample to Pinker’s analysis assume that, whenever one of the remaining doors contains a prize, the quiz master will open that door, showing the contestant that the initial door chosen is wrong. Only if none of the remaining doors contains the prize, will the quiz master open one of those two. Under this quiz master strategy, the contestant definitely should not switch! For a second counterexample and most plausible case, assume that the quiz master just randomly opens a door, and it is coincidence whether or not it contains the prize. Then switching is no use and the door chosen, Door 1 does have probability 0.5 of having the prize. This is the most plausible interpretation of Pinker’s text in the absence of other info and, hence, the answer that Pinker qualifies as incorrect is in fact the most plausible answer.

In the Monty Hall problem things are different from the above two examples of quiz master strategies. Here the quiz master strategy is to always open a door with no prize behind; he has the info to so so. Only if one knows this (and that 50-50 randomization if the two doors not chosen both have no prize) can one solve the problem, and see that switching is good. Pinker’s account does not state Monty’s strategy and is faulty. He repeats the mistake later in his example of divine intervention, showing that he really does not understand the aforementioned fact of probability theory and statistics.

I commonly use one sentence to explain the case of Monty Halls's problem to people: "If one switches one wins the prize whenever one started at a wrong door." %}

Pinker, Steven (2021) "Why You Should Always Switch: The Monty Hall Problem (Finally) Explained," https://behavioralscientist.org/steven-pinker-rationality-why-you-should-always-switch-the-monty-hall-problem-finally-explained/

{% Stecher et al. (2011, MS) introduced a method to generate objective ambiguity, by sampling from Cauchy distributions. This paper uses this to generate objective Dempster-Shafer belief functions and use them in game theory. It cites papers showing that ambiguity can be beneficial for some players in game theory %}

Pintér, Miklós (2022) "How to Make Ambiguous Strategies," *Journal of Economic Theory* 202, 105459. https://doi.org/10.1016/j.jet.2022.105459

{% His surname is "Pinto" and not "Luis Pinto."

tradeoff method: Person-tradeoff method asks: if 10 healthy people could live, or 11 blind, what would you decide if you were policy maker? So, no probabilities but frequencies. It does not ask people how good they consider something to be for themselves, but rather what they would decide if they were policy makers. Paper considers some measurement methods and sees how they agree with Euroqol measurements etc. %}

Pinto, José Luis (1997) "Is the Person Trade-off a Valid Method for Allocating Health Care Resources?," *Health Economics* 6, 71–81.

{% P. 581 shows that the authors allow for normative status of probability weighting and loss aversion (contrary to me and contrary to Diecidue & Wakker 2001, unlike the reference on p. 581 end of 3rd para). Argue that if different measurement methods give different results, then there is no way of telling which is best. %}

Pinto, José Luis & Jose-Maria Abellan-Perpiñan (2012) "When Normative and Descriptive Diverge: How to Bridge the Difference," *Social Choice and Welfare* 38, 569–584.

{% The lead time tradeoff is like the regular TTO (time tradeoff), but adds a period of good health before the other periods considered. Under time separability, it should not matter. Empirically, big differences are found. (**intertemporal separability criticized**) %}

Pinto, José Luis & Eva Rodríguez-Míguez (2015) "The Lead Time Tradeoff: The Case of Health States Better than Dead," *Medical Decision Making* 35, 276–291.

{% Prospect theory need not explain the Yitzhaki Puzzle. %}

Piolatto, Amedeo & Matthew D. Rablen (2017) "Prospect Theory and Tax Evasion: A Reconsideration of the Yitzhaki Puzzle," *Theory and Decision* 82, 543–565.

{% **dynamic consistency**: f**avors abandoning time consistency, so, favors sophisticated choice**;

updating under ambiguity %}

Pires, Cesaltina Pacheco (2002) "A Rule for Updating Ambiguous Beliefs," *Theory and Decision* 53, 137–152.

{% They find no effect of boredom on risk aversion/seeking. %}

Pirla, Sergio & Daniel Navarro-Martinez (2022) "Does Boredom Affect Economic Risk Preferences?," *Judgment and Decision Making* 17, 1094–1122.
https://orcid.org/0000-0001-5979-4528

{% **crowding-out**: seem to survey the crowding-out effect as studied by psychologists. %}

Pittman, Thane S. & Jack F. Heller (1987) "Social Motivation," *Annual Review of Psychology* 38, 461–489.

{% Aggregation of incomplete vNM preferences, with discussions of interpersonal comparability of utility. %}

Pivato, Marcus (2013) "Risky Social Choice with Incomplete or Noisy Interpersonal Comparisons of Well-being," *Social Choice and Welfare* 40, 123–139.

{% **strength-of-preference representation**;

Uses Hahn's embedding theorem. But it does not go for lexicographic

presentation, but instead for incompleteness with multi-function unanimity representation à la Dubra, Maccheroni, & Ok (2004). Under solvability, it gives necessary and sufficient conditions, mostly a sort of concatenation condition (called divisibility); $(x_1,x_2) \succcurlyeq (x,x)$ (positiveness of (x_1,x_2) then positivity of any n-fold self-concatenation of (x_1,x_2) with itself. %}

Pivato, Marcus (2013) "Multiutility Representations for Incomplete Difference Preorders," *Mathematical Social Sciences* 66, 196–220.

{% **Dutch book**; **ordered vector space**

Considers a preference relation on a product set X^I with I an infinite set, implying infinite dimensions. And then additive representations, many without an Archimedean axiom and with nonstandard real numbers. The paper gives a valuable collection of references to related works in intertemporal choice, decision under uncertainty, welfare, and so on. This paper considers additive representation with symmetry. It considers preferences between sequences that differ only on finitely many dimensions, so that the overtaking criterion can be used ($x > y$ iff SUM_i$\big(U(x_i)–U(y_i)\big) > 0$). U can take values in extended versions of $\mathbb{R}$, in Abelian ordered groups. Cites Hahn's embedding theorem (p. 56) mapping it into a lexicographically ordered vector space.

Necessary and sufficient conditions for additive representation are joint independence (= separability = sure-thing principle) and symmetry. At first I was surprised that this can be done with no richness such as connected-continuity or solvability in the outcome space or state space. But then I realized that the infinite symmetric coordinates generate additions of any length. We can calibrate U(x)/U(y) versus the rational number m/n by considering the preference between n states with x and m states with y. So, this gives an equivalent of richness in the state space.

P. 32, **criticizing the dangerous role of technical axioms such as continuity**: the author explains this.

P. 35 Example (ii): if infinitely many states are equally likely (by symmetry), and acts differ on only finitely many of them, then acts differ only on null sets.

Proposition 5(a) is Theorem 1.1 of Wakker (1986, Theory and Decision).

P. 40 gives Hölder's theorem. %}

Pivato, Marcus (2014) "Additive Representation of Separable Preferences over Infinite Products," *Theory and Decision* 73, 31–83.

{% **state space derived endogeously**: Acts and monetary (real-valued) outcomes are given. A set J (an algebra) of events is given, and for each of its elements, preferences conditional on it. The set of acts is a linear space, i.e., all linear combinations are included, as in financial markets. Then a state space S is derived endogenously, a compact Hausdorff space, where all acts are continuous mappings from S to outcomes, and preferences maximize (conditional) SEU.
It was not clear to me what the overlap of this paper is with the cited paper Pivato & Vergopoulos (2018a).

The space of conditioning events J has to be "rich." It must contain all bands, i.e., events that properly interact with the order structure and multiplication operator. It means that it is determined by the space of acts A. %}

Pivato, Marcus (2020) "Subjective Expected Utility with a Spectral State Space," *Economic Theory* 69, 249–313.
https://doi.org/10.1007/s00199-018-01173-5

{% Axiomatizes discounted utility when intertemporal profiles have to be continuous in time; this can be only on subsets of the time axis. A natural setup and amazing that it wasn't done before. %}

Pivato, Marcus (2021) "Intertemporal Choice with Continuity Constraints," *Mathematics of Operations Research* 46, 1203–1229.

{% The author axiomatizes maximization of Cesàro Averages of utility (CA). Let (x_1, x_2, …) be an infinite sequence.

$$\mathrm{Lim}_{n\to\infty} \sum_{j=1}^{n} u(x_j)$$

is the CA. The author only considers a restricted domain of "regular totally bounded" sequences and imposes invariance under "Levy" permutations, which can handle infinite sequences. He also imposes continuity w.r.t. a connected metric copology. I conjecture that the results of Kothiyal, Spinu, & Wakker (2014) can be used to handle completely general outcome sets X, with no continuity needed, as follows. Identify any finite sequence (x_1,…,x_n) with the

infinite sequence consisting of infinitely many repetitions of it. This way the domain of Kothiyal et al. is isomorphic to the subdomain consisting of all "periodic" sequences. The theorem of Kothiyal et al. gives necessary and sufficient conditions for maximization of CA (Cesàro average) here in full generality. Remains addition of a preference condition, capturing some sort of denseness, to extend it to the whole space. %}

Pivato, Marcus (2022) "A Characterization of Cesàro Average Utility," *Journal of Economic Theory* 201 105440.

{% Following up on Harsanyi (1955), when the individuals may have subjective probabilities that are different. Mongin (1995) gave an impossibility result, but Gilboa, Samet, & Schmeidler (2004) gave a possibility result by weakening Pareto to the case of identical beliefs. This paper examines such situations with new info arriving and updating. (**updating: discussing conditional probability and/or updating**:) Then "eventual" (long-run) Pareto gives eventual utilitarianism. %}

Pivato, Marcus (2022) "Bayesian Social Aggregation with Accumulating Evidence," *Journal of Economic Theory* 200, 105399.

{% This paper considers sets of preference relations and topologies on them. Relevant for instance if you are not sure about what the true preference relation is and want to talk about small deviations, a neighborhood of some preference relation. The paper links local continuous quasiorders to continuous strict partial orders. %}

Pivato, Marcus (2023) "Compact Spaces of Continuous Preferences," working paper.

{% They generalize a nice result of Mongin & Pivato (2015) on weighted utility in matixes. Say that uncertainty and persons are involved, that x_{ij} is the outcome for the ith person if the jth state of nature is true, and that utilitarian expected utility is maximized, necessitating the same subjective probabilities for every person. They formulate this as an impossibility theorem, in the sense that it is impossible for the persons to have different subjective probabilities, as in the classic Mongin (1995). They now allow for nonmonetary outcomes and non-Archimedean representations into Abelian groups. This is empirically and conceptually preferable but has the drawback that most researchers are not familiar with these concept, unfortunately. They also allow for state- and person-dependence of utility, in fact handling general additive composability, generalizing what has sometimes been called the theorem of aggregation (Nataf 1948). They generalize continuity into solvability, albeit unrestricted solvability which will imply two-sided unboundedness of the various utility functions. I expect that this could be avoided by taking restricted solvability. They also assume the existence of certainty equivalents. They also relax completeness somewhat, although the solvability axiom then is very restrictive. %}

Pivato, Marcus & Élise Flore Tchouante (2024) "Bayesian Social Aggregation with Non-Archimedean Utilities and Probabilities," *Economic Theory* 77, 561–595. https://doi.org/10.1007/s00199-023-01509-w

{% Consider aggregation over two components: states of the world and persons. That is, when welfare and uncertainty are both concerns, where there is ambiguity nonneutrality. They consider weakenings of weak separability/monotonicity, e.g., only when almost objective uncertainty. Then consider aggregation-(im)possibility as with Mongin (1995) and others. %}

Pivato, Marcus & Élise Flore Tchouante (2024) "Bayesian Social Aggregation with Almost-Objective Uncertainty," *Theoretical Economics* 19, 1351–1398. https://doi.org/10.3982/TE5164

{% **discounting normative**: according to Harvey (1994), Plato thinks that timing aversion is shortsightedness. %}

Plato, "Protagoras."

{% Seems to say, fourth century before Christ, that 50% of human talents is located in female brains, and that that is wasted if women do not participate in work, government, etc. Seems that he recognized that for physical labor men may be more suited because of their stronger muscles. %}

Plato, "The Republic."

{% **free will/determinism** %}

Pleasants, Nigel (2018) "Free Will, Determinism and the "Problem" of Structure and Agency in the Social Sciences," *Philosophy of the Social Sciences* 49, 3–30.

{% The authors argue and extensively document that in real-life decisions for gains the correlation between probabilities and outcomes usually is negative: High probabilities occur with low probabilities. P. 2013 ff. argues and documents that for laboratory experiment of risk attitudes there is no such relation. This effect can contribute to ambiguity aversion, and this becoming stronger as outcomes get higher. An experiment, study 3, p. 2010 ff., confirms it. I think that this finding is of special interest to DFE, but the authors do not discuss it.

On p. 2008 ℓ. −3 (reproduced below) and elsewhere (e.g. p. 2001) the authors incorrectly suggest that the dependence between probabilities and outcomes that they have found be inconsistent with common theories such as Savage (1954), who assumed that probabilities of events are independent of outcomes. But Savage's independence was mathematical, which is completely and totally different than empirical/stochastic independence. The authors are simply concusing these two concepts and, on the basis of this confusion, criticize common theories such as Savage's and claim novelty. Savage's independence concerns a mathematical independence *once the event capturing all relevant uncertainty has been completely specified*, and is a completely different concept. It would be absurd if Savage had claimed that high outcomes empirically occur as often with high probabilities as with low probabilities, but yet this is what the authors in fact claim.

The confusion is suggested by their text on p. 2002 when the authors write:

"It is these properties of intercue relationships and substitutability [empirical dependence of probability on outcome] that we suggest offer a *new* perspective on how people make decisions under uncertainty. Under uncertainty, cues such as the payoffs associated with different courses of actions may be accessible, whereas other cues—in this case, the probability with which those payoffs occur—are not. This missing probability information has been *problematic* for choice theories as typically both payoffs and probabilities are used in determining the value of options and in choosing" [italics added]

The confusion becomes completely apparent on p. 2008 when the authors write:

"The risk–reward heuristic envisions that when faced with choice under uncertainty people infer that the probability of an event is negatively related with the magnitude of the payoffs. This view conflicts [??] with other hypotheses about the relationship between these two variables during decision making. For instance, according to subjective expected utility theory (Savage, 1954)—the normative account of how people ought to make these decisions— payoffs and probabilities are two *independent* [this is mathematical independence, and the authors are confusing it with empirical independence] factors that determine the value of an alternative and, ultimately, choice. That is, the utility of an alternative that yields outcome x if the event A occurs otherwise 0, (x, A), is

$$u(x, A) = p(A)\cdot u(x) + p(\sim A)\cdot u(0) = p(A)\cdot u(x) \qquad (4)$$

where event A is a subset of possible states of the world S, $A \subset S$. The u is the utility function describing the subjective value of those consequences. The p is a probability measure on the state space S and reflects the decision maker's subjective beliefs about the likelihood of different states of the world occurring. However, note that the probability is based on the event only and not on the consequence of the event. Consequently, in subjective utility theory, payoffs and probabilities are ultimately compensating but not interacting [again, this is mathematical independence but the authors are confusing it with empirical independence] factors in determining the value of the alternative. Thus, if subjective expected utility theory is taken at first approximation as a descriptive theory of choice, then a consequence of this independence assumption is that the probabilities people use to make decisions under uncertainty must be estimated independently of the magnitudes of the payoffs." [italics from original]

The authors add here a footnote 10, which displays the same confusion and does not help:

"It is important to emphasize that Savage's (1954) subjective expected utility theory is a theory of choice. Utilities and probabilities are derived from preferences over acts. It does not explicitly state how probabilities are to be calculated. It does assume payoffs and probabilities are two independent constructs that determine the value of the construct. For this reason, we have stated the independence prediction—that probabilities be estimated independently from the magnitude of the payoffs—as a consequence that follows from the theory." %}

Pleskac, Timothy J. & Ralph Hertwig (2014) "Ecologically Rational Choice and the Structure of the Environment," *Journal of Experimental Psychology: General* 143, 2000–2019.
https://doi.org/10.1037/xge0000013

{% An early use of QALYs. The earliest I know is Fanshel & Bush (1970). %}

Pliskin, Joseph S. & Clyde H. Beck, Jr. (1976) "A Health Index for Patient Selection: A Value Function Approach," *Management Science* 22, 1009–1021.

{% **decreasing ARA/increasing RRA**: constant proportional tradeoffs implies power utility for life duration;
utility elicitation %}
Pliskin, Joseph S., Donald S. Shepard, & Milton C. Weinstein (1980) "Utility Functions for Life Years and Health Status," *Operations Research* 28, 206–224.

{% %}
Plonsky, Ori & Ido Erev (2021) "Prediction Oriented Behavioral Research and Its Relationship to Classical Decision Research, working paper.

{% People violate stochastic dominance in social games. The authors take it to indicate underweighting of rare events. %}
Plonsky, Ori, Yefim Roth, & Ido Erev (2021) "Underweighting of Rare Events in Social Interactions and Its Implications to the Design of Voluntary Health Applications," *Judgment and Decision Making* 16, 267–289.

{% **revealed preference** %}
Plott, Charles R. (1973) "Path Independence, Rationality, and Social Choice," *Econometrica* 41, 1075–1091.

{% **risky utility u = transform of strength of preference v, latter doesn't exist**: p. 541 seems to say that intensity of preference is meaningless. %}
Plott, Charles R. (1976) "Axiomatic Social Choice Theory: An Overview and Interpretation," *American Journal of Political Science* 20, 511–596.

{% Sometimes referred to as basis of experimental economics, joint with Smith (1982). %}
Plott, Charles R. (1986) "Rational Choice in Experimental Markets," *Journal of Business* 59, S301–S327.

{% Proposes the "discovered preference hypothesis." Argues that people have a consistent set of preferences but that such preferences become known to a person (are "discovered") only through thought and experience in repeated choices. This is distinguished from the constructive approach on pp. 227-228. %}

Plott, Charles R. (1996) "Rational Individual Behaviour in Markets and Social Choice Processes: The Discovered Preference Hypothesis." *In* Kenneth J. Arrow, Enrico Colombatto, Mark Perlman, & Christian Schmidt (eds.) *The Rational Foundations of Economic Behavior: Proceedings of the IEA Conference Held in Turin, Italy*, 225–250, St. Martins Press, New York.

{% %}

Plott, Charles R. (1996) "Comment." *In* Kenneth J. Arrow, Enrico Colombatto, Mark Perlman, & Christian Schmidt (eds.) *The Rational Foundations of Economic Behavior: Proceedings of the IEA Conference Held in Turin, Italy*, 220–224, St. Martins Press, New York.

{% P. 667: C**hristiane, Veronika & I**: Pay in so-called francs. They deliberately did this so as to control numerical aspects and avoid small numbers. %}

Plott, Charles R. & Shyam Sunder (1982) "Efficiency of Experimental Security Markets with Insider Information: An Application of Rational-Expectations Models," *Journal of Political Economy* 90, 663–698.

{% Many papers have demonstrated loss aversion and the endowment effect, finding loss aversion parameters of 2.25 etc. These studies have usually been designed to be optimal for the presence and detection of the effect, where framings must be properly chosen and, given the irrationality of the effects mentioned, subjects are not understanding things at a high level of rationality. It is first-gut preferences that are being examined in such studies. Nowadays (1980-2023), many studies have come to overstate their case, as if loss aversion were ubiquitous. Then it is useful that there come a counterreaction, showing that loss aversion need not arise under proper framing and instructions. Although the latter point is in fact trivial, it is useful that it be demonstrated very explicitly in these days. This paper provides such a demonstration.

As the loss aversion papers have sometimes gone too far, this paper goes too far in the opposite direction by claiming that loss aversion is only misconception and, "hence," not worth studying, and that prospect theory and the endowment effect are, consequently, not valid theories. This, obviously, is an overstatement. Prospect theory and the endowment effect are theories about misconceptions

(which contradicts the claim of Plott & Zeiler (2005) in several places, e.g. p. 531 2nd column second para, of such theories not existing) occurring in gut-feeling preferences. These exist, affect economic phenomena, and or worthy of study also by economists just as well as the sophisticated preferences that are Plott's primary interest. For prescriptive purposes the sophisticated Plott-interest-preferences are more important than the gut-feeling Kahneman-interest-preferences. I am, accordingly, more interested in the Plott-preferences, but both kinds are interesting and worth being studied.

random incentive system: p. 534 footnote 5, bringing the old Holt (1986) argument, shows that the authors, as so many other experimental economists, are not up to date on the random incentive system, the incentive system used by Holt & Laury (2002, American Economic Review), Harrison, Lau, & Williams (2002, American Economic Review), and many others.

Pp. 537-538 is nice statement of how subjects who do not understand the instructions can behave strategically even if irrational in WTP-WTA.

The conclusions of this paper are based on acceptance of null hypotheses under big variance, which is overstated several times (e.g. p. 542, end of §III, "allows us to reject strongly the hypothesis that …"). P. 541, 2nd column, top, to the contrary, nicely has a rejection of loss aversion exceeding 2.

Seem to criticize BDM (Becker-DeGroot-Marschak). %}

Plott, Charles R. & Kathryn Zeiler (2005) "The Willingness to Pay-Willingness to Accept Gap, the "Endowment Effect," Subject Misconceptions, and Experimental Procedures for Eliciting Valuations," *American Economic Review* 95, 530–545.

{% My notes are at the Isoni et al. comment. %}

Plott, Charles R. & Kathryn Zeiler (2011) "The Willingness to Pay−Willingness to Accept Gap, the "Endowment Effect", Subject Misconceptions, and Experimental Procedures for Eliciting Valuations: Reply," *American Economic Review* 101, 1012–1028.

{% Introductory book, written for lay audience, good for students?? %}

Plous, Scott (1993) "*The Psychology of Judgment and Decision Making*." McGraw-Hill, New York.

{% Common method bias means variance due to measurement instrument rather than heterogeneity in data. %}

Podsakoff, Philip M., Scott B. MacKenzie, & Nathan P. Podsakoff (2012) “Sources of Method Bias in Social Science Research and Recommendations on How to Control It,” *Annual Review of Psychology* 63, 539–69.

{% %}

Pogrebna, Ganna (2010) “Ambiguity Preference Reversals,” Department of Economics, University of Warwick, UK.

{% **updating: testing Bayes’ formula**: Urn with 20 balls has X yellow balls, with X unknown to subjects. Subjects are asked to guess X, receiving rewards if their guess is right. So, they should choose the most likely value X. All values of X have the same (2^{nd} order) probability 1/21 of being that. So, in principle subjects can calculate the optimal replies, using Bayes formula, in what follows. But, as is well known, they don’t.

Subjects observe a sample and then guess X. Next they get extra info about X being ≥ 10 or < 10, and can readjust. If the new info contradicts their original estimate, the extra info improves their guess. Paradoxically, if the new info confirms their original estimate, it worsens their predictions. %}

Poinas, François, Julie Rosaz, & Béatrice Roussillon (2012) “Updating beliefs with Imperfect Signals: Experimental Evidence,” *Journal of Risk and Uncertainty* 44, 219–241.

{% %}

Pojman, Louis P. (1986) “*Religious Belief and the Will.*” Routledge & Kegan Paul, London.

{% **foundations of statistics**; nice explanation of likelihood principle simple exposition of the discussion, yes, for economists; followed by discussions, a.o. by Geweke on tractability of Bayesian methods %}

Poirier, Dale J. (1988) “Frequentist and Subjective Perspectives on the Problems of Model Building in Economics,” *Journal of Economic Perspectives* 2 no. 1, 121–144.

{% %}
Poisson, Siméon D. (1837) “*Recherches sur la Probabilité des Jugements et Matière Criminelle et Matière Civile*.” Bachelier, Paris.

{% Use revealed preference data from multichoices to reveal the smooth ambiguity model. %}
Polemarchakis, Herakles, Larry Selden, & Xinxi Song (2017) “The Identification of Attitudes towards Ambiguity and Risk from Asset Demand,” working paper.

{% %}
Poletiek, Fenna H. (1996) “Paradoxes of Falsification,” *Quarterly Journal of Experimental Psychology* 49A, 447–462.

{% **foundations of statistics** (through psychological experiments) %}
Poletiek, Fenna (2000) “*Hypothesis-Testing Behaviour*.” Psychology Press, Hampshire.

{% **foundations of statistics** %}
Poletiek, Fenna H. & Mariëtte Berndsen (2000) “Hypothesis Testing as Risk Behavior with Regard to Beliefs,” *Journal of Behavioral Decision Making* 13, 107–123.

{% This paper considers revealed preferences between lotteries, so, probability distributions over money (only ≥ 0) with known probabilities (risk). Choice sets are compact sets. I think that in the main results those sets are what is called comprehensive in bargaining game theory: with every lottery, they also contain all lotteries stochastically dominated by that lottery in the sense of worsening outcomes (the use the term downward extension). It is important that they don’t consider only choices from linear budget sets, as often done in other papers, but general compact sets. (Because of it, they can’t use first-order conditions as other

papers do.) This is very desirable. Many papers consider linear budget sets, only because those are so familiar to economists working on consumer choice in markets with prices. But such sets are not at all very natural in other contexts. For risky decisions, they do appear in financial markets, but this comprises only a small part of human decisions under risk. Further, those linear budget sets do not give good discriminatory power to distinguish theories and, for instance, usually cannot identify nonconvex preferences. The authors mention this on p. 1787.

What the authors call the GRID (Generalized Restriction of Infinite Domains) method is based on their Theorem 1. Basically, it says that we have to consider only outcomes that occurred in a lottery chosen as best in some choice situation.

We assume a continuous preference functional assigning to each lottery $(p_1;x_1,\ldots,p_n;x_n)$ the value $\Phi(p_1,u(x_1),\ldots,p_n,u(x_n))$, where Φ has a number of free (subjective) parameters still to be determined, u (utility) being one of them. For instance, Φ is expected utility and then there is no other free parameter besides u. Or Φ is disappointment aversion theory and then there is $\beta\in\mathbb{R}$, the disappointment aversion parameter, as extra parameter. Or Φ is rank-dependent utility, and then the probability weighting function w is an extra free parameter.

Essential for Theorem 1 is that u can be any strictly increasing continuous function. We assume strict stochastic dominance, with Φ strictly increasing in each $u(x_j)$. The authors discuss the pros of this generality, of, for instance, also allowing for convex utility. There are both pros and cons to generality. Assume we observed finitely many, k, choices, from compact choice sets, maximizing Φ. Here each choice is singleton, and concerns only one element selected from the subset of best elements, which is nonempty because of compactness (and assumed continuity).

For Theorem 1, define X as the union of the support of the k lotteries chosen from some choice set (with added the minimal outcome 0, something which I ignore for now). So, it contains all outcomes that appeared in at least one chosen lottery. X is finite. L_X denotes the set of lotteries contained in at least one choice set that have support in X. Then there exists a Φ representing all choices if and only if there exists one when we only consider L_X. The authors provide a mathematical proof in the appendix, with induction with respect to the maximal number of outcomes in a lottery. I next give a verbal account of the gist of the proof, skipping technicalities: Take the solution restricted to L_X, and u restricted to X, where it is strictly increasing. We have to extend u to $\mathbb{R}$. All we have to do is let Φ be as bad as possible for all lotteries not yet covered, making sure that they were never chosen. We thus first take u*, the minimal nondecreasing extension of f to $\mathbb{R}$. That is, $u^*(\alpha) = \sup\{u(\beta): \beta \in X, \beta \leq \alpha\}$. Strict increasingness and avoidance of $u^* = -\infty$ will be discussed later. Using u* in Φ, all choices are properly represented: if a lottery was not covered before (support not in X), then its Φ value is equal to the best element of L_X dominated, and that was not chosen.

Technicalities remaining in the above proof are to moderate u* slightly to make it strictly increasing and to avoid values $-\infty$. For the latter, we must avoid the "driven-to-infinity" problem, which would happen for instance under EU if we had $1 \succ (1-p{:}2, p{:}0)$ for all $p > 0$, with all those lotteries contained in some compact choice set. This is handled by the authors' assumption that there is a minimal outcome 0 and that it is already contained in X.

P. 1783 writes, on nonparametric fitting: "This is empirically important because if we happen to find that a dataset is incompatible with a given model, then we can safely conclude that this incompatibility is attributable to the model itself rather than a poorly selected parametric form."

P. 1785 suggests that the GRID method can also be used for uncertainty.

The authors use their method to reanalyze three existing data sets.

They use Afriat's index to measure distances and for fitting. They find that most subjects satisfy GARP, i.e., transitivity & stoch. dominance. Of those, about half can be fitted by EU. Disappointment aversion does not give more fit, but RDU does, The good performance of EU may be because it is taken very general, allowing any utility function, and the stimuli have not been targeted to discriminate theories. In particular, no very small or large probabilities were involved. %}

Polisson, Matthew, John K.-H. Quah, & Ludovic Renou (2020) "Revealed Preferences over Risk and Uncertainty," *American Economic Review* 110, 1782–1820.
https://doi.org/10.1257/aer.20180210

{% Uses a.o. his intuitive criterion based on experts' judgments. %}

Politser, Peter (1991) "Do Decision Analyses' Largest Gains Grow from the Smallest Trees?," *Journal of Behavioral Decision Making* 4, 121–138.

{% **PT, applications**: Argues that RDU and T&K'92 PT are very useful for financial economics. Finds, through simulations and analysis of market data, that rank-dependent models can explain portfolio choices, comparative statics, lack of diversification, and violations of mean-variance efficiency to the favor of long-shot risk seeking, very well.

P. 1483 ℓℓ. 1-2 claim that risk aversion iff $w(p) \geq p$ (so, dual weighting) but this is not correct because it also depends on utility.

Seems to show that individual stocks and underdiversified portfolios have positive skewness. %}

Polkovnichenko, Valery (2005) "Household Portfolio Diversification: A Case for Rank-Dependent Preferences," *Review of Financial Studies* 18, 1467–1502.

{% **inverse S:** Show theoretically that several properties of empirical pricing kernels are consistent with rank-dependent utility with inverse S probability weighting. Conclusion (p. 606): "Our results confirm that probability weighting is an important and empirically relevant element for understanding asset prices."

They seem to obtain both probability weighting and the underlying probability measure, which I would call a-neutral, from data fitting. Thus, this fits well into the source method. %}

Polkovnichenko, Valery & Feng Zhao (2013) "Probability Weighting Functions Implied in Options Prices," *Journal of Financial Economics* 107, 580–609. http://dx.doi.org/10.1016/j.jfineco.2012.09.008

{% %}

Pollak, Robert A. (1967) "Additive von Neumann-Morgenstern Utility Functions," *Econometrica* 35, 485–494.

{% **dynamic consistency**; Introduced sophisticated planning?? No, Strotz (1956) had the concept before but Pollak introduced the term (p. 203 ℓ. 15 and 18), or at least

was an early user of the term. Pollak demonstrates a mathematical mistake in Strotz's optimal path theorem. %}

Pollak, Robert A. (1968) "Consistent Planning," *Review of Economic Studies* 35, 201–208.

{% Assumes habit formation; i.e., utility /demand of present consumption is endowed with terms from past consumption. Sees how then long-term demand can have different characteristics than short-term. Shows that, contrary to what was assumed before, Slutsky's conditions are problematic; i.e., the demand functions need not be related to utility functions. %}

Pollak, Robert A. (1970) "Habit Formation and Dynamic Demand Functions," *Journal of Political Economy* 78, 745–763.

{% Beginning about **revealed preference**, restrictions and extensions of budget sets %}

Pollak, Robert A. (1990) "Distinguished Fellow: Houthakker's Contributions to Economics," *Journal of Economic Perspectives* 4 no. 2, 141–156.

{% **paternalism/Humean-view-of-preference**;

What policy to take if public perceives risks differently than specialists? Go public's way, or specialists'? How much weight to give to "psychic benefits?" Paper doesn't take one point or other, but presents pros and cons. %}

Pollak, Robert A. (1998) "Imagined Risks and Cost-Benefit Analysis," *American Economic Review, Papers and Proceedings* 88, 376–380.

{% Work typical of philosophers. Discussions of the basic principles of choice theory. Things are never fully formalized, though. If plans are chosen, then suddenly we read that simultaneously other plans can be chosen etc. Such work is important prior to stages of complete formalization, and is as indispensable as the work after formalizations have been chosen.

P. 82 seems to assign a special meaning to utility level 0, by assigning it to doing nothing.

conservation of influence: P. 81 distinguishes deciding-whether from deciding-which. Paper also deals with problems of future and partial influence.

And that we can do good decisions without knowing they are optimal, because we don’t know all options. %}

Pollock, John L. (2005) “Plans and Decisions,” *Theory and Decision* 57, 79–107.

{% Loss aversion is reduced when it concerns others. %}

Polman, Evan (2012) “Self–Other Decision Making and Loss Aversion,” *Organizational Behavior and Human Decision Processes* 119, 141–150.

{% Tester accepting/rejecting forecasts of experts. %}

Pomatto, Luciano, Nabil Al-Najjar, & Alvaro Sandroni (2014) “Claim Validation,” *American Economic Review* 104, 3725–3736.

{% %}

Pomatto, Luciano, Nabil Al-Najjar & Alvaro Sandroni (2014) “Merging and Testing Opinions,” *Annals of Statistics* 42, 1003–1028.

{% **value of information**: for Blackwell-type matrices, given an axiomatization of a linear evaluation of info. Linearity entails that cost of two independent signals is sum of costs, and signal with probability 1/2 costs half its original cost. %}

Pomatto, Luciano, Philipp Strack, & Omer Tamuz (2023) “The Cost of Information: The Case of Constant Marginal Costs,” *American Economic Review* 113, 1360–1393.

https://doi.org/10.1257/aer.20190185

{% **Christiane, Veronika & I**: seems that they paid in numbers without telling subjects what the real unit would be, in order to “create a more stimulating situation” (p. 569). %}

Pommerehne, Werner W., Friedrich Schneider, & Peter Zweifel (1982) “Economic Theory of Choice and the Preference Reversal Phenomenon: A Re-Examination,” *American Economic Review* 72, 569–574.

{% %}

Pondorfer, Andreas, Toman Barsbai, & Ulrich Schmidt (2017) "Gender Differences in Stereotypes of Risk Preferences: Experimental Evidence from a Matrilineal and a Patrilineal Society," *Management Science* 63, 3268–3284.

{% Presented as main lecture in SPUDM2007 by Kacelnik. **conservation of influence**: initial idea presented by Alex at SPUDM (just for illustration, not one supported by data): in rainy season lion can get wilderbeasts in plenty, and one more is not very valuable. In dry season lion has no food and getting a rabbit or not may decide on survival, so that a rabbit is very valuable. Given a straight choice between wilderbeast and rabbit, the lion will remember the bigger happiness felt when rabbits, so, will choose the rabbit, even though the wilderbeast is superior food. The lion forgot to reckon with the state-dependence of the happiness gotten from the rabbit that was gotten in much worse circumstances. %}

Pompilio, Lorena, Alex Kacelnik & Behmer, Spencer T. (2006) "State-Dependent Learned Valuation Drives Choice in an Invertebrate," *Science* 311, 1613–1615.

{% Games with incompete information, **value of information** %}

Ponssard, Jean-Pierre (1976) "On the Concept of the Value of Information in Competitive Situations," *Management Science* 22, 739–747.

{% In golf (where I will not be able to use the jargon very well; sorry) the par is the average score. A golf player for a birdie does one better than average when succeeding, and otherwise will be equal or worse than par. A golfer playing for par does as good as average when succeeding, and otherwise is worse. They are, on average, some better when playing for par than playing for birdie. The authors can explain this using loss aversion. It is myopic loss aversion with real incentives and high stakes. The authors cite List, Rabin (2000), Köszegi & Rabin (2006), and others for being the classics that they are generally considered to be, all in full 100% agreement with the common ideas of prospect theory. %}

Pope, Devin G. & Maurice E. Schweitzer (2011) "Is Tiger Woods Loss Averse? Persistent Bias in the Face of Experience, Competition, and High Stakes," *American Economic Review* 101, 129–157.

{% %}
Pope, Robin E. (1990) "Rational People Do Not Always Prefer Stochastically Dominant Prospects," Paper presented at 5th FUR Conference, Duke University.

{% **dynamic consistency: favors abandoning RCLA when time is physical** %}
Pope, Robin E. (1995) "Towards a More Precise Decision Framework; A Separation of the Negative Utility of Chance from Diminishing Marginal Utility and the Preference for Safety," *Theory and Decision* 39, 241–265.

{% A theory is proposed where the timing of the receipt of information about future outcomes plays a role, following up on many preceding papers by Pope. Although it is called theory, it is in reality only a not well organized and not well related number of qualitative claims. %}
Pope, Robin & Reinhard Selten (2010/2011) "Risk in a Simple Temporal Framework for Expected Utility Theory and for SKAT, the States of Knowledge Ahead Theory," *Risk and Decision Analysis* 2, 5–32.

{% %}
Pope, Rulon D. & Richard E. Just (1977) "On the Competitive Firm under Production Uncertainty," *Australian Journal of Agricultural Economics* 21, 111–118.

{% An uncertain item of very positive value alone is evaluated higher than the same uncertain item when combined with a sure extra item of positive but smaller value. Explanation is that sure item is used to estimate value of better item.
Is similar to the violation of stochastic dominance found by Birnbaum, Coffey, Mellers, & Weiss (1992) which is related to an idea of Slovic. Also resembles Gneezy, List, & Wu (2007). %}
Popkowski Leszczyc, Peter T.L., John W. Pracejus, & Yingtao Shen (2008) "Why More Can Be Less: An Inference-Based Explanation for Hyper-Subadditivity in Bundle Valuation," *Organizational Behavior and Human Decision Processes* 105, 233–246.

{% **conservation of influence**: Abstract math. theories and I could not relate to them. Dit not seem to relate to my interests. %}

Popovych, Roman O., Michael Kunzinger, & Nataliya M. Ivanova (2008) "Conservation Laws and Potential Symmetries of Linear Parabolic Equations," *Acta Applicandae Mathematicae* 100, 113–185.

{% On falsifiability. Good to cite, together with Carnap's (1923) logical positivism, as basis of revealed preference.
The book is sometimes dated 1935, but 1934 is best. %}
Popper, Karl R. (1934) "*Logik de Forschung*." Springer, Berlin. Translated into English as Popper, Karl R. (1959) "*The Logic of Scientific Discovery*," Hutchingson and Co., London.

{% %}
Popper, Karl R. (1959) "*Logik de Forschung: The Logic of Scientific Discovery*." Hutchingson and Co., London.

{% **foundations of probability**: pp. 34 & 37 seem to discuss the frequentist interpretation of probability. %}
Popper, Karl R. (1959) "The Propensity Interpretation of Probability," *British Journal for the Philosophy of Science* 10, 25–42.

{% %}
Popper, Karl R. (1962) "*Conjecture and Refutations: The Growth of Scientific Knowledge*." Harper Torchbooks, New York.

{% **PT falsified**: A detailed study finding many violations of gain-loss separability in PT (as in Wu & Markle), using both CE measurements and choice. They use randomly generated stimuli. %}
Por, Han-Hui & David V. Budescu (2013) "Revisiting the Gain–Loss Separability Assumption in Prospect Theory," *Journal of Behavioral Decision Making* 26, 385–396.

{% **probability elicitation**: Let subjects estimate probability *ratios*. This works better than direct probability estimates, closer to real probabilities and fewer biases. The first, small, experiment, sort of pilot, had hypothetical choice. The 2nd paid for closeness of prtobability estimate to real probability. %}

Por, Han-Hui & David v. Budescu (2017) "Eliciting Subjective Probabilities through Pair-wise Comparisons," *Journal of Behavioral Decision Making* 30, 181–196.

{% Citation of Keynes (1921, p. 308).

"In order to judge of what we ought to do in order to obtain a good and to avoid an evil, it is necessary to consider not only the good and evil in themselves, but also the probability of their happening and not happening, and to regard geometrically the proportion which all these things have, taken together."

Is this the first statement of the expectation principle, even more so in the context of the expected utility criterion to guide decisions, with also utility recognizable in the sense that the good and the evil are apparently assumed quantifiable because a geometric mean (I assume probability-weighted average) can be taken? %}

"*The Port Royal Logic*" (1662) English translation.

{% %}

Porter, David C. & Daniel G. Weaver (1997) "Tick Size and Market Quality," *Financial Management* 26, 5–26.

{% **foundations of statistics**; History of statistics; %}

Porter, Theodore M. (1986) "*The Rise of Statistical Thinking, 1820-1900.*" Princeton University Press, Princeton NJ.

{% Results are applied in Post et al. (2002, *Stroke*) %}

Post, Piet N., Anne M. Stiggelbout, & Peter P. Wakker (2001) "The Utility of Health States Following Stroke; a Systematic Review of the Literature," *Stroke* 32, 1425–1429.

https://doi.org/10.1161/01.STR.32.6.1425

Direct link to paper

{% Uses the findings of Post, Stiggelbout, & Wakker (2001). %}

Post, Piet N., Job Kievit, Jary M. van Baalen, Wilbert B. van den Hout, & Hajo van Bockel (2002) “Routine Duplex Surveillance Does not Improve the Outcome after Carotid Endarterectomy,” *Stroke* 33, 749–755.

{% Suppose that deep preferences depend only on wealth. Ranking in society decides hoe wealthy a partner one gets, so, how wealthy one gets after marriage. The induced reduced-form preferences suggest that not only wealth but also ranking matters for utility. In a complete model, ranking itself does not “directly” influence utility but is instrumental in getting wealth.

P. 782:

“In interesting economic models, agents’ preferences are either unchanging over time, or change in a very structured way depending on history.”

P. 791: “As we have repeatedly stressed, adding arguments in the utility function weakens the predictions that can be made.” %}

Postlewaite, Andrew (1998) “The Social Basis of Interdependent Preferences,” *European Economic Review* 42, 779–800.

{% Giving possibility to commit to consumptions reduces costs. Can make risk-neutral agent behave as if risk averse for small stakes but risk seeking for large (p.s.: **inverse S**?). %}

Postlewaite, Andrew, Larry Samuelson, & Dan Silverman (2008) “Consumption Commitments and Employment Contracts,” *Review of Economic Studies* 75, 559–578.

{% Considers 4 risks that can terminate mankind: big astroid, global warming, and two others. %}

Posner, Richard (2004) “*Catastrophe: Risk and Response*.” Oxford University Press, New York.

{% Analyze the famous deal-or-no-deal show, where there are risky decisions with real incentives for hundreds of thousands of dollars. Qualitatively, they find that subjects become more risk seeking both by prior losses (break-even) and by prior gains (house-money effect).

They find expected utility rejected (p. 57 ℓ. –6). Prospect theory with some

assumptions about reference points (e.g. p. 61 2nd para) explains the data well. For simplicity, they do not incorporate probability weighting (p. 62 3rd para). Reference points are path-dependent in the sense of being affected by prior gains or losses. Had the authors analyzed only the shows of one country, they could not have concluded this because prior gains or losses are then inextrically correlated with remaining stakes. They, however, analyzed different countries and did separate experiments that use different stakes so that they could compare people who face the same future stakes but some with prior gains and others with prior losses.

There are some weird sentences stating that they do not accept or reject EU or any other theory (p. 40 penultimate para, p. 67 bottom), where EU is defended by the possibility of choosing strange utility functions (with convex segments and depending on prior gains, the latter being in fact prospect theory framing with reference dependence and not EU). However, there are oceans of literature, since Friedman & Savage (1948) showing that such functions are no good, so the statements are absurd. One of the authors told me they added these claims reluctantly because one referee insisted much on it. Another illustration that referees have too much power in the present system.

decreasing ARA/increasing RRA: they find it confirmed (p. 45 bottom, p. 46)

§4: in EU analysis, they use expo-power utility with initial wealth just as additional free parameter (p. 52 end of 1st para).

NonEU in dynamic situations is done through backward induction. %}

Post, Thierry, Martijn van den Assem, Guido Baltussen, & Richard Thaler (2008) “Deal or No Deal? Decision Making under Risk in a Large-Payoff Game Show,” *American Economic Review* 98, 38–71.

{% Subjects are daily investors in stock trading floors of brokerage houses in China. Consider two outcomes, good (U=1) or bad (U=0). For risk, they assume EU. For ambiguity, let us assume the whole set of probabilities, so that a gamble is valued by (1−α). If they find the objective probability p of getting the good prize that is equivalent, then immediately we have 1−α = p, so we, can measure α without having to measure risk attitude. It can similarly be done if the set of priors is a set other than the set of all known probabilities, e.g., [0.20, 0.70], as done in this paper (p. 199 sugests [20,70] but other parts suggest [30, 70]). Finding the p is in fact finding a matching probability. The authors give a somewhat complex derivation (§3), but it can be as simple as just stated (easily extended to [0.20, 0.70]). Dimmock, Kouwenberg, & Wakker (2016, Theorem 3.1) showed more generally that matching probabilities are easy tools to measure ambiguity attitudes. I regret now that we did not know about this paper, which I read only in March 2019, because I would have liked to cite it for partial priority here.

Risk aversion is measured through the CRRA index. **correlation risk & ambiguity attitude**: find a weakly positive relation (p. 209).

Anxious subjects are more risk averse. Subjects with higher school education are both more risk averse and more ambiguity averse. Income and wealth and gender have no effect. %}

Potamites, Elizabeth & Bei Zhang (2012) "Heterogeneous Ambiguity Attitudes: A Field Experiment among Smallscale Stock Investors in China," *Review of Economic Design* 16, 193–213.

{% **crowding-out**: government subsidies seem to crowd-out private donations and charitable contributions. %}

Poterba, James M., Stephen F. Venti & David A. Wise (1998) "401(k) Plans and Future Patterns of Retirement Saving," *American Economic Review* 88, 179–184.

{% **cognitive ability related to discounting**; **cognitive ability related to risk/ambiguity aversion**

This paper reanalyzes data by Falk et al. (2018 QJE). Countrywise, cognitive ability is negatively related to impatience but, remarkably, positively to risk aversion. %}

Potrafke, Niklas (2019) "Risk Aversion, Patience and Intelligence: Evidence Based on Macro Data," *Economics Letters* 178, 116–120.

{% %}

Potter van Loon, Rogier J. D., Martijn J. van den Assem, & Dennie van Dolder (2015) "Beyond Chance? The Persistence of Performance in Online Poker," *PLOS ONE* 10(3), e0115479.

https://doi.org/10.1371/journal.pone.0115479

{% %}

Poulton, E. Christopher (1968) "The New Psychophysics: Six Models for Magnitude Estimation," *Psychological Bulletin* 69, 1–19.

{% Aangeraden door Peep Stalmeier %}

Poulton, E. Christopher (1979) "Models for Biases in Juding Sensory Magnitude," *Psychological Bulletin* 86, 777–803.

{% (Taken from a Birnbaum 1992 review) Ch. 4 is on how small other stimuli in the experiment may lead to overestimation of a stimulus now considered, and so on. Ch. 5 is on the centering bias, Ch. 6 on the logarithmic bias (taking ratios, for instance, where differences should be taken; I guess it is like the **ratio bias**). Ch. 7 is on contraction biases (staying too close to average, as with regression to the mean), Ch. 8 is on range-equalizing biases (subects tend to just map whatever stimulus range presented onto the whole response-range presented). Ch. 9 is on transfer bias, where questions in experiments are influences by the other questions presented. Ch. 10 argues, in the log-power controversy, that power does not work. %}

Poulton, E. Christopher (1989) "*Bias in Quantifying Judgments.*" Erlbaum, Hillsdale NJ.

{% %}

Poupart, Pascal, Craig Boutilier, Relu Patrascu, & Dale Schuurmans (2002) "Piecewise Linear Value Function Approximation for Factored MDPs," Dept. of Cumputer Science, University of Toronto, Toronto, Canada.

{% Using the Indonesia Family Life Survey data, this paper finds that SEL (subjective economic ladder) is determined by the rank in society rather than by absolute level. %}

Powdthavee, Nattavudh (2009) "How Important is Rank to Individual Perception of Economic Standing? A within-Community Analysis," *Journal of Economic Inequality* 7, 225–248.

{% **gender differences in risk attitudes**: women are somewhat more risk averse than men.

correlation risk & ambiguity attitude: Although they have data, they do not report on this point. Seems they found women also to be more ambiguity averse, but I could not find it stated clearly. %}

Powell, Melanie & David Ansic (1997) "Gender Differences in Risk Behaviour in Financial Decision-Making: An Experimental Analysis," *Journal of Economic Psychology* 18, 605–628.

{% They gathered six focus groups with 30 members of the UK adults to come together three weekends, and discuss evaluations of health states. They focused the discussion on the question of whether one better consult the general public using hypothetical health states, or patients who experienced the health state. They conclude that the UK public is against evaluations by the general public using hypothetical health states.

The paper is in the spirit of the constructive view of preference, as I like it ("get more out of fewer subjects" by more interviewer influence). But it does not focus on what the evaluations of health states then can be (which would be the central topic of utility measurement using the constructive approach or whatever, and is my central interest), but instead on the meta-question of how the general public thinks about the measurement/policy question of which method to use. This study is still useful in weakening the argument, often put up for using the general public with hypothetical descriptions because they are paying (through taxes), that the general public does not seem to feel it that way. %}

Powell, Philip A., Milad Karimi, Donna Rowen, Nancy Devlin, Ben van Hout, & John E. Brazier (2023) "Hypothetical versus Experienced Health State Valuation: A Qualitative Study of Adult General Public Views and Preferences," *Quality of Life Research* 32, 1187–1197.
https://doi.org/10.1007/s11136-022-03304-x

{% **part-whole bias**: for attributes splitting and other biases for attribute weights. %}

Pöyhönen, Mari & Raimo P. Hämäläinen (2000) "Notes on the Weighting Biases in Value Trees," *Journal of Behavioral Decision Making* 11, 139–150.

{% They propose a sequential version of existing statistical tests, which can improve significance/power/sample size. %}
Pramanik, Sandipan, Valen E. Johnson, & Anirban Bhattacharya (2021) "A Modified Sequential Probability Ratio Test," *Journal of Mathematical Psychology* 101, 102505.

{% %}
Prasnikar, Vesna (1993) "Binary Lottery Payoffs: Do They Control Risk Aversion?," Discussion Paper (Northwestern University, The Center for Mathematical Studies in Economics and Management Science)

{% Multiple agents and multiple principals. Characterize pure-strategy equilibria and efficient equilibria. %}
Prat, Andrea & Aldo Rustichini (2003) "Games Played through Agents," *Econometrica* 71, 989–1026.

{% **foundations of statistics**; p. 164 seems to write: "nevertheless NP theory is arbitrary, be it however 'objective'," %}
Pratt, John W. (1961) Book Review of: Erich L. Lehmann (1959) "Testing Statistical Hypotheses," Wiley, New York; *Journal of the American Statistical Association* 56, 153–156.

{% %}
Pratt, John W. (1964) "Risk Aversion in the Small and in the Large," *Econometrica* 32, 122–136.

{% "Few problems are important enough or self-contained enough to warrant a full-blown approach with honest prior distributions and utility functions, and *I have been amazed by some people's success in getting subjective expected utility used in practical situations*. But to me, the clarification of thinking and discourse is much more important than any immediate practical application." [Italics added here.] The italicized part is, I guess, a criticism of the strong (**ubiquity fallacy**) one finds in decision analysis. %}

Pratt, John W. (2000) Interviewed by Thomas Eppel, *Decision Analysis Newsletter* 19, 4–5.

{% The paper presents a very elementary and accessible derivation of subjective expected utility that, à la Anscombe-Aumann (1963), uses objective probabilities. Unfortunately, the authors, as do Anscombe-Aumann, use multistage prospects in a heavy manner. %}

Pratt, John W., Howard Raiffa, & Robert O. Schlaifer (1964) "The Foundations of Decision under Uncertainty: An Elementary Exposition," *Journal of the American Statistical Association* 59, 353–375.

{% %}

Pratt, John W., Howard Raiffa, & Robert O. Schlaifer (1965) "*Introduction to Statistical Decision Theory.*" McGraw-Hill, New York.

{% Seem to have the **ratio-difference principle. %**}

Pratt, John W., David A. Wise, & Richard J. Zeckhauser (1979) "Price Differences in Almost Competitive Markets," *Quarterly Journal of Economics* 93, 189–211.

{% They assume expected utility. Proper risk aversion means that if two lotteries are unacceptable, the independent combination of the two should also be. So, exactly the thing to rule out the Samuelson colleague example. Most plausible utility functions satisfy properness. %}

Pratt, John W. & Richard J. Zeckhauser (1987) "Proper Risk Aversion," *Econometrica* 55, 143–154.

{% **foundations of statistics** %}

Pratt, John W. & Robert O. Schlaifer (1988) "On the Interpretation and Observation of Laws." *In* Omar F. Hamouda & J.C. Robin Rowley (1997, eds.) "*Statistical Foundations for Econometrics.*" Edward Elgar, Cheltenham.

{% **measure of similarity** %}

Prechelt, Lutz, Guido Malpohl, & Michael Philippsen (2002) “Finding Plagiarisms among a Set of Programs with JPlag,” *Journal of Universal Computer Science* 8, 1016–1038.

{% Modify the remarkably successful linear averaging aggregation rule for expert aggregation, by allowing for incompleteness and inconsistency, and doing something like best approximation. %}

Predd, Joel B., Daniel N. Osheron, Sanjeev R. Kulkarni, & H. Vincent Poor (2008) “Aggregating Probabilistic Forecasts from Incoherent and Abstaining Experts,” *Decision Analysis* 5, 177–189.

{% %}

Prékopa, András & Gergely Mádi-Nagy (2008) “A Class of Multiattribute Utility Functions, *Economic Theory* 34, 591–602.

{% %}

Prelec, Drazen (1982) “Matching, Maximizing, and the Hyperbolic Reinforcement Feedback Function,” *Psychological Review* 89, 189–231.

{% P. 27: “Two time intervals [t,s] and [t´,s´] have the same discount rate” is a beautiful way the author expresses (t:x) ~ (s:y) and (t´:x) ~ (s´:y). %}

Prelec, Drazen (1989) “Decreasing Impatience,” working paper.

{% %}

Prelec, Drazen (1990) “A ‘Pseudo-Endowment’ Effect and Its Implications for Some Recent Nonexpected Utility Models,” *Journal of Risk and Uncertainty* 3, 247–260.

{% **inverse S**; **tradeoff method**: in Appendix 1;

Introduces some parametric families for probability transformations.

The most interesting, and by far most popular, family is the two-parameter CI. (compound invariance),

$w(p) = [\exp(-(-\ln p)^{\alpha})]^{\beta}$, $0 < \alpha < 1$, $\beta > 0$.

Expected utility results for $\alpha = \beta = 1$. The smaller α the more inverse S-shaped it is, the higher β the lower (more pessimistic) the curve. It is an affine transformation at the level $-\ln(-\ln(p))$.) It satisfies subproportionality making it suited for very small probabilities, but also performs well, giving nice inverse S-shape, for not-very-small probabilities. Remarkably, this good empirical family also has a preference axiomatization. It also has other nice analytical properties.

Big drawback is that the parameter α, meant to capture insensitivity, also impacts optimism/pessimism. Garphical illustrations can show this. The following calculations also can: Set the pessimism index β at its neutrality level $\beta = 1$, and α at its empirically prevailing level of $\alpha = 0.65$. Then for all nonextreme probabilities $0.05 \le p \le 0.95$, we have $1 - w(p) - w(1-p) > 0$, with a maximal value 0.09 at $p = 0.50$, showing pessimism. For the extreme probabilities $|p| \le 0.04$ slight optimism is generated.

Unfortunately, Prelec promotes the one-parameter family with $\beta = 1$. I think that the two-parameter family is the most important one.

Definition 1 (compound invariance) should be restricted to nonzero outcomes and probabilities. $x = y = x' = 0 = p = q = r$ and $y' = 1 = s$ and $s = y' = 1$ provide a counterexample to the condition with 0 probabilities. (Restricting to only nonzero outcomes or to only nonzero probabilities will also work.)

(First version: Prelec, Drazen (1989) "On the Shape of the Decision Weight Function," Harvard Business School, Harvard University, Cambridge, MA, USA.)

In the CI family, the two parameters are not very well separated. The α parameter, supposed to capture insensitivity, also somewhat affects elevation. This can be seen from Wakker (2010 Figure 7.2.2). For the figures with $\beta = 1$, the fourth (outer right) figure with $\alpha = 0.35$ has the curve on average lower than the second figure with $\alpha = 1$ (EU). So, with β fixed, lowering α led to some decrease of elevation. In this regard the Goldstein-Einhorn (1987) family is better (Wakker 2010 Figure 7.2.3). %}

Prelec, Drazen (1998) "The Probability Weighting Function," *Econometrica* 66, 497–527.

{% **DC = stationarity**, p. 512 top, but bottom properly mentions the assumption of time invariance “and who resets the zero on the discount function when the next decision arrives”

Footnote 1 p. 513 lists empirical violations of stationarity; p. 516 bottom: Hybrid model. Considers Pratt-Arrow concavity of log of discount function as index of impatience. The paper throughout treats stationarity and dynamic consistency as if equivalent.

P. 526, end of §VI, suggests that time perception may be driven by the numerosity effect. It does not use the term numerosity effect, and refers only to Rubinstein’s similarity model, but it is in fact a general argument for the numerosity effect. %}

Prelec, Drazen (2004) “Decreasing Impatience: A Criterion for Non-Stationary Time Preference and “Hyperbolic” Discounting,” *Scandinavian Journal of Economics* 106, 511–532.

{% Prelec (personal communication) credits Shane Frederick for having invented the term truth serum to describe **proper scoring rules**.

probability elicitation. A large group of people all start from the same state of info (common prior à la Harsanyi 1988; logical view of probability à la Carnap). The only difference between people is which one of m possible signals each received. $t^r_i = 1$ means that person r received signal i (so, t can stand for True signal). Then $t^r_j = 0$ for all $j \neq i$. Each person is asked to report his signal, where they can lie if they want. $x^r_j = 1$ means that person r reports signal j. Then $x^r_i = 0$ for all $i \neq j$. $x\acute{}_k$ (denoted x_bar_k in the paper, but here on internet I cannot implement the bar notation) is the portion of the group reporting signal k; i.e., it is the average of the x^r_k over r. Every person is also asked to report an estimate of the $x\acute{}_k$. y^r_k is the estimate of person r of $x\acute{}_k$. Every person is rewarded for the y anwers and for the x answers, in the following way, where I treat only the case of $a = 1$ in Eq. 2 of Prelec. We will assume hereafter that the group is so large that a single-person’s answers do not influence the group averages. For the single-person optimization problems below, consequently, the group averages are treated as constants.

Person 1 (and every other person alike) is rewarded for his y answers through the usual (well, averaged) logarithmic proper-scoring rule reward:

$$\Sigma_k\, x'_k ln(y^1_k). \qquad (*)$$

(The *ln*'s are all negative, so, he has to pay here.) Given that the x'_k are the true population averages, it is well known that the optimal result is obtained by setting $y^1_k = x'_k$. Person 1 does not know x'_k and must use subjective estimates. It is well known that the person (under subjective expected value maximization) best gives the true subjective estimates of the x'_k's.

Person 1 also receives a positive constant amount:

$$-\Sigma_k\, x'_k ln(x'_k). \qquad (**)$$

Before we turn to the reward for person 1 for his x answer, first a notation: y'_k is the *geometric* average of y^r_k over r. That is, $ln(y'_k)$ is the average of $ln(y^r_k)$ over r. Now the reward for person 1 for his x answer is

$$ln(x'_k/y'_k) \text{ where k indicates the answer given.} \qquad (***)$$

That is, $x^1_k = 1$ and $x^1_j = 0$ for all $j \neq k$. The person should therefore seek to answer that k for which, in proportional terms, the population will mostly underestimate the true proportion. (Where they will be most surprised by the true proportion.) This paper assumes that person 1 expects the biggest underestimation by the population, so, the biggest surprise x'_k/y'_k, at his true answer of true signal k. In other words, *starting from the info that person 1 has about the others' opinions, he assumes that his private signal moves closer to the truth*. Then incentive compatibility trivially follows. The required assumptions are often not satisfied, (e.g., speaking for myself, if I like a politician then it usually is one that will receive only few votes), and this paper is to be applied only where they are. Often in case of violation something can be done such as embedding the question in more complex questions. Anyway, under the assumptions made you should honestly report your true signal.

In total person 1 receives (*) + (***), plus also the constant (**). Because the y-answer of person 1 does not affect (***) and the x-answer does not affect (*), these constitute two independent optimization problems. The one for y-answers serves only to get the true y-answer estimates from each individual, to be used in (***).

Several assumptions in this paper are questionable from the practical perspective. The assumption that apart from the private signal received and asked

in the question, everything else is common knowledge and is the same for all people, is very very restrictive. But given that, the basic idea is impressive and valuable. The rewards make people tell the truth without requiring that the events in question become observable before payment takes place. This is an impressive achievement distinguishing this paper from traditional proper scoring rules or decision-based elicitations. In principle, we can observe everything of people this way, how happy they feel, and so on. Also, it does not require observability of any prior distribution, resolving a major restriction to the application of proper scoring rules. The paper achieves these things by assuming a group process for the signals and the corresponding subjective probabilities depending on the true beliefs that make the true beliefs observable after all, because the difference between the private signal and the assumed group average is assumed to be in the direction of the believed truth. The paper applies its technique not only to observable questions/signals, where the application is clear-cut, but also to questions such as what people think is "the" or "best" probability estimate, given all the info of mankind, that mankind will survive the coming century. Such concepts of probability are not easy to imagine or think about, so that the application is less clear-cut here.

Johnson, Pratt, & Zeckhauser (1990) and others also study truth-revelation mechanisms, but a big difference seems to be that their mechanisms assume the common prior to be known, and Prelec does not need this info. %}

Prelec, Drazen (2004) "A Bayesian Truth Serum for Subjective Data," *Science* 306, October 2004, 462–466.

{% %}

Prelec, Drazen (2006) "Rebuilding the Boat while Staying Afloat: The Modeling Challenge for Behavioral Economics," *Journal of Marketing Research* 43, 332–336.

{% **present value**; **time preference**; they nicely list major empirical phenomena, found in several fields, here for time preference, such as decreasing absolute and inceasing proportional sensitivity, which correspond for instance to decreasing absolute (DARA) and increasing relative (IRRA) risk aversion of utility.

intertemporal separability criticized;
Point out discontinuity at 0 for discounting. %}

Prelec, Drazen & George F. Loewenstein (1991) “Decision Making over Time and under Uncertainty: A Common Approach,” *Management Science* 37, 770–786.

{% %}

Prelec, Drazen & George F. Loewenstein (1997) “Beyond Time Discounting,” *Marketing Letters*, 97–108.

{% %}

Prelec, Drazen & George F. Loewenstein (1998) “The Red and the Black: Mental Accounting of Savings and Debt,” *Marketing Science* 17, 4–28.

{% They reconsider the Prelec (Science, 2004) Bayesian truth serum. They consider now the answer k for which the people selecting that answer received the highest score. Under some assumptions about the relation between the true answer and how people develop their beliefs/probabilities, something like the true answer having a true group percentage most exceeding the estimated average, the method will then with high likelihood select the true answer. %}

Prelec, Drazen & H. Sebastian Seung (2007) “An Algorithm That Finds Truth even if Most People Are Wrong,”

{% %}

Prelec, Drazen & Duncan Simester (2001) “Always Leave Home without It: A Further Investigation of the Credit-Card Effect on Willingness to Pay,” *Marketing Letters* 12, 5–12.

{% %}

Prelec, Drazen, Birger Wernerfelt, & Florian Zettelmeyer (1996) “The Role of Inference in Context Effects: Inferring What You Want from What is Available,” *Journal of Consumer Research* 24, 118–125.

{% **foundations of statistics** %}

Press, James (2003) "*Subjective and Objective Bayesian Statistics, Principles, Models, and Applications*." Wiley, New York.

{% **crowding-out**: p. 18 seems to question the crowding-out effect. %}

Prendergast, Canice (1999) "The Provision of Incentives in Firms," *Journal of Economic Literature* 37, 7–63.

{% **conservation of influence**: through illusion of control. A meta-analysis. %}

Presson, Paul K. & Victor A. Benassi (1996) "Illusion of Control: A Meta-Analytic Review," *Journal of Social Behavior and Personality* 39, 104–113.

{% **inverse S**, intersecting diagonal at about .2 (for utility linear). Probability transformation seems to be .42 at .50!

Certainty equivalents were obtained from bidding games, each time between two persons, where the highest bidder got the prospect. This encourages subjects to bid less than the fair price and, hence, we get an overestimation of risk aversion, and strategic behavior as a horrible confound. The tendency to overbid, and winner's curse, lead to biases that reduce risk aversion.

questionnaire versus choice utility: p. 184 footnote 3: "Also by purely social scientists (e.g. J. von Neumann and O. Morgenstern, Theory of Games and Economic Behavior, 1944, 1-641). … It is interesting to note that these writers appear to hold the understanding of economic phenomena without recourse to psychological theory as a worthwhile ideal (a familiar theme for those acquainted with the efforts in psychology to understand psychological phenomena without recourse to physiological theory)."

Likelihood-sensitivity (inverse S) ordering: Unsophisticated men exhibit least, then sophisticated subjects, then women, in the sense that the first category has least overweighting of small probabilities and least underweighting of high probabilities (see Table II) (**gender differences in risk attitudes**). That sophisticated men deviate more from linearity than unsophisticated is strange, and deviates from the authors' suggestion on pp. 191 line 1 ("while it may reduce them [effects]"). It makes me wonder if the unsophisticated-men and sophisticated-subects have been interchanged in Table II.

linear utility for small stakes: They use linear utility. They justify this by pointing out that for small probabilities there is risk seeking, for large there is risk

aversion, irrespective of what the prizes are (pp. 187-188; **inverse S**). A strong argument deserving more attention also now, in 2015! %}

Preston, Malcolm G. & Philip Baratta (1948) “An Experimental Study of the Auction Value of an Uncertain Outcome,” *American Journal of Psychology* 61, 183–193. https://doi.org/10.2307/1416964

{% **probability communication**: communicate probabilities numerically and visually (icon arrays) in some variations and see how that affects risk attitudes. %}

Price, Paul C., Grace A. Carlock, Sarah Crouse, & Mariana Vargas Arciga (2022) “Effects of Icon Arrays to Communicate Risk in a Repeated Risky Decision-Making Task,” *Judgment and Decision Making* 17, 378–399.

{% %}

Principi, Giulio, Peter P. Wakker, & Ruodu Wang (2025) “Anticomonotonicity for Preference Axioms: The Natural Counterpart to Comonotonicity,” *Theoretical Economics*, forthcoming. http://personal.eur.nl/Wakker/pdf/antimon.pdf

{% **cognitive ability related to risk/ambiguity aversion**: has the data but does not seem to report this.

correlation risk & ambiguity attitude: has the data but does not seem to report this.

Follow-up on Abdellaoui, Klibanoff, & Placido (2015) and Halevy (2007). Better score in arithmetic test $\Rightarrow$ better RCLA. Framing also affects relation RCLA and ambiguity aversion. No clear relation is found.

Ambiguity is generated by starting from known composition, and then letting students randomly take out some things, unknown to all. This is in fact 2nd order probabilities. (**second-order probabilities to model ambiguity**). The thing it is to be related to. Use certainty equivalents (through choice list and RIS) to measure all attitudes. Ambiguity neutral likelihoods were always 0.5.

Index of risk aversion is risk premium normalized by dividing by maximum outcome, and ambiguity aversion index is difference between that and its analog for ambiguity. So, ambiguity aversion is indeed how much uncertainty *deviates* from risk, which is my preferred definition. For between-subject comparisons, the main purpose of this study, the indexes are OK. But they are not very well suited for comparisons to other studies, for one reason because dividing by the maximum outcome provides overcorrection, implementing local risk and ambiguity neutrality. Yet such measures are widely used in the literature. %}

Prokosheva, Sasha (2017) “Comparing Decisions under Compound Risk and Ambiguity: The Importance of Cognitive Skills,” *Journal of Behavioral and Experimental Economics* 64, 94–105.

{% P. 1383: that decision analysis is mostly used at group level. %}

Protheroe, Joanne, Tom Fahey, Alan A. Montgomery, & Tim J. Peters (2000) “The Impact of Patients’ Preferences on the Treatment of Atrial Fibrillation: Observational Study of Patient Based Decision Analysis,” *British Medical Journal* 320, 1380–1384.

{% **conservation of influence**; argue that intelligence is goal-oriented, and that getting this is the big problem in AI. %}

Prudkov, Pavel N. (2010) “A View on Human Goal-Directed Activity and the Construction of Artificial Intelligence,” *Minds & Machines* 20, 363–383.

{% Paradoxes of finite additivity and infinitesimals. %}

Pruss, Alexander R. (2014) “Infinitesimals are too Small for Countably Infinite Fair Lotteries,” *Synthese* 191, 1051–1057.

{% Used epicycles (midpoints of circles themselves circle around other midpoints) to explain planetary movements. Seems to have argued that this need not be going on physically, but it is only a mathematical model that happens to fit the planetary movements. So, that it was paramorph. %}

Ptolemy, Claudius (±150) “*Almagest*.”

{% Survey concepts of comonotonicity and counter-monotonicity. %}

Puccetti, Giovanni & Ruodu Wang (2015) “Extremal Dependence Concepts,” *Statistical Science* 30, 485–517.

https://doi.org/10.1214/15-STS525

{% r**eal incentives/hypothetical choice, for time preferences**: seems to be on it %}

Prissé, Benjamin (2023) "Visual Continuous Time Preferences," *Frontiers in Behavioral Economics* 2, 1206679.
https://doi.org/10.3389/frbhe.2023.1206679

{% %}

Puelz, Robert & Arthur Snow (1994) "Evidence on Adverse Selection: Equilibrium Signaling and Cross-Subsidization in the Insurance Market," *Journal of Political Economy* 102, 236–257.

{% PE (if I remember well, they call it SG) correlated better with validation measures. **PE doesn't do well**: well, here it does well! %}

Puhan, Milo A., Holger J. Schünemann, Eric Wong, Lauren Griffith, & Gordon H. Guyatt (2007) "The Standard Gamble Showed Better Construct Validity than the Time Trade-off," *Journal of Clinical Epidemiology* 60, 1029–1033.

{% Real incentives: not clear. P. 1082 describes instructions: "If you get a blue marble, you will be entered into a lottery draw with a cash prize." I saw no other info on it. So, I'm not sure if incentives are for real, and what the cash prize was or its probability. Footnote 1 p. 1084 refers to a nonpublished treatment with:

random incentive system between-subjects (paying only some subjects)**.**

The author writes precisely and accurately about concepts in a clear way that often is not psychologist s'strongest point. A pleasure to read!

suspicion under ambiguity: The author does the Ellsberg experiment where subjects cannot choose the color to gamble on. However, here it is not a mistake as it is in sloppy experiments, but here it is done deliberately so as to investigate suspicion about rigging the balls. In one treatment ambiguity is nothing but second-stage probability (**second-order probabilities to model ambiguity**) and there is no reason to suspect the experimenter has rigged the balls except when the experimenter did outright lying (which often happens especially in psychology where it sometimes cannot be avoided). In the other treatment no info is given and there is more reason to suspect rigging of the balls.

The author concludes (p. 1086, end of penultimate para): "Future researchers, using the two-colour Ellsberg urns task, with a specified target colour to be drawn, should also consider the issue of trust in the experimenter not to rig the urn, as this needs controlling for if pure ambiguity aversion is to be measured." (**suspicion under ambiguity**) %}

Pulford, Briony D. (2009) "Is Luck on My Side? Optimism, Pessimism, and Ambiguity Aversion," *Quarterly Journal of Experimental Psychology* 62, 1079–1087.

{% %}

Pulford, Briony D. & Andrew M. Colman (2007) "Ambiguous Games: Evidence for Strategic Ambiguity Aversion," *Quarterly Journal of Experimental Physiology* 60, 1083–1100.

{% Subjects play lotteries, not knowing they are rigged. The subjects who were lucky (or thought so) became more ambiguity seeking. So, it is a spillover effect. This was in the first experiment. It did not replicate in four follow-up experiments. Men are more ambiguity averse for gains but not for losses. Ambiguity is generated by 2nd order probability (**second-order probabilities to model ambiguity**). Not in the first, but in the 2nd experiment, subjects could choose the gaining color as control for suspicion. (**suspicion under ambiguity**) %}

Pulford, Briony D. & Poonam Gill (2014) "Good Luck, Bad Luck, and Ambiguity Aversion," *Judgment and Decision Making* 9, 159–166.

{% **questionnaire versus choice utility**: Derive utilities from discrete latent choice models, and from TTO, and investigate correlations (are big) and ways to transform one into the other. %}

Pullenayegum, Eleanor & Feng Xie (2013) "Scoring the 5-Level EQ-5D: Can Latent Utilities Derived from a Discrete Choice Model Be Transformed to Health Utilities Derived from Time Tradeoff Tasks?," *Medical Decision Making* 33, 567–578.

{% Door Wenny gepresenteerd in referaat op 1 december 1993. %}

Puma, John la & Edward F. Lawlor (1990) "Quality-Adjusted Life Years; Ethical Implications for Physicians and Policymakers," *JAMA* 263, 2917–2921.

{% Writes down the form of outcome dependent capacity; %}
Puppe, Clemens (1990) "Preference Functionals with Prize-Dependent Distortion of Probabilities," *Economics Letters* 33, 127–131.

{% %}
Puppe, Clemens (1990) "*Distorted Probabilities and Choice under Risk.*" Springer Lecture notes 363. Springer, Berlin.

{% fuzzy sets %}
Puppe, Clemens (1994) "Rational Choice Based on Vague Preferences," *Annals of Operations Research* 52, 67–81.

{% **preference for flexibility** %}
Puppe, Clemens (1995) "Freedom of Choice and Rational Decisions," *Social Choice and Welfare* 12, 137–153.

{% **preference for flexibility** %}
Puppe, Clemens (1996) "An Axiomatic Approach to "Preference for Freedom of Choice"," *Journal of Economic Theory* 68, 174–199.

{% Do Gilboa-Schmeidler minimax when outcome sets for different states need not be identical, but have sufficient overlap to do the scaling of priors and so on. %}
Puppe, Clemens & Karl H. Schlag (2009) "Choice under Complete Uncertainty when Outcome Spaces Are State-Dependent," *Theory and Decision* 66, 1–16.

{% **coalescing** %}
Puri, Indira (2024) "Simplicity and Risk," *Journal of Finance*, forthcoming. https://doi.org/10.1111/jofi.13417

{% %}
Puri, Manju, & David T. Robinson (2007) "Optimism and Economic Choice," *Journal of Financial Economics* 86, 71–99.

{% %}
Puri, Manju, & David T. Robinson (2013) “The Economic Psychology of Entrepreneurship and Family Business,” *Journal of Economics and Management Strategy* 22, 423–444.

{% Shows that intertemporal preferences have to reckon with subjective preferences if the market is not perfect, with different borrowing and lending rates. %}
Pye, Gordon (1966) “Present Values for Imperfect Capital Markets,” *Journal of Business* 39, 45–51.

{% Seems to describe wishful thinking: assigning higher likelihood to preferred outcome; (**inverse S (= likelihood insensitivity) related to emotions ?**) %}
Pyszczynski, Thomas A. (1982) “Cognitive Strategies for Coping with Uncertain Outcomes,” *Journal of Research in Personality* 16, 386–399.

{% Generalize additive representations by imposing separability (they use Reidemeister condition) on subsets. First they derive a general additive representation V(x,z) + V(y,z) for (x,y) for each fixed level of z. Then they use that to generalize many results in the literature, such as Rohde’s (2010) preference foundation of the Fehr-Schmidt welfare model, rank-dependent utility, linear representations in mixture spaces, and other things. %}
Qin, Wei-zhi & Hendrik Rommeswinkel (2024) “Conditionally Additive Utility Representations,” *Theory and Decision* 96, 555–595. https://doi.org/10.1007/s11238-023-09962-8

{% **tradeoff method**: Use it like Abdellaoui (2000), for gains. Replicate the Abdellaoui (2000) non-parametric measurement method with N = 124. **inverse S:** Strangely enough, find convex w more than concave or inverse S. It shows that probability weighting is volatile. (I would say that basic utility is most stable, then probability weighting is second, and loss aversion is the least.) A nice addition that this paper gives: Even though conceptually and theoretically, probability weighting is a new component, it would not be very worthwhile if it was strongly related to utility curvature statistically. This paper finds that it is not strongly related, so that it does explain additional variance in the data. They also

reanalyze the data of Bleichrodt & Pinto (2000), finding the same result. They could not reanalyze the data of Abdellaoui (2000) because those are lost.

Utility deviates from linearity and is concave. %}

Qiu, Jianying & Eva-Maria Steiger (2011) "Understanding the Two Components of Risk Attitudes: An Experimental Analysis," *Management Science* 57, 193–199.

{% The authors measure multiple priors, but take the term in an unconventional sense. On the one hand it refers to two-stage probabilities, on the other hand to single priors entertained by other students in the experiment. The latter is equated, for an event, with its matching probability. They equate these two, calling this equation a leap of faith (p. 57), but giving arguments. Thus they get the two-stage structure of the smooth model. For the smooth model they allow using information about 2nd order distribution, but for α maxmin not, and then smooth fits data better. %}

Qiu, Jianying & Utz Weitzel (2016) "Experimental Evidence on Valuation with Multiple Priors," *Journal of Risk and Uncertainty* 53, 55–74.
https://doi.org/10.1007/s11166-016-9244-9

{% Provides arguments against libertarian paternalism typical of philosophers. It says that libertarian paternalists can't be SURE that they maximize welfare and happiness, using "there is no reason that" claims, and being "potentially flawed," and "it is not clear that," "only imperfect guidance." So, it questions everything but gives no alternatives. P. 656 end of 2nd para: Only a few LP proposals would survive democratic debate. P. 657 adds that autonomy has a value of its own. Pp 657/658 argue that to do LP right, and to know welfare right, would require infinite calculative ability which is not available. %}

Qizilbash, Mozaffar (2012) "Informed Desire and the Ambitions of Libertarian Paternalism," *Social Choice and Welfare* 38, 647–658.

{% **probability elicitation**: if we have an incentive-compatible mechanism for measuring the subjective probability of one event E, then we can do if for a set of events by letting the subject report the subjective probability for each event in the set, then randomly selecting one, and applying the mechanism to that event. We

use here a dynamic assumption such as backward induction. The author does this where the set of events concerns all cumulative events in a continuous probability distribution, and links it with Karni (2009). %}
Qu, Xiangyu (2012) "A Mechanism for Eliciting a Probability Distribution," *Economics Letters* 115, 399–400.

{% Axiomatizes maxmin EU in Anscombe-Aumann framework, like Gilboa & Schmeidler (1989), but adds a set of unambiguous events characterized by satisfying regular independence. %}
Qu, Xiangyu (2013) "Maxmin Expected Utility with Additivity on Unambiguous Events," *Journal of Mathematical Economics* 49, 245–249.

{% Axiomatizes maxmin EU, but adds a set of unambiguous events characterized by satisfying regular EU axiom. This paper modifies Qu (2013 JME) by not using Anscombe-Aumann and instead using techniques of Alon & Schmeidler (2014). %}
Qu, Xiangyu (2015) "Purely Subjective Extended Bayesian Models with Knightian Unambiguity," *Theory and Decision* 79, 547–571.

{% Defines more ambiguity averse as Yaari-type bigger preference for certainty equivalents through a hypothetical intermediate agent who has the same utility function as one agent and the same weighting function as the other. Ambiguity neutrality is probabilistic sophistication. Ambiguity aversion is being pointwise dominated by a probability measure (so, a Core element). More ambiguity averse amounts to pointwise dominance of the weighting function. The latter results are in the spirit of Epstein and Ghirardato & Marinacci. %}
Qu, Xiangyu (2015) "A Belief-Based Definition of Ambiguity Aversion," *Theory and Decision* 79, 15–30.

{% A behavioral axiomatization of mean-variance maximization without assuming expected utility. The probabilities are subjective. I did not study the paper enough to understand how preference axioms such as strict quasi-concavity can use probabilities as input if those are subjective. %}

Qu, Xiangyu (2017) "Subjective Mean–Variance Preferences without Expected Utility," *Mathematical Social Sciences* 87, 31–39.

{% Gives a necessary and sufficient condition for a demand function to be monotonic. Formulates it in terms of a condition that is invariance w.r.t. ordinal transformations of utility, and relates it to the Pratt-Arrow index of concavity of the vNM utility function (that is one of the members of the set of all ordinal utility functions). Seems to be that Pratt-Arrow measure in each direction of the commodity space should not vary by more than 4. %}

Quah, John K.-H. (2003) "The Law of Demand and Risk Aversion," *Econometrica* 71, 713–721.

{% %}

Quaid, Kimbery A. & Michael Morris (1993) "Reluctance to Undergo Predictive Testing for Huntington's Disease," *American Journal of Medical Genetics* 45, 41–45.

{% %}

Quattrone, George A. & Amos Tversky (1986) "Self-Deception and the Voter's Illusion." *In* John Elster (ed.) *The Multiple Self*, 35–58, Cambridge University Press, New York.

{% P. 727, **ratio-difference principle**: "impact of any fixed positive difference between two positive amounts increases with their ratio." As formulated, it describes concavity only. %}

Quattrone, George A. & Amos Tversky (1988) "Contrasting Rational and Psychological Analyses of Political Choice," *American Political Science Review* 82, 719–736.

{% %}

Quercia, Simone (2016) "Eliciting and Measuring Betrayal Aversion Using the BDM Mechanism," *Journal of the Economic Science Association* 2, 48–59.

{% Assume two decision problems giving two outcomes and with subjective expected utility maximization each but unrelated otherwise, determining joint utility and separate marginal subjective probabilities, but without identifying joint distributions. %}

Qiu, Wenfeng & David S. Ahn (2021) "Uncertainty from the Small to the Large," *Journal of Economic Theory* 198, 105367. https://doi.org/10.1016/j.jet.2021.105367

{% %}

Qu, Xiangyu (2013) "Maxmin Expected Utility with Additivity on Unambiguous Events," *Journal of Mathematical Economics* 49, 245–249. https://doi.org/10.1016/j.jmateco.2013.02.004

{% **utility measurement**: c**orrect for probability distortion**. First publication of anticipated utility (not Quiggin, 1982!), though it was written after Quiggin (1982). This is a nice paper, clear and accessible, with good ideas on utility measurement.

inverse S

biseparable utility %}

Quiggin, John (1981) "Risk Perception and Risk Aversion among Australian Farmers," *Australian Journal of Agricultural Economics* 25, 160–169.

{% Was published first as Bureau of Agricultural Economics working paper, 1980, and before that in 1979 as part of thesis for Honours degree.

inverse S: p. 326: "Typically events at extremes of the range of outcomes are likely to be overweighted."

biseparable utility

Pp. 328-329, the derivation of Eq. 10 from Eq. 6, shows that a probability weighting function that depends only on the ranked probability vector, must be rank-dependent utility, under some natural assumptions including continuity. Wakker (2010 Exercise 6.7.1) gives a didactical account, showing that continuity is not needed for it. %}

Quiggin, John (1982) “A Theory of Anticipated Utility,” *Journal of Economic Behaviour and Organization* 3, 323–343. https://doi.org/10.1016/0167-2681(82)90008-7

{% %}

Quiggin, John (1982) “A Note on the Existence of a Competitive Optimum,” *Economic Record* 55, 174–176.

{% %}

Quiggin, John (1983) “Underwriting Agricultural Commodity Prices,” *Australian Journal of Agricultural Economics* 27, 200–211.

{% %}

Quiggin, John (1985) “Anticipated Utility, Subjectively Weighted Utility and the Allais Paradox,” *Organisational Behavior and Human Performance* 35, 94–101.

{% %}

Quiggin, John (1986) “Anticipated Utility: Some Developments in the Economic Theory of Uncertainty,” Ph.D. Thesis, University of New England, Australia.

{% %}

Quiggin, John (1987) “On the Nature of Probability Weighting: Response to Segal,” *Journal of Economic Behavior and Organization* 8, 641–645.

{% %}

Quiggin, John (1988) “Increasing Risk: Another Definition,” University of Sydney.

{% %}

Quiggin, John (1989) “Sure Things—Dominance and Independence Rules for Choice under Uncertainty,” *Annals of Operations Research* 19, 335–357.

{% %}

Quiggin, John (1990) “Stochastic Dominance in Regret Theory,” *Review of Economic Studies* 57, 503–511.

{% Explains Friedman-Savage (1948) and gambling. %}
Quiggin, John (1991) “On the Optimal Design of Lotteries,” *Economica* 58, 1–16.

{% Seems to propose, for random variables X,Y, that X(s)Y(s) ≥ 0, i.e., that they are cosigned. %}
Quiggin, John (1991) “Increasing Risk—Another Definition.” *In* Attila Chikàn et al. (eds.) *Progress in Decision, Utility and Risk Theory*, Kluwer Academic Publishers.

{% P. 122: D**C = stationarity**
Very unfortunately, the book applies the weighting function to badnews events and not, as is common nowadays (1990-2023), to goodnews events. So, concavity of the weighting function here is convexity in the modern literature, and so on.
P. 76 footnote 15 argues, and I agree, that it would be better to have the term risk aversion only refer to probabilistic attitude, independent of utility function. I proposed this terminology in early versions of Wakker (1994 Theory and Decision), but received so many criticisms that I gave up; it is too late. %}
Quiggin, John (1993) “*Generalized Expected Utility Theory - The Rank-Dependent Model.*” Kluwer Academic Publishers, Dordrecht.

{% %}
Quiggin, John (1993) “Testing between Alternative Models of Choice under Uncertainty—Comment,” *Journal of Risk and Uncertainty* 6, 161–164.

{% %}
Quiggin, John (1994) “Regret Theory with General Choice Sets,” *Journal of Risk and Uncertainty* 8, 153–165.

{% **PT falsified**: Background risk can “destroy” most of rank dependence, because the background risk mostly determines the ranking position of outcomes that can be all over the place. I learned this from Quiggin (personal communication, end of 1990s). This paper resulted from the insight but, unfortunately, it its final

version only has a weaker result, being that background risk can reduce the risk premium under constant relative and constant absolute risk aversion. A related result is in Barberis, Huang, & Thaler (2006). %}
Quiggin, John (2003) "Background Risk in Generalized Expected Utility Theory," *Economic Theory* 22, 607–611.

{% Proposes value of info (about probabilities) as index of ambiguity (aversion), and shows that for Machina's almost objective events it tends to 0 in the limit. %}
Quiggin, John (2007) "Ambiguity and the Value of Information: An Almost-Objective Events Analysis," *Economic Theory* 30, 409–414.

{% Separates value of awareness and value of information, which sum to a constant. %}
Quiggin, John (2016) "The Value of Information and the Value of Awareness," *Theory and Decision* 80, 167–185.

{% This paper opens with the history of Quiggin's discovery of rank-dependent utility, and confirms the story I tell my students each year, that John also submitted a letter to JPE to criticize Karmarkar (1978), and the history of the Arrow-Debreu state-contingent model. Then it shows that techniques for decision under uncertainty can be applied to production theory, and the history of this. %}
Quiggin, John (2022) "Production under Uncertainty and Choice under Uncertainty in the Emergence of Generalized Expected Utility Theory," *Theory and Decision* 92, 717–729.
https://doi.org/10.1007/s11238-022-09875-y

{% %}
Quiggin, John & Jock R. Anderson (1981) "Price Bands and Buffer Funds," *Economic Record* 57, 67–73.

{% CARA (constant absolute risk aversion) and CRRA jointly are very restrictive. The authors propose a weakening. %}
Quiggin, John & Robert G. Chambers (2004) "Invariant Risk Attitudes," *Journal of Economic Theory* 117, 96–118.

{% %}

Quiggin, John & Peter P. Wakker (1994) "The Axiomatic Basis of Anticipated Utility; A Clarification," *Journal of Economic Theory* 64, 486–499.
https://doi.org/10.1006/jeth.1994.1078
Direct link to paper

{% That sure-thing principle idicates how technical terms in a model should be interpreted. %}

Quine, Williard V. (1951) "Two Dogmas of Empiricism," *Philosophical Review* 60, 20–43.
Reprinted in *From a Logical Point of View*, 1953, Harvard University Press, Cambridge, MA.

{% %}

Quirk, James P. & Rubin Saposnik (1962) "Admissibility and Measurable Utility Functions," *Review of Economic Studies* 29, 140–146.

{% Discuss Binswanger (1981), and argue that Binswanger throughout assumed outcomes in terms of final wealth, and did not consider reference dependence. They discuss in particular for a study of relative risk aversion that one should compare U(w+x), with w initial wealth, to U(aw + ax) and not, as they argue, as Binswanger did, to U(w+ax). %}

Quizon, Jaime, Hans P. Binswanger, & Mark J. Machina (1984) "Attitudes towards Risk: Further Remarks," *Economic Journal* 94, 144–148.

{% They recommend that one QALY should not take more than €80,000. %}

Raad voor de Gezondheidszorg (2006, June 27) "Zinnige en Duurzame Zorg." Report for Minister of Health.

{% %}

Raaij, W. Fred (1997) "The Life and Work of Amos Tversky," *Journal of Economic Psychology* 14, 721–740.

{% %}

Rabin, Matthew (1990) “Communication between Rational Agents,” *Journal of Economic Theory* 51, 144–170. (Corrigendum 1992, *Journal of Economic Theory* 58, 110–111.)

{% %}

Rabin, Matthew (1993) “Information and the Control of Productive Assets,” *Journal of Law, Economics, and Organization* 9, 51–75.

{% %}

Rabin, Matthew (1993) “Incorporating Fairness into Game Theory and Economics,” *American Economic Review* 83, 1281–1302.

{% %}

Rabin, Matthew (1994) “Cognitive Dissonance and Social Change,” *Journal of Economic Behavior and Organization* 23, 177–194.

{% %}

Rabin, Matthew (1994) “Incorporating Behavioral Assumptions into Game Theory.” *In* James Friedman (ed.) *Problems of Coordination in Economic Activity*, Kluwer Academic Publishers, Norwell, MA.

{% %}

Rabin, Matthew (1994) “A Model of Pre-Game Communication,” *Journal of Economic Theory* 63, 370–391.

{% %}

Rabin, Matthew (1996) “Daniel Kahneman and Amos Tversky.” *In* Warren Samuels (ed.) *American Economists of the Late Twentieth Century*, 111–137, Edward Elgar Publishing Ltd, Cheltehem.

{% %}

Rabin, Matthew (1997) Review of Kenneth J. Arrow, Enrico Colombatto, Mark Perlman, & Christian Schmidt (eds.) The Rational Foundations of Economic Behaviour, MacMillan Press Ltd, 1996, *Journal of Economic Literature* 35, 2045–2046.

{% Survey of many empirical psychological findings of deviations from standard classical economic assumptions on preference. %}

Rabin, Matthew (1998) "Psychology and Economics," *Journal of Economic Literature* 36, 11–46.

{% %}

Rabin, Matthew (1999) "Comment on 'What Me Worry? A Psychological Perspective on Economic Aspects of Retirement,' by George F. Loewenstein, Drazen Prelec, & Roberto Weber." *In* Henry Aaron (ed.) *Behavioral Dimensions of Retirement Economics*, The Brookings Institution.

{% %}

Rabin, Matthew (2000) "Diminishing Marginal Utility of Wealth Cannot Explain Risk Aversion." *In* Daniel Kahneman & Amos Tversky (eds.) *Choices, Values, and Frames*, Ch. 11, 202–208, Cambridge University Press, New York.

{% The reasoning on p. 1282, 3rd para, is, for EU with concave utility:

Assume expected utility with concave utility U, and consider the following ASSUMPTION. A person prefers a sure amount $M to a gamble (.5, $M+11; .5, $M−10), for each level of wealth M.

Then u´(M+11)/u´(M−10) < 10/11 for all M. In other words, u´(x+21)/u´(x) < 10/11 for all x.

Then u´(11)/u´(–10) < 10/11, u´(32)/u´(11) < 10/11, etc.

The assumption implies that U is very concave for large amounts of money, and is unsatisfactorily concave. For example, U´(x+21)/U´(x) is at most 10/11 and, therefore, U´(x+2100)/U´(x) is at most $(10/11)^{100}$ = 0.00007; etc. Compare this with constant absolute risk averse (CARA) implying linear-exponential utility, which is also overly concave for large amounts. CARA is a condition of

the kind "for all lotteries and all probabilities …". That is, it is a mathematical condition whose empirical (un)reasonableness is not transparent. Rabin's condition, imposing the invariance w.r.t. M only for one natural preference with moderate stakes, makes the empirical restrictiveness of the Assumption more tangible and shocking. In footnote 2, Rabin points out that the basic idea was presented before by Hansson (1988). Hansson's presentation was, however, way less convincing. (Prelec, personal communication, called Rabin's attention to Hansson.) The conclusion is that expected utility advocates should abandon the displayed assumption. However, the Assumption can be restricted to bounded intervals for M where it is empirically convincing and still implies concavity of utility too extreme to be plausible.

linear utility for small stakes: this is the basic message of this paper.

It has been well known that utility is approximately linear for small stakes. This statement is a mathematical fact without much empirical relevance yet because "approximately" and "small" have no clear meaning. Rabin mentions concrete numbers and, thus, makes it clear that this point is empirically relevant.

People who really want the displayed assumption, may want to adopt a nonEU theory. For example, prospect theory with M as status quo and then loss aversion may explain much of the empirical realism of the above assumption.

risky utility u = strength of preference v (or other riskless cardinal utility, often called value): footnote 3, p. 1282, says that he finds the psychological interpreting of vNM utility the natural way to think about vNM utility.

If the amounts 10 and 11 in the assumption are replaced by $10/\lambda$ and $11/\lambda$ for positive λ, then the concavity of U gets larger as λ gets larger and becomes infinite if λ goes to infinity (so, the betting odds 10:11 are not accepted no matter how small the stake). That is, U then kind of explodes. EU advocates cannot have this. This point reflects that a concave U is almost everywhere differentiable, so is approximately linear for small amounts of money.

Empirically, it will matter a lot if people psychologically integrate M into the outcome (final wealth) as expected utility requires or do not in the Assumption. Prospect theory says they don't and then loss aversion can explain the findings. Rabin recommends loss aversion as main factor to explain in the last para of the main text, pp. 1288-1289.

The result can be reinforced by assuming that a person only declines this 50–50 +11 versus −10 gamble at the current state of wealth, but has concave utility and decreasing ARA (absolute risk aversion) so that he also declines the gamble for all smaller initial wealths. This point is alluded to on p. 1283-1284, with no mention of decreasing ARA, unfortunately.

Kahneman & Tversky (1979, p. 277): "The certainty equivalent of the prospect (1,000, .50), for example, lies between 300 and 400 for most people, in a wide range of asset positions."

Christiane, Veronika & I: P. 1287 discusses relation between small-stakes and large-stakes risk attitudes. In particular, footnote 10 points out the related difficulties for the coefficient of relative risk aversion.

P. 1282: "From such observations we should conclude that aversion to modest-stake risk has nothing to do with diminishing marginal utility of wealth."

Samuelson (1963) also showed that risk aversion in the small can imply implausible risk aversion in the large. Rabin's argument is, however, more convincing. Its preference assumption is less extreme (rejecting $11_{0.5}(-10)$ versus rejecting $200_{0.5}(-100)$), its domain-assumption is less demanding (Samuelson needs invariance of his assumed preference over a large wealth range [−10,000, +20,000]), and its conclusions are stronger (See Rabin's footnote 11, p. 1288).
%}

Rabin, Matthew (2000) "Risk Aversion and Expected-Utility Theory: A Calibration Theorem," *Econometrica* 68, 1281–1292.

{% %}

Rabin, Matthew (2002) "Inference by Believers in the Law of Small Numbers," *Quarterly Journal of Economics* 117, 775–816.

{% %}

Rabin, Matthew (2002) "A Perspective on Psychology and Economics," *European Economic Review* 46, 657–685.

{% Discusses behavioral economics, that it brings in more psychological inputs, but should maintain precision and prediction. The journal gives the author the space to give many examples, where the author himself contributed much. %}

Rabin, Matthew (2013) "Incorporating Limited Rationality into Economics," *Journal of Economic Literature* 51, 528–543.

{% **confirmatory bias**: many many refs %}
Rabin, Matthew & Joel L. Schrag (1999) "First Impressions Matter: A Model of Confirmatory Bias," *Quarterly Journal of Economics* 114, 37–82.

{% %}
Rabin, Matthew & Joel Sobel (1996) "Deviations, Dynamics, and Equilibrium Refinements," *Journal of Economic Theory* 68, 1–25.

{% Comments see the above reference Rabin (2000, Econometrica). The result is also discussed in The Economist of August 11, 2001. This paper brings Rabin's calibration argument more forcefully and eloquently, but several times lacks nuances and civilization.

P. 222 explicitly brings up that the preferences are assumed for all wealth levels.

P. 223, erroneously, writes for Samuelson's colleague that, under EU, rejecting the $200_{0.5}(-100)$ once should imply rejecting independent repetions, but it is very well known that this is not true (Liu & Colman 2009 p. 278). It is only true if [$200_{0.5}(-100)$ once] is rejected at every wealth level that can occur during the process, something that is implied for instance by constant absolute risk aversion.

Pp. 227-228 discusses money pumps. You can get people into small books when there are small transaction costs, e.g. people who, when subscribing to the phone company, in one blow take wiring insurance.

P. 228: "All said, myopic loss averters are subject to many short Dutch chapters in their lives, but not to **Dutch book**s." %}
Rabin, Matthew & Richard H. Thaler (2001) "Anomalies: Risk Aversion," *Journal of Economic Perspectives* 15, 219–232.

{% Develop a theory for the hot-hand fallacy, and derive implications. %}

Rabin, Matthew & Dimitri Vayanos (2010) "The Gambler's and Hot-Hand Fallacies: Theory and Applications," *Review of Economic Studies* 77, 730–778.

{% **real incentives/hypothetical choice**: Find no differences. D**utch book**: Do it only for statistically independent prospects. Prove that under EU no-book/arbitrage then implies exponential utility. This is, indeed, necessary and sufficient for your preference, conditioned on any stage in the decision tree with any acquired wealth up to then, to be the same as your unconditional de-novo preference would be. %}

Rabin, Matthew & Georg Weizsäcker (2009) "Narrow Bracketing and Dominated Choices," *American Economic Review* 99, 1508–1543.

{% %}

Rabinowicz, Wlodzimierz (1987) "Ratifiability and Stability." *In* Peter Gärdenfors & Nils-Eric Sahlin (eds.) *Decision, Probability, and Utility,* 406–427, Cambridge University Press, Cambridge.

{% **updating: discussing conditional probability and/or updating** %}

Rabinowicz, Wlodzimierz (1989) "On Probabilistic Representation of Nonprobabilistic Belief Revision," *Journal of Philosophical Logic* 18, 69–101.

{% %}

Rabinowicz, Wlodzimierz (1995) "To Have One's Cake and Eat It: How to Make Sequential Choices when One's Preferences Violate Expected Utility Axioms," *Journal of Philosophy* 112, 586–620.

{% **dynamic consistency**: argues that Seidenfeld's criticism of McClennen is incorrect. %}

Rabinowicz, Wlodzimierz (1997) "On Seidenfeld's Criticism of Sophisticated Violations of the Independence Axiom," *Theory and Decision* 43, 279–292.

{% **dynamic consistency** %}

Rabinowicz, Wlodzimierz (2000) "Preference Stability and Substitution of Indifferents: A Rejoinder to Seidenfeld," *Theory and Decision* 4, 311–318.

{% **concave utility for gains, convex utility for losses**: Finds evidence for that, convex for low incomes and concave for high. Develops a somewhat complex but pragmatic model where utility depends on reference points. Those are related to both intertemporal and social comparisons. The author makes pragmatic heuristic assumptions about these dependencies, and fits parameters for UK gross income data in 2002. %}

Rablen, Matthew D. (2008) “Relativity, Rank and the Utility of Income,” *Economic Journal* 118, 801–821.

{% Tested, according to Larrick (1993) prospect theory for animals. %}

Rachlin, Howard (1989) “*Judgment, Decision, and Choice: A Cognitive/Behavioral Synthesis*.” Freeman, San Francisco.

{% Not downloadable, strangely enough. %}

Rachlin, Howard (2006) “Notes on Discounting,” *Journal of the Experimental Analysis of Behavior* 85, 425–435.

{% **dynamic consistency**: P. 16 has the basic decomposition of stationarity à la consequentialism, dynamic consistency, prior commitment. They assume stopwatch time.

Use a very simple model of discounting through 1/t. P. 17 credits Ainslie, unpublished, for a similar setup, described in a Rachlin (1970) book. P. 21 has nice argument that t = 0 is impossible (to defend against 1/t being undefined there. Pigeon experiment was not clear to me. How about the time pigeons are waiting before making the next pick? It is hard to imagine how pigeons conceive of precommitment. P. 22 has strange discussion of experiment with children who, having to wait, sometimes fell asleep, and the authors explaining that as a very deliberate devise to help self-control, rather than pure boredom which I find more plausible. **%}**

Rachlin, Howard & Leonard Green (1972) “Commitment, Choice and Self-Control,” *Journal of the Experimental Analysis of Behavior* 17, 15–22.

{% Take social distance between people as primitive, measured through kind of introspection and test how it affects others-regarding, to find that it gets kind of discounted but stronger than intertemporal discounting. Eq. 2, referenced Rachlin (2006), is the same family as used by Goldstein & Einhorn (1987, Eqs. 22-24), also ascribed to Lattimore et al. (1992).

DC = stationarity: p. 31 2nd para %}

Rachlin, Howard & Bryan A. Jones (2008) "Social Discounting and Delay Discounting," *Journal of Behavioral Decision Making* 21, 29–43.

{% %}

Rachlin, Howard, David I. Laibson, & Joeri Gorter (1998) "The Matching Law: Papers in Psychology and Economics," *Economic Journal* 449, 1192–1193.

{% Tested, according to Larrick (1993) prospect theory for animals; seem to point out relation between high discounting and certainty effect. %}

Rachlin, Howard, Alexandra W. Logue, John Gibbon, & Marvin Frankel (1986) "Cognition and Behavior in Studies of Choice," *Psychological Review* 93, 33–45.

{% Seem to use Mazur (1987) discounting function, to use hypothetical questions, to assume linear utility, and fitted data at an individual level, but gives no info about outliers like increasing impatience. %}

Rachlin, Howard, Andres Raineri, & David Cross (1991) "Subjective Probability and Delay," *Journal of the Experimental Analysis of Behavior* 55, 233–244.

{% %}

Racine, Amy, Andrew P. Grieve, & Hubert U. Flühler (1986) "Bayesian Methods in Practice: Experiences in the Pharmaceutical Industry," *Applied Statistics* 35, 93–150.

{% %}

Radmayr, Christian, Hasan S. Dogan, Piet Hoebeke, Radim Kocvara, Rien J.M. Nijman., Raimund Stein, Shabnam Undre, & Serdar Tekgul (2016) "Management of Undescended Testes: European Association of Urology/European Society for Paediatric Urology Guidelines," *Journal of Pediatric Urology* 12, 335–343.

{% P. 147 Fig. 3 in right upper part has nonconnected curves …
P. 150 claim that a local brother of Thomsen condition implies the globale version, saying it is easy ...
Cluj is city in Transylvania in Rumenia. %}
Rado, François (1959) "Équations Fonctionnelles Caractérisant les Nomogrammes avec Trois Échelles Rectilignes," *Mathematica Universitatae Cluj* 1, 143–166.

{% Subjects observe realizations of objective lotteries, and both Gilboa & Schmeidler's CBDT and EU can be used to model the choices. CBDT would predict correlation neglect in a way not found, but EU also has problems. %}
Radoc, Benjamin, Robert Sugden, & Theodore L. Turocy (2019) "Correlation Neglect and Case-Based Decisions," *Journal of Risk and Uncertainty* 59, 23–49.

{% **discounting normative**: Not very clear on p 57, which seems to write: "The strength of the intellectual powers, giving rise to reasoning and reflective habits. . . brings before us the future. . . in its legitimate force, and urge the propriety of providing for it." %}
Rae, John (1834) "*The New Principles of Political Economy.*"
Reprinted in 1905 as "The Sociological Theory of Capital."Macmillan, New York.

{% Seem to show that subjects' paying more attention may exacerbate rather than attenuate biases. %}
Raghubir, Priya & Aradhna Krishna (1996) "As the Crow Flies: Bias in Consumers' Map-Based Distance Judgments," *Journal of Consumer Research* 23, 26–39.

{% %}
Raghubir, Priya & Joydeep Srivastava (2002) "Effect of Face Value on Product Valuation in Foreign Currencies," *Journal of Consumer Research* 29, 335–347.

{% Replies to Ellsberg's violation of the sure-thing principle. On p. 694, Raiffa considers a fifty-fifty mixture of two ambiguous gambles and a fifty-fifty mixture of two preferred unambiguous gambles. His "strict dominance" argument requires that the second mixture be preferred. It is similar to Luce's consequence

monotonicity or Segal's compound independence. His "objectively identical" claim is based on reduction (for events) and leads to the conclusion that the two mixtures are identical, and therefore equivalent. Because of the contradictory preferences that have resulted, Raiffa suggests that the original preference for the unambiguous gambles be changed. Of course, his argument has used all components of the vNM independence condition.

P. 690, on Savage's theory: "It is a theory which purports to advise any one of its believers how he *should* behave in complicated situations, *provided* he can make choices in a coherent manner in relatively simple, uncomplicated situations."

P. 690/691 states that a normative theory can be useful only if it sometimes !deviates! from actual behavior: "If most people behaved in a manner roughly consistent with Savage's thory then the theory would gain stature as a descriptive theory but would lose a good deal of its normative importance. We do not have to teach people what comes naturally." The same point is stated, but disliked, by McCord & De Neufville (1983), p. 281.

P. 694 is implicitly assuming independence-like conditions. %}

Raiffa, Howard (1961) "Risk, Uncertainty and the Savage Axioms: Comment," *Quarterly Journal of Economics* 75, 690–694.

{% **risk averse for gains, risk seeking for losses**

Good elementary textbook for getting to understand construction of decision trees, backward induction, and v**alue of information**. Ch. 3 on cost of sampling may be less central. Ch. 6 is kind of Anscombe-Aumann and can be skipped. Ch. 7 is a bit much on economics of sampling, and value of info. Ch. 8 is on risk sharing for groups. These could be skipped by someone interested only in individual decision under risk.

Preface p. ix-x: says book is about rational decisions as if this is all decision making, then brings only aggregation of uncertainty, and then casually mentions that uncertainty is a central topic.

risk averse for gains, risk seeking for losses: p. 75: in Fig. 4.18 Raiffa suggested that people prefer $-100_{0.5}0$ to -45; i.e., they are risk seeking there.

§4.9, pp. 81-82:

"If people always behaved as this prescriptive theory says they ought to, then there would be no reason to make a fuss about a prescriptive theory. We could then just tell people, "Do what comes naturally."

P. 85: in Allais paradox, one 0 outcome may be different from another.

decreasing ARA/increasing RRA: pp. 91-94 suggests that decreasing absolute risk aversion is plausible, I didn’t see RRA being discussed.

P. 110: judgmental probability of event E is p: $\$100_{p}0 \sim \$100_{A}0$; i.e., it is the matching probability. §4 discusses that these need not be additive.

P. 112: Raiffa’s famous ’61 argument against Ellsberg.

P. 146, principle of substitutability: is in fact like Anscombe & Aumann (1963), two-stage with states of nature and objective probability mixing of acts, but with prior mixing not posterior. For two states of nature.

P. 161-168 seems to discuss bisection for eliciting probability.

P. 287: Experimentor continuing until he has a result pleasing him, does good research. My handwritten notebook p. 639 %}

Raiffa, Howard (1968) “*Decision Analysis*.” Addison-Wesley, London.

{% Utility consists of costs (expenses time etc. it takes to use model, say “process utility”) and terminal utility (value otherwise, say “consequential utility”). %}

Raiffa, Howard & Robert O. Schlaifer (1961) “*Applied Statistical Decision Theory*.” Harvard University, Boston, MA. (5^{th} edn. 1970, there seems to be another of 1984).

{% India’s story about young prince who liberates woman with army of monkeys other big story is Mahabharata. %}

“Ramayana.”

{% This paper presents a model with both risk and time dimensions, so that EU falls out if we fix time and discounted utility falls out if we fix risk. It cites much literature. I did not read it enough to see what the novelty would be, because many such models have already been written—and are cited. %}

Rambaud, Salvador Cruz & Ana María Sánchez Pérez (2020) “Discounted and Expected Utility from the Probability and Time Trade-Off Model,” *Mathematics* 8, 601.

https://doi.org/10.3390/math8040601

{% %}

Ramsey, Frank P. (1927) "A Contribution to the Theory of Taxation," *Economic Journal* 37, 47–61.

Reprinted in William J. Baumol & Stephen M. Goldfeld (1968, eds.) "*Precursors in Mathematical Economics: An Anthology*," Selection 33, 341–354, Clowes and Sons, London.

{% **time preference**;

It seems that, to handel divergent sums of utility, he proposed an overtaking criterion with respect to some fixed bliss level.

discounting normative(?): writes, p. 543: "it is assumed that we do not discount later enjoyments in comparison with earlier ones, a practice which is ethically indefensible and arises merely from the weakness of imagination;"

discounting normative(?): seems to write also on p. 543: "practice which is ethically indefensible and arises merely from the weakness of the imagination"

Although he doesn't have Samuelson's constant discounting with time separability involved, he extensively discusses discounted utility, apparently only for one nonezero outcome, and distinguishes it from discounted money on p. 553.

P. 553: "In assuming the rate of discounting constant, I [mean that] the present value of an enjoyment at any future date is to be obtained by discounting it at the rate ρ … This is the only assumption we can make, without contradicting our fundamental hypothesis that successive generations are activated by the same system of preferences. For, if we had a varying rate of discounting—say a higher one for the first fifty years—our preference for enjoyments in 2000 A.D. over those in 2050 A.D. would be calculated at the lower rate, but that of the people alive in 2000 A.D. would be at the higher." %}

Ramsey, Frank P. (1928) "A Mathematical Theory of Saving," *Economic Journal* 38, 543–559.

Reprinted in William J. Baumol & Stephen M. Goldfeld (1968, eds.) "*Precursors in Mathematical Economics: An Anthology*," Selection 9, 125–128, Clowes and Sons, London.

https://doi.org/10.2307/2224098

{% %}

Ramsey, Frank P. (1929/1978) "Theories." *In* David H. Mellor (ed.), *Foundations: Essays in Philosophy, Logic, Mathematics and Economics* 101–125. Humanities Press, Atlantic Highlands, New Jersey.

{% This text by Ramsey is one of the best in all of decision theory, with refined and deep understanding of all relevant issues found nowhere else in the literature.

Brought to the attention of Arrow, Econometrica, (1951, p. 423), by Norman C. Dalkey, RAND-corporation; Arrow (p. 424) called Ramsey's work "none too clear."

Pp. 158-159 on frequentist probability (strongly criticized later in the paper, to my joy), that even if existing there are always situations of partial belief.

Pp. 160-166 criticize the logical interpretation of probability, advocated by his teacher and protector Keynes, and I found nuances lacking in this discussion. P. 161 has the nice concept of psychogalvanometer to directly measure degrees of belief.

Pp. 166-169 is a nice text on measurement in social science, with scale types and framing (that models hold only approximately).

Pp. 169 last para ("We are driven therefore") - p. 174 penultimate para ("no memory of the previous ones"): is a superb discussion of the dispositional nature of preference, as of virtually any property in natural sciences and elsewhere. It is the best discussion of this point that I ever read. All modern issues such as introspection and hypothetical choice are put right there. It is unbelievable that Ramsey immediately, even before our field was born, understood these things to an extent that most researchers will do never in their life (unless they were as fortunate as I was to have been exposed to Ramsey's text at a young age). For understanding why we need the random incentive system in experimental economics to implement real incentives, this is the best text. Ramsey wants subjective probability to be entirely revealed-preference based.

coherentism: P. 171 writes: "Suppose, however, I am wrong about this and that we can decide by introspection the nature of belief, and measure its degree; still, I shall argue, the kind of measurement of belief with which probability is concerned is not this kind but is a measurement of belief *qua* basis of action."

Used **just noticeable difference** for cardinal utility: p. 171 puts it forward as a basis for measuring beliefs/probabilities, but then properly criticizes it as just a different cardinal scale.

P. 172 beginning of 3rd para: "It is clear that we are concerned with dispositional rather than with actualized beliefs;" That is, subj. probability is not belief now had, but only as it would be had if we had to act on it. As Tversky would put it in support theory: it is in our mind, not on our mind.

P. 172 writes that a **Dutch book** can be made against nonEU. Does not define it, apparently considering it to be well known. However, it is the first mention of Dutch book in the literature that I am aware of. Pp. 182 & 183 will do it again.

P. 172 bottom: measuring belief may automatically affect it.

P. 173 penultimate para: "we seek things which we want, which may be our own or other people's pleasure, *or anything else whatever*, and our actions are such as we think most likely to realize these goods." [italics added here]
Ramsey here points out that from the representation it follows that we are maximizing something, utility (or its expectation), but does not commit to anything that that might be.

Para on pp. 173-174 nicely states how utility is a different, kind of exchangeable, scale differently than the scales we commonly use such as hours of swimming.

P. 174 3rd para nicely points out that normative here is something different than in ethics. The term ethically neutral event emphasizes this point.

linear utility for small stakes & **marginal utility is diminishing**: p. 176: "Since it is universally agreed that money has a diminishing marginal utility, if money bets are to be used, it is evident that they should be for as small stakes as possible. But then again the measurement is spoiled by introducing the new factor of reluctance to bother about trifles."

P. 174: in repeated choices to measure subjective probabilities there should be no learning to make this interpretation work. When Luce worked with repeated decisions in the 1990s he overlooked this point. I, exposed to Ramsey at young age, wrote Luce an email about it. He acknowledged me for it on p. 10 (footnote) in Luce, R. Duncan (2000) "*Utility of Gains and Losses: Measurement-Theoretical and Experimental Approaches*." Lawrence Erlbaum Publishers, London.

P. 176 2nd para: The formal analysis of his preference foundation starts. Will be until p. 184. It starts with what is called an ethically neutral event. (Ramsey uses the term proposition instead of event.) This is an event that carries no value in itself. That is an event in a Savagean sense. An event that carries a value in itself is a bit like a consequence in Savage (1954), although may be also like a Savagean event, and it is not very clear how to model this, a bit Jeffrey-type maybe. At any rate, Ramsey then assumes an ethically neutral event that you just as much like to gamble on as against. Under EU it means that it has subjective probability 0.5. Then observations (0.5:x, 0.5:z) ~ y show that y is the utility midpoint between x and z. In this way, we can measure utility to any desired degree of precision. With utility available, we can measure subjective probabilities. This is how Ramsey does it.

Savage's definition of acts, states, consequences, distinguishing them, is not clearly present in Ramsey's writing. Davidson & Suppes (1956) can be taken as a full formalization, although it may not be what Ramsey had in mind.

updating: discussing conditional probability and/or updating: discussed on p. 180. Nice that actual receipt of info can alter things and requires an assumption for invoking Bayes' formula.

(P.s.: simultaneity in the penultimate para refers to the discussion of Einstein on p. 169.)

P. 183 last para writes that, essentially, we should get by with finite models. A point also central in the Shapiro (1969) (& Richter) quasi-characterization of subjective expected utility.

P. 184 - end is philosophical, on induction and so on.

P. 188, on objective/subjective probabilities: "And in a sense we may say that the two interpretations are the objective and subjective aspects of the same inner meaning,"

P. 189, on finding equally probable basic events:

"it is a matter of physics rather than pure logic."

His suggestion that Keynes would think differently is hard to believe and is probably driven by his young desire to disagree with his befriended teacher. One also sees that top of p. 167. Whenever Keynes is involved Ramsey becomes unreasonably negative.

coherentism: Ramsey doesn't need more than one sentence to, for once and for all, refute coherentism: p. 191: "we want our beliefs to be consistent not merely with one another but also with the facts."

P. 193 and also preceding texts: "the highest ideal would be always to have a true opinion and be certain of it;"

Pp. 204-205 has text on statistics.

Pp. 206 ff. is on the meaning of probability, criticizing frequentism. The opening: "there are no such things as objective chances" is reminiscent of de Finetti's "probability does not exist."

Ramsey died before completing the paper. Then a friend finished the paper. (It may have been by the editor of this book, Richard Braithwaite, as suggested by Fienberg 2008, p. 21; Braithwaite provided the same valuable service to Johnson (1932).) Probably Ramsey himself had finished the text up to p. 184, which is all of the highest possible level. Braithwaite finished starting p. 184 and then there are, besides strong parts, also parts of less interest. Braithwaite has given a wonderful service to us by finishing this paper. %}

Ramsey, Frank P. (1931) "Truth and Probability." *In* Richard B. Braithwaite (ed.), *The Foundations of Mathematics and Other Logical Essays*, 156–198, Routledge and Kegan Paul, London.
Reprinted in Henry E. Kyburg Jr. & Howard E. Smokler (1964, eds.) *Studies in Subjective Probability*, 61–92, Wiley, New York. (2nd edn. 1980, Krieger, New York.)

{% %}

Ramsey, Frank P. (1978) "*Foundations: Essays in Philosophy, Logic, Mathematics and Economics.*" (David H. Mellor Ed.) Humanities Press, Atlantic Highlands, New Jersey.

{% **information aversion**: under SEU, no information aversion %}

Ramsey, Frank P. (1990; Nils-Eric Sahlin, ed.) "Weight or the Value of Knowledge," *British Journal for the Philosophy of Science* 41, 1–4.

{% Written text of lecture Ramsey gave in 1922. %}

Ramsey, Frank P. (2007) "Truth and Simplicity," *British Journal for the Philosophy of Science* 58, 379–386.

{% %}

Ramsey, Frank P. Collection of all his writings:

http://digital.library.pitt.edu/cgi-bin/f/findaid/findaid-idx?c=ascead&cc=ascead&rgn=main&view=text&didno=US-PPiU-asp198301

{% **foundations of statistics**; this guy seems to have been the only Ph.D. student of Fisher. Worked with Fisher during many years. %}

Rao, C. Radhakrishna (1992) "R.A. Fisher: The Founder of Modern Statistics," *Statistical Science* 7, 34–48.

{% If people must produce randomized sequences, they can't. (**producing random numbers**) %}

Rapoport, Amnon & David V. Budescu (1997) "Randomization in Individual Choice Behavior," *Psychological Review* 104, 603–617.

{% **decreasing ARA/increasing RRA**: increasing RRA but not prominent %}

Rapoport, Amnon (1984) "Effects of Wealth on Portfolios under Various Investment Conditions," *Acta Psychologica* 55, 31–51.

{% **three-doors problem** %}

Rapoport, Anatol (1996) "Effects of Information on Assessment of Probabilities, A Reply to Marinoff," *Theory and Decision* 41, 149–155.

{% %}

Rasch, George (1980) "*Probabilistic Models for Some Intelligence and Attainment Tests.*" University of Chicago Press, Chicago, Ill (expanded edn.).

{% %}

Rasmusen, Eric B. (2012) "Internalities and Paternalism: Applying the Compensation Criterion to Multiple Selves across Time," *Social Choice and Welfare* 38, 601–615.

{% Seems to correct a mistake in the proof of Rotschild-Stiglitz. %}

Rasmusen, Eric B. & Emmanuel Petrakis (1992) "Defining the Mean-Preserving Spread: 3-pt versus 4-pt." *In* John Geweke (ed) *Decision Making under Risk and Uncertainty: New Models and Empirical Findings*, 53–60, Kluwer, Amsterdam.

{% %}
Raspe, Rudolph E. (1786) "Baron Münchhausens Narrative of His Marvellous Travels and Campaigns in Russia." Translated from English into German by Gottfried A. Bürger.

{% **probability elicitation** %}
Ravinder, Handanhal V., Don N. Kleinmuntz, & James S. Dyer (1988) "The Reliability of Subjective Probabilities Obtained through Decomposition," *Management Science* 34, 186–199.

{% **Z&Z** %}
Raviv, Arthur (2005) "The Design of an Optimal Insurance Policy," *American Economic Review* 69, 84–96.

{% %}
Rawling, Piers (1994) "A Note on the Two Envelopes Problem," *Theory and Decision* 36, 97–102.

{% **discounting normative**: argues for zero discounting for intergenerational justice in social welfare.

Seems to use the term **reflective equilibrium** for the gradual convergence between normative decision rules and their implications.

P. 137 footnote 11 credits Harsanyi for the veil of ignorance. %}
Rawls, John (1971) "*A Theory of Justice.*" Harvard University Press, Cambridge, MA.

{% **nonconstant discount = nonlinear time perception**;
Argue, as did other papers, that deviations from constant discounting may actually be due to nonlinear perception of time. In this theoretical paper it is the central point, illustrated by simulations. %}
Ray, Debajyoti & Peter Bossaerts (2011) "Positive Temporal Dependence of the Biological Clock Implies Hyperbolic Discounting," *Frontiers in Decision Neuroscience* 5(2).

{% Consider intertemporal choice where also past consumption affects felicity, and discuss ways of discouning the past and resulting, claimed, dynamic inconsistencies. %}

Ray, Debraj & Ruqu Wang (2001) "On Some Implications of Backward Discounting," Manuscript. New York: New York Univ., Dept. Econ.

{% **revealed preference**; Derives choice function from group relation. The result that it then satisfies IIA(R-M) is not surprising. P. 990 1st line, 4th para ("This is the source …" and condition of partitioned information are well observed. %}

Ray, Paramesh (1973) "Independence of Irrelevant Alternatives," *Econometrica* 41, 987–991.

{% **decreasing/increasing impatience**: seems to find increasing instead of the common decreasing.

One typically finds:

$A now ~ $B in one year,

$B in one year ~ $C in two years,

but $A now ~ $C−X in two years for a positive X. The author calls this subadditivity. It in fact entails intransitivity. Such effects may be underlying studies that find hyperbolic discounting. Such studies typically look at [$A now ~ $B in one year] in combination with [$A now ~ $C − X] in two years. They, thus, compare time intervals of different lengths.

I discovered March 5, 2014, that p. 25 Eq. 16 proposes a variation of exponentional discounting where we take t to a power s. This is what Ebert & Prelec (2007) call constant sensitivity, Bleichrodt, Rohde, & Wakker (2009) call CRDI, and Bleichrodt, Kothiyal, Prelec, & Wakker (2013) call unit invariance. Read claims that the formula implies no declining impatience but this depends on the parameter s, and is not so for $s < 1$. %}

Read, Daniel (2001) "Is Time-Discounting Hyperbolic or Subadditive?," *Journal of Risk and Uncertainty* 23, 5–32.

{% **real incentives/hypothetical choice**: argues mostly in favor of hypothetical choice.

real incentives/hypothetical choice, for time preferences: Because of special problems of implementing real incentives in intertemporal choice, sems to plead here for hypothetical choice in particular. %}

Read, Daniel (2005) "Monetary Incentives, What Are They Good for?," *Journal of Economic Methodology* 12, 265–276.

{% %}

Read, Daniel & Fergus I.M. Craik (1995) "Earwitness Identification: Some Influences on Voice Recognition," *Journal of Experimental Psychology, Applied* 1, 6–18.

{% **decreasing/increasing impatience**: find counter-evidence against the commonly assumed decreasing impatience and/or present effect.

Experiments show that calendar time makes subjects behave rather differently (lower discounting, and less hyperbolic) than stopwatch time (authors don't use latter term, but instead use term of delay etc. %}

Read, Daniel & Shane Frederick, Burco Orsel, & Juwaria Rahman (2005) "Four Score and Seven Years from now: The Date/Delay Effect in Temporal Discounting," *Management Science* 51, 1326–1335.

{% %}

Read, Daniel & George F. Loewenstein (1995) "Diversification Bias: Explaining the Discrepancy in Variety Seeking between Combined and Separated Choices," *Journal of Experimental Psychology, Applied* 1, 34–49.

{% **time preference**; **total utility theory** %}

Read, Daniel & Goerge F. Loewenstein (1999) "Enduring Pain for Money: Decisions Based on the Perception and Memory of Pain," *Journal of Behavioral Decision Making* 12, 1–17.

{% Choice bracketing means the extent to which you incorporate aspects relevant to the decision into your judgment. Narrow bracketing is like myopic, broad bracketing is like unbounded rationality.

Kahneman & Lovallo (1993) put forward similar arguments against narrow bracketing. %}

Read, Daniel, George F. Loewenstein, & Matthew Rabin (1999) “Choice Bracketing,” *Journal of Risk and Uncertainty* 19, 171–197.

{% **dominance violation by pref. for increasing income**: violations of monotonicity due to preferences for increasing sequences, à la Loewenstein & Sicherman (1991), %}

Read, Daniel & Melanie Powell (2002) “Preferences for Lifetime and One-Year Distributions of Health and Money,” *Journal of Behavioral Decision Making* 15, 433–460.

{% %}

Read, Daniel & Peter H.M.P. Roelofsma (2003) “Subadditive versus Hyperbolic Discounting: A Comparison of Choice and Matching,” *Organizational Behavior and Human Decision Processes* 91, 140–153.

{% **PE higher than others**; **utility elicitation**; standard gamble (= PE), time tradeoff, and direct scaling, are not interchangeable, and their relationships with each other are complex. %}

Read, J. Leighton, Robert J. Quinn, Donald M. Berwick, Harvey V. Fineberg, & Milton C. Weinstein (1984) “Preferences for Health Outcomes: Comparisons of Assessment Methods,” *Medical Decision Making* 4, 315–329.

{% %}

Rébillé, Yann (2007) “Patience in some Non-Additive Models,” *Journal of Mathematical Economics* 43, 749–763.

{% %}

Rébillé, Yann (2008) “A Yosida–Hewitt Decomposition for Totally Monotone Set Functions on Locally Compact S-Compact Topological Spaces,” *International Journal of Approximate Reasoning* 48, 676–685.

{% For weighting funnctions that are belief functions on finite state spaces and monetary outcomes, the Choquet integral is the minimum of means, and als the mean of minimums, and Möbius transform relates it to unanimity games. This

paper provides many generalizations, extending the result to more general state spaces and outcomes. %}
Rébillé, Yann (2015) "Integral Representation of Belief Measures on Compact Spaces," *International Journal of Approximate Reasoning* 60, 37–56.

{% Preferences are over $C \times \mathbb{R}^+$. The author defines a quasi-linear representation as $(c,\alpha) \rightarrow v(c) + \alpha$, so, additivity and linearity in money. The main axiom reflects linearity in α: $((x,0) \sim (0,z) \Rightarrow (x,y) \sim (0,z+y)$. %}
Rébillé, Yann (2017) "An Axiomatization of Continuous Quasilinear Utility," *Decisions in Economics and Finance* 40, 301–315.
https://doi.org/10.1007/s10203-017-0202-z

{% %}
Rébillé, Yann (2018) "Continuous Utility on Connected Separable Topological Spaces," *Economic Theory Bulletin* 7, 147–153.

{% Considers preferences on $C \times \mathbb{R}$, where C can be any set but has a neutral element denoted 0_c here, and assumes that monetary equivalents y $((c,x) \sim (0_c,y))$ always exist, representing preferences, and denoted V here. Axiomatizes all kinds of separabilities, including an additive representation v(c) + x, where utility of money is linear. The latter is axiomatized by $(x,0) \sim (x,y) \Rightarrow (x,z) \sim (x,z+y)$. %}
Rébillé, Yann (2019) "Representations of Preferences with Pseudolinear Utility Functions," *Journal of Mathematical Psychology* 89, 1–12.

{% %}
Recktenwald, H. Claus & Wilhelm E. Krelle (1988) "*Gossens Gesetze: Leitmuster Moderner Nutzentheorie.*" Franz Steiner Verlag Wiesbaden, Stuttgart, 1988.

{% Find that discounting is not constant but decreases over time. They consider having a health problem during 4 months. It can be gotten at different times, starting in one day, six months, one year, five years, or ten years. Then they use the standard gamble (and direct scaling) to measure the utility of these. They find 10% negative discounting and 28% positive discounting. Health impairement is negative outcome and then discounting is more variable. Positive discounting gives a convex discount function. But because it is multiplied by a negative value of health the function becomes concave, giving the usual risk aversion. Hence, although they in fact consider risky decisions over waiting time as does the appealing Onay & Öncüler (2007) paper, they do not find a paradox. %}

Redelmeier, Donald A. & Daniel N. Heller (1993) "Time Preference in Medical Decision Making and Cost Effectiveness Analysis," *Medical Decision Making* 13, 212–217.

{% %}

Redelmeier, Donald A. & Daniel Kahneman (1996) "Patients' Memories of Painful Medical Treatments: Real-Time and Retrospective Evaluations of Two Minimally Invasive Procedures," *Pain* 66, 3–8.

{% %}

Redelmeier, Donald A., Derek J. Koehler, Varda Liberman, & Amos Tversky (1995) "Probability Judgment in Medicine: Discounting Unspecified Posibilities," *Medical Decision Making* 15, 227–230.

{% %}

Redelmeier, Donald A., Paul Rozin, & Daniel Kahneman (1993) "Understanding Patients' Decisions: Cognitive and Emotional Perspectives," *Journal of the American Medical Association* 270 72–76.

{% context-dependence, violation of IIA; adding one alternative !increases! percentage of people who chose another alternative. %}

Redelmeier, Donald A. & Eldar Shafir (1995) "Medical Decision Making in Situations that Offer Multiple Alternatives," *JAMA* 273, 302–305.

{% Penultimate sentence suggests that the authors consider the discrepancy nonnormative: "Physicians and policy makers may wish to examine problems from both perspectives to ensure that treatment decisions are appropriate whether applied to one or to many patients." %}

Redelmeier, Donald A. & Amos Tversky (1990) "Discrepancy between Medical Decisions for Individual Patients and for Groups," *New England Journal of Medicine* 322, 1162–1164.

{% Seem to point out that repeated choice and income effect can enhance EV. %}
Redelmeier, Donald A. & Amos Tversky (1992) "On the Framing of Multiple Prospects," *Psychological Science* 3, 191–193.

{% **Z&Z**: p. 2895/2890: "… selective matching, the tendency to focus on salient coincidences, thereby capitalizing on chance and neglecting contrary evidence." References are given. %}
Redelmeier, Donald A. & Amos Tversky (1996) "On the Belief that Arthritis Pain Is Related to the Weather," *Proceedings of the National Academy of Sciences* 93, 2895–2896.

{% **equity-versus-efficiency**: writes somewhere: "Welfare economics is in a very unhappy state ... considerations of the welfare implications of envy make it impossible even to say that welfare will be increased by everyone having more of every commodity."

Referred to by Robertson (1954 p. 677 without more bibliographic info than that it was in "Welfare Economics"). %}
Reder, Melvin W. (1952) "Welfare Economics." *In* Bernard F. Haley (ed.) *Survey of Contemporary Economics*, vol. II, Irwin, Homewood, Illinois.

{% **updating: discussing conditional probability and/or updating** %}
Redhead, Michael L.G. (1986) "Novelty and Confirmation," *British Journal for the Philosophy of Science* 37, 115–118.

{% **foundations of quantum mechanics**. Gives all the background. Maths seem to be of not too high a level, according to review in *Philosophical Review* XCIX (1990), 275–277. %}
Redhead, Michael L.G. (1990) "*Incompleteness, Nonlocality and Realism: A Prolegomenon to the Philosophy of Quantum Mechanics*." Clarendon Press, New York.

{% Suggests that there is nothing new in nudge, it just being classical corrections of of market inadequacies. (It thus misses how nudge adds a subtle nuance to debates on paternalism, by exploiting incompleteness of preference.) Then it cites some references criticizing the effects of New Zealand's KiwiSaver program, initiated by the Labour government in New Zealand in 2007 as a response to the presumption that New Zealand households were undersaving, and presented by Thaler & Sunstein as a big success of nudge. %}

Reed, W. Robert (2013) Book Review of: Thaler, Richard H. & Cass R. Sunstein (2008) "*Nudge: Improving Decisions About Health, Wealth, and Happiness*." Yale University Press, New Haven," *Journal of Economic Psychology* 34, 302–303.

{% %}

Reeck, Crystal, Karoline Gamma, Elke U. Weber (2022) "How We Decide Shapes What We Choose: Decision Modes Track Consumer Decisions That Help Decarbonize Electricity Generation," *Theory and Decision* 92, 731–758. https://doi.org/10.1007/s11238-022-09874-z

{% Nice evidence of loss aversion: from U.S. tax (1979-1990), return data, the author estimates that taxpayers facing a payment on tax day reduce their tax liability by $34 more than taxpayers owed a refund. %}

Rees-Jones, Alex (2018) "Quantifying Loss-Averse Tax Manipulation," *Review of Economic Studies* 85, 1251–1278.

{% Behavioral incentive compatibility reckons with behavioral deviations from rational behavior. Bardsley et al. (2010 §6.5) wrote nicely about it. This paper gives three long examples, with much economic flesh, where researchers reckoned with behavioral insights and gives recommendations such as that one specify the model of welfare assumed and the model of behavior assumed. %}

Rees-Jones, Alex (2024) "Behavioral Incentive Compatibility and Empirically Informed Welfare Analysis: An Introductory Guide," *Journal of Economic Perspectives* 38, 155–174. https://doi.org/10.1257/jep.38.4.155

{% %}

Reeves, Tim & Robert S. Lockhart (1993) "Distributional versus Singular Approaches to Probability and Errors in Probabilistic Reasoning," *Journal of Experimental Psychology: General* 122, 207–226.

{% **Dutch book** %}

Regazzini, Eugenio (1987) "De Finetti's Coherence and Statistical Inference," *Annals of Statistics* 15, 845–864.

{% This paper criticizes traditional tests of transitivity that assume a deterministic theory and classical statistical tests of it. It thus strongly criticizes statistical analyses based on majority choices (e.g. p. 46 1st column). It favors using probabilistic choice models with what Loomes & Sugden call the random preference model (p. 47) and what can also be called a mixture model. The paper opens with an example where an agent randomly has one of three preference relations, each transitive, but observed majority preferences violate transitivity. Advocates of classical deterministic theories can argue that this is a type I error, which is known to happen sometimes. The paper has done an enormous work by analyzing over 100 classical data sets, and adding an experiment. It derives a triangular inequality for the mixture model, argues that this is a strong test of transitivity (p. 44). Acceptance of the null of the triangular inequality is taken as evidence for transitivity. P. 45 1st column argues that deterministic theories are reasonable only if not very much noise.

The paper also strongly argues against 2-alternative forced choice (2AFC) studies, which cannot measure indifference (e.g. p. 54 2nd para). %}

Regenwetter, Michel, Jason Dana, & Clintin P. Davis-Stober (2011) "Transitivity of Preferences," *Psychological Review* 118, 42–56.

{% %}

Regenwetter, Michel, Jean-Claude Falmagne, & Bernard Grofman (1999) "A Stochastic Model of Preference Change and Its Application to 1992 Presidential Election Panel Data," *Psychological Review* 106, 362–384.

{% %}

Regenwetter, Michel & Moon-Ho R. Ho & Ilia Tsetlin (2007) "Sophisticated Approval Voting, Ignorance Priors, and Plurality Heuristics: A Behavioral Social Choice Analysis in a Thurstonian Framework," *Psychological Review* 114, 994–1014.

{% %}

Regenwetter, Michel & Anthony A.J. Marley (2001) "Random Relations, Random Utilities, and Random Functions," *Journal of Mathematical Psychology* 45, 864–912.

{% **foundations of statistics** %}

Reid, Nancy (1995) "The Roles of Conditioning in Inference," *Statistical Science* 10, 138–199.

{% %}

Reik, Theodor (1948) "*Listening with the Third Ear.*" Farrar, Straus & Giroux Inc, New York.

{% %}

Reilly, Robert J. (1982) "Preference Reversal: Further Evidence and Some Suggested Modifications in Experimental Design," *American Economic Review* 72, 576–584.

{% %}

Remage Russell, Jr. & William A. Thompson, Jr. (1966) "Maximum-Likelihood Paired Comparison Rankings," *Biometrika* 53, 143–149.

{% %}

Reny, Philip J. (2015) "A Characterization Of Rationalizable Consumer Behavior," *Econometrica* 83, 175–192.

{% **Nash equilibrium discussion** %}

Reny, Philip J. & Arthur J. Robson (2004) "Reinterpreting Mixed Strategy Equilibria: A Unification of the Classical and Bayesian Views," *Games and Economic Behavior* 48, 355–384.

{% **Dutch book**

recommended by Gerry Evers-Kieboom

Dutch book: Ch. 3 is on de Finetti's book making argument.

Elementary introduction into decision theory, emphasizing conceptual logical and philosophical issues. Reviewed in Philosophical Review XCIX, 1990, 272–275. %}

Resnik, Michael (1987) "*Choices: An Introduction to Decision Theory.*" University of Minnesota Press, Minneapolis, MN.

{% **measure of similarity** %}

Resnik, Philip (1999) "Semantic Similarity in a Taxonomy: An Information-Based Measure and Its Application to Problems of Ambiguity and Natural Language," *Journal of Artificial Intelligence Research* 11, 95–130.

{% Seems that he proposed that similarity between things is based more on what they have different than what they have in common. Features of dissimilarity, so to say. %}

Restle, Frank (1961) "*Psychology of Judgment and Choice: A Theoretical Essay.*" Wiley, New York.

{% Measuring subjective discounting for money has the problem that money is fungible: can be saved in the bank at market interest rate. (**time preference, fungibility problem**) So, this paper compares it with subjective discounting for chocolate and so on, being things that are not fungible. It finds significant correlations, which give some support for money being usable for measuring subjective discounting. %}

Reuben, Ernesto, Paolo Sapienza, & Luigi Zingales (2010) "Time Discounting for Primary and Monetary Rewards," *Economics Letters* 106, 125–127.

{% %}

Reutskaja, Elena, Rosemarie Nagel, Colin F. Camerer, & Antonio Rangel (2011) "Search Dynamics in Consumer Choice under Time Pressure: An Eye-Tracking Study," *American Economic Review* 101, 900–926.

{% %}

Reve, Gerard Cornelis van het (1967) "*Veertien Etsen van Frans Lodewijk Pannekoek voor Arbeiders Verklaard*." Rapenburg, Amsterdam.

{% **total utility theory**; **questionnaire versus choice utility**: in this review, 15 studies are mentioned that have done both utility measurement and psychometric measurement; TTO typically has R2 of .18 till .43 with valuations of health status scales.

PE doesn't do well: PE (if I remember well, they call it SG) is worse, .07 to .30. Note that we should not expect overly high correlations because of interindividual variation in the use of response scales. %}

Revicki, Dennis A. & Robert M. Kaplan (1993) "Relationship between Psychometric and Utility-Based Approaches to the Measurement of Health-Related Quality of Life," *Quality Life Research* 2, 477–487.

{% %}

Revuz, André (1955-56) "Fonctions Croissantes et Mesures sur les Espaces Topologiques Ordonnés," *Anneles de l'Institut Fourier* 6, 187–268.

{% **principle of complete ignorance**: p. 11

inverse S: This paper discusses in much detail the psychology of being more or less sensitive to numerical scales, and the ability to more or less discriminate between options, and maybe taking numbers only as categories. I did not understand all experimental details though; for example, on p. 38, isn't a 1/3 probability to save "some" people trivially inferior to a certainty of saving "some" people?

ratio bias: pp. 9-10 and 35 give references showing that people take 10:100 probability as higher than 1:10 probability, and that subjects reduce both probabilities and outcomes to categories.

There is a nice comparison of the fuzzy-trace theory with the intuitionistic approach to mathematics of Brouwer. %}

Reyna, Valerie F. & Charles J. Brainerd (1995) "Fuzzy-Trace Theory: An Interim Synthesis," *Learning and Individual Differences* 7, 1–75.

{% Measure risk attitudes by EU utility fitting (the Holt & Laury 2002 method), by an Eckel & Grossman method, and by psychometric questionnaire, among French farmers. The measures are correlated but not identical. Violations of EU can contribute to explaining the difference, as the authors note although still using EU à la Holt-Laury to fit data. The authors' main conclusion is, then, that risk attitude is context dependent. A conclusion often favored by psychologists. %}

Reynaud, Arnaud & Stéphane Couture (2012) "Stability of Risk Preference Measures: Results from a Field Experiment on French Farmers," *Theory and Decision* 73, 203–221.
https://doi.org/10.1007/s11238-012-9296-5

{% Uses **tradeoff method** to evaluate the assessment of mortality risks. %}

Rheinberger, Christophe M. (2010) "Experimental Evidence against the Paradigm of Mortality Risk Aversion," *Risk Analysis* 30, 590–604.

{% **foundations of probability** %}

Rice, Adrian & Eugene Seneta (2005) "De Morgan in the Prehistory of Statistical Hypothesis Testing," *Journal of the Royal Statistical Society A* 168, 615–627.

{% Introduced the idea of multiattribute risk aversion that plays a role in the Arne & I paper on the ACM model, independently of his predecessor de Finetti (1932). %}

Richard, Scott F. (1975) "Multivariate Risk Aversion, Utility Independence, and Separable Utility Functions," *Management Science* 22, 12–21.

{% **tradeoff method's error propagation**: This paper assumes asymmetric errors in the tradeoff method, with arguments that this is reasonable because answers are bounded from one side (because of monotonicity) and not from the other in the method. They show that their assumed errors lead to biases making TO utility more concave. Possible remedies are: (1) use choice lists instead of direct matching, so that upper bounds for answers can be imposed; this may reduce but does not remove the problem; (2) quantify the errors and then correct for them. (3) use answers normalized in the money dimension, such as $(x_i-x_0)/(x_4-x_0)$ instead of $x_0, \ldots, x_4$, for instance, as I usually let students do when I teach on this. Again, this reduces but does not remove the problem. It is in general a better method. Further in defense of the TO method: it usually gives less concave, close to linear, utility, more than other methods, suggesting that there is no big error in the direction of concavity. The keyword used here gives several simulations that suggested that the error propagation probem is not big. %}

Richard, Thibault & Valentin Baudin (2020) "Asymmetric Noise and Systematic Biases: A New Look at the Trade-Off Method,"

{% Argues against the PE (if I remember well, he calls it SG) as gold standard for utility measurement because, first, EU is empirically violated (I agree) and, second, EU is neither appropriate normatively (I disagree) (**PE doesn't do well**). He prefers the TTO.

I agree with virtually all of pages 7-10, in particular that the author emphasizes that the PE cannot be a gold standard in view of violations of EU. I disagree more often with the texts following p. 10.

The footnote on p. 11 cites in an affirmative manner the, I think incorrect, criticisms of Allais and Pope on the mathematics of Machina.

P. 8, 2nd column, end of 1st para (referring to Gescheider 1988 for it): "As with other psychological concepts these attributes cannot be directly observed but only inferred. The concept itself is a construct and the functional relationship between the construct and external evidence must be embodied in psycho-physical theory."

P. 8 2nd column at about 2/3 of the page, on the ordinalist move in economics: "While removing the psychological connotations, this also reduced the value of the concept outside the framework of positive economics."

risky utility u = strength of preference v (or other riskless cardinal utility, often called value): p. 9, 2nd column: "It is likely that the great appeal of N-M utility in the context of CUA [Cost-Utility Analysis] is derived from such a conflation of concepts [representational utility versus strength of preference]."

P. 10 discusses **utility of gambling** (later the term utility of risk is also used). For the author, however, it seems to entail regret etc., any global aspect that cannot be modeled through the utility of single outcomes.

P. 13 has a nice citation of Claude Bernard, taken from Allais.

P. 18 discusses the **HYE** in a critical manner. %}

Richardson, Jeff (1994) "Cost Utility Analysis: What Should Be Measured?," *Social Science and Medicine* 39, 7–20.

{% %}

Richardson, Jeff, Jane Hall & Glenn Salkfeld (1996) "The Measurement of Utility in Multiphase Health States," *International Journal of Technology Assessment in Health Care* 13, 35–48.

{% **questionnaire versus choice utility**: Measure choice utility through the HUI (which is based on EU for risk) and experienced utility through 5 introspective measures including EQ-5D, relate them, and find relations but not clear. Argue for nonlinear transformations to transform one into the other. %}

Richardson, Jeff Richardson, Munir A. Khan, Angelo Iezzi, & Aimee Maxwell (2015) "Comparing and Explaining Differences in the Magnitude, Content, and Sensitivity of Utilities Predicted by the EQ-5D, SF-6D, HUI 3, 15D, QWB, and AQoL-8D Multiattribute Utility Instruments," *Medical Decision Making* 35, 276–291.

{% A German poet, often called (Jean) Paul wrote the following, a nice statement of loss aversion suggesting that it exceeds 2:

"Der Besitz macht uns nicht halb so glücklich, wie uns der Verlust unglücklich macht."

(My translation: possession does not make us half as happy as loss makes us unhappy.)

He lived from 1763 to 1825. %}

Richter, Johann Paul Friedrich (17/18)

{% **revealed preference**; This beautiful paper is the first to give completely necessary and sufficient conditions for revealed preference to be representable by a weak order, being an acyclicity condition, called congruency, in its Theorem 1. The term congruency, as the term rational, is not very informative. Many credit Varian (1982) for this result. The paper is a case of dillution: Theorem 1 is the

most important result in all of revealed preference theory. All the rest in this paper is minor. %}
Richter, Marcel K. (1966) "Revealed Preference Theory," *Econometrica* 34, 635–645.

{% **revealed preference** %}
Richter, Marcel K. (1971) "Rational Choice." *In* John S. Chipman, Leonid Hurwicz, Marcel K. Richter, & Hugo F. Sonnenschein (eds.) *Preferences, Utility, and Demand*, 29–58, Hartcourt, New York.

{% %}
Richter, Marcel K. (1975) "Rational Choice and Polynomial Measurement Theory," *Journal of Mathematical Psychology* 12, 99–113.

{% %}
Richter, Marcel K. (1980) "Continuous and Semi-continuous Utility," *International Economic Review* 21, 293–299.

{% This paper is written in the spirit of Richter's work, understanding very well how theoretical concepts should be related to observations and that deriving concepts from finitely many observed preferences is the thing to do. It shows how, under subjective expected utility with both utility and probability unknown, finitely many observations can reveal the info that subjective probabilities are in some interval [a,b] for any algebraic numbers a,b, and similar things. Algebraic means the solution to a polynomial equation with only natural numbers as weights involved. So, we can find out that p_1 is 2/3 or that it is squareroot of 2. We cannot find out that it is pi. At most we can find out that it is close to pi. Nice examples are given to illustrate this.

Unfortunately, there are some advanced results on necessary and sufficient conditions for polynomial sets for which utilities can always be found and more similar results which I did not find very interesting. %}
Richter, Marcel K. & Leonard Shapiro (1978) "Revelations of a Gambler," *Journal of Mathematical Economics* 5, 229–244.

{% How to solve infinitely many linear inequalities. Probably related to Jaffray (1974). %}

Richter, Marcel K. & Kam-Chau Wong (2004) "Infinite Inequality Systems and Cardinal Revelations," *Economic Theory* 26, 947–971.

{% Consider a preference relation ≽ over a domain, and a set of binary relations $≽_j$ on this set called criteria. They consider the condition: b ≽ a whenever for each criterion $≽_j$ there is a level x s.t. b $≽_j$ x ≽ a. Note that here we first take criterion $≽_j$ and then preference relation ≽. Example 2 shows that regular convexity on a Euclidean space results if we take all linear functions as criteria. This supports the authors' interpretation as generalized convexity. Many other properties are special cases. The relation is often represented by maxmin utility, for utility functions for the criteria. %}

Richter, Michael & Ariel Rubinstein (2019) "Convex Preferences: A New Definition," *Theoretical Economics* 14, 1169–1183.

{% The experiment uses hypothetical choice, because for environmental risks this is the only way, and then for best comparison also for financial. Extra pro is that financial choices then can use high significant amounts, where utility can be nonlinear for real reasons. Nicely, the author finds that Porsche club of America members do EU throughout, and elite rock climbers do so for financial risks.

Measures probability weighting (as Tanaka et al. (2010 American Economic Review) for both financial and environmental risks. Confirms inverse S (**inverse S**). Probability overweighing of best outcomes is the same for financial and environmental, but for worst outcomes it is more pronounced for environmental. %}

Riddel, Mary (2012) "Comparing Risk Preferences over Financial and Environmental Lotteries," *Journal of Risk and Uncertainty* 45, 135–157.

{% **second-order probabilities to model ambiguity**: use 2^{nd}-order probability to model ambiguity, with normal distribution and variance reflecting ambiguity, and use it to quantitatively analyze an application of nuclear waste. %}

Riddel, Mary & W. Douglass Shaw (2006) "A Theoretically-Consistent Empirical Model of Non-Expected Utility: An Application to Nuclear-Waste Transport," *Journal of Risk and Uncertainty* 32, 131–150.

{% Use two choicelists per person to derive two indifferences and then calculate two parameters, one the power of power-utility, the other one the inverse S parameter of Prelec's (1998) one-parameter family, which is taken to reflect the overweighting of small probabilities. Measure these for amateur car racers, technical rock climbers, SCUBA divers, and a student control group. Amateur auto racers are more rational in the sense of less probability weighting. Women (**gender differences in risk attitude**), older subjects (**relation age-risk attitude**), and rock climbers transform probabilities more.

As outcome the authors do not take money but life duration. They suggest that there have not been many measurements of utility of life duration, but there have been many in the health domain, including papers by my colleagues Attema and Bleichrodt.

Unfortunately, the authors use the term risk aversion for concave utility, which is not correct under prospect theory (**equate risk aversion with concave utility under nonEU**), and the term multiple choice list, where multiple is redundant. In the choice situations, prospects are compared that have different outcomes but also different probabilities, which is not easy for subjects. %}

Riddel, Mary & Sonja Kolstoe (2013) "Heterogeneity in Life-duration Preferences: Are Risky Recreationists Really More Risk Loving," *Journal of Risk and Uncertainty* 46, 191–213.
https://doi.org/10.1007/s11166-013-9161-0

{% **HYE** Points out difference between continuous and discrete health flows in the debates; that CEs (certainty equivalents) are more naturally in terms of life years (for natural continuum) than in terms of health status and some other points. Some criticisms are not correct, e.g. in Footnote 50 on Johannesson, Pliskin & Weinstein 1993, because they refer, !in Ried's terminology!, to HYE and not HYE-approach. %}

Ried, Walter (1998) "QALYs versus HYEs—What's Right and What's Wrong. A Review of the Controversy," *Journal of Health Economics* 17, 607–625.

{% Does backward induction with maxmin EU. Then usually submartingales. Uses condition called rectangularity by Epstein & Schneider (2003, JET) that was also given by Sarin & Wakker (1998, JRU) and that is needed to have multiple priors as conjugate family. %}

Riedel, Frank (2009) "Optimal Stopping with Multiple Priors," *Econometrica* 77, 857–908.

{% Show that for many prospects (lotteries) the measures of Aumann & Serrano (2008) and Foster & Hart (2009) are not defined because of divergence. Show that it is usually identical to or close to worst outcome. %}

Riedel, Frank & Tobias Hellmann (2015) "The Foster-Hart Measure of Riskiness for General Gambles," *Theoretical Economics* 10, 1–9.

{% Games where players can choose to randomize using unknown probabilities (through Ellsberg urns provided to them), modeled using contraction EU of Gajdos et al. (2008). They use the term Ellsberg equilibria for the new equilibria. The data of Holt & Goereee (2001) can be accommodated by Ellsberg equilibria. %}

Riedel, Frank & Linda Sass (2014) "Ellsberg Games," *Theory and Decision* 76, 469–509.

{% Show that probability estimates (judged probabilities, not decision-based, let be incentivized) of elements of a partition usually add to more than 1 also within-individually. More numerate subjects violated additivity less, especially if primed with numerical task first. (**cognitive ability related to likelihood insensitivity**) Direct matching, where subjects just directly choose probabilities, generates fewer additivity violations than when they choose from pre-chosen answer categories. %}

Riege, Anine H. & Karl Halvor Teigen (2013) "Additivity Neglect in Probability Estimates: Effects of Numeracy and Response Format," *Organizational Behavior and Human Decision Processes* 121, 41–52.

{% **SPT instead of OPT**: Eq. 2 %}

Rieger, Marc Oliver (2014) "Evolutionary Stability of Prospect Theory Preferences," *Journal of Mathematical Economics* 50, 1–11.

{% %}

Rieger, Marc Oliver (2017) "Comment on Cenci et al. (2015): "Half-Full or Half-Empty? A Model of Decision Making under Risk"," *Journal of Mathematical Psychology* 81, 110–113.
https://doi.org/10.1016/j.jmp.2017.09.007

{% A prospect over gains with finite expectation has finite expected utility if U is concave, but then need not have finite PT because of the overweighting of the high outcomes. Conditions about it are derived. Fig. 1 shows that w of T&K'92 need not be nondecreasing for $\gamma = 0.2$, and p. 668 gives formulas and details.

P. 677 proposes

$$w(p) = p + (3 - 3b)(p^3 - (a+1)p^2 + ap)/(a^2 - a+1)$$

with $0 < a < 1$ and $0 < b < 1$

as new parametric family of weighting functions, with a the intersection with the diagonal ($w(a) = a$) and b a curvature parameter.

They argue that this is the simplest polynomial with such a concave-convex switch. %}

Rieger, Marc Oliver & Mei Wang (2006) "Cumulative Prospect Theory and the St. Petersburg Paradox," *Economic Theory* 28, 665–679.

{% Extend separable prospect theory, the separable Edwards version of prospect theory, with a normalization of weights, to continuous distributions. For each continuous distribution they choose one of several possible ways to approximate it discretely, and then define its value as the limit of the discrete approximations. In this way, the value of the continuous distribution depends only on probability weighting w through the derivative of w at 0. This convinces me that the model is not valuable for continuous distributions. It is a virtue of this paper to bring this point to the fore. %}

Rieger, Marc Oliver & Mei Wang (2008) "Prospect Theory for Continuous Distributions," *Journal of Risk and Uncertainty* 36, 83–102.

https://doi.org/10.1007/s11166-007-9029-2

{% %}

Rieger, Marc Oliver & Mei Wang (2008) "What Is Behind the Priority Heuristic? A Mathematical Analysis and Comment on Brandstätter, Gigerenzer, and Hertwig (2006)," *Psychological Review* 115, 274–280.

{% Used data from as in other studies by these authors, e.g. Rieger, Oliver, Wang, & Hens (2015 Management Science). Here students from many countries were asked a variation of Ellsberg's 3-color urn, where there are 30 red balls and 70 black or yellow balls. The most ambiguity averse country was Thailand (80% choose Red), and the last was the US (42% or so choose Red). They correlated these percentages with equity premiums in the countries, finding correlation 0.5 (p = 0.008). Macro-economic controls do not affect the result. Problem: their question did not control for suspicion (**suspicion under ambiguity**) and hence it may have been suspicion rather than ambiguity aversion that drove the correlation.

They also correlated with Hofstede's (2001) uncertainty aversion index. It was positively correlated with ambiguity aversion, and explained the same variance in the equity premium puzzle as ambiguity aversion. %}

Rieger, Marc Oliver & Mei Wang (2012) "Can Ambiguity Aversion Solve the Equity Premium Puzzle? Survey Evidence from International Data," *Finance Research Letters* 9, 63–72.

{% Measure risk and ambiguity attitudes of 6912 subjects (students) in 53 countries, involving N = 6912 students. Section 2 reviews other international studies, which never involved as many countries.

Use WTP for gains but WTA for losses, doing hypothetical choice. Six gain lotteries and two loss lotteries, but no probability smaller than 0.1 or larger than 0.9, so, cannot really observe inverse S. Strictly speaking, the gain lotteries are not really gains because subjects pay their WTP, leading to net payment −WTP (negative, so, a loss) if the lottery gives outcome 0.

Use as index of risk aversion the risk premium divided by the absolute value of EV. Because no mixed lotteries here and no EV = 0 this can be done, although, as is not well known, this normalization is too much and makes moderate payments too risk neutral. An analysis of these data determining PT parameters is in the authors' 2017 paper in Theory and Decision.

For ambiguity have 30 of 100 balls red, and the other 70 black or yellow in unknown proportion. 4.1% of the questions violate weak internality, and 15.1% strict.

risk averse for gains, risk seeking for losses: is found in all 53 countries. Positively related to Hofstede's uncertainty avoidance index.

gender differences in risk attitude: p. 642 §4.2.1: women are more risk averse for gains and more risk seeking for losses.

Pp. 642-643: older people are less risk averse both for gains and for losses (**relation age-risk attitude**).

P. 642: For gains, risk aversion is increasing in wealth between countries. Given that the index that the authors is more a relative risk aversion index than an absolute one, this is consistent with common findings at the individual level. For losses it is not significant (p. 643).

reflection at individual level for risk: risk aversion for gains is negatively correlated with risk aversion for losses (p. 643).

P. 645: using only students reduces heterogeneity within countries, making between-country comparisons more reliable.

For 48 of 53 countries they have only one university. It is in itself good, if studying between-country variations, to have within-country homogeneity. Yet here typicalities of one particular university can much interfere with characteristics of the country. %}

Rieger, Marc Oliver, Mei Wang, & Thorsten Hens (2015) "Risk Preferences around the World," *Management Science* 61, 637–648. https://doi.org/10.1287/mnsc.2013.1869

{% The authors published on this data set in Management Science in 2015, using a-theoretical indexes of risk attitudes such as normalized risk premium. This paper calculates five PT parameters, the same as T&K'92, and then re-analyzes. The data of such a big study have to be noisy, and with eight questions per subject it is difficult to estimate five parameters of PT. Hence, they mostly take all answers per country assuming representative agent. One difficulty in this study is that for losses they only have prospects with one nonzero outcome, so that a common power of utility and probability weighting is unidentifiable. (Pointed out by the authors on p. 584.) Because the authors use a weighting function family, the one-parameter family of T&K'92, their data fitting gives a unique fit, but this is due to assumed functions and not based on data. For gains they have only one of six prospects with more than one nonzero outcome, which should fully determine the power.

gender differences in risk attitude: women do more probability weighting than men.

concave utility for gains, convex utility for losses: is found (p. 582). Utility for losses is more linear than for gains, but not much.

inverse S: is found for both gains and losses. But they only fit the one-parameter family of TK92. Closer to linear for losses than for gains (p. 583).

p. 583: Utility parameters are related to portfolio decisions, but probability weighting parameters are not. This fits with my hypothesis that probability weighting is more noisy than utility.

reflection at individual level for risk: p. 584 finds it, with a positive correlation between concavity of utility for gains and convexity for losses.

P. 587: their nonparametric analysis of probability weighting depends much on utility assumed to be logpower, because only then the third displayed equation implies a constant ratio of CEs.

P. 587: For losses, unlike for gains, the probability weighting parameter is not correlated with the nonparametric estimate, showing that the measurement for losses is more noisy than for gains. Of course, they have fewer observations for losses.

P. 589: of Hofstede's indexes, individualism and uncertainty avoidance enhance more probability weighting.

P. 593: Cites Hofstede (2001) on desirability, if studying between-country differences, to have within-country homogeneity of the sample. %}

Rieger, Marc Oliver, Mei Wang & Thorsten Hens (2017) "Estimating Cumulative Prospect Theory Parameters from an International Survey," *Theory and Decision* 82, 567–596.

{% %}

Riella, Gil (2015) "On the Representation of Incomplete Preferences under Uncertainty with Indecisiveness in Tastes and Beliefs," *Economic Theory* 58, 571–600.

{% The probabilistic dominance model works as follows. It is a regular Anscombe-Aumann framework. In (A,f), A is a set of acts containing f, where f has a special role: it is a status quo. The agent deemes as unacceptable all acts in A that have a probability of θ or more of yielding a utility loss relative to the status quo of λ or more. Here θ and λ are thresholds set by the agent. The unacceptable acts are removed from A. For the ones remaining, expected utility is maximized. A comparative condition of revealing more bias towards the status quo is defined (always having stronger preference for the status quo) that implies the same EU model but with θ and λ being more extreme. %}

Riella, Gil & Roee Teper (2014) "Probabilistic Dominance and Status Quo Bias," *Games and Economic Behavior* 87, 288–304.

{% %}

Riesbeck Christopher K. & Roger C. Schank (1989) "*Inside Case-Based Reasoning*." Lawrence Erlbaum, Hillsdale, NJ.

{% P. 631 2nd column clearly specifies the topic of this paper: **paternalism/Humean-view-of-preference**: "Many have argued (e.g., Gerd Gigerenzer 1996a) that consistency principles are insufficient for defining rationality. If the achievement of an individual's goal does not imply consistency, it is questionable whether functional behavior that violates consistency principles should be called "irrational." "

Another cite is p. 632: "In contrast, we are interested in consistency principles that go beyond assumptions about the properties or attributes of the choice objects. For example, the transitivity axiom is applicable to a wide range of choice objects, …" %}

Rieskamp, Jörg, Jerome R. Busemeyer, & Barbara A. Mellers (2006) "Extending the Bounds of Rationality: Evidence and Theories of Preferential Choice," *Journal of Economic Literature* 44, 631–661.

{% From abstract; Considers EU, PT, and decision field theory (DFT), in deterministic and probabilistic versions. The latter fit better than the former, and DFT does best. %}

Rieskamp, Jörg (2008) "The Probabilistic Nature of Preferential Choice," *Journal of Experimental Psychology. Learning, Memory, and Cognition* 34, 1446–1465.

{% %}

Riesz, Marcel (1927) "Sur les Maxima des Formes Bilinéaires et sur les Fonctionnelles Linéaires," *Acta Mathematica* 49, 465–497.

{% Use belief functions: And their updating is used to explain investment bubbles. The belief functions are not endogenous but exogenous, as in Jaffray's works. They use Shafer's 1976 updating. (**updating: nonadditive measures**) %}

Rigotti, Luca, Matthew Ryan, & Rhema Vaithianathan (2016) "Throwing Good Money after Bad," *Decisions in Economics and Finance* 39, 175–202.

{% %}

Rigotti, Luca & Chris Shannon (2005) "Uncertainty and Risk Aversion in Financial Markets," *Econometrica* 73, 203–243.

{% Take general convex preferences referring to Yaari (1969) for it and, as did the latter, take local marginal rates of substitution between states as kind of subjective probabilities or decision weights (can be interpreted as local beliefs). That is, they are accepted odds for bets at infinitesimal stakes. Show what this does in all kinds of models for ambiguity. Footnote 13 points out an inaccuracy in the proof of Billott, Chateauneuf, Gilboa, & Tallon (2000). Pp. 1179-1180 reminds me of a famous observation of Wald of the 1950s that a Pareto-optimal choice maximizes an expected value (through hyperplane supporting at optimum) which generates subjective probabilities. %}

Rigotti, Luca, Chris Shannon, & Tomasz Strzalecki (2008) "Subjective Beliefs and ex Ante Trade," *Econometrica* 76, 1167–1190.

{% On "pariteitsschending," meaning that left and right are not always symmetric in nature. %}

Rikker, Geert & … (2000)

{% **Z&Z**: shows that adverse selection can be detrimental for competitive markets. %}

Riley, John G. (1979) "Informational Equilibria," *Econometrica* 47, 331–359.

{% Incompleteness in markets can be explained by ambiguity aversion. %}

Rinaldi, Francesca (2009) "Endogenous Incompleteness of Financial Markets: The Role of Ambiguity and Ambiguity Aversion," *Journal of Mathematical Economics* 45, 880–901.

{% Generalize results on existence and continuity of solutions to Koopmans' recursive equation. Consider consumption streams that have their growth rate unbounded above and below. %}

Rincón-Zapatero, Juan Pablo & Carlos Rodríguez-Palmero (2007) "Recursive Utility with Unbounded Aggregators," *Economic Theory* 33, 381–391.

{% Students in exams with multiple choice questions were valued by means of **proper scoring rules**. %}

Rippey, Robert M. & Anthony E. Voytovich (1983) "Linking Knowledge, Realism and Diagnostic Reasoning by Computer-Assisted Confidence Testing," *Journal of Computer-Based Instruction* 9, 88–97.

{% **foundations of statistics**: citing much on the debates. %}

Risingener, D. Michael (2013) "Reservations about Likelihood Ratios and Some Other Aspects of Forensic 'Bayesianism'," *Law, Probability and Risk* 12, 63–73.

{% **conservation of influence** %}

Risjord, Mark (2005) "Reasons, Causes, and Action Explanation," *Philosophy of the Social Sciences* 35, 294–306.

{% %}

Riskey, Dwight R. & Michael H. Birnbaum (1974) “Compensatory Effects in Moral Judgments: Two Rights Don’t Make up for a Wrong,” *Journal of Experimental Psychology* 103, 171–173.

{% People don’t want to vaccinate their child even if that decreases the total probability of death of the child, only so as to avoid perceived responsibility. %}
Ritov, Ilana & Jonathan Baron (1990) “Reluctance to Vaccinate: Omission Bias and Ambiguity,” *Journal of Behavioral Decision Making* 3, 263–277.

{% %}
Ritov, Ilana & Jonathan Baron (1995) “Outcome Knowledge, Regret, and Omission Bias,” *Organizational Behavior and Human Decision Processes* 64, 119–127.

{% %}
Ritov, Ilana, & Daniel Kahneman (1997) “How People Value the Environment: Attitudes vs Economic Values.” *In* Max H. Bazerman, David Messick, Ann Tembrunzel, & Kimberly A. Wade-Benzoni (eds.) *Psychological Approaches to Environmental and Ethical Issues in Management*, New Lexington Press.

{% **game theory for nonexpected utility** %}
Ritzberger, Klaus (1996) “On Games under Expected Utility with Rank Dependent Probabilities,” *Theory and Decision* 40, 1–27.

{% **ranking economists** %}
Ritzberger, Klaus (2008) “On Ranking of Journals in Economics and Related Fields,” *Games and Economic Behavior* 9, 402–430.

{% Considers (and rejects) Fisher as inductive, says NP are deductive. Argues that these all are decision-theories. **foundations of statistics** %}
Rivadulla, Andrés (1991) “Mathematical Statistics and Metastatistical Analysis,” *Erkenntnis* 34, 211–236.

{% %}

Rivero, J. Carlos, David R. Holtgrave, Robert N. Bontempo, & William P. Bottom (1989) "The St. Petersburg Paradox: Data, at Last," *Commentary* 8, 46–51. Reprinted in Wing Hong Loke (ed.) *Perspectives on Judgment and Decision Making*, Lanham Press, Kent, England.

{% Nice data illustrating loss aversion. For young male physicians between 1986 and 1990, the growth of income can best be explained through a model of reference points and loss aversion. %}

Rizzo, John A. & Richard J. Zeckhauser (2004) "Reference Incomes, Loss Aversion, and Physician Behavior," *Review of Economics and Statistics* 85, 909–922.

{% %}

Robert, Christian P. (1994) "*The Bayesian Choice, A Decision-Theoretic Motivation; From Decision-Theoretic Foundations to Computational Implementation*." Springer, Berlin. (2nd edn. 2001.)

{% Seems to have introduced the problem of the multi-armed bandit: A slot machine (one-armed bandit) may have more than one lever. When pulled, each lever provides a reward drawn from a distribution associated to that specific lever. The objective of the gambler is to maximize the collected reward sum through iterative pulls. It is classically assumed that the gambler has no initial knowledge about the levers, but through repeated trials, he can focus on the most rewarding levers. The exploration versus exploitation problem concerns to what extent one pulls the lever that performed best up to that time so as to maximize immediate reward, and to what extent one continues to pull levers inferior up to that point so as to continue collecting info about them. %}

Robbins, Herbert E. (1952) "Some Aspects of the Sequential Design of Experiments," *Bulletin of the American Mathematical Society* 55, 527–535.

{% **risky utility u = transform of strength of preference v, latter doesn't exist**: seems to have been very influential in the ordinal revolution.

P. 16 of 1937 edn. seems to define economics: "Economics is the science which studies human behavior as a relationship between ends and scarce means which have alternative uses." Often credited for being one of the main initiators of the ordinal revolution.

P. 85 seems to write, about economics: "… is capable of being set out and defended in absolutely non-hedonistic term [and has no] essential connection with psychological hedonism, or for that matter with any other branch of Fach-Psychology." %}
Robbins, Lionel (1932) "*An Essay on the Nature and Significance of Economic Science*." MacMillan, London.

{% %}
Robbins, Lionel (1938) "Interpersonal Comparisons of Utility: A Comment," *Economic Journal* 48, 635–641.

{% **foundations of statistics**: book review of Mayo & Spanos (2012) "*Error and the Growth of Experimental Knowledge*." University of Chicago Press, Chicago. %}
Robert, Christian (2013) "Error and Inference: An Outsider Stand on a Frequentist Philosophy," *Theory and Decision* 74, 447–461.

{% %}
Roberts, Arthur W. & Dale E. Varberg (1973) "*Convex Functions*." Academic Press, New York.

{% %}
Roberts, Fred S. (1979) "*Measurement Theory*" (Encyclopedia of Mathematics and its Applications, Vol. 7). Addison-Wesley, London.

{% Pp. 332-335 list emotional reasons other than aversion to unknown probabilities that can underlie the Ellsberg paradox. In his, long, reply, Ellsberg agrees with this view. %}
Roberts, Harry V. (1963) "Risk, Ambiguity, and the Savage Axioms: Comment," *Quarterly Journal of Economics* 77, 327–336.

{% %}
Roberts, John M., Jr. (1990) "Modeling Hierarchy: Transitivity and the Linear Ordering Problem," *Journal of Mathematical Sociology* 16, 77–87.

{% **foundations of probability**; **foundations of quantum mechanics**; **foundations of statistics**: discusses how Bayesian view on subjective probability as degree of belief can go together with the view of quantum mechanics that nature is random. %}

Roberts, John T. (2013) “Chance without Credence,” *British Journal for the Philosophy of Science* 64, 33–59.

{% This paper considers social choice/welfare theory, starting from quantitative info (utility, which can be cardinal) about individual preferences. Then Arrow’s choice setup, with only ordinal info, is specified as a special case. It gives a good framework to study ordinal versus cardinal info there.

Arrow’s voting paradox ==> ordinality does not work: the paper has the perfect framework to state this, and may well have been inspired by it, but never states this opinion.

SIIA/IIIA: the paper has a good framework for this, and cites also Nash (1950 ECMA) for his IIA I guess, but I did not read it enough for it. %}

Roberts, Kevin W.S. (1980) “Interpersonal Comparability and Social Choice Theory,” *Review of Economic Studies* 47. 421–439.

{% P. 135 proposes loss aversion, i.e., the utility kink at zero! Does assume concave utility throughout. Referred to in Robertson (1954, footnote 4). That footnote suggests that Chapman (1912) preceded him, but Chapman only has parts of increasing marginal utility and not loss aversion. %}

Robertson, Dennis H. (1915) “*A Study of Industrial Fluctuation; An Enquiry into the Character and Causes of the So-Called Cyclical Movement of Trade*.” P.S. King & Son ltd., London.

{% **risky utility u = strength of preference v (or other riskless cardinal utility, often called value)**. Author writes informally, is probably text of spoken lecture. Presents himself as not formally trained. Says that he believes in cardinal utility and diminishing marginal utility on the basis of introspection. He is one of the few to think so in those days. Does not give formal arguments but suggests strong intuition. In that regard I am with him! For example, p. 667 ℓ. 15-18. P. 673 footnote 4 describes loss aversion. A reaction is by Friedman (1955). %}

Robertson, Dennis H. (1954) "Utility and All What?," *Economic Journal* 64, 665–678.

{% r**eal incentives/hypothetical choice, for time preferences**: seems to be on it %}
Robertson, Stephen H., & Erin B. Rasmussen (2018) "Comparison of Potentially Real versus Hypothetical Food Outcomes in Delay and Probability Discounting Tasks," *Behavioural Processes* 149, 8–15.
https://doi.org/10.1016/j.beproc.2018.01.014

{% %}
Robinson, Abraham (1974) "*Non-Standard Analysis*; revised edn." Elsevier, New York.

{% **adaptive utility elicitation**; find that VAS performs badly. %}
Robinson, Angela, Paul Dolan, & Alan Williams (1997) "Valuing Health Status Using VAS and TTO: What Lies behind the Numbers," *Social Science and Medicine* 45, 1289–1297.

{% **risky utility u = transform of strength of preference v**. Authors use Schwartz's (1998) proposal to correct VAS scores by means of Parducci's R-F model, which describes range- and frequency biases. Seems to work OK for VAS. Unfortunately, there is also a negative message, i.e., relating it to PE (if I remember well, they call it SG) scores does not give good results. (**PE doesn't do well**)

Did qualitative interviews of subjects asking how they had reasoned. The interviews suggest that subjects do take the sure outcome in the PE as a reference point, confirming the suggestion by Hersey & Schoemaker (1985). %}
Robinson, Angela, Graham Loomes, & Michael Jones-Lee (2001) "Visual Analog Scales, Standard Gambles, and Relative Risk Aversion," *Medical Decision Making* 21, 17–21.

{% %}
Robinson, Angela & Anne Spencer (2006) "Exploring Challenges to TTO Utilities: Valuing States Worse than Dead," *Health Economics* 15, 393–402.

{% Measure indifferences (p:H_1, 1−p: perfect health) ~(q:H_2, 1−q: perfect health), derived using matching, so, two outcomes with one being perfect health. Under EU, if we scale U(perfect health) = 0, then this readily gives proportions of U and thus entire U for all health states worse than perfect health. Health states worse than dead need no special treatment here. This method has the (uninformative) name "modified standard gamble." The authors cite preceding papers using it. They add an analysis base on RDU using power weighting function. Point out that T&K'92 family did not work well, finding mostly pessimism (p. 346 penultimate para). They find pessimism and, hence, utility is less low (concave) than EU would have it. A problem with RDU is that power may not be identifiable, most clearly seen if we scale U(perfect ealth) = 0. %}

Robinson, Angela, Anne Spencer, & Peter Moffatt (2015) "A Framework for Estimating Health State Utility Values within a Discrete Choice Experiment Modeling Risky Choices," *Medical Decision Making* 35, 276–291.

{% A pet could be in one of two locations. Children did not know, but could put food in one or two locations. If the location was to be determined in the future, they would put food in both locations. If the location had been determined in the past (but unknown to them) they would put it in one of the two locations. Thus, they treat uncertainty in the physical world (physical uncertainty) differently than when in their own perspective of ignorance (epistemic uncertainty). %}

Robinson, Elizabeth J., Martin G. Rowley, Sarah R. Beck, Dan J. Carroll, & Ian A. Apperly (2006) "Children's Sensitivity to Their Own Relative Ignorance: Handling of Possibilities under Epistemic and Physical Uncertainty," *Child Development* 77, 1642–1655.

{% Discusses behavioral economics, and the degree to which it enhances paternalism or better informing consumers.

paternalism/Humean-view-of-preference: Favor non-paternalism. Argue that preferences should be taken as stated, where we seek to have people well-informed when choosing. But no paternalism. The abstract writes: "we take the perspective that analysts should avoid making judgments about whether values are "rational" or "irrational." ... More generally, behavioral research has led some to argue for a more paternalistic approach to policy analysis. We argue instead for continued focus on describing the preferences of those affected, while working to ensure that these preferences are based on knowledge and careful reflection." End of §3 argues for consumer sovereignty.

P. 1412 1st column argues that, if WTP-WTA discrepancy due to different reference point (income effect cannot explain), then the right perspective depends on what the reference point in reality is. I disagree! The discrepancy signals a bias.

P. 1413 2nd column 2nd para, argues that WTP can never be more than the wealth possessed, and WTA has no limit, and takes this as argument in favor of WTP. I would think that it is an argument against WTP. %}

Robinson, Lisa A. & James K. Hammitt (2011) "Behavioral Economics and Regulatory Analysis," *Risk Analysis* 31, 1408–1422.

{% r**eal incentives/hypothetical choice**: seems to be on it %}

Robinson, Peter J. & W.J. Wouter Botzen (2019) "Determinants of Probability Neglect and Risk Attitudes for Disaster Risk: An online Experimental Study of Flood Insurance Demand among Homeowners," *Risk Analysis* 39, 2514–2527. https://doi.org/10.1111/risa.13361

{% r**eal incentives/hypothetical choice**: seems to be on it %}

Robinson, Peter J., & W.J. Wouter Botzen (2020) "Flood Insurance Demand and Probability Weighting: The Influences of Regret, Worry, Locus of Control and the Threshold of Concern Heuristic," *Water Resources and Economics* 30, 100144.
https://doi.org/10.1016/j.wre.2019.100144

{% The authors use the smooth model, or, rather, recursive expected utility, to analyze ambiguity. Do what title says. Measurements of ambiguity attitudes done for gains better predict than those done for losses. %}

Robinson, Peter J., W. J. Wouter Botzen, & Fujin Zhou (2021) "An Experimental Study of Charity Hazard: The Effect of Risky and Ambiguous Government Compensation on Flood Insurance Demand," *Journal of Risk and Uncertainty* 63, 275–318.

https://doi.org/10.1007/s11166-021-09365-6

{% **utility elicitation**; beginning gives some nice refs.; theoretical discussion is confused and hard to follow. %}

Robison, Lindon J. (1982) "An Appraisal of Expected Utility Hypothesis Tests Constructed from Responses to Hypothetical Questions and Experimental Choices," *American Journal of Agricultural Economics* 64, 367–375.

{% %}

Robles, Elias, Perla Amalia Vargas, & Rafael Bejarano (2009) "Within-Subject Differences in Degree of Delay Discounting as a Function of Order of Presentation of Hypothetical Cash Rewards," *Behavioural Processes* 81, 260–263.

{% %}

{% N = 2012 subjects; Study JEM (joint evaluation of some things —reduction of road risk) versus SEM (separate evaluation, each in isolation; called monadic in marketing). SEM shows insensitivity towards relevant quantities, JEM shows context dependence. Give an explanation in terms of choice errors. %}

Robles-Zurita, José Antonio, José Luis Pinto, José María Abellán-Perpiñán, Jorge Martínez-Pérez, & Fernando I. Sánchez-Martínez (2017) "Improving Scope Sensitivity in Contingent Valuation: Joint and Separate Evaluation of Health States," *Health Economics* 26, e304–e318. https://doi.org/10.1002/hec.3508

{% Shows how (nonlinear) risk attitudes can result from evolutionary optimization. %}

Robson, Arthur J. (1996) "A Biological Basis for Expected and Non-Expected Utility," *Journal of Economic Theory* 68, 397–424.

{% This paper presents models in which it is plausible that a utility function to evaluate outcomes is related to expected offspring. It assumes statistical independence between offspring of different individuals. Then those individuals with highest expected number of offspring will outnumber all others, as is well

known.

The statistical independence is, of course, not completely valid. Species of which some individuals do not maximize offspring but sacrifice this number to increasing the offspring of other individuals, (e.g. by developing and distributing ideas and neglecting the family, as some researchers do), will outperform species of which all individuals do nothing but maximizing own offspring.

P. 902: "The stochastic nature of reproduction is identified as a key reason why a built-in utility function is necessary …Finally, it is argued that a hedonic interpretation of utility is persuasive in this biological setting." §III.D on pp. 908-909 indeed argues for it. %}

Robson, Arthur J. (2001) "Why Would Nature Give Individuals Utility Functions?," *Journal of Political Economy* 109, 900–914.

{% Extensive survey on evolutionary preference theory %}

Robson, Arthur & Larry Samuelson (2010) "The Evolutionary Foundations of Preferences." *In* Jess Benhabib, Alberto Bisin, & Mathew O. Jackson (eds.) *Handbook of Social Economics*, 221–310, North-Holland, Amsterdam.

{% Following Robson (1996), study how nonlinear) risk attitudes can result from evolutionary optimization. %}

Robson, Arthur & Larry Samuelson (2022) "The Evolution of Risk Attitudes with Fertility Thresholds," *Journal of Economic Theory* 205, 105552. https://doi.org/10.1016/j.jet.2022.105552

{% Give evolutionary/biological basis to discounting, with individuals more impatient than groups. %}

Robson, Arthur J. & Balázs Szentes (2014) "A Biological Theory of Social Discounting," *American Economic Review* 104, 4184–4204.

{% Evolution can lead to discounting expected utility with discount rate related to population growth and death rate. Aggregate uncertainty about death rates can lead to deviations from constant discounting. %}

Robson, Arthur J. & Larry Samuelson (2009) "The Evolution of Time Preference with Aggregate Uncertainty," *American Economic Review* 99, 1925–1953.

{% Redo the Rogers (1994) analysis with some other assumptions about (homogeneity of) utility and other things.

conservation of influence: generalize also criterion of reproductive value. %}

Robson, Arthur J. & Balázs Szentes (2008) "Evolution of Time Preference by Natural Selection: Comment," *American Economic Review* 98, 1178–1188.

{% Incentives: Do both with and without real incentives. Each subject did three choices, each of them paid under real incentives (income effect).

ambiguity seeking: If subjects are first endowed with the ambiguous Ellsberg gamble, and are asked if they want to exchange it for the unambiguous one, then most don't want that. In terms of final wealth, they then exhibit ambiguity seeking. The main conclusion can be that loss aversion dominates ambiguity aversion.

The authors use the term source preference differently than prospect theory does. In this paper it means whether it matters if subjects just got a prior endowment or had selected it.

An alternative title for this paper could have been:
"The status quo bias dominates ambiguity aversion."

suspicion under ambiguity: p. 181: They controlled for suspicion in Ellsberg choices both by letting subjects select color to gambe on, and by gambling on all colors. Unfortunately, in the latter case they really played all three choices, so that income effects and, in particular, hedging may have been going on.

reflection at individual level for ambiguity: experiment 1 gives no data.

Experiment 2 does not give it explicitly. Maybe it can be derived from the data given in Tables 5 and 6, but it was too complex to me (would have to read line by line) how the groups and treatments had been organized. This similarly holds for Experiment 3. %}

Roca, Mercè, Robin M. Hogarth, & A. John Maule (2006) "Ambiguity Seeking as a Result of the Status Quo Bias," *Journal of Risk and Uncertainty* 32, 175–194.

{% Study in more detail the nice finding of Roca, Hogarth, & Maule (2006). %}

Roca, Mercè & A. John Maule (2009) "The Effects of Endowment on the Demand for Probabilistic Information," *Organizational Behavior and Human Decision Processes* 109, 56–66.

{% %}

Rockafellar, R. Tyrrell (1970) "*Convex Analysis.*" Princeton University Press, Princeton NJ.

{% **risk averse for gains, risk seeking for losses**: They find it. They confirm common ratio, preference reversal, and reflection.

Teams are not closer to EU than individuals, but they do get higher EV at lower risk so, in that sense are better.

loss aversion: erroneously thinking it is reflection: p. 416 confuses reflection (what they do) with loss aversion, calling it reference point effect, and even explicitly stating the confusion: "the reference point effect (also referred to as loss aversion or reflection effect)." %}

Rockenbach, Bettina, Abdolkarim Sadrieh, & Barbara Mathauschek (2007) "Teams Take the Better Risks," *Journal of Economic Behavior and Organization* 63, 412–422.

{% They use RIS.

ambiguity seeking for losses: they claim so, but it is only mismodeling of outcomes and utility.

First two experiments mainly redo Fox & Tversky (1995) with joint and separate evaluation of prospects (separable prospect theory). They do not replicate the FT finding but find that separate evaluation still gives ambiguity aversion. They suggest too much that this is their own idea, citing FT too late and vaguely at the end of §3 p. 279. There are later related findings by Chow & Sarin (2001, 2002).

P. 271 argues that not just EU should be maximized, but sometimes also variance of utility should be considered, which is to be minimized if we are above our needs and is to be maximized if we are below our needs. The authors simply misunderstand utility. If there is a level of needs below which everything is very bad then this should be incorporated in our utility function, e.g. being steep or having a jump below that level of needs, and we still just maximize EU. What they say then is correct in terms of variance of outcomes, but not in terms of variance of utility contrary to what they say. Wakker (2010 Comment 2.6.5) criticizes such considerations of variance of utility.

In their experiments, ambiguity was generated by providing intervals, with center equal to objective probability. Unfortunately, subjects could not choose the color to gamble on, so that there can be suspicion. (**suspicion under ambiguity**; P. 283 explains that Rode 1996 had done it properly.)

Experiment 4: P. 289 end of §6 explains that they generate the same probability distributions over the same outcomes with only different reference points (they don't use the latter term). Those quasi-reference points are however presented as different levels of needs to the subjects where subjects need to attain that level for some important purpose (making it to a second stage of some nice prospect). So, it is not at all the same outcomes but it is just very different situations in which outcomes mean very different things, with very different utilities. This rather than any attitude to ambiguity explains their findings. %}

Rode, Catrin, Leda Cosmides, Wolfgang Hell, John Tooby (1999) "When and why Do People Avoid Unknown Probabilities in Decisions under Uncertainty? Testing some Predictions from Optimal Foraging Theory," *Cognition* 72, 269–304.

{% Problems with infinity; p. 1 gives references to people discussing matters. %}

Röd, Wolfgang (1990) "Das Problem des Unendlichen bei Kant," *Deutsche Zeitschrift für Philosophie* 38, 497–505.

{% **revealed preference**: Many references to empirical violations. Shows how proper parameter choices of decision field theory can accommodate them.

paternalism/Humean-view-of-preference: they show that, by accounting for contextual effects as described by decision field theory, we can get back a context-free psychophysical function. %}

Roe, Robert M., Jerome R. Busemeyer, & James T. Townsend (2001) "Multialternative Decision Field Theory: A Dynamic Connectionist Model of Decision Making," *Psychological Review* 108, 370–392.

{% **time preference** %}

Roelofsma, Peter H.M.P. (1994) "Intertemporal Choice." Ph.D. dissertation, Free University of Amsterdam, the Netherlands.

{% **time preference**; **DC = stationarity =** time consistency %}
Roelofsma, Peter H.M.P. (1996) "Modelling Intertemporal Choices: An Anomaly Approach," *Acta Psychologica* 93, 5–22.

{% **time preference** %}
Roelofsma, Peter H.M.P. & Gideon B. Keren (1995) "Framing and Time-Inconsistent Preferences." *In* Jean-Paul Caverni, Maya Bar-Hillel, Francis Hutton Barron, & Helmut Jungermann (eds.) *Contributions to Decision Making*—I, 351–361, Elsevier, Amsterdam.

{% %}
Roelofsma, Peter H.M.P. & Daniel Read (2000) "Intransitive Intertemporal Choice," *Journal of Behavioral Decision Making* 13, 161–177.

{% %}
Röell, Ailsa (1987) "Risk Aversion in Quiggin and Yaari's Rank-Order Model of Choice under Uncertainty," *Economic Journal* 97 (suppl), 143–160.

{% Nicely point out that whereas maximum of maxima is maximum, and average of averages is average, things are complex when these operations are mixed, as when evaluating decision trees. Propose statistical ways through choices of random paths to evaluate decision trees. %}
Rogard, Erwann, Andrew Gelman, & Hao Lu (2007) "Evaluation of Multilevel Decision Trees, *Journal of Statistical Planning and Inference* 137, 1151–1160.

{% **time preference**; in a kind of evolutionary market, about 2 percent discounting (ln 2 per generation) comes out as optimal. Young adults should discount more strongly than elderly. %}
Rogers, Alan R. (1994) "Evolution of Time Preference by Natural Selection," *American Economic Review* 84, 460–481.

{% **equity-versus-efficiency**: one of the topics. It is an experiment on how subjects think about social risks, ex ante fairness, ex post fairness, with real incentives.

Subjects are sensitive not only to risk level, but also to inequality in risk. Ex ante they are averse to such inequality and risk, but ex post they are, surprisingly, seeking. %}

Rohde, Ingrid M. T. & Kirsten I. M. Rohde (2015) "Managing Social Risks – Tradeoffs between Risks and Inequalities," *Journal of Risk and Uncertainty* 51, 103–124.

{% %}

Rohde, Kirsten I.M. (2008) "Arbitrage Opportunities in Frictionless Markets with Sophisticated Investors," *Economic Theory* 34, 389–393.

{% For many purposes (when evaluating intertemporal choice with one nonzero outcome), not the discount function, but its logarithm, plays a role analogous to utility in expected utility. Prelec (2004) demonstrated this, for instance regarding the Pratt-Arrow index and convexity of the logarithm of the discount function. This paper considers convexity of the discount function rather than of its logarithm. The latter is equivalent to something called decreasing relative impatience. It is also equivalent to something called spread seeking. Although equivalent mathematically in the model assumed, the conditions seem to be different intuitively. %}

Rohde, Kirsten I.M. (2009) "Decreasing Relative Impatience," *Journal of Economic Psychology* 30, 831–839.

{% %}

Rohde, Kirsten I.M. (2010) "The Hyperbolic Factor: A Measure of Time Inconsistency," *Journal of Risk and Uncertainty* 41, 125–140.

{% Shows that the very famous Fehr-Schmidt welfare model in fact is a special case of rank-dependent utility with monotonicity relaxed. So, in the generalization of De Waegenaere & Wakker (2001). %}

Rohde, Kirsten I.M. (2010) "A Preference Foundation for Fehr and Schmidt's Model of Inequity Aversion," *Social Choice and Welfare, Social Choice and Welfare* 34, 537–547.

{% This paper proposes an index of decreasing impatience. Assume

(s,x) ~ (t,y)

(s+σ,x) ~ (t+τ,y).

It uses the tradeoff technique to obtain, in my 2010 book notation,

$s \ominus t \sim^t (s+\sigma) \ominus (t,t+\tau)$. It then takes as index $\frac{\tau-\sigma}{\sigma(t-s)}$, and analyzes and calculates it for popular discount families. I would be curious for which discount family it is constant. It shares with Prelec (2004) that it only considers the lengths of the time periods during which stationarity is violated, and for instance not the utility loss one is willing to suffer. There are pros and cons to this, depending on application and purpose. In an experiment, more increasing than decreasing impatience is found! (**decreasing/increasing impatience**) The index is not related to other personality questions. %}

Rohde, Kirsten I. M. (2019) "Measuring Decreasing and Increasing Impatience," *Management Science* 65, 1700–1716.
https://doi.org/10.1287/mnsc.2017.3015

They disentangle attitudes toward positive and negative intertemporal correlation. Subjects exhibit correlation aversion both for lotteries with positive correlation and for lotteries with negative correlation. That is, subjects disliked positive correlations and liked negative correlations. %}

Rohde, Kirsten I.M. & Xiao Yu (2024) "Intertemporal Correlation Aversion — A Model-Free Measurement," *Management Science* 70, 3493–3509.
https://doi.org/10.1287/mnsc.2023.4863

{% %}

Rohner, Dominic, Mathias Thoenig, & Fabrizio Zilibotti (2013) "War Signals: A Theory of Trade, Trust, and Conflict," *Review of Economic Studies* 80, 1114–1147.

{% During lecture on Jan. 31, 2018, said:

"Psychologists don't just stop at the facts." %}

Romagnoli, Giorgia (2018)

{% **foundations of probability** %}

Romeijn, Jan-Willem (2005) "Bayesian Inductive Logic," Ph.D. dissertation.

{% **game theory can/cannot be viewed as decision under uncertainty; updating: nonadditive measures**: does so for RDU (she uses the term CEU (Choquet expected utility)), using a Sarin-Wakker updating rule. %}

Romm, Aylit Tina (2014) "An Interpretation of Focal Point Responses as Non-Additive Beliefs," *Judgment and Decision Making* 9, 387–402.

{% r**eal incentives/hypothetical choice**: seems to be on it %}

Rommel, Jens, Daniel Hermann, Malte Müller, & Oliver Mußhoff (2019) "Contextual Framing and Monetary Incentives in Field Experiments on Risk Preferences: Evidence from German Farmers," *Journal of Agricultural Economics* 70, 408–425.
https://doi.org/10.1111/1477-9552.12298

{% **updating: discussing conditional probability and/or updating**: The basic novelty of the paper concerns the framework of decision under uncertainty that is most central today, Savage's. A state space S is given. Exactly one state is true, the others are not true, and it is uncertain which is the true one. An agent chooses between acts. Each act f maps the state space to an outcome space, say ℝ (money), to yield outcome f(s) where s is the true state. Because the true state is uncertain, it is uncertain what the outcome of an act is. In Savage's model the very only purpose of the agent is to get the best outcome (with highest utility), but because of uncertainty this is not easy and expected utility is maximized. This paper adds a novel aspect where we make the mostly satisfied assumption that the agent knows what act he chooses and what outcome x he receives. The paper observes that the agent then automatically also receives info, being that $f^{-1}(x)$ is a true event, i.e., contains the true state. It is assumed that this info can bring additional utility. The representation, called subjective knowledge utility representation, is:

$$f \quad \text{-->} \quad \text{SUM}_\alpha\, u(\alpha)\mu\big(f^{-1}(\alpha)\big) \;+\; \text{SUM}_\alpha\, h\big(f^{-1}(\alpha)\big)$$

Here the summations are over all outcomes α. The first summation captures regular expected utility. Thus, u denotes a regular utility function and μ a subjective probability measure. In the second summation, h captures the value of the information that event $(f^{-1}(\alpha))$ is true. μ is unique and u is an interval scale, as usual. However, h is unique only up to any measure. This means that only its deviaton from additivity matters. $h(A) + h(B) - h(A \cup B)$ captures how much extra value there comes from separating A and B; in general, it is allowed to be negative. P. 11 Proposition 1: Subadditivity means it is always positive, and characterizes preference for information. (**value of information**)

The paper modifies Savage's axioms to accommodate the added value of information, which is, essentially, that the axioms hold only under information neutrality, i.e., when the informational value can play no role by it being fixed. For instance, monotonicity in outcomes (their Axiom 3 on p. 7; Savage's P3):

$\gamma \succcurlyeq \beta \Rightarrow \gamma_E\mu \succcurlyeq \beta_E\mu$ only if $\mu \neq \gamma$ and $\mu \neq \beta$.

The same basic novelty is, independently, in work byYucheng Liang, as indicated by the authors on top of p. 3, with more details on p. 18. Liang used a more complex model with updating whole probability distributions, more advanced and formal but less accessible. The authors use an unconventional continuity axiom (Axiom 6; p. 9) that is very strong and readily implies Villegas' monotonicity condition. %}

Rommeswinkel, Hendrik, Hung-Chi Chang, & Wen-Tai Hsu (2023) "Preference for Knowledge," *Journal of Economic Theory* 214, 105737. https://doi.org/10.1016/j.jet.2023.105737

{% **dynamic consistency: favors abandoning RCLA**: gives empirical evidence that RCLA is violated; seems to be test of event commutativity. %}

Ronen, Joshua (1971) "Some Effects of Sequential Aggregation in Accounting and Decision-Making," *Journal of Accounting Research* 9, 307–332.

{% Sequence bias in compound events; seems to be test of event commutativity; uses same data set as Ronen (1971). %}

Ronen, Joshua (1973) "Effects of Some Probability Displays on Choices," *Organizational Behavior and Human Performance* 9, 1–15.

{% May have been the first to say:

"It is difficult to make predictions, especially about the future." %}

Ronner, Markus M. (1918)

{% %}

Roorda, Berend & Reinoud Joosten (2014) Tuned Risk Aversion as Interpretation of Non-Expected Utility Preferences," in preparation.

{% %}

Roorda, Berend & Reinoud Joosten (2020) "The Deal-by-Deal Principle for Rational Choice on the Qui Vive," working paper.

{% 16 chimpanzees and 14 bonobos could sometimes take from a bowl with 100% chance of a banana, or from 50% of a banana, or from 0% chance of a banana. Some later they got the option of either choosing from a bowl from which the lid had not been removed, of from the 50% bowl. They preferred the latter. %}

Rosati, Alexandra & Brian Hare (2010) "Chimpanzees and Bonobos Distinguish between Risk and Ambiguity," *Biology Letters*, 2010. http://dx.doi.org/10.1098/rsbl.2010.0927

{% **revealed preference** %}

Rose, Hugh (1958) "Consistency of Preference: The Two-Commodity Case," *Review of Economic Studies* 25, 124–125.

{% %}

Rose, Jason P. (2012) "Debiasing Comparative Optimism and Increasing Worry for Health Outcomes," *Journal of Health Psychology* 17, 1121–1131.

{% Study equilibria in zero-sum games when one player has uncertainty and is ambiguity averse. Provide conditions for equilibrium existence. Consider the case of a better-informed opponent. %}

Rosenberg, Dinah & Nicolas Vieille (2019) "Zero-Sum Games with Ambiguity," *Games and Economic Behavior* 117, 238–249.

{% Find that loss aversion works well to explain macroeconomic data. Use utility linear for gains and losses. %}
Rosenblatt-Wisch, Rina (2008) "Loss Aversion in Aggregate Macroeconomic Time Series," *European Economic Review* 52, 1140–1159.

{% **losses from prior endowment mechanism**: Seems that some subjects received the prior endowment two weeks before the experiment, and others at the beginning. Those who received it two weeks before were more risk averse. Suggests that the latter group integrated the payoffs less. %}
Rosenboim, Mosi, & Tal Shavit (2012) "Whose Money Is It anyway? Using Prepaid Incentives in Experimental Economics to Create a Natural Environment," *Experimental Economics* 15, 145–157.

{% Show that taking publically announced reserve price as reference point in auctions improves fit. %}
Rosenkrantz, Stephanie & Patrick W. Schmitz (2007) "Reserve Prices in Auctions as Reference Points," *Economic Journal* 117, 637–653.

{% Comes close to find that capacity ν being convex implies that its Choquet integral is minimum over core integrals (e.g., Theorem 1.1, Corollary 2.3) but does not really state that. %}
Rosenmüller, Joachim (1971) "On Core and Value," *Methods of Operations Research* 9, 84–104.

{% %}
Rosenmüller, Joachim (1972) "Some Properties of Convex Set Functions, Part II," *Methods of Operations Research* 17, 287–307.

{% **foundations of statistics**; bias because negative results cannot be published %}
Rosenthal, Robert (1979) "The "File Drawer Problem" and Tolerance for Null Results," *Psychological Bulletin* 86, 638–641.

{% Text book on analysis of variance. %}

Rosenthal, Robert & Ralph L. Rosnow (1991) "*Essentials of Behavioral Research: Methods and Data Analysis;*" 2nd edn. McGraw-Hill, New York.

{% Seems to be: d**ecision under stress**; descriptive studies of coping with catastrophes, with general types of processing and coping. %}

Rosenthal, Uriel & Menno van Duin (1989) "Decision Making in Technological Emergencies." *In* Charles A.J. Vlek & George Cvetkovich (eds.) *Social Decision Methodology for Technological Projects*, 277–295, Kluwer, Dordrecht.

{% Seems to be as follows:

Take discounted utility of $(C_t - C_{min})^{\rho}/(1-\rho)$, where C_t is money spent on consumption in time t, of households that have bullocks in India. C_{min} is minimal consumption for survival. Idea is that if C_t threatens to be below, family will borrow from others, or be helped by others -I guess. There is also risk, and expected utility. Investigate if insurance helps families to optimally invest in bullocks, and find it doesn't. %}

Rosenzweig, Mark R. & Kenneth I. Wolpin (1993) "Credit Market Constraints, Consumption Smoothing, and the Accumulation of Durable Production Assets in Low-Income Countries: Investments in Bullocks in India," *Journal of Political Economy* 101, 223–244.

{% **inverse S:** finds over-betting on small-probability gain horses (p. 604: for $p < .03$) %}

Rosett, Richard N. (1965) "Gambling and Rationality," *Journal of Political Economy* 73, 595–607.

{% **SEU = SEU**: says on p. 534 that transforming probabilities is still SEU.

Argues that Yaari's 1965 (QJE) result confirms overestimation of small probabilities, but need not reject the Friedman/Savage (1948) utility hypothesis if the subjects of Yaari's experiment were involved in other side gambles unknown to the experimentor (hidden stakes in Kadane & Winkler's 1988 sense). It is, however, generally accepted nowadays (1990-2023) to ignore hidden stakes,

mostly because of the isolation effect. Therefore, whereas Rosett is formally right, his point should not affect Yaari's finding. %}

Rosett, Richard N. (1967) "The Friedman-Savage Hypothesis and Convex Acceptance Sets: A Reconciliation," *Quarterly Journal of Economics* 81, 534–535.

{% **inverse S:** data support finding of Yaari which suggests inverse S probability weighting: sets of lotteries preferred to status quo is convex suggesting concave utility but decision weights, inferrable from tangent of convex set of lotteries, differ from objective probabilities and suggest overweighting of low probabilities.

Nice opening sentence:

" … are the modest final product of an initially ambitious attempt …"

real incentives: **random incentive system**

Highly remarkable is the last paragraph on p. 482. It shows that Edwards fixed-probability-transformation model (separable prospect theory) violates stochastic dominance for the special case of overestimation of small probabilties (so, it already has part of Fishburn 1978). This latter model is described as Yaari's hypothesis. Probability-weighted means weighting through "subjective probabilities" that are transforms of objective probabilities:

> Yaari's hypothesis is appealing as long as we confine our attention to gambles with only two outcomes. If we consider gambles with many outcomes we need to deal with the problems that all the probabilities may be small and if they are all subjectively exaggerated, their sum will exceed one. To trace the implications of this anomaly, it is necessary to specify the rule for calculating expected values. If, for example, expected utility is calculated simply by summing the probability-weighted utilities of outcomes, it should be possible to persuade a gambler that by giving away money he makes himself better off. If his initial wealth is X_0 and his utility is $U(X_0)$, it will be possible to find a set of pay-offs,
>
> $X_i < X_0$, $i = 1, \ldots, n$,
>
> such that $\Sigma p_i U(X_i) > U(X_0)$.
>
> This happens because $\Sigma p_i > 1$ and we can select the X_i to make $U(X_i)$ as close to $U(X_0)$ as we please.

Next he goes on to show that adding a constant to U can affect preference.

Conclusion points out importance of framing (“exact conditions of the experiment”) %}
Rosett, Richard N. (1971) “Weak Experimental Verification of the Expected Utility Hypothesis,” *Review of Economic Studies* 38, 481–492.

{% %}
Roskam, Edward E.Ch.I. (1968) “*Metric Analysis of Ordinal Data in Psychology*.” VAM, Voorschoten.

{% %}
Roskies, Ralph (1965) “A Measurement Axiomatization for an Essentially Multiplicative Representation of Two Factors,” *Journal of Mathematical Psychology* 2, 266–276.

{% Claiming that we are too pessimistic, focusing on dangers and bad news. %}
Rosling, Hans (2018) “*Factfulness: Ten Reasons We’re Wrong about the World—and why Things Are Better than You Think*.” Flatiron Books, New York.

{% %}
Ross, Lee, David Greene, & Pamela House (1977) “The ‘False Consensus Effect’: An Egocentric Bias in Social Perception and Attribution Processes,” *Journal of Experimental Social Psychology* 13, 279–301.

{% %}
Ross, Stephen A. (1981) “Some Stronger Measures of Risk Aversion in the Small and in the Large with Applications,” *Econometrica* 49, 621–638.

{% Ch. 1 seems to present the fundamental theorem of finance (on no arbitrage). %}
Ross, Stephen A. (2005) “*Neoclassical Finance*.” Princeton University Press, Princeton.

{% %}
Ross, Lee D., Mark R. Lepper, Fritz Strack, & Julia Steinmetz (1977) “Social Explanation and Social Expectation: Effects of Real and Hypothetical

Explanations on Subjective Likelihood," *Journal of Personality and Social Psychology* 35, 817–829.

{% % Seem to point out that correlation of behavior is usually small. %}
Ross, Lee & Richard E. Nisbett (1991) "*The Person and the Situation: Perspectives of Social Psychology*." McGraw-Hill, New York.

{% %}
Rosser, J. Barkley (1993) "Belief: Its Role in Economic Thought and Action," *American Journal of Economics and Sociology* 52, 355–368.

{% **intuitive versus analytical decisions**; seem to use a "psychometric approach" to value states of illness, involving lengthy and painful interviews. Work of Rosser et al. seems to be basis of most of the work on cost per QALY in the UK.

Seem to have searched for a **reflective equilibrium**. That is, decision-theoretic implications were confronted with direct intuitive choices (in context of health policies concerning others) and in case of discrepancy, subjects were asked if they wanted to revise some of their decisions. %}
Rosser, Rachel M. & Paul Kind (1978) "A Scale of Valuation of States of Illness: Is there a Social Consensus?," *International Journal of Epidemiology* 7, 347–358.

{% **optimal scale levels**: seems to argue that for unipolar scales five answer levels is optimal, and for bipolar scales it is seven. %}
Rossiter, John R. (2002) "The C-OAR-SE Procedure for Scale Development in Marketing," *International Journal of Research in Marketing* 19, 305–335.

{% Measure eye-fixation patterns to see if subjects do more attribute-based or alternative-based evaluations. (Terms explained in annotations at Scholten et al. (2024 Psychological Review). It is the former. %}
Russo, J. Edward & Barbara A. Dosher (1983) "Strategies for Multiattribute Binary Choice," *Journal of Experimental Psychology: Learning, Memory, and Cognition* 9, 676–696.
https://doi.org/10.1037/0278-7393.9.4.676

{% In a Savagean setup, preference foundation for maximization of the quantile of the probability distribution. So, of the VaR. §6.1 may at first seem to suggest that quantiles are not that, but it does not, and instead it argues that VaR are often not used as a final-decision criterion. Quantile maximization is mathematically the same as VaR. %}

Rostek, Marzena J. (2010) "Quantile Maximization in Decision Theory," *Review of Economic Studies* 77, 339–371.
https://doi.org/10.1111/j.1467-937X.2009.00564.x

{% Seems to be a classic on Möbius inverse. %}

Rota, Gian-Carlo (1964) "On the Foundations of Combinatorial Theory I. Theory of Möbius Functions," *Zeitschrift für Warscheinlichkeitstheorie und Verwandte Gebiete* 2, 340–368.

{% r**eal incentives/hypothetical choice, for time preferences**: seems to be on it %}

Rotella, Amanda, Cody Fogg, Sandeep Mishra, & Pat Barclay (2019) "Measuring Delay Discounting in a Crowdsourced Sample: An Exploratory Study," *Scandinavian Journal of Psychology* 60, 520–527.
https://doi.org/10.1111/sjop.12583

{% Nice example of neurobiologist who criticizes psychologists by saying that there is not one fixed collection of mental processes, but that it depends on biological and chemical processes. Nice analogy of psychologists' criticisms of economists. %}

Roth, Alvin E. (1996) "Comment." *In* Kenneth J. Arrow, Enrico Colombatto, Mark Perlman, & Christian Schmidt (eds.) *The Rational Foundations of Economic Behavior: Proceedings of the IEA Conference Held in Turin, Italy*, 198–202, St. Martins Press, New York.

{% Empirical tests of bargaining solutions;
Christiane, Veronika & I: binary lottery technique: Pay not in money but in probability for gaining a prize. Thus, they have have linearity in outcome under EU (P.s.: this was proposed before by Smith (1961) and by Anscombe &

Aumann (1963), and independently after by Allen (1987) and Berg, Daley, Dickhaut, & O'Brien (1986). %}

Roth, Alvin E. & Michael W. Malouf (1979) "Game-Theoretic Models and the Role of Information in Bargaining," *Psychological Review* 86, 574–594.

{% **discounting normative**: object to discounting of life savings; argue that uncertainty cannot be used to justify discounting because it should be modeled as uncertainty. And that discounting of money does not necessarily imply discounting of life years. %}

Roth, Carl A., Roy T. Ing, & David A. Ross (1978) letter to *New England Journal of Medicine* 2998, 1088.

{% **discounting normative**: refers to Lottini da Volterra in the sixteenth century who argued against discounting "overestimation of a present on moral grounds". Seems that Rothbard wrote: "da Volterra in the sixteenth century "inaugurated the tradition of moralistically deploring (positive) time preference as an overestimation of a present that can be grasped immediately by the sense" %}

Rothbard, Murray N. (1990) "Time Preference." *In* John Eatwell, Murray Milgate, & Peter K. Newman (eds.) *The New Palgrave: A Dictionary of Economic Theory and Doctrine*, Vol. 4, 644–646, The MacMillan Press, London.

{% It seems that subjects could gamble on risks resolved in the past but yet unknown, and equal-probability risks reesolved in the future. They preferred to gamble on future risks. (difference between pre- and post-diction) The authors explain it by magical thinking. Heath & Tversky (1991) pp. 8-9 will suggest the competence effect. %}

Rothbart, Myron & Mark Snyder. (1970) "Confidence in the Prediction and Postdiction of an Uncertain Outcome," *Canadian Journal of Behavioral Science* 2, 38–43.

{% %}

Rothblum, Uriel G. (1975) "Multivariate Constant Risk Posture," *Journal of Economic Theory* 10, 309–322.

{% **probability elicitation**: he seems to consider corrections for overconfidence that work well. %}
Rothschild, David (2009) "Forecasting Elections: Comparing Prediction Markets, Polls, and Their Biases," *Public Opinion Quarterly* 73, 895–916.

{% Introduce second-order stochastic dominance (together with Hadar & Russell, 1969). P. 226 point 4 explains that being more risky is not identical to having more variance. %}
Rothschild, Michael & Joseph E. Stiglitz (1970) "Increasing Risk: I. A Definition," *Journal of Economic Theory* 2, 225–243.

{% %}
Rothschild, Michael & Joseph E. Stiglitz (1971) "Increasing Risk: II Its Economic Consequences," *Journal of Economic Theory* 3, 66–84.

{% %}
Rothschild, Michael & Joseph E. Stiglitz (1973) "Some Further Results on the Measurement of Income Inequality," *Journal of Economic Theory* 6, 188–204.

{% **Z&Z**: shows that adverse selection can be detrimental for competitive markets; there will be competition with cream skimming. %}
Rothschild, Michael & Joseph E. Stiglitz (1976) "Equilibrium in Competitive Markets," *Quarterly Journal of Economics* 90, 629–649.

{% Discussion of referee procedures; references to other nonmedical areas; was referaat at LUMC. %}
Rothwell, Peter M. & Christopher N. Martyn (2000) "Reproducibility of Peer Review in Clinical Neuroscience. Is Agreement between Reviewers Any Greater than Would Be Expected by Chance Alone?," *Brain* 123, 1964–1969.

{% **utility depends on probability**: seems to argue that in sports the utility of a result depends on its probability. %}
Rottenberg, Simon (1956) "The Baseball Players' Labor Market," *Journal of Political Economy* 64, 242–258.

{% On support theory; find that position-neutrality (focal hypothesis or alternative hyp.) affects support, but context-dependence not, exactly opposite to what I would expect a priori. It casts doubt on binary complementarity. %}

Rottenstreich, Yuval & Lyle A. Brenner (1996) "Likelihood Judgment as Asymmetric Evaluation of Evidence," Caltech, not to be cited.

{% **utility of gambling**: a low-affect outcome was preferred to a high-affect outcome if received with certainty, but not if received with low probability.

PT falsified; probability weighting depends on outcomes: probability weighting more curved for more affective outcomes (**inverse S (= likelihood insensitivity) related to emotions**) %}

Rottenstreich, Yuval & Christopher K. Hsee (2001) "Money, Kisses, and Electric Shocks: On the Affective Psychology of Risk," *Psychological Science* 12, 185–190.

{% The authors point out that a prospect, sure in terms of final wealth, if perceived as change w.r.t. a reference point, can be perceived as risky if the reference point is risky. This can make it less attractive. Experiments with introspective questions about perception confirm the authors' theory. The authors qualify this phenomenon as perceptual.

P. 4717 writes the usual "important implications" texts to suggest fit with the journal, and please a distant editor, with a title "Effective Organizational Decision Making" and "yield divergent implications for managing in organizations" and then a page with such texts.

P. 4708: the authors nicely indicate that Sprenger (2015) is not new: "recently highlighted by Sprenger (2015) and previously observed by other researchers (Hershey et al. 1982, Knetsch and Sinden 1984, Bleichrodt et al. 2001, van Osch et al. 2004)." %}

Rottenstreich, Yuval, Alex Markle, & Johannes Müller-Trede (2023) "Risky Sure Things," *Management Science* 69, 4707–4720. https://doi.org/10.1287/mnsc.2022.4590

{% They give up explicit additivity of original support theory, replacing it by the weaker explicit subadditivity. %}

Rottenstreich, Yuval & Amos Tversky (1997) "Unpacking, Repacking, and Anchoring: Advances in Support Theory," *Psychological Review* 104, 406–415.

{% **foundations of statistics**

This paper pleas for using Bayes factors, which are likelihood ratios.

One view is that researchers want to find and confirm equalities because they are informative. The authors use the term invariants for equalities, and p. 225 penultimate para nicely link those to conservation laws, although the concrete examples given are far-fetched in only stating functional relations. The paper points out that psychologists have [too] much the Popperian attitude of rejecting and falsifying things. P. 225: "the psychological field has a Popperian orientation, in which demonstrations of effects or associations are valued more than demonstrations of invariances (Meehle 1978)."

The opening pages, and also elsewhere, often argue that classical hypothesis testing has no way of supporting the null. But power analysis is a common tool for it, and showing that other nulls could be rejected so that the data is not just noise also helps.

The authors often write that the choice of priors affects the resulting Bayes factor (e.g., p. 229). I do not understand this because they are independent of each other. Probably the authors mean choice of alternative hypothesis/parameters, where they let that be influenced by choice of prior.

The authors give many examples of reasonable choices of priors and alternatives, calculating through their effects, and they favor choosing noninformative priors.

P. 235 3rd para: "in Bayesian analysis, the elements of subjectivity are transparent rather than hidden". %}

Rouder, Jeffrey N., Paul L. Speckman, Dongchu Sun, Richard D. Morey, & Geoffrey Iverson (2009) "Bayesian t Tests for Accepting and Rejecting the Null Hypothesis," *Psychonomic Bulletin & Review* 16, 225–237.

{% Use scaling properties of the QALY model to justify that U(dead) = 0. Mathematical psychologists have advanced theories of ratio scales giving this, but this paper explains the point using arguments shown to be relevant for health. %}

Roudijk, Bram, A., Rogier T. Donders, & Peep F.M. Stalmeier (2018) "Setting Dead at Zero: Applying Scale Properties to the QALY Model," *Medical Decision Making* 38, 627–634.
https://doi.org/10.1177/0272989X18765184

{% **criticizing the dangerous role of technical axioms such as continuity**: I did not really find it. It does call continuity an idealization, but I don't see it getting mre concrete. %}

Roussos, Joe (2025) "Normative Formal Epistemology as Modeling," *British Journal for the Philosophy of Science* 76.
https://doi.org/10.1086/718493

{% Propose a variation of Gul's disappointment aversion model where not all outcomes below the CE (certainty equivalent) are overweighted with weight θ, but only those below δCE, where δ is a subjective parameter to choose. This model is, obvioudly, only for positive outcomes, with the level 0 very empirically meaningful. Remarkably, this model is one of the few that is not rank-dependent when restricted to binary prospects because the minimum outcome of a prospect may exceed δCE for $\delta < 1$ and then it is not overweighted. It does have the multiplicative representation as usual for single nonzero outcome prospects. A preference foundation is, unfortunately, not in the paper (it is in a technical web appendix, but I prefer not to read such). As they point out on p. 1308, this model is a betweenness model. If we fix CE, then simply all utility differences below δCE are indeed increased, and then it is EU. Betweenness means EU within each indifference class.

The authors intuitively justify their model by the desirability to overweigh low outcomes, where low is relative to the prospect (they argue in favor of this aspect p. 1307 last para). Rank dependence also does that. They refer repeatedly to the value-at-risk model for motivation (p. 1307, p. 1329), but this is a rank dependent model (my prospect theory book shows this in Exercise 6.4.4, p. 181). They also justify their model by having countercyclical risk aversion (p. 1317 ℓ. –2 and p. 1329 opening sentence in Conclusion.

biseparable utility violated %}

Routledge, Bryan R. & Stanley E. Zin (2010) "Generalized Disappointment Aversion and Asset Prices," *Journal of Finance* 64, 1303–1332.

{% **conservation of influence** %}

Rovelli, Carlo (2018) "*The Order of Time*." Penguin Books, London.

{% Continue on Popper's struggle with probabilities to model evidence. %}

Rowbottom, Darrell P. (2013) "Popper's Measure of Corroboration and P(H|B)," *British Journal for the Philosophy of Science* 64, 739–745.

{% %}

Roy, Andrew D. (1952) "Safety First and the Holding of Assets," *Econometrica* 20, 431–449.

{% On October 2, 2012, the Royal Statistical Society of the UK asked 97 members of parliament the following question:

"If you spin a coin twice, what is the probability of getting two heads?" Only 40% gave the correct answer of 1/4, and the modal answer was 0.5. %}

Royal Statistical Society (2012)

{% %}

Royal Swedish Academy of Sciences (2017) "Press Release: The Prize in Economic Sciences 2017,"
https://www.nobelprize.org/prizes/economic-sciences/2017/press-release/

{% **foundations of statistics**; nice on likelihood principle %}

Royall, Richard (1968) "An Old Approach to Finite Population Sampling," *Journal of the American Statistical Association* 63, 1269–1279.

{% **foundations of statistics**; argues for likelihood principle; Reviewed by Thomas (2000) %}

Royall, Richard (1997) "*Statistical Evidence: A Likelihood Paradigm.*" Chapman & Hall, New York.

{% P. 113 seems to give Hölders inequality

Problem 2.42 describes “Cantor ternary function” as continous and strictly increasing, problem 5.9 says the function is not absolutely continuous.

Theorem 11.29 gives Riesz representation theorem. %}

Royden, Halsey L. (1963) “*Real Analysis*.” MacMillan, New York (2nd edn., 1988).

{% **utility of gambling** %}

Royden, Halsey L., Patrick Suppes, & Karol Walsh (1959) “A Model for the Experimental Measurement of the Utility of Gambling,” *Behavioral Science* 4, 11–18.

{% **intertemporal separability criticized**: Central in habit formation of course. A reference point is developed that is a linear combination of past consumption.

It seems that at each timepoint instant utility experienced at that timepoint can be replaced by an equivalent money amount, turning general consumption stream into money stream, and that for the latter no habit formation is assumed, so that it can be evaluated using classical models. In the transformation of instant experienced utility into money then all the effects of habit formation can be captured. Then money is a bit like instant utility in Kahneman, Wakker, & Sarin (1997).

DC = stationarity: properly discriminates between dynamic consistency and other conditions such as stationarity. %}

Rozen, Kareen (2010) “Foundations of Intrinsic Habit Formation,” *Econometrica* 78, 1341–1373.

{% Do as Fox & Tversky and Chow & Sarin, ambiguous versus unambiguous, both in joint and in separate evaluation, but measure affective reactions rather than WTP. Confirm the findings of the previous two studies. In experiment 2 they do the same but all with unambiguous prospects. In the separate treatment, subjects do not have better affects for a preferable prospect. %}

Rubaltelli, Enrico, Rino Rumiati, & Paul Slovic (2010) “Do Ambiguity Avoidance and the Comparative Ignorance Hypothesis Depend on People’s Affective Reactions?,” *Journal of Risk and Uncertainty* 40, 243–254.

{% Field study (N = 20,507). Changing default from early contribution rate of 10% to 20%, leaving people free to choose. Second, warning letter if lowering. Third, informing about tax saving. Good results. %}

Rubaltelli, Enrico & Lorella Lotto (2021) "Nudging Freelance Professionals to Increase Their Retirement Pension Fund Contributions," *Judgment and Decision Making* 16, 551–565.

{% P. 1051, ℓℓ. 6/7: verbal statement of sure-thing principle/independence? Seems to have done something Anscombe-Aumann-like, seems state-dependent-like; that is, according to Arrow, Econometrica 1951

P. 1051, ℓℓ. 6/7: verbal statement of sure-thing principle/independence? %}

Rubin, Herman (1949) "Postulates for the Existence of Measurable Utility and Psychological Probability (abstract 493)," *Bulletin of the American Mathematical Society* 55, 1050–1051.

{% Axiom IV is preference version of independence, for all mixture weights. Rubin gives dynamic interpretation: "that it is immaterial in which order choice or random event occur, provided that a decision can be made before the random event occurs which corresponds to an arbitrary decision made afterwards." This is dynamic consistency/time consistency! %}

Rubin, Herman (1949) "The Existence of Measurable Utility and Psychological Probability," Cowles Commission Discussion paper: Statistics: No. 332. Unpublished; undated but probably 1949. Abstract (entitled "Postulates for the existence of measurable utility and psychological probability") appeared in *the Bulletin of the American Mathematical Society* 55, 1949, pp. 1050–1051. http://personal.eur.nl/Wakker/refs//pdf/rubin(1949).pdf

{% First with independence? With infinitely many prizes; The following reference is given this way by Marschak (1950) %}

Rubin, Herman (undated, before 1951) "An Axiomatic System for Measurable Utility."

{% This was in 1983 Technical Report 83-27 of Purdue University. %}

Rubin, Herman (1987) "A Weak System of Axioms for "Rational" Behavior and the Nonseparability of Utility from Prior," *Statistics and Decision* 5, 47–58. https://doi.org/10.1524/strm.1987.5.12.47

{% %}

Rubin, Jared, Anya Samek, & Roman M. Sheremeta (2018) "Loss Aversion and the Quantity–Quality Tradeoff," *Experimental Economics* 21, 292–315.

{% %}

Rubin, Rose M. & Cyril F. Chang (2003) "A Bibliometric Analysis of Health Economics Articles in the Economics Literature: 1991-2000," *Health Economics* 12, 403–414.

{% %}

Rubinstein, Ariel (1979) "Equilibrium in Supergames with the Overtaking Criterion," *Journal of Economic Theory* 21, 1–9.

{% %}

Rubinstein, Ariel (1980) "Ranking the Participants in a Tournament," *SIAM Journal on Applied Mathematics* 38, 108–111.

{% **measure of similarity**; Model: in choice between (p,x) and (q,y), subjects consider probabilities or utilities identical if they are sufficiently similar, and then go by "nonidentical" dimension only. Otherwise they do something else. This is very similar to threshold models.

This paper considers single-nonzero outcome lotteries. It shows that similarity relations on p and x, compatible with ratios of functions g and u, respectively, can be combined with the preference relation defined from g(p)u(x). It also shows that a preference relation representable by functions g, u through g(p)u(x), can be combined with similarity relations defined from g and u.

These theorems are not really representation theorems because they don't start from (similarity relations +) preference relations, but from only one of these two, and derive the other not from observed preferences but from the functions elicited from the one.

In Proposition 2, the pref relation on top of p. 151 is not given beforehand, but defined there. So, it is not a representation theorem. %}

Rubinstein, Ariel (1988) "Similarity and Decision-Making under Risk (Is there a Utility Resolution to the Allais Paradox?)," *Journal of Economic Theory* 46, 145–153.

{% Argues what I heard Shapley once say in dinner in Nijmegen at the end of a game theory day in the early 1980s; i.e., good game theory should incorporate communication etc.)

§3, p. 913 1st para is on randomization: "goes against our intuition. We are reluctant to believe that our decisions are made at random."

P. 922 1st para seems to assume that future repetitions of a game just exist, which is Rubinstein's favorite assumption. %}

Rubinstein, Ariel (1991) "Comments on the Interpretation of Game Theory," *Econometrica* 59, 909–924.

{% **real incentives/hypothetical choice**: p. 626 argues against the necessity of real incentives, mentioning many informal game experiments where it did not matter. %}

Rubinstein, Ariel (2001) "A Theorist's View of Experiments," *European Economic Review* 45, 615–628.

{% Argues that the phenomena described by Rabin (2000, Econometrica) can be explained by a "minor" modification of expected utility, i.e., one where consequences are changes with respect to a reference point, referring also to Kahneman & Tversky (1979). Does not seem to be aware that this is the same as the idea of reference dependence of Kahneman & Tversky (1979) about consequences, and that Rabin refers to this same idea by writing that loss aversion is a plausible explanation. %}

Rubinstein, Ariel (2002) "Comments on the Risk and Time Preference in Economics," text of lecture on Dec. 5th, 2001; working paper 867.

{% Probability matching %}

Rubinstein, Ariel (2002) “Irrational Diversification in Multiple Decision Problems,” *European Economic Review* 46, 1369–1378.

{% **decreasing/increasing impatience**: find counter-evidence against the commonly assumed decreasing impatience and/or present effect.

Kirsten&I: intro has countably many outcomes and timepoints. The alternative model, starting in §2, however, takes uncountably many timepoints. This is used in his similarity model. Theoretically, it could also be a countable but dense subset of the time axis, such as the rational timepoints. There can be several consumptions, as in the second experiment. Really the hybrid model, with outcomes evaluated separately discretely and not as flow per time unit.

Presents three intertemporal choice problems data (no real incentives) that violate constant discounting for future and not present consumptions, so that the quasi-hyperbolic discounting that only overweights current consumption is violated also. Tries to explain the data through Rubinstein’s (1988) similarity model, although it was not clear to me why some dimensions were more similar than others. An alternative explanation for experiments I and III at least can be that for choices with small differences subjects choose the least complex option.

The auther argues that greater brakeaways from traditional economic models may be desirable and concludes: “We need to open the black box of decision making, and come up with some completely new and fresh modeling devices.” %}

Rubinstein, Ariel (2003) “Economics and Psychology?” The Case of Hyperbolic Discounting”,” *International Economic Review* 44, 1207–1216.

{% Criticizes the famous kindergarten experiment by Gneezy & Rustichini, questioning the data. %}

Rubinstein, Ariel (2006) “Comments on Behavioral Economics.” *In* Richard Blundell, Whitney K. Newey & Torsten Persson (eds.) *Advances in Economics and Econometrics Theory and Applications*, vol. II, 246–254, Cambridge University Press, Cambridge.

{% Personal view about Theoretical Economics, complaining many times that it is not useful.

Starts with a story about Adam in paradise, having time-consistent invariant preferences over apples, but preferring one apple today to two apples tomorrow and 2 today to 1 today and 1 tomorrow. Then he prefers 1 apple today to one apple each day from day 17 till age of 100. This is not desirable and is Adam's "first traumatic experience." The following traumatic experiences nicely illustrate the gradual development away from classical economics. Many claims, such as that against new models as much counterevidence will be found as against classical ones (e.g. p. 871 1st para), should be taken as subjective personal opinions backed up with little evidence.

P. 869 is very negative about Rabin's calibration theorem. Rubinstein's "solution" is that outcomes should be interpreted as changes with respect to a reference point and not as final wealth. He cites Kahneman & Tversky (1979) for it, and also Cox & Sadiraj in an affirmative manner. What Rubinstein does not realize here is that this "solution" is not a minor modification of expected utility, but a major breakaway, half of the breakaway comprised by prospect theory. What he does not realize either is that Rabin himself also agrees with this solution and puts it forward as a primary explanation (Rabin 2000, Econometrica, when putting forward loss aversion which entails reference dependence; see last para of the main text, pp. 1288-1289). Rubinstein mistakes economics for abstract mathematics. Feynman's lecture "What Differs Physics from Mathematics" is equally relevant to economics and explains that one cannot do that.

Rubinstein's time paradox attempts to suggest that Rabin's paradox is a routine exercise and, thus, to downplay it. %}

Rubinstein, Ariel (2006) "Dilemmas of an Economic Theorist," *Econometrica* 74, 865–883.

{% No real incentives were used.

Decisions to be taken after thinking take more time than decisions to be taken instinctively. Demonstrated through internet experiment with many different things such as game situations. Last experiment is Allais paradox. Risky choice always takes more time. %}

Rubinstein, Ariel (2007) "Instinctive and Cognitive Reasoning: A Study of Response Times," *Economic Journal* 117, 1243–1259.

{% %}

Rubinstein, Ariel & Peter C. Fishburn (1986) "Algebraic Aggregation Theory," *Journal of Economic Theory* 38, 63–77.

{% **game theory for nonexpected utility**; **Nash bargaining solution**; nice explanation of role of alternatives underlying utility space and restrictive nature of affine-utility-transformation-invariance. A local optimality condition characterizes Nash B.S without resort to EU. %}

Rubinstein, Ariel, Zvi Safra, & William Thomson (1992) "On the Interpretation of the Nash Bargaining Solution and Its Extension to Non-Expected Utility Preferences," *Econometrica* 60, 1171–1186.

{% %}

Rubinstein, Ariel & Yuval Salant (2016) " "Isn't Everyone Like Me?": On the Presence of Self-Similarity in Strategic Interactions," *Judgment and Decision Making* 11, 168–173.

{% **common knowledge** %}

Rubinstein, Ariel & Asher Wolinsky (1990) "On the Logic of "Agreeing to Disagree" Type Results," *Journal of Economic Theory* 51, 184–193.

{% %}

Rubinstein, Ariel & Lin Zhou (1999) "Choice Problems with a 'Reference' Point," *Mathematical Social Sciences* 37, 205–209.

{% %}

Rubinstein, Mark (1994) "Implied Binomial Trees," *Journal of Finance* 49, 771–818.

{% %}

Rudin, Walter (1964) "*Principles of Mathematical Analysis*; 2nd edn." McGraw-Hill, New York.

{% Test prospect theory with N=4098 subjects from 19 countries and 13 languages. Concluding sentence in abstract: "We conclude that the empirical foundations for prospect

theory replicate beyond any reasonable thresholds." (**Prospect theory/Rank-Dependent Utility most popular for risk**) %}

Ruggeri, Kai, Sonia Alí, Mari Louise Berge, Giulia Bertoldo, Ludvig D. Bjørndal, Anna Cortijos-Bernabeu, Clair Davison, Emir Demić, Celia Esteban-Serna, Maja Friedemann, Shannon P. Gibson, Hannes Jarke, Ralitsa Karakasheva, Peggah R. Khorrami, Jakob Kveder, Thomas Lind Andersen, Ingvild S. Lofthus, Lucy McGill, Ana Espejo Nieto, Jacobo Marrero Pérez, Sahana K. Quail, Charlotte Rutherford, Felice L. Tavera, Nastja Tomat, Chiara Van Reyn, Bojana Većkalov, Keying Wang, Aleksandra Yosifova, Francesca Papa, Enrico Rubaltelli, Sander van der Linden, & Tomas Folke (2020) "Replicating Patterns of Prospect Theory for Decision under Risk," *Nature Human Behavior* 4, 622 –633. https://doi.org/10.1038/s41562-020-0886-x

{% Cooperative game theory. For a cooperative game, find the allocation (probability measure after normalization v(N) = 1) that most closely fitst the game by quadratic distance. Given that they normalize, this is equivalent to minimizing the variance of the excess vS) – x(S), which would be a kind of egalitarian principle. Unfortunately, the authors put the latter central, whereas I find the former more appealing. The authors give many properties of their solution. %}

Ruiz Luis M., Frederico Valenciano, & Jose M. Zarzuelo (1996) "The Least Square Prenucleolus and the Least Square Nucleolus. Two Values for TU Games Based on the Excess Vector," *International Journal of Game Theory* 25, 113–134.

{% Relaxes completeness axiom for SEU with linear utility. There exists some events $E_1,\ldots,E_n$ such that f ≽ g iff there exists a subjective probability such that the conditional expectation of f given E_j exceeds that of g, for each j. %}

Rumbos, Beatriz (2001) "Representing Subjective Orderings of Random Variables: An Extension," *Journal of Mathematical Economics* 36, 31–43.

{% This and more is on http://www.slate.com/id/2081042/

Here is Rumsfelt's famous saying:

THE UNKNOWN

As we know,

There are known knowns.
There are things we know we know.
We also know
There are known unknowns.
That is to say
We know there are some things
We do not know.
But there are also unknown unknowns,
The ones we don't know
We don't know. %}

Rumsfeld, Donald (2002) "The Unkown." Department of Defense News Briefing, February 12, 2002.

{% **risky utility u = strength of preference v (or other riskless cardinal utility, often called value)** & **questionnaire versus choice utility**: Pigou cites Russell, referring to p. 182-183, on the point that, if we cannot measure quantities, then we may still be able to judge them, and even to judge on difference comparisons. This is, however, not really what Russell writes there. Anyway, this is a moot point for strength of preference, for instance. %}

Russell, Bertrand A.W. (1903) "*The Principles of Mathematics.*" (Later edn. 1972, Allen & Unwin, London).

{% **preferring streams of increasing income**: p. 462, on Spibnoza's ideas:

"if the universe is gradually improving, we think better of it than if it is gradually deteriorating, even if the sum of good and evil be the same in the two cases. … Accoring to Spinoza this is irrational. … as God sees it; to Him, the date is irrelevant" (the latter is on **discounting normative**) %}

Russell, Bertrand A.W. (1945) "*A History of Western Philosophy.*" Simon & Schuster, New York.

{% On bipolar scales. %}

Russell, James A. & James M. Carroll (1999) "On the Bipolarity of Positive and Negative Affect," *Psychological Bulletin* 125, 3–30.

{% P. 557 3rd para: value of life in the us now is ±6.5 million dollar. %}

Russell, Louise B. (2014) “Do We Really Value Identified Lives More Highly than Statistical Lives?,” *Medical Decision Making* 34, 556–559.

{% The panel, 13 people, was convened by the US public Health Service (PHS), met 11 times during 2.5 years (first in 1993), in order to improve standardization in Cost-Effectiveness studies. They take societal perspective.

P. 1175, top: health states worse than death have negative utility.

P. 1175: they take QALY, which has advantage of combining length of time and health quality

P. 1175: “Second, since the purpose of investing in health is to make people better-off, it seems appropriate to let them be the judge of what constitutes better or worse outcomes and of the relative magnitudes of health effects.” I disagree with the opinion suggested here and stated also elsewhere, that the utility of the general public having to be maximized, would automatically imply that the general public is best to decide on what that utility function is. Other people such as patients or doctors mauy be able to judge better. Tversky & Kahneman (1981) p. 458 2nd column 1st para argue for the opposite: “A predictive orientation encourages the decision-maker to focus on future experience and to ask “What will I feel then?” rather than “What do I want now?” The former question, when answered with care, can be the more useful guide in difficult decisions.”

P. 1175 discusses question of whether people in a health state judge it more favorable than others, and gives several references. Some find the effect but others don’t find it and find equal judgments. The issue is not clear.

P. 1176, that decision analyses often only consider part of the criteria, where this is only an ingredient for final decisions to be made by others. “But real-world decisions must balance health against other goals—fair access to services, help for those worst off, and values outside health affected by health decisions. Thus, it is seldom appropriate to apply CEA mechanically. The panel recommended that CEA be used as an aid to decision makers who must weigh the information it provides in the context of these other values.” %}

Russell, Louise B., Marthe R. Gold, Joanna E. Siegel, Norman Daniels, & Milton C. Weinstein (1996, for the Panel on Cost-Effectiveness in Health and Medicine) “The Role of Cost-Effectiveness Analysis in Health and Medicine,” *JAMA* 276, 1172–1177.

{% Book seems to be most popular textbook on AI.
P. 532 of 2nd edn., Ch. 14, has nice discussion of fuzzy measures, belief functions, and the like, and their relations with probability. %}
Russell, Stuart & Peter Norvig (1993) "*Artificial Intelligence A Modern Approach*." (3rd edn. 2009.) Prentice-Hall, Englewood Cliffs, NJ.

{% Seems to have recursive EU. %}
Rustichini, Aldo (1992) "Decision Theory with Higher Order Beliefs." *In* Proceedings of TARK IV.

{% One page on Ellsberg and maxmin EU, nicely written, with deck of cards rather than urns. %}
Rustichini, Aldo (2005) "Neuroscience: Emotion and Reason in Making Decisions," *Science* 310 (5754) 1624–1625.

{% P. 672 2nd para takes choosing university degree as choice. There, however, is no situation in which we can simply choose a university degree.
P. 673 point f (independence) claims that according to classical economics time and risk attitude are uncorrelated, and that these are also uncorrelated with intelligence and other personality traits: ???? No one ever claimed such a thing, to my knowledge.
ubiquity fallacy: P. 673 2nd para claims that in classical economics, man is two-dimensional, completely characterized by risk attitude and intertemporal attitude: ??? What about marginal rates of substitution between commodities, to mention just one of million other things?
DC = stationarity: p. 673 2nd column 2nd para middle + p. 674 2nd column 1st para near end. The latter also claims that the management of deviations from past plans (time inconsistencies) has never been discussed in classical economics: ??? Didn't Strotz himself already discuss it?
P. 674 near end claims that according to neuro-economics, the classical two-dimensional man (see above) should be replaced by a five-dimensional man, but it is not explained what the (3 I guess) extra dimensions are. %}
Rustichini, Aldo (2009) "Neuroeconomics: What Have We Found, and What Should We Search for," *Current Opinion in Neurobiology* 19, 672–677.

{% Choices between riskless, risky, very ambiguous, and somewhat ambiguous prospects. The usual ambiguity aversion is found. Neuro-effects are analyzed. %}
Rustichini, Aldo, John Dickhaut, Paolo Ghirardato, Kip Smith & José V. Pardo (2005) "A Brain Imaging Study of Procedural Choice," *Games and Economic Behavior* 52, 257–282.

{% %}
Ruszczyński, Andrzej & Alexander Shapiro (2006) "Optimization of Convex risk Functions," *Mathematics of Operations Research* 31, 433–452.

{% **probability elicitation**: applied to experimental economics;
Experimentally show that eliciting subjective beliefs using scoring rules in a game situation can impact the play in the game after.
questionnaire versus choice utility: pp. 617-618 argue that stated beliefs may better predict game behavior than elicited beliefs, and they find it confirmed in the experiment. No real incentives for stated beliefs!? %}
Rutström, Elisabet E. & Nathaniel T. Wilcox (2009) "Stated Beliefs versus Inferred Beliefs: A Methodological Inquiry and Experimental Test," *Games and Economic Behavior* 67, 616–632.

{% **PE gold standard**: seem to write that; seem to argue that the rating scale has drawback of making subjects "spread" answers over whole scale. %}
Rutten-van Molken, Maureen P.M.H., Carla H. Bakker, Eddy K.A. van Doorslaer, & Sjef van der Linden (1995) "Methodological Issues of Patient Utility Measurement," *Medical Care* 33, 922–937.

{% %}
Rutten, Frans F.H., Han Bleichrodt, Werner B.F. Brouwer, Marc A. Koopmanschap, & Frederik T. Schut (2001) "Handbook of Health Economics," *Journal of Health Economics* 20, 855–879.

{% %}

Rutten, Frans F.H., & Gouke J. Bonsel (1992) "High Cost Technology in Health Care: A Benefit or a Burden?," *Social Science and Medicine* 4, 567–577.

{% %}
Rutten, Frans H., Han Bleichrodt, Werner B.F. Brouwer, Marc A. Koopmanschap, & Frederik T. Schut (2001), Book Review of Antony J. Culyer & Joseph P. Newhouse (2001) "Handbook of Health Economics," Elsevier, Amsterdam; *Journal of Health Economics* 20, 855–879.

{% %}
Ryan, Elizabeth G., Christopher C. Drovandi, James M. McGree, & Anthony N. Pettitt (2016) "A Review of Modern Computational Algorithms for Bayesian Optimal Design," *International Statistical Review* 84, 128–154.

{% What they call completeness is consistency (repeating same choice some time later so that independent and not remembered), and what they call discontinuous is lexicographic (no tradeoffs). They test and discuss these conditions. %}
Ryan, Mandy, Verity Watson, & Vikki Entwistle (2009) "Rationalising the Irrational: A Think Aloud Study of Discrete Choice Experiment Responses," *Health Economics* 18, 321–336.

{% Definition of support in nonadditive measure theory %}
Ryan, Matthew J. (1996) "CEU Preferences and Game-Theoretic Equilibria," Yale University.

{% **dynamic consistency**; **updating: nonadditive measures** %}
Ryan, Matthew J. (2001) "Capacity Updating Rules and Rational Belief Changes," *Theory and Decision* 51, 73–87.

{% Generalizes/simplifies result of Chew, Karni, & Safra, and many related results. %}
Ryan, Matthew J. (2006) "Risk Aversion in RDEU," *Journal of Mathematical Economics* 42, 675–697.

{% Didactical survey of nonEU representation theorems using the Anscombe-Aumann approach. %}
Ryan, Matthew J. (2009) "Generalizations of SEU: A Geometric Tour of Some Non-Standard Models," *Oxford Economic Papers* 61, 327–354.

{% Gives examples of finite sets that are mixture sets. Then usually all nontrivial mixtures of x and y are either x or y. Relates it to a mathematical theory of antimatroids. This paper is useful for alternative axiomatizations of vNM EU. Refers to Hausner (1954), for one. %}
Ryan, Matthew J. (2010) "Mixture Sets on Finite Domains," *Decisions in Economics and Finance* 33, 139–147.

{% **revealed preference**: a variation on Plott's path independence. %}
Ryan, Matthew (2014) "Path Independent Choice and the Ranking of Opportunity Sets," *Social Choice and Welfare* 42, 193–213.

{% **Z&Z**; **inverse S:** is used to explain some empirical findings on moral hazard. %}
Ryan, Matthew J. & Rhema Vaithianathan (2003) "Medical Insurance with Rank-Dependent Expected Utility," *Economic Theory* 22, 689–698.
https://doi.org/10.1007/s00199-002-0336-1

{% **Z&Z**; **inverse S:** is used to explain some empirical findings on adverse selection. %}
Ryan, Matthew J. & Rhema Vaithianathan (2003) "Adverse Selection and Insurance Contracting: A Non-Expected Utility Analysis," *Contributions in Theoretical Economics* 3, 1074–1074.
https://doi.org/10.2202/1534-5971.1074

{% %}
Ryan, Terence M. (1974) "The Use of Unbounded Utility Functions in Expected-Utility Maximization: Comment," *Quarterly Journal of Economics* 88, 133–135.
https://doi.org/10.2307/1881799

{% A well-known problem in experiments is that subjects replace information that the experimenter provides by info that they find more plausible, or mix it with own prior info. This paper studies this phenomenon, but only in the context of moral dilemmas such as the trolly problem. There subjects replace certainty provided by experimenter by their own probability estimates. %}

Ryazanov, Arseny A., Knutzen, J., Samuel C. Rickless, Nicholas J.S. Christenfeld, & Nelkin, D. K. (2018) "Intuitive Probabilities and the Limitation of Moral Imagination," *Cognitive Science* 42, 38–68.

{% Reconsider Gneezy & Rustichini (2000). Support the Camerer & Hogarth (1999) view that cognitive effort is important. %}

Rydval, Ondrej & Andreas Ortmann (2004) "How Financial Incentives and Cognitive Abilities Affect Task Performance in Laboratory Settings: An Illustration," *Economics Letters* 85, 315–320.

{% Re-examine and doubt about Gneezy, List, & Wu (2006). %}

Rydval, Ondřej, Andreas Ortmann, Sasha Prokosheva & Ralph Hertwig (2009) "How Certain is the Uncertainty Effect?," *Experimental Economics* 12, 473–487.

{% Introduced logical behaviorism: one can talk of mental states, which ultimately can be re-expressed in behavioral language. %}

Ryle, Gilbert (1949) "*The Concept of Mind*." Penguin, Harmondsworth, UK.

{% %}

Saaty, Thomas L. (1980) "*The Analytic Hierarchy Process*." McGraw-Hill, New York.

{% %}

Saaty, Thomas L. (1986) "Axiomatic Foundation of the Analytic Hierarchy Process," *Management Science* 32, 841–855.

{% **questionnaire for measuring risk aversion**: p. 39 table 1 has nice way to measure risk attitude: People choose one from 10 prospects, and the more to the right they choose the more risk seeking they are. Bit like Binswanger (1981). %}

Sabater-Grande, Gerardo & Nikolaos Georgantzis (2002) “Accounting for Risk Aversion in Repeated Prisoners’ Dilemma Games: An Experimental Test,” *Journal of Economic Behavior and Organization* 48, 37–50.

{% %}

Saccardo, Silvia & Marta Serra-Garcia (2023) “Enabling or Limiting Cognitive Flexibility? Evidence of Demand for Moral Commitment,” *American Economic Review* 113, 396–429.
https://doi.org/10.1257/aer.20201333

{% **utility elicitation**; They list five questions on utility measurement as their central topics; I am puzzled about the answers to Questions 3 and 5 below, which seem to be contradictory.

Question 3 asks if the utility of a health state depends on the time spent in that health state. They find that the utility of a health state falls “dramatically” (p. 703; i.e., a violation of Stalmeier’s proportionality heuristic) as the duration is longer.

Question 5 addresses the question of whether being in a health state affects its utility. They find that people in a health state (e.g., kidney dialysis patients) value their state higher than the general public does (which runs contrary to strategic answering). %}

Sackett, David L. & George W. Torrance (1978) “The Utility of Different Health States as Perceived by the General Public,” *Journal of Chronic Disease* 31, 697–704.

{% This paper introduces a nice paradox for RDU that is a sort of analog of Rabin’s (2000) calibration paradox for EU. It is tested empirically in the follow-up paper by Cox, Sadiraj, Vogt, & Dasgupta (2013). It is discussed in Exercise 7.4.2 of Wakker (2010), who cites Cox et al. (2013 EE; well, their 2007 working paper version) for it. But this paper by Sadiraj has the priority. Assume RDU. For each i = 0,…,98, we write r_i = i/100. Assume that a subject exhibits risk averse preferences as follows:

$(r_i{:}6,\ 0.01{:}6,\ 0.01{:}0,\ (1 - r_i - 0.02){:}0) \prec$

(r_i:6, 0.01:2, 0.01:2, $(1-r_i-0.02)$:0)

and that, with $U(0)=0$, $U(6)/U(2)>2.1$. Then it follows that $w(0.5)<0.01$. %}

Sadiraj, Vjollca (2014) "Probabilistic Risk Attitudes and Local Risk Aversion: A Paradox," *Theory and Decision* 77, 443–454.

{% **information aversion**: Cites literature, including Savage (1954), that some versions of maxmin EU are vulnerable to aversion to info. Wakker 1988 JBDM, showed that this happens for all nonEU that are not dynamically consistent, with p. 173 first objection in §4 putting forward that forgone-event independence is assumed. This paper shows there are even situations in which all info is rejected. %}

Sadler, Evan (2015) "Minimax and the Value of Information," *Theory and Decision* 78, 575–586.

{% **preference for flexibility** %}

Sadowski, Philipp (2013) "Contingent Preference for Flexibility: Eliciting Beliefs from Behavior," *Theoretical Economics* 8, 503–534.

{% The paper assumes hidden acts by agents, not observable to researchers, and shows how then nonexpected utility models and ambiguity models can result from that. Reminds me of Drèze (1959).

P. 2 writes an argument that ambiguity aversion can result from evolutionary optimization: "The starting point of our analysis is an observation which dates back to a seminal paper by Robson (1996): Evolutionary optimality generates a preference for idiosyncratic uncertainty over common uncertainty, and ambiguity is closely associated with common uncertainty in many instances. Hence, natural selection favors ambiguity aversion."

I do not read enough to understand the point of "idiosyncratic uncertainty" and cannot understand. In general, being Bayesian, I do not think that evolution will favor ambiguity aversion. %}

Sadowski, Philipp & Todd Sarver (2024) "Adaptive Preferences: An Evolutionary Model of Non-Expected Utility and Ambiguity Aversion," *Journal of Economic Theory* 218, 105840.

https://doi.org/10.1016/j.jet.2024.105840

{% %}

Sadrieh, Abdolkarim, Werner Güth, Peter Hammerstein, Stevan Harnard, Ullrich Hoffrage, Bettina Kuon, Bertrand R. Munier, Peter M. Todd, Massimo Warglien, & Martin Weber (1999) "Is there Evidence for an Adaptive Toolbox?," Arbeitsbericht 99-51, Universität Mannheim.

{% A 2002 paper was called Discounting and Future Selves, and Weibull and I discussed it in Amsterdam.

General discounted utility says that $U = SUM_{t=0}^{n} f(t)u(x_t)$ is to be maximized, with u some instant utility, maybe hedonic. The case $f(t) = \delta^t$ is constant discounting. The authors rewrite it as a linear combination in their Eq. 2 on p. 258 (I only write it for time $t = 0$)

$$U_0(x) \quad = \quad u(x_0) + SUM_{t=1}^{n} a(t)U_t(x) \qquad\qquad (*)$$

where each $U_t(x)$ is a linear combination of $u(x_t)$ and the $U_j(x)$'s for $j > t$.

U_t is the total happiness experienced at time t. The authors impose conditions on the U_t's and analyze when then all a(t)'s can be nonnegative. It feels some like double/multiple counting where x_n affects the happiness at time n, then also that at time n−1 through altruism of self at time n−1 with time n, then at time n−2, and thus affects happiness at time 0 indirectly through all intermediate utilities.

In Eq. (*), if the left term involved U then the definition would be problematic, circular/emplicit. But now with u for present, why not u for all future times?

Constant discounting can be obtained as the special case where U_t depends only on x_t and U_{t+1} (reminiscent of recursive formulas) and is a boundary case (p. 260 end of §3).

Footnote 7 explains that altruistic utility can only be generated for future selfs and not past selfs because the latter "do not exist" anymore at the present time. I add here: if it could, funny spirals could arise where a small future consumption due to altruism makes the present self happier, but then through reversed altruism towards the past, this makes the future self more happy, which makes the present self yet more happy, and so on. %}

Sáez-Martí, María & Jörgen Weibull (2005) "Discounting and Altruism to Future Decision-Makers," *Journal of Economic Theory* 122, 254–266.

{% Nice introduction to, frequent, use of multi-attribute utility, or conjoint measurement, in marketing research literature. %}

Safizadeh, M. Hossein (1989) "The Internal Validity of the Trade-Off Method of Conjoint Analysis," *Decision Sciences* 20, 451–461.

{% %}

Safra, Zvi & Uzi Segal (1993) "Dominance Axioms and Multivariate Nonexpected Utility Preferences," *International Economic Review* 34, 321–334.

{% %}

Safra, Zvi & Uzi Segal (1995) "How Complicated Are Betweenness Preferences?," *Journal of Mathematical Economics* 24, 371–381.

{% What they call "constant risk aversion" is constant absolute !and! constant RRA.

Theorem 1: Fréchet differentiable functional V over lotteries that satisfies constant absolute and RRA is an expected value functional.

P. 29 argues against the use of rank-dependence in axioms (similarly to Luce, 1996): "Since rank dependent functionals evaluate outcomes not only by their value but also by their relative rank as compared to other possible outcomes, axioms that presuppose attitudes that are based on outcomes' relative rank are arguably less convincing than axioms that do not make an explicit appeal to such ranks."

Theorem 3 characterizes the Yaari functional, so, RDU with linear utility, for a quadratic probability weighting function of the form $w(p) = p + cp - cp^2$. %}

Safra, Zvi & Uzi Segal (1998) "Constant Risk Aversion," *Journal of Economic Theory* 83, 19–42.

{% The authors argue, as do Safra & Segal (1998) and Luce, that axiomatizations of rank-dependent utility explicitly using rank-ordering of outcomes are unsatisfactory. I agree that it is interesting to have an axiomatization that does not explicitly use rank-dependence. I disagree, however, with the claim that an explicit use of rank-ordering be unsatisfactory: the rank-ordering of outcomes is directly observable (and there is an intuition to using it) and, hence, there is no reason not to use it explicitly. %}

Safra, Zvi & Uzi Segal (2001) "Rank-Dependent Preferences without Ranking Axioms," *Journal of Mathematical Economics* 35, 547–562.

{% The authors assume that the Rabin paradox (RP) preference $(0 \succ 11_{0.5}(-10))$ holds in isolation, but also when merged with a wide range of "background" risky prospects. With "merged" I mean that there is no isolated choice where the background risk is ignored, as is the common assumption in prospect theory, but the payoffs of the background risk are integrated with the gamble payoffs. Then, under RDU, the same implausible implications follow as in Rabin's analysis under EU. The authors argue that, therefore, RDU does not help explain RP.

One difficulty is that the background risk assumption is too strong to be empirically reasonable. A direct way to see this: The background risk can concern many independent replicas of the prospect in Figure 8.6.1. Then repeated application of the assumption together with transitivity implies rejecting many repetitions of the prospect, which violates the law of large numbers. This case also makes LeRoy's (2003) criticism of Rabin's paradox implausible. An indirect way to see this: with the background risk assumption, RDU reduces to EU. Unfortunately, I do not know a place in the literature where this was clearly written. I learned it from Quiggin (persona communication, and of 1990s). Quiggin (2003) was derived from it but, unfortunately, doesn't have the general result. A related result is in Barberis, Huang, & Thaler (2006). %}

Safra, Zvi & Uzi Segal (2008) "Calibration Results for Non-Expected Utility Theories," *Econometrica* 76, 1143–1166.

{% They consider the case of many decisions under ambiguity, mutually independent. Then even without learning behavior can get close to ambiguity neutrality. For risk, they assume expected utility. %}

Safra, Zvi & Uzi Segal (2022) "A Lot of Ambiguity," *Journal of Economic Theory* 200, 105393.

{% BDM (Becker-DeGroot-Marschak) %}

Safra, Zvi, Uzi Segal, & Avia Spivak (1990) "Preference Reversals and Non-Expected Utility Behavior," *American Economic Review* 80, 922–930.

{% %}

Safra, Zvi, Uzi Segal, & Avia Spivak (1990) “The Becker-DeGroot-Marschak Mechanism and Anticipated Utility,” *Journal of Risk and Uncertainty* 3, 177–190.

{% **favors sophisticated choice** %}

Safra, Zvi & Eyal Sulganik (1995) “On the Nonexistence of Blackwell’s Theorem-Type Results with General Preference Relations,” *Journal of Risk and Uncertainty* 10, 187–201.

{% **information aversion** %}

Safra, Zvi & Eyal Sulganik (1995) “Schur Convexity, Quasi-Convexity and Preference for Early Resolution of Uncertainty,” *Theory and Decision* 39, 213–218.

{% %}

Safra, Zvi, Lin Zhou, & Itzhak Zilcha (1990) “Risk Aversion in the Nash Bargaining Problem with Risky Outcomes and Risky Disagreement Points,” *Econometrica* 58, 961–965.

{% %}

Sagara, Namika (2013) “Representation of Preference Orderings with an Infinite Horizon: Time-Additive Separable Utility in Continuous Time,” *Journal of International Economic Studies* 27, 3–22.

{% Preference condition considered concerns choice with reference points. It is a no-regret condition of the following kind: Assume that, with some arbitrary reference point, you can choose between x and y, and you choose x. Then, so it is assumed, x becomes your new reference point (an essential modification and clarification of this point comes later). The paper then assumes that, with x as new reference point, y should never be preferred to x. So, a point should always become more preferred if it becomes a reference point, suggesting a status-quo preference. The paper shows that most theories violate this condition unless reference independence.

The essential modification and clarification announced above is that for a prospect x not x itself (a random reference point as in Sugden 2003; this paper is referenced in footnote 13, but as a betweenness paper, and not for his modeling of reference dependence; data of Roca, Hogarth, & Maule 2006 support that x itself, and not its certainty equivalent, is taken as reference point) is taken as reference point, but instead a constant outcome, being the certainty equivalent of the prospect.

The reference point above is defined in an implicit manner because the preference relation w.r.t. which the certainty equivalent is determined, depends on the reference point and hence on the certainty equivalent. The following example on prospect theory clarifies what is going on.

Assume that PT holds with linear probability weighting and linear utility for gains and for losses, and loss aversion factor 2. This means that prospects are judged relatively unfavorable, with certainty equivalent below expectation, if the reference point is somewhere between the outcomes of the prospect so that the prospect is mixed, and they are judged relatively favorable, with certainty equivalent being expectation as under risk neutrality if the reference point is below or above all outcomes of the prospect.

Now for each prospect the reference point is the sure outcome such that the absolute value of the expectation of the prospect below the outcome is half of its expectation above; this reference point is smaller than the expectation of the prospect.

Imagine that a current reference point is below a prospect’s lowest outcome. The agent must choose between that prospect and its expectation minus a very small positive epsilon. All outcomes being above the reference point and, hence, expected value governing preference, the agent prefers the prospect and takes it. Then, so it is assumed, the agent adjusts the reference point to the present situation, taking the reference point as explained above. In this new situation the reference point is between the outcomes of the prospect, loss aversion with overweighting of the lowest outcomes is effective and generates risk aversion, and the agent now prefers the expectation minus epsilon to the prospect, and regrets the previous choice. The phenomenon is generated by the reference point being the sure outcome and not the prospect. %}

Sagi, Jacob S. (2006) “Anchored Preference Relations,” *Journal of Economic Theory* 130, 283–295.

{% %}

Sagi, Jacob (2006) “What is an ‘Endogenous State Space´?,” *Economic Theory* 27, 305–320.

{% %}

Sagi, Jacob, David Laughton, & Michael Samis (2000) “Modern Asset Pricing and Project Evaluation in the Energy Industry?,” *Journal of Energy Literature*.

{% %}

Sagi, Jacob & Mark S. Seasholes (2007) “Firm Specific Attributes and the Cross-Section of Momentum?,” *Journal of Financial Economics* 84, 389–434.

{% **utility families parametric**: expo-power utility function, u(x) = 1−exp(−βx$^{\alpha}$), for αβ > 0; (I think that α = and β = can be included also, for α = 0 it is x^{β}, for β = 0 it seems to be logarithmic I’m not sure).

Pratt-Arrow measure: –U´´/U´ = r + α(1–r)x^{1-r}.

Discusses some properties of the family; for α ≤ 1 the functions are concave and exhibit decreasing absolute risk aversion; for α > 0 (i.e., β > 0) they exhibits increasing RRA. In short, for 0 < α < 1 they are really nice.

P. 906: refs to some studies on risk attitude in agriculture using negatively exponential utility. %}

Saha, Atanu (1993) “Expo-Power Utility: A Flexible Form for Absolute and Relative Aversion,” *American Journal of Agricultural Economics* 75, 905–913.

{% %}

Saha, Atanu, C. Richard Shumway, & Hovav Talpaz (1994) “Joint Estimation of Risk Preference Structure and Technology Using Expo-Power Utility,” *American Journal of Agricultural Economics* 76, 173–184.

{% **second-order probabilities to model ambiguity** %}

Sahlin, Nils-Eric (1983) "On Second-Order Probabilities and the Notion of Epistemic Risk." *In* Bernt P. Stigum & Fred Wendstøp (eds.) *Foundations of Utility and Risk Theory with Applications*, 95–104, Reidel, Dordrecht.

{% %}

Sahlin, Nils-Eric (1985) "Three Decision Rules for Generalized Probability Representations," *Behavioral and Brain Sciences* 84, 751–753.

{% Ch. 1 discusses Ramsey's work. %}

Sahlin, Nils-Eric (1990) "*The Philosophy of F.P. Ramsey.*" Cambridge University Press, Cambridge.

{% %}

Sahlin, Nils-Eric (1991) "Bacon Inductivism in Research on Human Decision-Making," *Theory & Psychology* 1, 431–450.

{% **second-order probabilities to model ambiguity**: p. 13 bottom cites many discussions, with Keynes (1921) the earliest.

Nice citation of Hume on uncertainty about uncertainty about ... ad infinitum.

Nice citation of Ramsey who writes, a.o., on the probability of Fermat's last theorem being true. He says, having accepted some objective physical notion of probability, that its probability is 1 or 0. "but we cannot see it." Then he goes on to explain that "our attitude towards it ... we may attach considerable probability in virtue of our knowledge of Fermat, and this probability must determine our conduct with regard to this theorem, whose own probability we cannot determine."

In next paragraph, Ramsey explains in fact Bayesian priors: "We have to make some hypothesis as to the initial likelihood of different values of its probability." Let me repeat that the term probability here seems to by objective physical probability.

I disagree with Sahlin's discussion of Savage's writing on p. 24/25 and in his closing sentence, because one should understand Savage's writing within Savage's model, and not within Sahlin's model as Sahlin does on p. 25. %}

Sahlin, Nils-Eric (1994) "On Higher Order Beliefs." *In* Jacques-Paul Dubucs (ed.) *Philosophy of Probability*, 13–34. Kluwer, Dordrecht.

{% %}

Sahlin, Nils-Eric & Johannes Persson (1994) "Epistemic Risk: The Significance of Knowing What One Does Not Know." *In* Berndt Brehmer & Sahlin, Nils-Eric (eds.) *Future Risks and Risk Management*, 37–62, Kluwer, Dordrecht.

{% %}

Sainfort, François & Jean M. Deichtmann (1993) "Decomposition of Utility Functions on Subsets of Product Sets."

{% Shows a mistake in Halevy (2008, American Economic Review) and corrects it. See my comments at Halevy (2008). %}

Saito, Kota (2011) "Strotz Meets Allais: Diminishing Impatience and the Certainty Effect: Comment," *American Economic Review* 101, 2271–2275.

{% Analyzes ex post versus ex ante equity in a lottery setup. It is a probabilized extension of Fehr-Schmidt.

P. 3087 gives axiomatization of Fehr-Schmidt (formal result in Lemma 1 in Appendix) very similar to Rohde (2010). P. 3093 3rd para claims simultaneous independent discovery. I recommend dropping such novelty claims three years after. %}

Saito, Kota (2013) "Social Preferences under Risk: Equality of Opportunity versus Equality of Outcome," *American Economic Review* 103, 3084–3101. http://dx.doi.org/10.1257/aer.103.7.3084

{% **quasi-concave so deliberate randomization**: has it.

criticism of monotonicity in Anscombe-Aumann (1963) for ambiguity.

Discusses Raiffa's randomization argument against Ellsberg. That Raiffa implicitly assumes dynamic decision principles that amount to (most of) EU anyhow. Raiffa assumes that prior commitment can be. Further, Raiffa assumes conditioning on the ambiguous events, but one can as well condition on the risky events and then his randomization does not remove ambiguity. I want to add here a point in my 2008 paper for which I credit Jaffray there: it is more natural to condition on the unambiguous event, say the roulette wheel, than on the ambiguous event. This paper proposes and axiomatizes a model that with δ

weight has the ambiguous events precede the objective probabilities, and with 1–δ takes the ordering the other way around, doing backward induction in both cases. %}

Saito, Kota (2015) "Preferences for Flexibility and Randomization under Uncertainty," *American Economic Review* 105, 1246–1271. https://doi.org/10.1257/aer.20131030

{% **measure of similarity** %}

Saito, Takayuki (1994) "Psychological Scaling of the Asymmetry Observed in Comparative Judgement," *British Journal of Mathematical and Statistical Psychology* 47, 41–62.

{% %}

Salanié, Bruno (2003) "*The Economics of Taxation.*" The MIT Press, Cambridge, MA.

{% **revealed preference** They formalize framing simply as a new empirical primitive. (C,f) with C a subset of the conceivable choice prospects designates choosing from C under framing f. Derive some theorems. Is similar to Bernheim & Rangel (2009). Reminds me some of Wang & Fischbeck (2004) who took as extra parameter whether subjects used a gain or loss frame. %}

Salant, Yuval & Ariel Rubinstein (2008) "Choice with Frames," *Review of Economic Studies* 75, 1287–1296.

{% %}

Sales, Célia M.D. (2005) "Terapia Familiar en Contexto Psiquiátrico: Aportaciones para la Comprensión del Cambio Psicoterapéutico." Seville: Faculty of Medicine, Department of Psychiatry. Ph.D. Thesis.

{% **measure of similarity** %}

Sales, Célia M.D. & Peter P. Wakker (2009) "The Metric-Frequency Measure of Similarity for Ill-Structured Data Sets, with an Application to Family Therapy," *British Journal of Mathematical and Statistical Psychology* 62, 663–682.

https://doi.org/10.1348/000711008X376070
Direct link to paper

{% %}
Sales, Célia M. D., Peter P. Wakker, Paula C. G. Alves, & Luís Faísca (2015) "MF Calculator: A Web-based Application for Analyzing Similarity," *Journal of Statistical Software* 65, May 2015, code snippet 2.
http://dx.doi.org/10.18637/jss.v065.c02
Direct link to paper

{% %}
Salminen, Pekka & Jyrki Wallenius (1993) "Testing Prospect Theory in a Deterministic Multiple Criteria Decision-Making Environment," *Decision Sciences* 24, 279–294.

{% %}
Salo, Ahti A. (1995) "Interactive Decision Aiding for Group Decision Support," *European Journal of Operational Research* 84, 134–149.

{% MAUT with imprecise, interval, statements %}
Salo, Ahti A. & Raimo P. Hämäläinen (1992) "Preference Assessment by Imprecise Ratio Statements," *Operations Research* 40, 1053–1061.

{% **PT, applications**: nonadditive measures, overbidding.
Use convex capacities to obtain alternative explanation for phenomenon that submitted bids exceed EU-Nash-Equilibrium predictions in first-price sealed-bid auctions. %}
Salo, Ahti A. & Martin Weber (1995) "Ambiguity Aversion in First-Price Sealed-Bid Auctions," *Journal of Risk and Uncertainty* 11, 123–137.

{% **updating: discussing conditional probability and/or updating** %}
Salop, Steven C. (1987) "Evaluating Uncertain Evidence with Sir Thomas Bayes: A Note for Teachers," *Economic Prespectives* 1, 155–160.

{% **foundations of statistics**: a book on the history of statistics aiming at a general public. %}

Salsburg, David (2001) "*Who Said Statistics is a Dull Subject? The Lady Tasting Tea: How Statistics Revolutionized Science in the 20th Century*." W.H. Freeman and Company, New York.

{% **common knowledge** %}

Samet, Dov (1990) "Ignoring Ignorance and Agreeing to Disagree," *Journal of Economic Theory* 52, 190–207.

{% **R.C. Jeffrey model** %}

Samet, Dov & David Schmeidler (2023) "Desirability Relations in Savage's Model of Decision Making," *Theory and Decision* 94, 1–33. https://doi.org/10.1007/s11238-022-09883-y

{% Value of independent sources is not additive. %}

Samson, Danny, Andrew Wirth, & John Rickard (1989) "The Value of Information from Multiple Sources of Uncertainty in Decision Analysis," *European Journal of Operational Research* 39, 254–260.

{% **real incentives/hypothetical choice**: whether and how much real incentives improve performance is not at all clear, and depends on many details. This paper investigates it in the context of the use of decision aids. %}

Samuels Janet A. & Stacey M. Whitecotton (2011) "An Effort Based Analysis of the Paradoxical Effects of Incentives on Decision-Aided Performance," *Journal of Behavioral Decision Making* 24, 345–360.

{% %}

Samuels, Warren J. (1988) "An Essay on the Nature and Significance of the Normative Nature of Economics," *Journal of Post Keynesian Economics* 10, 347–354.

{% https://doi.org/10.1257/0022051053737816

General observations regarding theories and experiments.

Pp. 88-91 discuss Rabin's (2000) paradox, suggesting utility of income as solution, and I guess he missed the last para of Rabin's paper where Rabin suggests the same solution through the term loss aversion. %}

Samuelson, Larry (2005) "Economic Theory and Experimental Economics," *Journal of Economic Literature* 63, 65–107.

{% Seems to be his first publication.

marginal utility is diminishing: p. 158: "In general, economists assume on a priori grounds that marginal utility decreases with income in a monotonic manner."

P. 155 ℓ. −2 describes DC vaguely, but deliberately vaguely: "whose tastes maintain a certain invariance throughout the time"

P. 156 starts with a general "state-dependent EU" functional $\int$V(x,t)dt studied a.o. by Wakker & Zank (1999 MOR)

time preference; derives cardinal utility from additive (or integrated) utility of money over time, assuming discounting that is known a priori; (by the way, it could be done without knowing the discount factor by means of the **tradeoff method** of Wakker & Deneffe, 1996). P. 161: "ordering *differences* in utility by the individual. The advantage of our experiment is that it compels indidividuals to make just such judgments." [italics from original].

P. 160 2nd para carefully distinguishes calendar time from stopwatch time.

P. 160, last full paragraph, already describes, I think, Becker's idea, "theory of history," that one might incorporate all of history in utility, and calls theory of history a contradiction in terms, maybe for being too general.

risky utility u = transform of strength of preference v: This paper is not at all on risk, but on time preference. There it explicitly distinguishes (last paragraph of paper, on p. 161), the cardinal utility function of constant discounting from cardinal utility for welfare theory.

DC = stationarity? P. 160 third paragraph beginning describes, I think, forgone-act independence (often called consequentialism) (the 1940 sentence), and then after that DC (e.g., mentioning precommitment). So, he never explicitly mentions stationarity but it's nicely implied à la Han & I.

Top of p. 160 says that functions that allow unlimited interrelationships become so general as to be almost vacuous.

risky utility u = transform of strength of preference v: well, he says that time-pref. utility is not welfare utility, but that's the same kind of thinking.

risky utility u = transform of strength of preference v (?latter doesn't exist?): p. 161 discusses that additive time preference leads to cardinal utility and, hence, meaningful comparison of utility difference and writes:

"…we must invoke Pareto's Postulate Two, which relates to the possibility of ordering *differences* in utility by the individual. … The advantage of our experiment is that it compels the individual to make just such judgments. …Thus, with postulates one and two being fulfilled, it is to be expected that utility is uniquely measurable.

In conclusion, any connection between utility as discussed here and any welfare concept is disavowed. The idea that the results of such a statistical investigation could have any influence upon ethical judgments of policy is one which deserves the impatience of modern economists." [italics and paragraph break from original]

In the first sentence of the last para, Samuelson points out that one cardinal utility in one context need not automatically serve as cardinal utility in another. He does not go as far as conjecturing two different cardinal concepts of utility, but it is a similar point. %}

Samuelson, Paul A. (1937) "A Note on Measurement of Utility," *Review of Economic Studies* 4 (Issue 2, February 1937) 155–161.

{% **coherentism**

revealed preference; p. 71 (Sen's citation) wants the analysis to be "freed from any vestigial traces of the utility concept." Introduced WARP. %}

Samuelson, Paul A. (1938) "A Note on the Pure Theory of Consumer's Behaviour," *Economica*, N.S. 5, 61–71, 353–354.

{% **risky utility u = transform of strength of preference v, latter doesn't exist**;

P. 344: "Secondly, there has been a progressive movement toward the rejection of hedonistic, introspective, psychological elements."

Derives, I think, some results of prices, equilibria, for consumer theory, showing that nothing more than ordinal utility is needed. %}

Samuelson, Paul A. (1938) "The Empirical Implications of Utility Analysis," *Econometrica* 6, 344–356.

{% **risky utility u = transform of strength of preference v, latter doesn’t exist**: Argues that cardinal utility in welfare economics is useless, p. 65: “Only those who consider general welfare as the algebraic sum of individual utilities require that utility be measurable in a cardinal sense. It is not only that we can get along without this cardinal concept, but literally nothing is added by its assumption.”

P. 66 shows that, under smoothness, same ordering of utility differences implies cardinal equivalence.

P. 70 shows, on strength of preferences, that $[X_1;X_2]$ ~* $[X_1';X_2']$ and $[X_2;X_3]$ ~* $[X_2';X_3']$ should imply $[X_1;X_3]$ ~* $[X_1';X_3']$ is the main condition required to have a utility difference representation. Claims that it is not a plausible condition. A theoretical study of Samuelson’s axiom, generalizing all existing characterizations of strength-of-preference through utility difference, is in Köbberling (2004, Economic Theory). %}

Samuelson, Paul A. (1938) “The Numerical Representation of Ordered Classifications and the Concept of Utility,” *Review of Economic Studies* 6 (Issue 1, October 1938) 65–70.

{% %}

Samuelson, Paul A. (1940) “Foundations of Analytical Economics, The Observational Significance of Economic Theory,” (Ph.D. dissertation), Harvard University, Dept. of Economics, Cambridge, MA.

{% %}

Samuelson, Paul A. (1942) “Constancy of the Marginal Utility of Income.” *In* Oskar Lange, Francis McIntyre, & Theodore O. Yntema (eds.) *Studies in Mathematical Economics and Econometrics: In Memory of Henry Schultz,* 75–91, The University of Chicago Press, Chicago.

{% **risky utility u = transform of strength of preference v, latter doesn’t exist**

P. 206: “To a man like Edgeworth, steeped as he was in the Utilitarian tradition, individual utility—nay social utility—was as real as his morning jam.”

Seems to write: “The method of comparative statics consists of the study of the response of our equilibrium unknowns to designated changes in the parameters.” %}

Samuelson, Paul A. (1947) “*Foundations of Economic Analysis.*” Harvard University Press, Cambridge, MA. Enlarged edn. 1983.

{% **revealed preference** %}
Samuelson, Paul A. (1948) “Consumption Theory in Terms of Revealed Preference,” *Economica*, N.S. 15, 243–253.

{% End of footnote 2 already predicts that different methods for **utility elicitation**, which should lead to identical results under expected utility, in reality can be expected to give different empirical results.

P. 120 gives the famous Samuelson saying that the axioms should satisfy themselves, ascribing it to a friend. Samuelson presents the most rational man that he knows, Ysidro (most probably Edgeworth), presents a nonEU functional for him, and then writes about him:

“When told that he did not satisfy all of the v. Neumann-Morgenstern axioms, he replied that he thought it more rational to satisfy his preferences and let the axioms satisfy themselves.”

Footnote on p. 119 nicely credits Marschak for working on preference conditions for risk. On later occasions Samuelson, in personal correspondence to Fishburn and me, wrote that he learned the independence condition from Marschak. In a 1965 postscript, Samuelson says that Marschak, in this work, enjoyed many discussions on the topic with Herman Rubin.

Footnote on p. 121: **risky utility u = transform of strength of preference v, latter doesn’t exist** %}
Samuelson, Paul A. (1950) “Probability and the Attempts to Measure Utility,” *Economic Review* 1, 117–126.
Reprinted in Joseph E. Stiglitz (1966, ed.) *The Collected Scientific Papers of Paul A. Samuelson*, Ch. 12, MIT-Press, London.

-
{% **revealed preference** %}
Samuelson, Paul A. (1950) “The Problem of Integrability in Utility Theory,” *Economica*, N.S. 17, 355–385.

{% P. 671: “I must refer the reader to the forthcoming book by L.J. Savage, which will represent a landmark in the history of probability theory.”

independence/sure-thing principle due to mutually exclusive events: P. 672: "Prior to 1950, I hesitated to go much further. But much brooding over the magic words "mutually-exclusive" convinced me that there was much to be said for a further "strong independence axiom." When I did a history search, jointly with Fishburn, in the early 1990s, reading the letter correspondence of Fishburn and Samuelson of which Friedman had kindly sent us paper copies, I added in handwriting to "brooding" that it had taken place in the summer of 1950. I do not remember now where I got this from. Moscati (2016) cites a letter by Marschak (May 1950) to Samuelson pointing out the mutual exclusivity, to which Samuelson then reacts in a confused manner. So, probably, Marschak (1950) wrote it to Samuelson, but Samuelson only digested it later.

independence/sure-thing principle due to mutually exclusive events: para on pp. 672-673:

"It is this independence axiom that is crucial for the Bernoulli-Savage theory of maximization of expected cardinal utility, and which is the concern of the present symposium. Within the stochastic realm, independence has a legitimacy that it does not have in the nonstochastic realm. Why? Because either heads or tails must come up: if one comes up, the other cannot; so, there is no reason why the choice between A_1 and B_1 should be "contaminated" by the choice between A_2 and B_2.[3] How different this is as compared to the two blends of gasoline, where we must reckon with physical and chemical interactions."

The footnote 3, on p. 673, starts with: "Around 1950, Marschak, Dalkey, Nash, and others independently recognized the crucial importance of the independence axiom." %}

Samuelson, Paul A. (1952) "Probability, Utility, and the Independence Axiom," *Econometrica* 20, 670–679.

{% **consequentialism/pragmatism**: I took from Machina (1989, JEL) that Samuelson (pp. 676-677 in Stiglitz's 1966 book) noted that separability across alternative consequences

"must always be applied to a definite set of entities—e.g., (1) single-event money prizes, (2) single-event vectors of goods, (3) single-event money prizes cum gaming and suspense feelings . . . [Separability] then has implications and restrictions upon choices among such entities; but, strictly speaking, it need not impose restrictions upon some different (and perhaps simpler) set of entities.

In what dimensional space are we "really" operating? If every time you find my axiom falsified, I tell you to go to a space of still higher dimensions, you can legitimately regard my theories as irrefutable and meaningless . . . From my own direct and indirect observations, I am satisfied that a large fraction of the sociology of gambling and risk taking will never significantly be discernible in terms of money prizes alone, as distinct from elements of suspense . .” %}

Samuelson, Paul A. (1953) “Utilité, Préférence et Probabilité” (including discussion; paper given before the conference on “Les Fondements et Applications de la Théorie du Risque en Économetrie,” May, 1952) *Colloques Internationaux du Centre National de la Recherche Scientifique* (Econométrie) 40, 141–164. Translated into English in Joseph E. Stiglitz (1966, ed.) *The Collected Scientific Papers of Paul A. Samuelson*, Ch. 13, MIT-Press, London.

{% %}

Samuelson, Paul A. (1953) “Consumption Theorems in Terms of Over-Compensation Rather than Indifference Comparisons,” *Economica*, N.S. 20, 1–9.

{% %}

Samuelson, Paul A. (1958) “An Exact Consumption-Loan Model of Interest with or without the Social Contrivance of Money,” *Journal of Political Economy* 46, 467–482.

{% P. 146 suggests that utility functions are bounded.

linear utility for small stakes: Bottom of p. 147 says that utility tends to linearity if outcomes tend to zero (which I agree, though it does not hold for log-power utility; but this is a problem of that parametric family). Point 7 on p. 35 repeats the point, with the premise of smoothness made explicit though.

Point 7 on p. 35 points out, à la de Finetti, that we can elicit subjective probabilities by taking small stakes to that utility is approximately linear. Footnote 5 points out the problem that there is no incentive for small stakes. This is a nice footnote anyhow, because it also points out a similarity to the Heisenburg uncertainty principle, though the similarity refers only to utility being nonlinear for methods requiring linear utility, and not to the constructive view of preference in full force. %}

Samuelson, Paul A. (1960) “The St. Petersburg Paradox as a Divergent Double Limit,” *International Economic Review* 1, 31–37.

Reprinted as Ch. 15 in Joseph E. Stiglitz (1966, ed.) “*The Collected Scientific Papers of Paul A. Samuelson.*” MIT-Press, London.

https://doi.org/10.2307/2525406

{% Colleague did not accept 50/50 gamble for $200 and -$100, but would accept multiple gambles of that sort. Note that the point had already been mentioned by Edwards (1954).

P. 2 ℓ. 3 writes: "I won't bet because I would feel the $100 loss more than the $200 gain."

Footnote 2 on p. 50 also states loss aversion as a "corner" in utility at the "initial point." %}

Samuelson, Paul A. (1963) "Risk and Uncertainty: A Fallacy of Large Numbers," *Scienta* 98, 108–113.

{% Discussions about the vNM independence axiom: Vol. I Ch. 12 (1950), Ch. 13 (1952), Ch. 14 (1952), Ch. 14 (1952), %}

Samuelson, Paul A. (1966-1986) "*The Collected Scientific Papers of Paul A. Samuelson*," Vol. I-V. Vols I and II, Joseph E. Stiglitz (ed. 1966) MIT-Press, Cambridge, MA. Vol. III, Robert C. Merton (ed. 1970), MIT-Press, Cambridge, MA. Vol. IV, Hiroaki Nagatani & Kate Crowley (e(eds.)d. 1977) MIT-Press, Cambridge, MA. Vol. V, Kate Crowley (e(eds.)d. 1986) MIT-Press, Cambridge, MA.

{% %}

Samuelson, Paul A. (1969) "Lifetime Portfolio Selection by Dynamic Stochastic Programming," *Review of Economics and Statistics* 51, 239–246.

{% Discusses the Kelly criterion. %}

Samuelson, Paul A. (1971) "The "Fallacy" of Maximizing the Geometric Mean in Long Sequences of Investing or Gambling," *Proceedings of the National Academy of Sciences* 68, 7958–7962.

{% Pp. 34, 49, 29 note that unbounded EU iff infinite certainty equivalent.

P. 34 2nd para points out that bounded utility implies that certainty equivalents of truncations of the St. Petersburg paradox converge to a real-valued limit, citing Menger. This is a special case of my truncation-continuity (Wakker 1993 MOR). %}

Samuelson, Paul A. (1977) "St.-Petersburg Paradoxes: Defanged, Dissected and Historically Described," *Journal of Economic Literature* 15, 24–55.

{% Below p. 509-518: Samuelson's development w.r.t. independence. %}
Samuelson, Paul A. (1983) "*Foundations of Economic Analysis*; enlarged edn." Harvard University Press, Cambridge, MA.

{% Many results on functional equations. %}
Samuelson, Paul A. (1992) "A Long-Open Question on Utility and Conserved-Energy Functions." *In* Mukul Majumdar (ed.) *Essays in Honor of David Gale*, 287–306, St. Martin's Press, New York.

{% p. 8 seems to write:
"economists cannot perform the controlled experiments of chemists or biologists because they cannot easily control other important factors" %}
Samuelson, Paul A. & William Nordhaus (1985) "Economics," 12 edn. McGraw-Hill, New York.

{% Seems that they introduced the term status quo bias.
§2.2 considers retirement plans of 850,000 teachers in the TIAA association. They can divide their money over a safe TIAA fund consisting of bonds and other safe investments, and a more risky CREF stock funds. Tables 12 and 13 shows that the mode division is 50-50, chosen by some 47% of subjects. The second most-chosen is all in the safe fund (22% of subjects). Although they can every year redivide at no cost, almost no one ever changes. %}
Samuelson, William F. & Richard J. Zeckhauser (1988) "Status Quo Bias in Decision Making," *Journal of Risk and Uncertainty* 1, 7–59.

{% %}
Sánchez, M. Carmen (1999) "Rationality of Bargaining Solutions," *Journal of Mathematical Economics* 33, 389–399.

{% **revealed preference** %}

Sánchez, M. Carmen (1998) "Rational Choice on Non-Finite Sets by Means of Expansion-Contraction Axioms," *Theory and Decision* 45, 1–17.

{% %}

Sanders, Marianne, Andrée Tingloo, & Hans Verhulst (1992) "*Advanced Writing in English; A Guide for Dutch Authors.*" Garant-Uitgevers, Apeldoorn. (4th edn. 1998.)

{% %}

Sandmo, Agnar (1970) "The Effect of Uncertainty on Savings Decisions," *Review of Economic Studies* 37, 353–360.

{% **revealed preference**: They consider revealed preference theory for a choice function C but with a consideration function L intervening: for each choice set B, first a subset L(B) is chosen, and then utility is maximized only over L(B). For instance, L can specify what is legally allowed. The leveling axiom, for a consideration function L: L({x,y}) = {x,y}, L({y,z}) = {y,z}, L({x,z}) = {x,z} ⇒ L({x,y,z}) = {x,y,z}. They then provide characterizations of maximizations of asymmetric relations. %}

Sandroni, Alvaro & Leo Katz (2024) "The Leveling Axiom," *Theory and Decision* 96, 135–152.
https://doi.org/10.1007/s11238-023-09943-x

{% Generalize Foster & Vohra (1997) and Lehrer (2001). %}

Sandroni, Alvaro, Rann Smorodinsky, & Rakesh V. Vohra (2003) "Calibration with Many Checking Rules," *Mathematics of Operations Research* 28, 141–153.

{% **measure of similarity**; Use fuzzy measures and Choquet integral (p. 877). %}

Santini, Simone & Ramesh Jain (1999) "Similarity Measures," *IEEE Transactions on Pattern Analysis and Machine Intelligence* 21, 871–883.

{% **losses from prior endowment mechanism**: explained top of p. 579
Experiment with all mixed two-outcome lotteries. 50% of subjects satisfy EU and

50% violate it. The authors use the term reference dependence for what I would call sign dependence. The reference point is always fixed at 0 so reference dependence plays no role. But losses can be treated differently than gains, which is sign dependence.

For NonEU, sign-dependence of probability weighting works well, and there is no loss aversion. They use choice-lists to get mixed lotteries equivalent to 0. %}

Santos-Pinto, Luis, Adrian Bruhin, José Mata, & Thomas Astebro (2015) "Detecting Heterogeneous Risk Attitudes with Mixed Gambles," *Theory and Decision* 79, 573–600.

{% %}

Sapienza, Paola, Anna Toldra-Simats, & Luigi Zingales (2013) "Understanding Trust," *Economic Journal* 123, 1313–1332.

{% **gender differences in risk attitudes**: women more risk averse than men. %}

Sapienza, Paolo, Luigi Zingales, & Dario Maestripieri (2009) "Gender Differences in Financial Risk Aversion and Career Choices are Affected by Testosterone," *Proceedings of the National Academy of Sciences* 106, 15268–15273.

{% %}

Saponara, Nick (2017) "Revealed Understanding," working paper.

{% %}

Sarin, Rakesh K. (1982) "Strength of Preference and Risky Choice," *Operations Research* 30, 982–997.

{% **dynamic consistency**; didactical description of nonEU models %}

Sarin, Rakesh K. (1990) "Analytical Issues in Decision Methodology." *In* Ira Horowitz (ed.) *Organization and Decision Theory*, 13–62, Kluwer, Dordrecht.

{% **dynamic consistency** %}

Sarin, Rakesh K. (1992) "What Now for Generalized Utility Theory." *In* Ward Edwards (ed.) *Utility Theories: Measurement and Applications*, 137–163, Kluwer Academic Publishers, Dordrecht.

{% %}

Sarin, Rakesh K. & Peter P. Wakker (1992) "A Simple Axiomatization of Nonadditive Expected Utility," *Econometrica* 60, 1255–1272.
https://doi.org/10.2307/2951521
Direct link to paper

{% **dynamic consistency** %}

Sarin, Rakesh K. & Peter P. Wakker (1994) "Folding Back in Decision Tree Analysis," *Management Science* 40, 625–628.
https://doi.org/10.1287/mnsc.40.5.625
Direct link to paper

{% %}

Sarin, Rakesh K. & Peter P. Wakker (1994) "A General Result for Quantifying Beliefs," *Econometrica* 62, 683–685.
https://doi.org/10.2307/2951663
Direct link to paper
Extended version

{% %}

Sarin, Rakesh K. & Peter P. Wakker (1994) "Gains and Losses in Nonadditive Expected Utility." *In* Mark J. Machina & Bertrand R. Munier (eds.) *Models and Experiments on Risk and Rationality*, 157–172, Kluwer Academic Publishers, Dordrecht.
Direct link to paper

{% %}

Sarin, Rakesh K. & Peter P. Wakker (1997) "A Single-Stage Approach to Anscombe and Aumann's Expected Utility," *Review of Economic Studies* 64, 399–409.
https://doi.org/10.2307/2971720

Direct link to paper

{% **updating: nonadditive measures**: see §9. %}
Sarin, Rakesh K. & Peter P. Wakker (1998) "Revealed Likelihood and Knightian Uncertainty," *Journal of Risk and Uncertainty* 16, 223–250.
https://doi.org/10.1023/A:1007703002999
Direct link to paper

{% **dynamic consistency. NonEU & dynamic principles by restricting domain of acts,**
The recursive maxmin EU in Theorem 2.1, was later axiomatized by Epstein & Schneider (2003, *Journal of Economic Theory* 113). What S&W called the reduced family, was called rectangular by E&S. Hansen, Sargent, Turmuhambetova, & Williams (2006, p. 78) argued that this family is too restrictive. %}
Sarin, Rakesh K. & Peter P. Wakker (1998) "Dynamic Choice and Nonexpected Utility," *Journal of Risk and Uncertainty* 17, 87–119.
https://doi.org/10.1023/A:1007769628257
Direct link to paper

{% %}
Sarin, Rakesh K. & Peter P. Wakker (2000) "Cumulative Dominance and Probabilistic Sophistication," *Mathematical Social Sciences* 40, 191–196.
https://doi.org/10.1016/S0165-4896(99)00048-7
Direct link to paper

{% %}
Sarin, Rakesh K. & Martin Weber (1992) "Risk-value Models," *European Journal of Operational Research* 70, 135–149.

{% Two different market organizations, sealed bid auctions and double oral auctions, were used to let graduate business students and bank executive choose between ambiguous and unambiguous lotteries. The ambiguous ones were valued lower.
ambiguity seeking for unlikely: no ambiguity aversion around p = .05. %}

Sarin, Rakesh K. & Martin Weber (1993) "Effects of Ambiguity in Market Experiments," *Management Science* 39, 602–615.

{% Seem to argue that ambiguity can be modeled through utilities of outcomes, rather than through beliefs. (**event/outcome driven ambiguity model: outcome driven**) %}
Sarin, Rakesh K. & Robert L. Winkler (1992) "Ambiguity and Decision Modeling: A Preference-Based Approach," *Journal of Risk and Uncertainty* 4, 389–407.

{% %}
Sarsons, Heather, Klarita Gërxhani, Ernesto Reuben, & Arthur Schram (2020) "Gender Differences in Recognition for GroupWork," working paper.

{% (**conservation of influence**) Seems that he wrote: "l'homme n'est rien d'autre que son projet, il n'existe que dans la mesure où il se réalise, il n'est donc rien d'autre que l'ensemble de ses actes, rien d'autre que sa vie." English translation (by Philip Mairet): "Man is nothing else but what he purposes, he exists only in so far as he realizes himself, he is therefore nothing else but the sum of his actions, nothing else but what his life is."

Seems that Sartre also said, here or elsewhere: "Man is not the sum of what he has already, but rather the sum of what he does not yet have, of what he could have." %}
Sartre, Jean-Paul (1946) "*L'Existentialisme Est un Humanisme.*" Nagel, Paris.

{% %}
Sarver, Todd (2008) "Anticipating Regret: Why Fewer Options May be Better," *Econometrica* 76, 263–305.

{% This paper presents an advanced economic model for intertemporal choice under risk, assuming basic knowledge of such models on the part of the readers. P. 1352: "The setting for the axiomatic analysis is the space of infinite-horizon temporal lotteries. This domain is rich enough to encode not only the atemporal distribution of consumption streams but also how information about future consumption arrives through time. For example, future wealth and hence future consumption may depend on the returns to investments which are realized gradually over a sequence of interim periods."

The model contains all preferences that satisfy a convexity preference

condition (p.1353 Axiom 1) w.r.t. probabilistic mixing, and in this sense is rich, general. The axiom means that if you are willing to sacrifice x so as to increase a probability from p to q, then you are only more willing to increase it from d+p to d+q for any positive d. It is some stronger than quasi-convexity in probabilistic mixing. Then in Definition 3 (p. 1354) it is specified as an optimal risk attitude (ORA):

$$V(c,m) = u(c) + \beta \sup_{\varphi \in \Phi} E_m\big(\varphi(V)\big)$$

where E_m denotes expectation w.r.t. probability measure m. I guess that m denotes both saved money and probability distribution over it. V is the representing functional, c is immediate consumption and u its utility, and V inherits randomness from its arguments c and m. φ is a transformation of the representing function V ($\varphi(x) \le x$ for all x required). The set Φ of functions φ considered is subjective. The author interprets different φ as different risk attitudes, and the agent then chooses the risk attitude giving her maximal utility. Of course, different interpretations are possible. Mathematically, the optimization over φ results from the quasiconvexity preference condition. As the author shows, the functional is general enough to accommodate all prevailing empirical findings related to risk aversion. One cannot accommodate everything of course, so inverse S and fourfold pattern cannot be accommodated.

P. 1353 defines certainty equivalents as general functions satisfying stochastic dominance and idempotence (CE(x)=x for all degenerate x), prior to specifying preferences. They follow in the ensuing para.

§4.3 analyzes the Rabin paradox and the role of background risk for it, citing Safra & Segal (2008) for the claim that RDU has difficulties. As my annotations at Safra & Segal (2008) explain, I disagree because their empirical assumption is not plausible. This paper shows that the model is general enough to accommodate Rabin paradox choices while maintaining differentiability (by taking functionals that are close enough to kinked but not really kinked) and that it can accommodate at least moderate background risk. However, p. 1367 writes, realistically, that RDU, a special case of the general model, may work best: "Finally, specification RDU1 [RDU], which exhibits first-order risk aversion, is perhaps the best suited for generating high risk aversion for small gambles and moderate risk aversion for larger gambles." (**Prospect theory/Rank-Dependent Utility most popular for risk**) %}

Sarver, Todd (2018) “Dynamic Mixture-Averse Preferences,” *Econometrica* 86, 1347–1382.

{% **measure of similarity** %}
Sattath, Shmuel & Amos Tversky (1977) “Additive Similarity Trees,” *Psychometrika* 42, 319–345.

{% Use big real incentives. Find that temporal distance increases insensitivity to probability. %}
Savadori, Lucia & Luigi Mittone (2015) “Temporal Distance Reduces the Attractiveness of P-Bets Compared to $-Bets,” *Journal of Economic Psychology* 46, 26–38.

{% P. 6 writes that not only the vNM book, but also repeated conversations with vN, confirm that vN is no frequentist. %}
Savage, Leonard J. (1950, 19 May) Letter to Paul Samuelson.

{% Seems to be review of Wald (1950) and seems to have Savage’s 1954 framework with acts mapping states to consequences. %}
Savage, Leonard J. (1950) “The Role of Personal Probability in Statistics” (abstract), *Econometrica* 18, 183–184.

{% P. 56 writes: “Acts have consequences for the actor, and these consequences depend on facts, not all of which are generally known to him. The unknown facts will often be referred to as states of the world, or simply states,” and thus can be taken as an early appearance of the “acts map states to outcomes” model.

P. 57, footnote 3: acknowledges Samuelson for putting him right on a mistake in the Friedman & Savage (1948) paper.

P. 61 last para credits de Finetti, but, unfortunately, for Savage’s ideas on minimax, which I am not much interested in. Those ideas are interesting in the sense that they are the first appearance, to my best knowledge, of an attribute-based, rather than alternative-based, evaluation. (Terms explained in annotations at Scholten et al. (2024 Psychological Review).

Pp. 63-64 seem to argue that a statistical loss function is different than a negative economic utility function, partly because the latter may not be known, but it remains mysterious to me. %}

Savage, Leonard J. (1951) "The Theory of Statistical Decision," *Journal of the American Statistical Association* 46, 55–67.

{% I copied this reference from Allais (1953, 1979). %}

Savage, Leonard J. (1952) "An Axiomatisation of Reasonable Behavior in the Face of Uncertainty."

{% Paper is at http://personal.eur.nl/Wakker/refs/pdf/savage52.pdf

Also in "The Writings of Leonard Jimmie Savage—A memorial Selection," The Amer. Statis. Assn. and the Institute of Math. Statist., 1981. %}

Savage, Leonard J. (1953) "Une Axiomatisation du Comportement Raisonnable Face à l'Incertitude." *Colloques Internationaux du Centre National de la Recherche Scientifique* (Econométrie) 40, 29–40.

{% The first five chapters are, I think, the greatest contribution to all of decision theory. The rest of the book is not very interesting.

As explained for instance by Fienberg (2008), when Savage wrote this book he did not know that his sure-thing principle amounted to the likelihood principle for statistics (later Barnard seems to have explained the likelihood principle to Savage), nor that it implies a breakaway from classical statistics. The whole second part of the book tries to do classical-like statistics and decisions, such as through minimax, and is not interesting.

On Savage's use of the term sure-thing principle, which has raised many misunderstandings: p. 22 2nd para:

"It will be preferable to regard the principle as a loose one that suggests certain formal postulates well articulated …". In his analysis, the principle is related to three formal postulates, P2 and P3 (page 21 and the rest of §2.7), and P7 (p. 77, the para preceding P7). Since, the terminology in the field has shifted. Nowadays (after 1990), it is commonly accepted to let the term sure-thing principle refer only to Savage's P2 and not, as he did, to P2, P3, and P7.

P. 17 seems to briefly mention the problem of indifference for observability of

revealed preference.

questionnaire versus choice utility: p. 17: "I think it of great importance that preference, and indifference, between f and g be determined, at least in principle, by decisions between acts and not by response to introspective questions."

P. 20 seems to say about the use of his axioms:

"to make complicated decisions depend on simpler ones."

Section 3.1, pp. 27-30, on general meaning of preference is nice.

questionnaire versus choice utility: pp. 27-28 argue that one should observe choice rather than do direct questioning. P. 27 writes: "direct interrogation has justifiably met with antipathy from most statistical theorists."

Pp. 27-28: "if the state of mind in question is not capable of manifesting itself in some sort of extraverbal behavior, it is extraneous to our main interest. If, on the other hand, it does manifest itself through more material behavior, that should, at least in principle, imply the possibility of testing whether …"

At the end of p. 28 it says that questioning "what would you do if" seems fine. This is an example where for normative purposes one deliberately uses hypothetical choice, so that this if of interest in its own right. (**real incentives/hypothetical choice**) P. 28 penultimate para says that for normative it is right. P. 29, by way of digression, discusses empirical observations for descriptive purposes. Top says that real incentives is problematic for high stakes and losses. Middle nicely discusses observability problem that choice f from {f,g,h} does not reveal preference between g and h, and the paradox that for transitivity testing you need to observe three choices but take each one as only choice. Income effect if observing more than one. Then it proposes, last para, the random incentive system (RIS), ascribing the idea to his teacher the statistician W. Allen Wallis but also writing that Allais used it. Lines −3/−2 point out that one needs a conditioning assumption (the point of Holt American Economic Review 1986) to justify the RIS.

Pp. 40-43, §3.4: For Savage, countable additivity was not central and it was only a pragmatic matter of convenience. He used all subsets of the state space (which excludes countable additivity) and not a sigma-algebra only for expositional purposes, actually preferring sigma-algebra other than for exposition. Savage did express a slight preference for not committing to countable additivity but, again, not out of principle but only pragmatically, and not committing clearly. (Probably to quite some extent so as not to get in conflict with de Finetti who was in a less refined league than Savage.)

§3.3, p. 37 of 1972 version, has Theorem 3 (so, Theorem 3.3.3 in Savage's notation) with item 7 stating solvability for P: for every event E and every $0 < \mu < P(E)$ there is a subset $B \subset E$ with $P(B) = \mu$.

§ 3.4, pp. 42-43: That his results all hold true on sigma-algebras, but that at least his proof does not work on algebras. Kopylov (2007) extends the result to algebras of events, and even mosaics.

Savage (1972, pp. 57-58): "To approach the matter in a somewhat different way, there seem to be some probability relations about which we feel relatively "sure" as compared with others. When our opinions, as reflected in real or envisaged action, are inconsistent, we sacrifice the unsure opinions to the sure ones. The notion of "sure" and "unsure" introduced here is vague, and my complaint is precisely that neither the theory of personal probability, as it is developed in this book, nor any other device known to me renders the notion less vague."

linear utility for small stakes: P. 60, on book making argument of de Finetti: "but it seems to me a somewhat less satisfactory approach than the one sponsored here, because it must assume either that the bets are for infinitesimal sums or … that the utility of money is linear."

linear utility for small stakes: P. 91: for small amounts, utility is approximately linear

risky utility u = transform of strength of preference v, latter doesn't exist: p. 91, "the now almost obsolete economic notion of utility in riskless situations, a notion still sometimes confused with the one under discussion." P. 94 (using Bernoulli's term moral worth for utility): "It seems mystical, however, to talk about moral worth apart from probability and, having done so, doubly mystical to postulate that this undefined quantity serves as a utility."

P. 94, on Bernoulli's logarithmic utility: "To this day, no other function has been suggested as a better prototype for Everyman's utility function."

P. 95, "Cramer therefore concluded, and I think rightly, that the utility of cash must be bounded, at least from above." Then Savage says there must also be lower bounds.

P. 96 (of 72 ed.) says that utility is ordinal if only to determine choice between riskless options, says that useful requirements may be discovered in the future that do make utility cardinal, says "That possibility remains academic to date".

P. 101, end of second paragraph: ... the law of the conservation of energy ...

new sorts of energy are so defined as to keep the law true. Whole p. 101 discusses point that theories can in principle explain everything, at the cost however of becoming tautological.

P. 103: example of car with or without radio.

Seems to say that individuals with same evidence can have different beliefs.

value of information: seems to write somewhere "the person is free to ignore the observation. That obvious fact is the theory's expression of the commonplace that knowledge is not disadvantageous."

derived concepts in pref. axioms: Using concepts derived from prefs in axioms: Back of front leaf has first defined concepts and then axioms using these, for virtually all postulates (P2, P3, P4, P5, P7), being preferences given events, null events, preferences over consequences, and qualitative ordering of events. Main text uses derived concepts in P3 (p. 26) and P7 (pp. 77-78).

biseparable utility: for his EU;

A criticism of the mathematical analysis is that Savage never clearly specifies what the domain of preference is. I think that in the main text we should take it to be ALL maps from states to consequences, where, as his §3.4 (pp. 40-43) explains, it can equally well be with a sigma-algebra of events (and a sigma-algerba on the set of consequences) and only ALL measurable maps from states to consequences. The difference between whether measurability and sigma-algebras are present or not, is not important for what follows and will be ignored henceforth. Fishburn (1970), in his clear account of Savage's (1954) theorem, does it this way, immediately writing "F is the set of all functions of S into X" (§14.1, p. 192). Whether the domain includes all maps, or at least all simple (finitely many values) acts, or at least all bounded acts, is left unspecified by Savage.

Continuing, I think that Savage surely needs all simple acts (he calls them gambles) in his proof. The proof of Theorem 4 in §5.3 (pp. 75-76) in its last para refers to the "convex set of all gambles" which suggests it quite. I conjecture that, because Savage did not know how to handle the set of all acts and, for instance, unbounded utility with integrals possibly hard to define, he deliberately wrote vaguely about it, to cover up that he did not understand. See for instance the following text on p. 42, §3.4: "All that has been, or is to be, formally deduced in this book concerning preferences among sets, could be modified, mutatis mutandis, so that the class of events would not be the class of *all* subsets of S, but rather a Borel field, that is, a σ-algebra, on S;

the set of *all* consequences would be a measurable space, that is, a set with a particular σ-algebra singled out; and an act would be *a measurable function* from the measurable space of events to the measurable space of consequences." [italics added] Note how Savage explicitly writes the word "all" for the events and consequences, but none of such for the acts. His intelligence here works against him in the sense that I do not believe that this ambiguity in language came by accident. The last part of §5.4, pp. 81-82, speculates on acts with unbounded utility and clearly shows that Savage is in the blue on what the domain of preference, i.e, the set of acts considered, is. His nonbehavioral definition of bounded acts on p. 79 in §5.4 (could easily have referred to upper/lower bound *consequences* instead, which under finite additivity is somewhat more restrictive and safer) is also unfortunate.

Fishburn (1970) deviates from Savage by clearly and unambiguously stating that the preference domain contains all maps from states to consequences, and then proving that utility has to be bounded. Fishburn is kind to Savage by stating that Savage missed this implication, rather than that Savage covered up his lack of understanding by being vague. Wakker (1993 MOR) showed how to handle unbounded utility in Savage's model.

I think that mainly Savage's P2 is responsible for the vast implications in statistics, being main in implying the likelihood principle, ruling out classical statistics. Savage's book does not contain this view. As he explained in the preface of his 1972 edition, he was not aware of the likelihood principle in 1954. His text on pp. 206 bottom and p. 207, §13.5, goes a bit in the direction. He does mention a special role of P2 there. But the first example, on Chernoff, only involves his P1, weak ordering. His second example, minimax loss, does indeed seem to involve violation of P2, but not clearly explained, and if so then in an almost trivial manner. Then he seems to return, on the banquet committee, to just P1. So, P2 does not give much mileage. %}

Savage, Leonard J. (1954) "*The Foundations of Statistics.*" Wiley, New York. (2nd edn. 1972, Dover Publications, New York.)

{% Points out that one's view of probability (frequentist or subjective or otherwise) will contribute to one's view on statistics, but does not pin it down as I have in mind. Discusses behavior theory versus inferential theory. Section 5, especially p. 581 3rd para, tries to argue that the classical approach is more subjective than the

Bayesian, but does so by taking as only objective component in the classical approach the admissibility criterion, which I do not agree with. P. 580 2nd para is very interesting. It shows that by betweenness, a weak version of von Neumann-Morgenstern independence w.r.t. probabilistic mixing, the tradeoffs between errors of type I and type II should be linear, leading to a critical likelihood ratio mentioned in the third para of that p. 580. This vNM independence is similar in spirit to the sure-thing principle (I mean here only Savage's P2), but nothing in the paper comes closer to P2. P. 582, 4th para, writes negative about the 1954 book in being too deeply in the frequentist tradition to do a good job. Savage (1954) was indeed confused about what the brilliant first half of his book would imply for statistics.

P. 583 2nd para is on the likelihood principle, but does not link it to the sure-thing principle. It points out that the likelihood function is a minimal sufficient statistic.

P. 585 2nd para has me surprised, in saying that randomization is useful to statistics. As a Bayesian, I think that an optimal decision never involves randomization. But, on the other hand, it is a useful mathematical devise that can give us useful insights. The value of a two-person zero-sum game may require randomization but still gives useful insights. %}

Savage, Leonard J. (1961) "The Foundations of Statistics Reconsidered." *In Proceedings of the Fourth Berkeley Symposium on Mathematics and Probability*, Berkeley, University of California Press.

{% P. 17: Likelihood follows from subjective probabilities + Form. Bayes. Seems that he says having learned about the Stopping Rule Principle from Barnard in 1952 and then considering it patently wrong, to now considering it patently right. So, in 1952 he had little awareness of the likelihood principle.

paternalism/Humean-view-of-preference: Adrian F.M. Smith seems to have written: "Consistency is not *necessarily* a virtue: one can be consistently obnoxious." %}

Savage, Leonard J. (1962) "*The Foundations of Statistical Inference.*" Wiley, New York.

{% %}

Savage, Leonard J. (1962) "Discussion on a Paper by A. Birnbaum [On the Foundations of Statistical Inference]," *Journal of the American Statistical Association* 57, 307–308.

{% **updating: discussing conditional probability and/or updating**
P. 308 first full para and p. 309 first full para (pointed out to me by Bob Clemen and Bob Nau): "In what sense is this theory normative? It is intended that a reflective person who finds himself about to behave in conflict with the theory will reconsider. … To use the preference theory is to search for incoherence among potential decisions, of which you, the user of the theory, must then revise one or more. The theory itself does not say which way back to coherence is to be chosen, and presumably should not be expected to." %}

Savage, Leonard J. (1967) "Difficulties in the Theory of Personal Probability," *Philosophy of Science* 34, 305–310.

{% **proper scoring rules**: P. 785 discusses that proper scoring rules assume linear utility. Section 9.4 proves that the logarithm and its linear transformations are the only proper scoring rules for three or more nonnull events that are local (have payment under some event depend only on score assigned to that event, and not on how the scores for the other events). Most papers in the literature prove this only under differentiability assumptions, but Savage proves it in full generality.

BEGINNING OF EXPLANATION OF EQ. 9.27

It took me several hours before I understood the correctness of Savage's reasoning as follows (p. 794)

" $f_1(yw)q + f_2\big((1-y)w\big)(1-q) \;<\; f_1(qw)q + f_2\big((1-q)w\big)(1-q)$ (9.27)

if $y \neq q$. The left side of (9.27) is, therefore, in q, a strict linear function of support at y of g_w, where

$$g_w(y) \;=\; f_1(yw)y + f_2\big((1-y)w\big)(1-y) \qquad (9.28)\text{"}$$

mostly because of the use of the symbol y in Eq. 9.28. For me the following reasoning works: take

$$g_w(q) = f_1(qw)q + f_2((1-q)w)(1-q)$$

as a function with the variable argument q. Take any fixed value y in its domain, say $y = ¼$. Then the linear (affine) function $f_1(¼w)q + f_2(¾w)(1-q)$ of q is linear in q, it is equal to g_w at $q = 1/4$, and is strictly below g_w everywhere else because of Eq. 9.27. We can do this for every fixed value y in the domain of g_w other than

¼ and, hence, g_w is strictly convex. For me it was confusing that Savage seemed to denote by y the variable function argument in Eq. 9.28. Only later I understood that he means y to be a constant there, substituted for the variable argument q. But, at any rate, his reasoning is correct.

END OF EXPLANATION OF EQ. 9.27

random incentive system: P. 785 1st column suggests it, ascribing it to personal communication with W. Allen Wallis, and referring to Allais (1952) for it.

linear utility for small stakes: p. 786: "Within sufficiently narrow limits, any person's utilities can be expected to be practically linear." %}

Savage, Leonard J. (1971) "Elicitation of Personal Probabilities and Expectations," *Journal of the American Statistical Association* 66, 783–801.

{% %}

Savage, Leonard J. (1973) "Probability in Science: A Personalistic Account." *In* Patrick Suppes, Leon Henkin, Athanase Joja, & Grigore C. Moisil (eds.) *Logic, Methodology and Philosophy of Science IV*, 417–428, North-Holland, Amsterdam.

{% **foundations of statistics** %}

Savage, Leonard J. (1976; John W. Pratt, ed.) "On Rereading R.A. Fisher," *Annals of Statistics* 44, 441–500.

{% %}

Savochkin, Andrei, Alexander Shklyaev, & Alexey Galatenko (2022) "Dynamic Consistency and Rectangularity for the Smooth Ambiguity Model," working paper.

{% %}

Sawa, Ryoji & Jiabin Wu (2021) "Statistical Inference in Evolutionary Dynamics," working paper.

{ % Meta-analysis of data on WTP-WTA discrepancy. Find that iterative bidding and within-subjects designs decrease disparity; out-of-pocket payments increase disparity. Explicitly stating price: nonsignificant. %}

Sayman, Serdar & Ayse Öncüler (2005) “Effects of Study Design Characteristics on the WTA-WTP Disparity: A Meta Analytic Framework,” *Journal of Economic Psychology* 26, 289–312.

{% **decreasing/increasing impatience**: Find the usual decreasing impatience for long periods, but increasing for short (less than a week). Time consistency is equated with dynamic consistency (where, for fixed calendar time of consumption, the calendar time of choice changes and then should not matter). It is also referred to as longitudinal test of time inconsistency. Cross-sectional test of time consistency is stationarity (calendar time of decision is always now, and calendar time of consumption changes). P. 471 2^{nd} column last para points out that equating the two involves the implicit assumption of time invariance (decisions go by stopwatch time; so, these authors do not confuse **DC = stationarity**). P. 473 2^{nd} column 2^{nd} para does it again. Yet some sentences are hard to read because they refer to changes in time without specifying if consumption time or decision time is changing.

Table 1 lists many studies in the literature, where only three really test longitudinal (p. 472 last para).

real incentives/hypothetical choice, for time preferences: study 1 has real incentives, with monetary outcomes. %}

Sayman, Serdar & Ayse Öncüler (2009) “An Investigation of Time-Inconsistency,” *Management Science* 55, 470–482.

{% Subsumed by their 2012 JBDM paper with Philipp Koellinger. This Feb. 20 paper however serves to settle priority on their modified WTP, which they have. %}

Schade, Christian & Howard Kunreuther (2001) “Worry and Mental Accounting with Protective Measures,”

{% 1^{st} commentary: **uncertainty amplifies risk**: they find this, although overestimation of probabilities may also play a role.

N = 254 subjects were told that they had inherited a painting (part A of exp.) or a sculpture (part B), each worth $2000. Were asked WTP for insurance against fire/theft. Only one of 254 subjects played for real, which is not much. Note that they insure a thing given to them, so, no real loss. Groups 1 & 2 were told that the painting would be considered strolen iff 24 rain days in July at Frankfurt airport (sculpture: 23 rain days in August). This will confuse subjects, because is it risk of theft or risk of 24 days of rain that the experimenter wants them to think of? Authors estimate probability 1/10000 (so, 1/5000 for the two events together), but do not tell subjects. Group 3 had it contingent on 12 rain days in July (probability 1/10). ´After that subjects were asked the same but now with those probabilities as objectively given. Note that a 1/5000 probability of losing $2000 is very small, and of little concern. That only one or two (if both objects) o 254 play for real further decreases the interest.

They use BDM (Becker-DeGroot-Marschak) where subjects were given sealed envelope beforehand with the random prize already specified. After stating WTP, subjects were asked for estimates of subjective probabilities. They were also asked “how worried” they were.

Subjects paid much more under ambiguous probability than under objective. One-third of subjects paid nothing (fewer under ambiguity). Subjects greatly underestimate small ambiguous probabilities 1/5000, and slightly underestimate 1/5 (contrast effects will contribute). WTP is hardly different for small and large probabilities! Can be explained by subjects thinking of theft rather than rain. The worry variable predicts WTP well. No surprise, because it can be proxy for WTP. (Tests around Table 7 do not help.) Subjects pay much more than EV.
2nd commentary:
losses from prior endowment mechanism & random incentive system between-subjects (paying only some subjects; p. 535)**.** Only some subjects play for real, get prior endowment and then pay back. But nicely and convincingly implemented: N = 263 students were told they own a valuable painting ($2000), given a picture, told that small risk of losing, and asked premium to insure. Only two randomly chosen played for real at the end. Did modified WTP (introduced by Schade & Kunreuther 2001 in their working paper), where the random prize is drawn at the beginning (but left unknown; no info such as probability distribution is given to the subjects about this). Marvelous way to give them reference point. Found that feelings of worry better predict premium than subjective probability

estimate, but little surprise it is because feeling of worry is quite the same as fear-of-loss, so willingness to pay. Many subjects pay nothing for insurance, others do remarkably much. They pay more under ambiguity than under risk. They are remarkably insensitive to changes in likelihood (even by a factor 1000), suggesting insensitivity. %}

Schade, Christian, Howard Kunreuther, & Philipp Koellinger (2012) "Protecting against Low-Probability Disasters: The Role of Worry," *Journal of Behavioral Decision Making* 25, 534–543.

{% Investigate how prior gains or losses affect future coordination-game behavior. %}

Schade, Christian, Andreas Schroeder, & Kai Oliver Krause (2010) "Coordination after Gains and Losses: Is Prospect Theory's Value Function Predictive for Games?," *Journal of Mathematical Psychology* 54, 426–445.

{% **foundations of probability**: argues that probability cannot exist in a deterministic world. %}

Schaffer, Jonathan (2007) "Deterministic Chance?," *British Journal for the Philosophy of Science* 58, 113–140.

{% %}

Schakenraad, Jan (1989) "Data-Analyse en Modelkeuze: Een Indeling van Standaard-Analyse-Technieken in Multivariaat en Meerdimensioneel," *Kwantitatieve Methoden* 31, 147–161.

{% %}

Schaller, Mark (1992) "Sample Size, Aggregation, and Statistical Reasoning in Social inference," *Journal of Experimental Social Psychology* 28, 65–85.

{% %}

Schank, Roger C. & Ellen J. Langer, (1994, ed.) "*Beliefs, Reasoning, and Decision Making: Psycho-Logic in Honor of Bob Abelson.*" Erlbaum Associates Inc., Hillsdale.

{% Study how to communicate probabilities. %}

Schapira, Marilyn M., Anne B. Nattinger, & Colleen A. McHorney (2001) “Frequency or Probability? A Qualitative Study of Risk Communication Formats Used in Health Care,” *Medical Decision Making* 21, 459–467.

{% Shows that a power of utility to fit data is about −0.92 (1 − 1.92, CRRA index) on average for data on Paraguaya farmer data set of 2002 (N = 188) if reference point is chosen 0, but is something like −2500 if wealth level is chosen as reference point. This finding is explained theoretically in Wakker (2008, Health Economics, Example 4.2). The author suggests that there is a relation with Rabin’s calibration theorem. %}

Schechter, Laura (2007) “Risk Aversion and Expected-Utility Theory: A Calibration Exercise,” *Journal of Risk and Uncertainty* 35, 67–76.

{% Empirical tests of bargaining solutions %}

Schellenberg, James A. (1988) “A Comparative Test of Three Models for Solving ‘The Bargaining Problem’,” *Behavioral Science* 33, 81–96.

{% %}

Schelling, Thomas C. (1968) “The Life You Save May be Your Own.” *In* Samuel B. Chase jr., (ed.) *Problems in Public Expenditure Analysis*, 127–162, Brookings Institution, Washington DC.

{% %}

Schelling, Thomas C. (1978) “Egonomics, or the Art of Self-Management,” *American Economic Review* 68, 290–294.

{% **DC = stationarity**; p. 6: different selves compete for command.
favors resolute choice: p. 1 1st para of Section I favors the McClennen-Machina approach of going for prior commitment.
P. 4 end of 1st para shows the different views on gender differences of those days:
“useless outcries and womanish lamentations.” %}

Schelling, Thomas C. (1984) "Self-Command in Practice, in Policy, and in a Theory of Rational Choice," *American Economic Review, Papers and Proceedings* 74, 1–11.

{% %}

Schelling, Thomas C. (1984) "*Choice and Consequence; Perspectives of an Errant Economist.*" Harvard University Press, Cambridge, MA.

{% %}

Schelling, Thomas C. (1988) "The Mind as a Consuming Organ." *In* David E. Bell, Howard Raiffa, & Amos Tversky (1988, eds.) "*Decision Making, Descriptive, Normative, and Prescriptive Interactions*," 343–357, Cambridge University Press, Cambridge.

{% "A. Lee" below should probably be Allison Lee Thoeny

r**eal incentives/hypothetical choice, for time preferences**: seems to be on it %}

Scheres, Anouk, Lee, A., & Motofuni Sumiya (2008) "Temporal Reward Discounting and ADHD: Task and Symptom Specific Effects," *Journal of Neural Transmission* 115, 221–226. https://doi.org/10.1007/s00702-007-0813-6

{% r**eal incentives/hypothetical choice, for time preferences**: seems to be on it %}

Scheres, Anouk, Motofuni Sumiya, & Allison L. Thoeny (2010) "Studying the Relation between Temporal Reward Discounting Tasks Used in Populations with ADHD: A Factor Analysis," *International Journal of Methods in Psychiatric Research* 19, 167–176. https://doi.org/10.1002/mpr.309

{% **foundations of statistics**; considers p-value for H_0 that is a continuum %}

Schervish, Mark J. (1996) "*P* Values: What They Are and What They Are Not," *American Statistician* 50, 203–206.

{% Seem to generalize Schervish, Seidenfeld, & Kadane (1995, Annals of Statistics) by considering choice functions rather than binary relations. %}

Schervish, Mark J. & Teddy Seidenfeld (2010) “Coherent Choice Functions under Uncertainty,” *Synthese* 172, 157–176.

{% **state-dependent utility**; §5 shows how Savage’s **small worlds** in fact reduce to state-dependent expected utility. %}

Schervish, Mark J., Teddy Seidenfeld, & Joseph B. Kadane (1990) “State-Dependent Utilities,” *Journal of the American Statistical Association* 85, 840–847.

{% **state-dependent utility**

When do aggregated state-dependent SEU models of agents give SEU model for group? Almost always they turn out to be state-independent. They do this for Anscombe -Aumann framework. Research question: how about tradeoff consistency agents? %}

Schervish, Mark J., Teddy Seidenfeld, & Joseph B. Kadane (1991) “Shared Preferences and State-Dependent Utilities,” *Management Science* 37, 1575–1589.

{% From Seidenfeld’s email: seems to use a (not-necessarily convex) set S of pairs of probabilities and utilities (p, u), with the criterion that horse-lottery1 is strictly preferred to horse-lottery2 iff the former has greater expected utility than the latter for each probability-utility pair (p,u) in the set S. %}

Schervish, Mark J., Teddy Seidenfeld, & Joseph B. Kadane (1995) “A Representation of Partially Ordered Preferences,” *Annals of Statistics* 23, 2168–2217.

{% %}

Schervish, Mark J., Teddy Seidenfeld, & Joseph B. Kadane (2000) “How Sets of Coherent Probabilities May Serve as Models for Degrees of Incoherence,” *International Journal of Uncertainty, Fuzziness and Knowledge-Based Systems* 8, 347–355.

{% Variations on Levi’s E-admissibility. %}

Schervish, Mark J., Teddy Seidenfeld, & Joseph B. Kadane (2009) “Self Knowledge, Uncertainty and Choice,” *Synthese* 172, 157–176.

{% De Finetti (1974) showed that coherence à la Dutch book and in proper scoring rules is equivalent for the quadratic scoring rule. This paper generalizes this to a number of other scoring rules. %}

Schervish, Mark J., Teddy Seidenfeld, & Joseph B. Kadane (2009) "Proper Scoring Rules, Dominated Forecasts, and Coherence," *Decision Analysis* 6, 202–221.

{% **Dutch book**: Various stricter and less strict dominance conditions are considered, and infinitely many fair prices. Appendix A gives a convenient discussion of integration w.r.t. finitely additive measures. %}

Schervish, Mark J., Teddy Seidenfeld, & Joseph B. Kadane (2014) "Dominating Countably Many Forecasts," *Annals of Statistics* 42, 728–756.

{% **free will/determinism** %}

Schick, Fredrick (1979) "Self Knowledge, Uncertainty and Choice," *British Journal for the Philosophy of Science* 30, 235–252.

{% **Dutch book**; seems to show that nonEU can lead to dynamic inconsistency. %}

Schick, Fredrick (1986) "Dutch Bookies and Money Pumps," *Journal of Philosophy* 83, 112–119.

{% Compare Bayesian hierarchical estimation, where parameter estimations of one subject are influenced by data of others (meta-population), with estimations strictly at the individual level. Do predictive exercise, with choices repeated at a later time. Bayesian hierarchical estimation is more stable, and predicts better according to one, but not to two other, criteria. They do it for PT and Birnbaum's TAX. For PT take power utility and Goldstein-Einhorn (1987) weighting family. They take the same utility power for gains and losses, but allow sign-dependence of probability weighting. Table 1 gives the parameter estimates, with utility power $\alpha = 0.54$, loss aversion only 1.2, *inverse S the same for gains and losses nicely supporting its cognitive interpretation*. (**cognitive ability related to likelihood insensitivity (= inverse S)**) Strangely enough, elevation much higher for losses than for gains.

Fortunately, the authors use the term sensitivity both for probability weighting and utility curvature.

Unfortunately, they did not implement the outcomes as described, but divided them by a factor not specified on p. 395. The choice error and utility elevation parameters interacted strongly, which can be understood from the Luce-error model used. %}

Scheibehenne, Benjamin & Thorsten Pachur (2015) "Using Bayesian Hierarchical Parameter Estimation to Assess the Generalizability of Cognitive Models of Choice," *Psychonomic Bulletin and Review* 22, 391–407. https://doi.org/10.3758/s13423-014-0684-4

{% %}

Schiereck, Dirk, Werner DeBondt, & Martin Weber (1999) "Contrarian and Momentum Strategies in Germany," *Financial Analyst Journal* 6, 104–116.

{% On bipolar scales. %}

Schimmack, Ulrich (2001) "Pleasure, Displeasure, and Mixed Feelings: Are Semantic Opposites Mutually Exclusive?," *Cognition and Emotion* 15, 81–97.

{% Anscombe-Aumann framework; null events versus unawareness. %}

Schipper, Burkhard C. (2013) "Awareness-Dependent Subjective Expected Utility," *International Journal of Game Theory* 42, 725–753.

{% An agent observes repeated trials from an exchangeable process (iid but with unknown probabilities). This paper looks at observations of properties never observed before. It uses Carnap's formulas of induction (i.e., Bayesian updating with beta priors) and variations. Properties never observed is important in biology for species never observed before, and in anonimity protection of data files for the probability of a unique (so, very identifiable) subject showing up. It is also related to reversed Baysianism of Karni & Vierø (2013). %}

Schipper, Burkhard C. (2024) "Predicting the Unpredictable under Subjective Expected Utility," working paper.

{% Proper scoring rules and matching probabilities have been used to measure beliefs (subjective probabilities). These two methods can be used for one-off events of whom we can only observe whether or not they happen, and sometimes even without that (Prelec 2004). But these methods are not very easy to understand for subjects. This paper considers cases where way more information is available: the events have objective probabilities already known to the experimenter. For instance, they concern the proportion of white balls in an urn, or, as in the experiment in this paper, the number of subjects in an experiment on the stag hunt game that chose to be selfish. The experimenter wants to measure the subjective probabilities of subjects who do not yet know the objective probabilities. Then other measurement methods, using different reward systems, become available. This paper considers what is called the frequency method. Subjects receive a reward if their guess is fully correct, and nothing otherwise. So, it is a kind of guessing game. It can be considered to be a special case of calibration.

Pro of the frequency method is that it is easier to understand for subjects than the above two methods. Besides the big con of restricted applicability, another con is that the method is not really incentive compatible: Assume Bayesianism beliefs with a 2nd order subjective probability distribution over the frequency to be estimated. Optimal in this method is to take the *modus* of the 2nd order distribution, whereas the subjective belief is the mean. In practice, these will often agree.) As for the restricted applicability, belief measurements are often used if the experimenter wants to learn from the subject (e.g., an expert). The frequency method cannot be used then.

The writing of the paper is sometimes misleading. Whereas the first two lines of the abstract properly write that the frequency method needs (way!) more info than other methods, many parts, including the whole discussion-conclusion §6, never mentions this restriction, suggesting that the frequency method is on a par with other methods regarding applicability. %}

Schlag, Karl & James Tremewan (2021) “Simple Belief Elicitation: An Experimental Evaluation,” *Journal of Risk and Uncertainty* 62, 137–155. https://doi.org/10.1007/s11166-021-09349-6

{% **survey on belief measurement**; p. 463 footnote 5 suggests that the logarithmic proper scoring rule is the only one that is proper for more than two events, with payment for any event depending only on that event (locality), although the footnote seems to consider only two events where it is not only the logarithmic function. The authors suggest that this result is hard to find in the literature. On the basis of this footnote I asked some people if they know about proofs in the literature. In the end, Jingni Yang found a general proof in Savage (1971 §9.4).

P. 465 Proposition 1: For every proper scoring rule different than quadratic there is a distribution where quadratic gives better incentives to tell truth. So, in a way, quadratic is not Pareto inferior.

P. 469 2nd para suggests that Offerman et al. (2009) could only handle probabilistic sophistication, but this is not so. Offerman et al. consider as Case 3 probabilistic sophistication, and then Case 4 as its generalization where probabilistic sophistication need no more hold, and they also handle that case. Weele (12Oct2015, email) explained to me that the text here is ambiguous. They had meant this text to refer back only to §2.4.3, which is about probabilistic sophistication, and did not mean to suggest that Offerman et al. cannot handle probabilistic sophistication.

The authors point out several times, e.g. p. 473 top, that we have no gold standard of true subjective beliefs usually.

§4.1 discusses how belief elicitation can distort decision making to be measured later. %}

Schlag, Karl H., James Tremewan, & Joël J. van der Weele (2015) “A Penny for Your Thoughts: A Survey of Methods for Eliciting Beliefs,” *Experimental Economics* 18, 457–490.

{% **probability elicitation**: Consider proper scoring rules when paying in probability of winning a prize and then show that one can easily elicit quantiles and moments. They assume expected utility in this. Similar is Hossain & Okui (2013). %}

Schlag, Karl H. & Joël J. van der Weele (2013) “Eliciting Probabilities, Means, Medians, Variances and Covariances without Assuming Risk Neutrality,” *Theoretical Economics Letters* 3, 38–42.
http://dx.doi.org/10.4236/tel.2013.31006

{% An expert should provide an interval estimate of a variable. He should be off (true variable outside estimated interval) no more than 1-gamma times, which can encourage him to take the interval large. However, given the restriction, he gets rewarded for taking the interval as tight as possible. It is obvious that the expert will choose a threshold and incorporate all values with probability density exceeding the threshold. Question is how to make him choose the right threshold, giving probability gamma. A most likely interval rewarding formula is proposed (p. 458). The purpose is that, as long as the expert's subjective probability of an interval stated is smaller than gamma, it pays to enlarge, and when it is bigger than gamma, it pays to reduce. In the optimum, the first-order condition should imply a probability gamma. The result holds under EU where utility is concave (or linear). A question is why the criterion to have exactly subjective probability gamma (in the spirit of classical statistical hypothesis testing, a theory not respected by me I must say). Section 4 gives examples. %}

Schlag, Karl H. & Joël J. van der Weele (2015) "A Method to Elicit Beliefs as Most Likely Intervals," *Judgment and Decision Making* 10, 456–468.

{% **value of information**: seems to be the first to present the value of information under EU, if not we give priority to Ramsey (1990) who at least demonstrated that the value of info is nonnegative under EU. %}

Schlaifer, Robert O. (1959) "*Probability and Statistics for Business Decisions: An Introduction to Managerial Economics under Uncertainty*." McGraw-Hill, New York.

{% **substitution-derivation of EU**: §4.4.5 shows how SEU follows from decision tree principles (where end-point outcomes are replaced by lotteries between highest and lowest outcome). %}

Schlaifer, Robert O. (1969) "*Analysis of Decisions under Uncertainty*." McGraw-Hill, New York.

{% **utility families parametric** %}

Schlaifer, Robert O. (1971) "*Computer Programs for Elementary Decision Analysis.*" Division of Research, Graduate School of Business Administration, Harvard University, Boston.

{% **information aversion** %}

Schlee, Edward E. (1990) "The Value of Information in Anticipated Utility Theory," *Journal of Risk and Uncertainty* 3, 83–92.

{% risk aversion %}

Schlee, Edward E. (1990) "Multivariate Risk Aversion and Consumer Choice," *International Economic Review* 31, 737–745.

{% %}

Schlee, Edward E. (1992) "Marshall, Jevons, and the Development of the Expected Utility Hypothesis," *History of Political Economy* 24, 729–744.

{% **information aversion** %}

Schlee, Edward E. (1997) "The Sure Thing Principle and the Value of Information," *Theory and Decision* 42, 21–36; correction see Schlee, Edward E. (1998) "The Sure-Thing Principle and the Value of Information: Corrigenda," *Theory and Decision* 45, 199–200.

{% **information aversion**. He points out that such an aversion is obvious if the information becomes public, e.g. in insurance. %}

Schlee, Edward E. (2001) "The Value of Information in Efficient Risk Sharing Arrangements," *American Economic Review* 91, 509–524.

{% Five studies on probability weighting under prospect theory. The authors consider the theory that subjects divide the [0,1] domain into categories, and are extra sensitive at the boundaries of categories. For instance, there can be categories [0, 0.1), [0.1, 0.2), …, [0.9, 1] where the weighting function has jumps at $j \times 0.1$. They find it in many data sets, with categories depending on context. %}

Schley, Dan, Alina Ferecatu, Hang-Yee Chan, & Manissa Gunadi (2023) “How Categorization Shapes the Probability Weighting Function,” working paper.

{% **cognitive ability related to risk/ambiguity aversion**: seems that they find more probability weighting and framing-dependence for low numerate subjects. %}
Schley, Dan R. & Ellen Peters (2014) “Assessing “Economic Value” Symbolic-Number Mappings Predict Risky and Riskless Valuations,” *Psychological Science* 25, 753–761.
https://doi.org/10.1177/0956797613515485

{% %}
Schliesser, Eric (2005) “Galilean Reflections on Milton Friedman’s “Methodology of Positive Economics,” with Thoughts on Vernon Smith’s “Economics in the Laboratory” ,” *Philosophy of the Social Sciences* 35, 50–74.

{% **free will/determinism**: criticizes Libet’s work for not really operationalizing free will. %}
Schlosser, Markus E. (2014) “The Neuroscientific Study of Free Will: A Diagnosis of the Controversy,” *Synthese* 191, 245–262.

{% %}
Schmeidler, David (1969) “The Nucleolus of a Characteristic Function Game,” *SIAM Journal of Applied Mathematics* 17, 1163–1170.

{% Shows: Assume connected topological space, with binary relation that is transitive, has weakly preferred and weakly dispreferred sets closed, and strictly preferred and strictly dispreferred sets open. Then the binary relation must be complete. Many generalizations are in Khan & Uyanik (2021). %}
Schmeidler, David (1971) “A Condition for the Completeness of Partial Preference Relations,” *Econometrica* 39, 403–404.

{% Exact means that the capacity is the minimum of dominating probability measures. %}

Schmeidler, David (1972) "Cores of Exact Games," *Journal of Mathematical Analysis and Applications* 40, 214–225.

{% %}

Schmeidler, David (1982) "Subjective Probability without Additivity," Foerder Institut of Economic Research, Tel Aviv University, Tel Aviv, Israel. (Rewritten as Schmeidler, David (1984) "Subjective Probability and Expected Utility without Additivity." Caress working paper 84–21 (first part), University of Pennsylvania, Center for Analytic Research in Economics and the Social Sciences, Philadelphia, PA.)

{% %}

Schmeidler, David (1984) "Nonadditive Probabilities and Convex Games." Caress working paper 84–21 (second part), University of Pennsylvania, Center for Analytic Research in Economics and the Social Sciences, Philadelphia, PA.

{% Compare to Anger (1977). Propositions 1, 2, and 3 do not assume monotonicity. %}

Schmeidler, David (1986) "Integral Representation without Additivity," *Proceedings of the American Mathematical Society* 97, 255–261.

{% **biseparable utility**

event/outcome driven ambiguity model: event driven

my handwritten notebook p. 401;

Argues against prior probabilities of statistics, against probability sophistication; does not say clearly that for risk one should do EU, although comment 4.2, p. 586, argues normatively against probability transformation of RDU. Says nowhere clearly if capacity reflects only belief and not attitude towards belief, although some places do suggest it a bit.

P. 576 nicely points out that in Schmeidler's view, completeness is the most restrictive axiom: "Out of the seven axioms listed here the completeness of the preferences seems to me the most restrictive and most imposing assumption of the theory." (**completeness criticisms**)

Pp. 586-587 points out that his model can accommodate the co-existence of gambling and insurance.

A small mathematical problem is that the paper assumes only an algebra of events, but needs a sigma-algebra. The reason is that it assumes closedness with respect to the mixing of acts. As Wakker (1993 MOR, Example 1.2) shows, with an algebra of events the sum (or mixture) of two measurable acts need not be measurable. %}

Schmeidler, David (1989) "Subjective Probability and Expected Utility without Additivity," *Econometrica* 57, 571–587.
https://doi.org/10.2307/1911053

{% A philosophical and at time mystic text on limitations on decision theory research. %}

Schmeidler, David (2022) "Frames and Decisions under Uncertainty in Economics Theory," *Theory and Decision* 92, 759–764.
https://doi.org/10.1007/s11238-021-09832-1

{% %}

Schmeidler, David & Karl Vind (1972) "Fair Net Trades," *Econometrica* 40, 637–642.

{% %}

Schmeidler, David & Peter P. Wakker (1987) "Expected Utility and Mathematical Expectation." *In* John Eatwell, Murray Milgate, & Peter K. Newman (eds.) *The New Palgrave: A Dictionary of Economics*, Vol. 2, 229–232, The MacMillan Press, London.
Direct link to paper
Link to 1990 reprint with repagination and nicer layout

{% %}

Schmeidler, David & Peter P. Wakker (1990) "Expected Utility and Mathematical Expectation." *In* John Eatwell, Murray Milgate, & Peter K. Newman (eds.) *Utility and Probability. The New Palgrave*, 70–78, The MacMillan Press, London.
This is a reprint of Schmeidler & Wakker (1987).

Direct link to paper

{% Show that high-variance gamble is preferred to low-variance gamble in both choice and minimum selling price when evaluated separately, but low-variance are when evaluated jointly. How they implemented choice in separate evaluation I did not check out. So, contrast effects do much. %}

Schmeltzer, Christophe, Jean-Paul Caverni, & Massimo Warglien (2004) "How Does Preference Reversal Appear and Disappear? Effects of the Evaluation Mode," *Journal of Behavioral Decision Making* 17, 395–408.

{% **random incentive system**: show that more risk seeking if paying both of two lottery choices than if paying by RIS. %}

Schmidt, Barbara & Johannes Hewig (2015) "Paying Out One or All Trials: A Behavioral Economic Evaluation of Payment Methods in a Prototypical Risky Decision Study," *Psychological Record* 65, 245–250.

{% Mixing bets are sort of two-stage bets using Seltens observation that with only two prizes, utility does not play a role. Mixing intervals give probability intervals, whose indpoint is taken as ambiguity neutral. The paper gives a detailed theoretical analysis, and data, to separate ambiguity attitude, perception and a-neutral probabilities. %}

Schmidt, Patrick (2025) "Eliciting Ambiguity with Mixing Bets," *American Economic Journal: Microeconomics* 17, 354–388. https://doi.org/10.1257/mic.20220370

{% %}

Schmidt, Ulrich (1996) "Demand for Coinsurance and Bilateral Risk-Sharing with Rank-Dependent Utility," *Risk Decision and Policy* 1, 217–228.

{% Takes vNM EU with utility u only for risky lotteries, for riskless lotteries an alternative function v instead of u is used. If v≠u, then necessarily, stochastic dominance is violated. This is a correct version of what Gafni et al. tried to do but

couldn’t because they thought to follow EU everywhere, not being aware that everywhere includes also riskless lotteries. %}

Schmidt, Ulrich (1998) “A Measurement of the Certainty Effect,” *Journal of Mathematical Psychology* 42, 32–47.

{% This paper presents some trivial results. It describes some probability weighting functions and observes that certainty effect models can be described through these probability transformations. %}

Schmidt, Ulrich (2000) “The Certainty Effect and Boundary Effects with Transformed Probabilities,” *Economics Letters* 67, 29–33.

{% %}

Schmidt, Ulrich (2001) “Lottery Dependent Utility: A Reexamination,” *Theory and Decision* 50, 35–58.

{% **tradeoff method**: used theoretically, both for outcomes and for decision weights.

This paper is the first to study prospect theory with varying status quo. It gives preference conditions for all kinds of relations between weighting functions and value functions corresponding with different status quos. %}

Schmidt, Ulrich (2003) “Reference Dependence in Cumulative Prospect Theory,” *Journal of Mathematical Psychology* 47, 122–131.

{% **survey on nonEU** %}

Schmidt, Ulrich (2004) “Alternatives to Expected Utility: Some Formal Theories.” *In* Salvador Barberà, Peter J. Hammond, & Christian Seidl (eds.) *Handbook of Utility Theory II*, Ch. 15, 757–838, Kluwer Academic Publishers, Dordrecht.

{% Uses prospect theory to analyze insurance. Considers two reference points, being prior or posterior position, and finds that mostly people either take full insurance or no insurance at all. %}

Schmidt, Ulrich (2016) “Insurance Demand under Prospect Theory: A Graphical Analysis,” *Journal of Risk and Insurance* 83, 77–89.

{% **error theory for risky choice** %}

Schmidt, Ulrich & John D. Hey (2004) "Are Preference Reversals Errors? An Experimental Investigation," *Journal of Risk and Uncertainty* 29, 207–218.

{% N = 24 subjects. Those with many choice inconsistencies have more violations of EU than those with few for 14 risky Allais-type pairs of choices, but it is opposite for one 3-color Ellsberg type choice. This suggests that in the risky Allais-type choices the percentage violating EU was always below 50%, and in the Ellsberg it was above 50%. This is in agreement with the finding in the literature that for moderate payments (between 0 and 40 pounds in this paper) the Allais effect is not very strong. %}

Schmidt, Ulrich & Tibor Neugebauer (2007) "Testing Expected Utility in the Presence of Errors," *Economic Journal* 117, 470–485.

{% They take prospect theory where the reference outcome need not be constant, but can depend on the state of nature, as in Sugden (2003, JET). Then they consider preference reversals such as a P-prospect (0.97:$4) versus a $-prospect (0.31:$16). They do not consider straight certainty equivalent determination from ping-pong choices for instance, but only WTA: The subject is first endowed with the prospect, can focus on this as reference outcome (not constant, of course), and then evaluates giving up the $-prospect for a sure amount x as a (0.97: −$4+x, 0.03:x), and the P-prospect as (0.31:−$16+x, 0.69:x). They then show that under usual Tversky & Kahneman (1992) parametrizations of PT, preference reversals are accommodated. They, finally, add numerical calculations of which parameter combinations can accommodate preference reversals, and numerical analyses of which parameter combinations of PT generate preference reversals. %}

Schmidt, Ulrich, Chris Starmer, & Robert Sugden (2008) "Third-Generation Prospect Theory," *Journal of Risk and Uncertainty* 36, 203–223.

{% Test loss aversion preference condition of Tversky & Wakker (1993), nicely made tractable through loss aversion premiums characterized in Theorem 1 (absolute premium) and Theorem 3 (relative premium). It is, then, the first parameter-free test of loss aversion. Their findings on loss aversion and gain seeking (I use "gain seeking" as the opposite of "loss aversion") depend much on the criteria that they used to classify subjects, the power it has, and the noise in the data, as they mention on p. 244.

The authors find about as many subjects classified as loss averse as as gain seeking, but those that are loss averse are more extremely so than those that are gain seeking. This could contribute to loss aversion being found at aggregate levels. They found considerably more frequent, and extreme, loss aversion for women than for men (**gender differences in risk attitudes**). This study does suggest that loss aversion is more volatile and less universal than sometimes thought. %}

Schmidt, Ulrich & Stefan Traub (2002) "An Experimental Test of Loss Aversion," *Journal of Risk and Uncertainty* 25, 233–249.

{% **coalescing**; **dynamic consistency**: Test dynamic principles that imply independence. Isolate coalescing from RCLA and find that coalescing is violated, but compound independence and RCLA are not. P. 335 last para explains both aversion to and preference for complexity. %}

Schmidt, Ulrich & Christian Seidl (2014) "Reconsidering the Common Ratio Effect: The Roles of Compound Independence, Reduction, and Coalescing," *Theory and Decision* 77, 323–339.
https://doi.org/10.1007/s11238-014-9456-x

{% Endowing subjects with the highest prize of the lottery reverses the income effect of the WTP-WTA discrepancy, but does not affect it much, further illustrating that the income effect cannot explain the discrepancy. The discrepancy is reduced when background risk is added, which could be used to improve the measurements. They used a small sample, N = 24. %}

Schmidt, Ulrich & Stefan Traub (2009) "An Experimental Investigation of the Disparity between WTA and WTP for Lotteries," *Theory and Decision* 66, 229–262.

{% N = 24 subjects. Do binary choice, WTA (although only by asking subjects to imagine that they possess prospect), and WTP (where right before subjects get endowed with maximum prize). Test common consequence effect, away from certainty effect. Find no real violations for choice, but do, and then as fanning out (less risk aversion if better prospects), for WTA and WTP. Point out that testing common consequence effect for pricing such as WTA and WTP has (almost) never been done before. %}

Schmidt, Ulrich & Stefan T. Trautmann (2014) “Common Consequence Effects in Pricing and Choice,” *Theory and Decision* 76, 1–7.

{% Derive PT with linear utility with kink at zero from cosigned comonotonic additivity (nicely called independence of common increments), generalizing Chateauneuf (1991) to PT. %}

Schmidt, Ulrich & Horst Zank (2001) “An Axiomatization of Linear Cumulative Prospect Theory with Applications to Portfolio Selection and Insurance Demand,” School of Economic Studies, The University of Manchester.

{% **tradeoff method** %}

Schmidt, Ulrich & Horst Zank (2001) “A New Axiomatization of Rank-Dependent Expected Utility with Tradeoff Consistency for Equally Likely Outcomes,” *Journal of Mathematical Economics* 35, 483–491.

{% Derive PT with linear utility with kink at zero from cosigned comonotonic additivity (nicely called independence of common increments), generalizing Chateauneuf (1991) to PT. %}

Schmidt, Ulrich & Horst Zank (2001) “An Axiomatization of Linear Cumulative Prospect Theory with Applications to Portfolio Selection and Insurance Demand,” School of Economic Studies, The University of Manchester.

{% Define weak loss aversion as $y_{0.5}(-y) >' x_{0.5}(-x)$ ($>'$ denotes strict preference) whenever $x > y \geq 0$ (Kahneman & Tversky, 1979, p. 279), and strong loss aversion as $\alpha y + \alpha(-y) + (1-2\alpha)P >' \alpha x + \alpha(-x) + (1-2\alpha)P$ whenever $x > y \geq 0$, where α is a probability, x and y are degenerate prospects, the mixing is probabilistically, and the outcomes x and y have the same rank in both mixtures, and so do –x and –y. Under EU and OPT (’79 prospect theory) these conditions are equivalent to utility differences for losses exceeding those for gains. Under ’92 PT (CPT), an equality comes in with ratios of weighting functions.

SPT instead of OPT: they do this for general lotteries in Eq. 2.

Authors plead strongly for a definition of loss aversion entirely in terms of preferences, and not in terms of theory-dependent concepts such as utility.

P. 164 para –3: For probability weighting functions that are “too steep” at zero, the loss-aversion condition of the authors cannot be satisfied. The authors write that such weighting functions are unreasonable. %}

Schmidt, Ulrich & Horst Zank (2005) “What is Loss Aversion?,” *Journal of Risk and Uncertainty* 30, 157–167.

{% Characterize PT with linear utility for risk. They properly assign priority to a 2002 version of Schmidt & Zank (2009) that appeared later but was written earlier.

RDU with linear utility has been characterized by Chateauneuf (1991, JME), De Waegenaere & Wakker (2001), and Diecidue & Wakker (2002). This paper extends sign dependence to those results. %}

Schmidt, Ulrich & Horst Zank (2007) “Linear Cumulative Prospect Theory with Applications to Portfolio Selection and Insurance Demand,” *Decisions in Economics and Finance* 30, 1–18.

{% Study strong risk aversion under prospect theory. Holds iff:

(i) For gains, U concave and w+ convex;

(ii) For losses, U concave and w- concave (or convex if you do, like they do, top-bottom instead of the conventional bottom-up integration for losses);

(iii) The ratio of the left- and right-derivatives of utility at zero should exceed w+´(p)/w-´(p) (w+ weighting for gains, w- for losses) at each p in (0,1).

Here, (i) and (ii) are like Chew, Karni, & Safra (1987), but, very nice, they don’t use differentiability. This is desirable because there is no easy preference condition to give differentiability. (iii) is an entirely new thing. Utility can be linear for gains and losses, strictly convex at zero, if probability weightings are accordingly, in particular have appropriate jump(s) at 1. %}

Schmidt, Ulrich & Horst Zank (2008) “Risk Aversion in Cumulative Prospect Theory,” *Management Science* 54, 208–216.

{% Characterize PT with linear utility for uncertainty through a rank-sign weakening of additivity. Although this paper appeared later than Schmidt & Zank (2007), it preceded it in writing and Schmidt & Zank (2007) properly assign priority to this paper. RDU with linear utility has been characterized by Chateauneuf (1991, JME), De Waegenaere & Wakker (2001), and Diecidue & Wakker (2002). This paper extends sign dependence to those results. First consider only finite state space with nonnull states (at least three of them) and strictly increasing linear utility. Then do general state space with null-invariance (being nonnull for one rank-ordering and sign then for all) where they handle all bounded prospects using supnorm continuity. They use a theorem of Chew & Wakker (1993) to obtain their result.

In their integration for losses, they (unfortunately!) do top-down integration instead of the bottom-up integration that was used by Tversky & Kahneman (1992) and that is conventional. %}

Schmidt, Ulrich & Horst Zank (2009) "A Simple Model of Cumulative Prospect Theory," *Journal of Mathematical Economics* 45, 308–319.

{% **tradeoff method**: used theoretically.

Big issue in PT is what the reference point can be. Many want to derive it endogenously. This paper does so, by taking it as the inflection point of utility. The essential condition, constant diminishing sensitivity (p. 104) is nice: For every outcome, either there should be consistent concavity above (if it is a gain) or consistent convexity below (if it is a loss). It is formulated such that it also implies PT by a kind of implied tradeoff consistency (Theorem 1, p. 106). If there are outcomes of both kind, then their strict inequality conditions imply that there is one unique outcome that is of both kinds: this is the reference point.

They also present a more general condition (one-sided comonotonic tradeoff consistency, p. 107), which does not commit to concave or convex, but only requires that for each outcome either the utility standard sequences are consistent above this outcome (then it is a gain) or below (then it is a loss). They again state it in such a manner that it automatically implies PT, by capturing a kind of tradeoff consistency (Theorem 2, p. 108). Very nice! Would be nice to derive it from loss aversion, which the authors state as an important topic for future research. %}

Schmidt, Ulrich & Horst Zank (2012) "A Genuine Foundation of Prospect Theory," *Journal of Risk and Uncertainty* 42, 97–113.

{% **risky utility u = transform of strength of preference v**:
Consider decision under risk with simple lotteries over money. The authors consider a functional

$(p_1{:}x_1,\ldots,pn{:}x_n) \mapsto V(x_1) + p_2U(x_2-x_1) + \cdots + p_nU(x_n-x_1)$ (for x_1 the minimal outcome), and call it chance theory. Here V can be interpreted as a riskless utility function and U as a risky utility function. (**risky utility u = transform of strength of preference v**) Unlike utility of gambling models, chance utilitydoes not violate basic conditions such as monotonicity or transitivity. It can accommodate paradoxes such as Allais and Rabin.

If we increase x by a small $\varepsilon > 0$, so that it remains the minimal outcome then the functional gains

$V(x+\varepsilon)-V(x)$

but also loses

$P(E_2)\big(U(x_2-x_1+\varepsilon)-U(x_2-x_1)\big) + \cdots + P(E_2)\big(U(x_n-x_1+\varepsilon)-U(x_n-x_1)\big)$

Taking p_1 very small we see that, to satisfy monotonicity, $V'(x_1)$ should not be smaller than $U'(y)$ for any $y \geq 0$. V' exceeding U´ ever ywhere (U can only have positive arguments) means that lowest outcomes get overweighted. Proposition 1 shows that the functional satisfies weak risk aversion.

The authors provide a preference foundation and comparative results.

Because of the deviating treatment of $x_2,\ldots,x_n$, chance theory only overlaps EU in expected value.

In some places, the authors put up as motivation for the different treatment of the minimal outcome that one can be sure about that from the start whereas other uncertainties may get resolved later and there may be intermediate decisions to be taken, where one can already reckon on the minimal outcome but not yet on the other outcomes. But I think that this deviates too much from the basic decision model and I therefore prefer different motivations.

The functional, and its treatment of $x_2,\ldots,x_n$, is VERY reminiscent of the formula for prospect theory for many outcomes in the working paper Kahneman & Tversky (1975), which also gives a similar special place to the minimal outcome (for gains).

Kahneman and Tversky later replaced utility of difference by difference of utility in their published 1979 paper, thus extending to general not-real-valued outcomes. It is very natural to, similarly, replace chance theory by

$(p_1{:}x_1,\ldots,pn{:}x_n) \mapsto V(x_1) + p_2\big(U(x_2)-U(x_1)\big) + \cdots + p_n\big(U(x_n)-U(x_1)\big)$ (for x_1 minimal). %}

Schmidt, Ulrich & Horst Zank (2022) "Chance Theory: A Separation of Riskless and Risky Utility," *Journal of Risk and Uncertainty* 65, 1–32. https://doi.org/10.1007/s11166-022-09385-w

{% **EU+a*sup+b*inf**; They vary upon this model by dropping the a-worst part of the distribution and the b-best part of the distribution, and then overweighting what is minimal and maximal. %}

Schmidt, Ulrich & Alexander Zimper (2007) "Security and Potential Level Preferences with Thresholds," *Journal of Mathematical Psychology* 51, 279–289.

{% **time preference**; do not explicitly relate preference for increasing/decreasing to violations of monotonicity. %}

Schmitt, David R. & Theorore D. Kemper (1996) "Preference for Different Sequences of Increasing and Decreasing Rewards," *Organizational Behavior and Human Decision Processes* 66, 89–101.

{% %}

Schmittlein, David C., Jinho Kim, & Donald G. Morrison (1990) "Combining Forecasts: Operational Adjustments to Theoretically Optimal Rules," *Management Science* 36, 1044–1056.

{% **suspicion under ambiguity**: He pointed this out and provides simple game-theoretic analysis leading to maxmin. The final sentence of the abstract is:

"If one adopts the view-point that the Savage axioms only apply to decisions under an uncertain but indifferent world, and not to decisions made in game-like situations with a rational opponent, then the results of Ellsberg's experiment cannot be considered as evidence against the rationality of the Savage axioms." (**game theory can/cannot be viewed as decision under uncertainty**) %}

Schneeweiss, Hans (1973) "The Ellsberg Paradox from the Point of View of Game Theory," *Inference and Decision* 1, 65–78.

{% **criticism of monotonicity in Anscombe-Aumann (1963) for ambiguity**: **updating under ambiguity with sampling**; Consider Anscombe-Aumann framework. Under probabilistic sophistication, independence for risky choice becomes equivalent to monotonicity and SEU. An experiment shows that monotonicity is violated in a systematic direction by half the subjects, and this is strongly correlated with just violating independence in the regular Allais paradox. The experiment considers the common consequence version of Allais' paradox. With M denoting $\$10^6$, the conditional choice is between M on balls 1-11 versus 5M on balls 2-11 and 0M on ball 1.

- First they do the regular Allais paradox, where there are 89 other balls in the same urn (so, it has 100 balls in total), and in one choice situation the common consequence is 1M under these balls so that the certainty effect comes in, and in the other situation one receives 0M under these balls, so, no certainty effect.
- Then they do an uncertainty version. There are no more than the 11 balls in the urn. But now a horse race takes place, with 100 symmetric horses. In both situations the conditional choice is only if horse 1-11 wins the race. The conditional outcome on horses 12-100 is either 1M, so that the certainty effect comes in, or 0M, and then no certainty effect.

Under probabilistic sophistication (+ RCLA) the two choice situations should be identical. %}

Schneider, Florian H. & Martin Schonger (2019) "An Experimental Test of the Anscombe-Aumann Monotonicity Axiom," *Management Science* 65, 1667–1677. https://doi.org/10.1287/mnsc.2017.3010

{% **ranking economists** %}

Schneider, Friedrich & Heinrich W. Ursprung (2008) "The 2008 GEA Journal-Ranking for the Economics Profession," *German Economic Review* 9, 532–538.

{% The agent is a convex combination of a rational EU maximizing constant discounter and a prospect theory maximizing nonconstant discounter. The model can accommodate many anomalies. %}

Schneider, Mark (2018) “Dual Process Utility Theory: A Model of Decision under Risk and over Time,” working paper.

{% %}

Schneider, Mark & Jonathan W. Leland (2015) “Reference Dependence, Cooperation, and Coordination in Games,” *Judgement and Decision Making* 10, 123–129.

{% This paper considers violations of independence/sure-thing principle under different framings. In particular, a matrix frame that displays the common outcome in a salient manner, has fewer violations. The paper only cites some recent papers on this dependence on framing, but it has been known for decades. Wakker, Erev, & Weber (1994) mention it on top of p. 202, citing Keller (1985) and Erev, Bornstein, & Wallsten (1993) for it and, hence, using four different framings.

Here is another, old, argument: That subjects violate less in the matrix frame where the common outcome is clear, need not mean that their true preferences satisfy it, but it can also mean that subjects do it only as heuristic to simplify their task without this being their true preference. Unfortunately, I cannot give a reference now where this was stated, but it has been written long ago. I stated it for several years preceding 2019 in this annotated bibliography when commenting on the issue for p. 1267 of Bordalo, Gennaioli, & Shleifer (2012). I think that the point has also been discussed in the literature on regret theory (Starmer & Sugden 1998 find that the matrix representation better fits regret theory). Different, but similar in spirit, is the shaping hypothesis of Loomes, Starmer, & Sugden (2003). %}

Schneider, Mark, Jonathan W. Leland, & Nathaniel T. Wilcox (2018) “Ambiguity Framed,” *Journal of Risk and Uncertainty* 57, 133–151.

{% They study ambiguity in the Anscombe-Aumann framework. They propose a new ambiguity model that reminds me of Gul’s (1991) disappointment aversion model, although that is not cited. For an act, a separation is made between the bad states that have an outcome (is horse-race lottery) worse than the act itself (disappointment) and the good ones that have a better outcome (elation). Then the subjective probabilities (those are assumed in the model for the horses) of the bad states are overweighted by a factor 1+ρ, those of the good states are overweighted by a factor 1−ρ, and then there is renormalization; if my diagonal reading made me understand properly. Because objective probabilities are available, matching and calibration can be done. The main axiom, Axiom 6 (p. 28) requires existence of a ρ such that … and then recalibration with objective probabilities. The main point of the analysis is that unique subjective probabilities on the horses result, and this is interesting. It means that we have probabilistic sophistication within the horse race, and that it fits within the source method.

The model seems to satisfy Siniscalchi's Complementary independence (p. 28), which means that it cannot accommodate the empirically prevailing insensitivity or reflection. %}

Schneider, Mark A. & Manuel A. Nunez (2015) "A Simple Mean–Dispersion Model of Ambiguity Attitudes," *Journal of Mathematical Economics* 58, 25–31.

{% Hypothetical choice. Spillover effect: first experiencing losses increases risk seeking, and first experiencing gains increases risk aversion, the latter going against previous findings on house money effects as the authors indicate. %}

Schneider, Sandra, Sandra Kauffman & Andrea Ranieri (2016) "The Effects of Surrounding Positive and Negative Experiences on Risk Taking," *Judgment and Decision Making* 11, 424–440.

{% **SPT instead of OPT**: the paper never gives the formula used, but I am pretty sure that they used separable prospect theory instead of OPT.

N = 60; essentially hypothetical; gain- and loss questions were separated by a week. P. 541 1st column explains some of data analysis but I do not understand. The authors claim that for examining risk aversion, a value function must be specified, and they take 2/3 power for gains and 3/4 power for losses. This leaves me in the blue what their concept of risk aversion is. Some lines below it is written that they analyze risk aversion "if we ignore for the moment effects due to probability weighting" and again I have no clue what they are doing.

PT falsified: **risk averse for gains, risk seeking for losses**: seem to be risk neutral for losses; multioutcome lotteries; conclude that OPT does not do well. P. 546 first para and p. 548 last para say OPT is rejected. %}

Schneider, Sandra L. & Lola L. Lopes (1986) "Reflection in Preferences under Risk: Who and when May Suggest why," *Journal of Experimental Psychology: Human Perception and Performance* 12, 535–548. https://doi.org/10.1007/s11238-014-9456-x

{% Hegelian dialectic: thesis-antithesis-synthesis
Seems that Hegel attributed the terminology to Immanuel Kant. %}

Schnitker, Sarah A. & Robert A. Emmons (2013) "Hegel's Thesis-Antithesis-Synthesis Model." *In* Anne L.C. Runehov & Lluis Oviedo (eds.) *Encyclopedia of Sciences and Religions*, p. 978, Springer, Dordrecht.

{% Agents doing CAPM with a deviation measure can be described by having generalised mean-risk preferences with certain constraints on the utility function. %}

Schoch, Daniel (2017) "Generalised Mean-Risk Preferences," *Journal of Economic Theory* 168, 12–26.

{% Discusses history+basic references of certainty factors and the like. %}

Schocken, Shimon & Tim Finin (1990) "Meta-Interpreters for Rule-Based Inference under Uncertainty," *Decision Support Systems* 6, 165–181.

{% **risky utility u = transform of strength of preference v, latter doesn't exist**: Schoemaker is real strong on this (p. 533 bototom of 1st column), calling other things oversights.

P. 530 top of 2nd column: takes separate-outcome-probability-transformation model (separable prospect theory) as point of departure, does not seem to be aware that for normative purposes (stoch. dom.) this reduces to EU (e.g., p. 537).

P. 533 1st oclumn well distinguishes psychological and mathematical meaning of cardinal utility.

I disagree with several claims, for instane, p. 533 1/34 of 2nd column, that EU would automatically implicitly have to assume neo-additive utility. P. 535 2/3 of 1st column distinguishes between risky and riskless utility, which is like the distinction between elephant and non-elephant zoology. P. 537 3/4/5 of 1st column is not awarethat $\sum_{j=1}^{n} f(p_i) = 1$ implies that f is the identity. P. 543 ¾ of 2nd column writes that people are usually risk averse “particularly for losses.”

Volgens Marcel zegt ’ie that EU nice theorie is zonder relevantie voor realworld decision making

Table 1: S**EU = SEU**

P. 536 cites Burks (1977)!! However, only for describing unresolved philosophical problems in the area of probability.

P. 554 writes: “The failure to optimize appears to be cognitive (i.e., related to the way problems are structured and what decision strategies are used) rather than motivational (i.e., the amount of mental effort expended).” This is not the cognitive-motivational terminology that I use in interpreting probability weighting. It only concerns the mental effoft of subjects in experiments. %}

Schoemaker, Paul J.H. (1982) “The Expected Utility Model: Its Variations, Purposes, Evidence and Limitations,” *Journal of Economic Literature* 20, 529–563.

{% N > 200;

real incentives/hypothetical choice: P. 1455 etc.: Compares real choice to hypothetical choice with a large sample but finds no significant difference. Bit more risk aversion for real incentives, as is the common finding. More difference for losses than for gains.

concave utility for gains, convex utility for losses: Is found (p. 1453)

risk averse for gains, risk seeking for losses: is found (p. 1453). With much risk aversion for mixed.

reflection at individual level for risk: Is found (Table 1 second subtable; risk aversion for gains is combined with risk most seeking for losses (2/3) of cases, but risk seeking for gains is combined with same risk seeking as risk aversion for losses. P. 1454 2nd para gives statistics that confirm, althoughconcluding sentence p. 1455 ℓ. 2 says weak relation. Nicely, also considers correlations between gain- and loss risk aversion indexes. They are all weakly negative for gains and losses, CE (certainty equivalent; $\rho = -0.22$), CE ($\rho = -0.15$), OE (outcome equivalent) ($\rho = -0.38$). No p-values are given. %}

Schoemaker, Paul J.H. (1990) “Are Risk-Attitudes Related across Domains and Response Modes?,” *Management Science* 36, 1451–1463.

{% Para on pp. 2-3: S**EU = SEU**. The author seems to think that Chew's weighted utility and Savage's SEU both involve probability transformation, and that the difference is that for Savage the transformations still satisfy the axioms of probability and for weighted utility they do not. This is far from the truth. %}

Schoemaker, Paul J.H. (1992) "Subjective Expected Utility Theory Revisited: A Reduction ad Absurdem Paradox," *Theory and Decision* 36, 1–21.

{% **insurance frame increases risk aversion**: seem to find that presenting risky decisions in context of insurance enhances risk aversion. %}

Schoemaker, Paul J.H. & John C. Hershey (1979) "An Experimental Study of Insurance Decisions," *Journal of Risk and Insurance* 46, 603–618.

{% %}

Schokkaert, Erik & Bert Overlaet (1989) "Moral Intuitions and Economic Models of Distributive Justice," *Social Choice and Welfare* 6, 19–31.

{% **decreasing/increasing impatience**: find counter-evidence against the commonly assumed decreasing impatience and/or present effect.

Subadditive discounting: First discounting from t_1 to t_2, and then from t_2 to t_3, can be different, and usually bigger, than immediately from t_1 to t_3, as demonstrated in recent papers by Read and others. This paper refines for very small intervals, where it can be superadditive. %}

Scholten, Marc & Daniel Read (2006) "Discounting by Intervals: A Generalized Model of Intertemporal Choice," *Management Science* 52, 1424–1436.

{% **intertemporal separability criticized**: probably.

Propose an intertemporal choice model with attribute-based rather than alternative-based evaluations. (Terms explained in annotations at Scholten et al. (2024 Psychological Review). Tradeoffs are put central and basic separabilities are NOT assumed. Use this to accommodate all existing violations of discounted utility. %}

Scholten, Marc & Daniel Read (2010) "Intertemporal Tradeoffs," *Psychological Review* 117, 925–944.

{% Discuss Markowitz' (1952) 4-fold pattern with risk seeking for small gains and risk aversion for large gains, these things being reflected for losses. This can be reconciled with prospect theory if utility for large gains is sufficiently concave to overcome risk seeking induced by probability overweighting. They consider logarithmic utility ln (x + a), transformed properly. Drawback is that this function can only be concave for gains.

risky utility u = strength of preference v (or other riskless cardinal utility, often called value): they argue that their risky utility function is also suited for intertemporal choice. (**time preference: comparing risky and intertemporal utility**) %}

Scholten, Marc & Daniel Read (2014) "Prospect Theory and the "Forgotten" Fourfold Pattern of Risk Preferences," *Journal of Risk and Uncertainty* 48, 67–83.

{% **dominance violation by pref. for increasing income**: They seem to show that adding a small positive receipt before a delayed payment or adding a small positive delayed receipt after an immediate receipt makes subjects prefer it less, violating dominance. Seem to explain it by preference for improvement. May also be special effects of the 0 outcome in the spirit of Birnbaum, Coffey, Mellers, & Weiss (1992), something discussed by the authors. %}

Scholten, Marc & Daniel Read (2014) "Better is Worse, Worse Is Better: Violations of Dominance in Intertemporal Choice," *Decision* 1, 215–222.

{% **preferring streams of increasing income**: P. 1178 2nd colum 1st para writes that evidence is not clear. There is asymmetric hidden-zero effect: Assume indifference between small-soon large-late: (s:σ) ~ (ℓ:λ). If we point out to subjects that large-late means receiving nothing now, then preference goes to small-soon. But if we point out that small-soon means receiving nothing later, then preference is not affected.

The authors introduce a tradeoff model. Here at a timepoint not so much the utility of the amount received then, but the total cumulated instant utilities up to that point, matters. It is used to calculate some average cumulated amount, but also a sort of average duration, where the average of duration is taken weighted

by cumulated amount up to that point. Then pairs of average cumulated amount and average duration are evaluated, trading off one against the other. The model fits several empirical findings well, and also data. %}

Scholten, Marc, Daniel Read, & Adam Sanborn (2016) "Cumulative Weighing of Time in Intertemporal Tradeoffs," *Journal of Experimental Psychology: General* 145, 1177–1205.

{% Show that describing the outcome $0 as "losing nothing" or "gaining nothing" makes a difference. %}

Scholten, Marc, Daniel Read, & Neil Stewart (2019) "The Framing of Nothing and the Psychology of Choice," *Journal of Risk and Uncertainty* 59, 125–149.

{% The authors propose an intertemporal choice model with attribute-based rather than alternative-based evaluations, simpler and more comprehensive than a preceding model by Scholten & Read (2010) in this journal. Alternative-based evaluation means that each choice option is evaluated by aggregating over its attributes (independent of everything else), and a choice between two is determined by the one that received the higher evaluation. This is typical for transitivity, or unitary evaluation as Burks (1977) nicely called it. Attribute-based evaluation means that in a choice between two, first for each attribute comparisons are made, and then those are aggregated into an overall evaluation. This is typical of regret theory and may give violations of transitivity. The latter way of reasoning underlies the tradeoff method that I worked much on in young years. Tversky (1969) called the former approach horizontal and the latter vertical. The intro cites many papers using attribute-based evaluation for risk and time. The time bias is quite like the present bias, adapted to the new model. %}

Scholten, Marc, Daniel J. Walters, Craig R. Fox, & Daniel Read (2024) "The Unified Tradeoff Model," *Psychological Review* 131, 1007–1024. https://doi.org/10.1037/rev0000458

{% Psychologist at Pittsburg, uses term "verbal overshadowing" to indicate when decisions are better intuitive (e.g. **decision under stress**).

intuitive versus analytical decisions; Adding verbal descriptions of psychological experiences may only hinder a subject to experience properly. This can be related to the analytical-versus-intuitive debates from decision theory, where adding analytical info may only confuse a subject. %}

Schooler Jonathan W., Stellan Ohlsson, & Kevin Brooks (1993) "Thoughts beyond Words: When Language Overshadows Insight," *Journal of Experimental Psychology: General* 122, 166183.

{% **survey on belief measurement**: %}

Schotter, Andrew, & Isabel Trevino (2014) "Belief Elicitation in the Laboratory," *Annual Review of Economics* 6, 103–128.

{% Aumann & Serrano (2008) proposed a global index of riskiness of a prospect:

For a lottery and a level of wealth, the risk factor is the risk tolerance (reciprocal of the Pratt-Arrow index of risk aversion) for which the lottery, at that level of wealth, is equivalent to not gambling. It is real-valued for prospects with both positive and negative outcomes.

This paper does the same in a relative sense. It considers lotteries with positive outcomes, at both sides of 1. It considers the risk tolerance (reciprocal of now the relative index of risk aversion) for which the lottery is equivalent to having 1 for sure. It is real-valued for prospects with outcomes at both sides of 1. Outcomes are best interpreted as returns per unit invested.

The literature uses the term risk tolerance both for the reciprocal of absolute risk aversion used by Aumann & Serrano, and the reciprocal of relative risk aversion used in this paper. %}

Schreiber, Amnon (2014) "Economic Indices of Absolute and Relative Riskiness," *Economic Theory* 56, 309–331.

{% An applied study using Tversky & Kahneman's (1992) prospect theory to fit observed certainty equivalents. The use logpower (CRRA) utility and the one-parameter probability weighting family of T&K. Strangely enough, although T&K used choice lists and are cited three times more than Holt & Laury (2002), the authors still credit Holt & Laury for the use of choice lists. Well, this is the spirit of current times (2025). They do it regarding drought risks for Kenyan (agro-)pastoralists, deriving policy recommendations. %}

Schrieks, Teun, W.J. Wouter Botzen, Toon Haer, & Jeroen C.J.H. Aerts (2024) "Drought Risk Attitudes in Pastoral and Agro-Pastoral Communities in Kenya," *Journal of Behavioral and Experimental Economics* 108, 102143. https://doi.org/10.1016/j.socec.2023.102143

{% **ambiguous outcomes vs. ambiguous probabilities**: subjects play lotteries where with known probability they get "something," where the latter is an unknown outcome. Those stimuli are called lotto lotteries. So, there is uncertainty about the outcome. An example is taking a medicine with known probabilities of side effects but uncertain what the effects of those side effects will be. The author remodels it as I like: as two-stage uncertainty, where the second stage of uncertainty concerns the outcome and is ambiguous. Subjects are very averse to the second-stage ambiguity which is naturally explained as a contrast effect. Note that the model is what Machina jokingly called an Aumann-Anscombe model. The roulette events precede the horse events. The paper takes a two-stage evaluation with backward induction and α-maxmin (w.r.t. a set of subjective priors that if I understand right is determined and communicated to the subjects by the experimenter; I did not check carefully) to model ambiguity. It notices the similarities with belief functions and, to my joy, cites Jaffray (1989) for it. %}

Schröder, David (2025) "Lotto lotteries — Decision Making under Uncertainty when Payoffs Are Unknown," *Journal of Behavioral and Experimental Economics* 114, 102310. https://doi.org/10.1016/j.socec.2024.102310

{% Use RIS. Use choice list (as did so many preceding Holt & Laury 2002) to get certainty equivalents.

gender differences in risk attitudes: in insurance-framed decisions, women are as risk averse as men. In the abstract framing women are more risk averse for gains and more risk seeking for losses, suggesting more pronounced **inverse S.** Loss prospects were identical to gain prospects in final wealth, but were implemented by **losses from prior endowment mechanism**, so that it was really only framing.

reflection at individual level for risk: they do not report this;

risk averse for gains, risk seeking for losses: I did not find whether there is risk aversion for gains and risk seeking for losses. %}

Schubert, Renate, Martin Brown, Matthias Gysler, & Hans-Wolfgang Brachinger (1999) "Financial Decision-Making: Are Women Really more Risk-Averse?," *American Economic Review, Papers and Proceedings* 89, 381–385. https://doi.org/10.1257/aer.89.2.381

{% %}

Schultz, Henri (1938) "*The Theory and Measurement of Demand.*" University of Chicago Press, Chicago.

{% QALY measurement: they often take body height. %}

Schultz, T. Paul (2002) "Wage Gains Associated with Height as a Form of Health Human Capital," *American Economic Review* 92, 349–353.

{% %}

Schulzer, Michael, Douglas R. Anderson, & Stephen M. Drance (1991) "Sensitivity and Specificity of a Diagnostic Test Determined by Repeated Observations in the Absence of an External Standard," *Journal of Clinical Psychology* 44, 1167–1179.

{% P. 831: **utility = representational**:

"the unholy alliance between economics and Benthamite philosophy,"

it is directed against Benthamite utilitarianism.

Appendix to Ch. 7 describes history of utility, criticizing Benthamite utility again and again, in the context of utilitarianism. For example, in §3, "impression that marginal utility theory depended upon utilitarian or hedonist premisses—Bentham certainly thought so—and could be attacked successfully by attacking these. Jevons was the chief culprit: he even went so far as to call economic theory a 'calculus of pleasure and pain' "

§4 of the appendix ("Psychology and the Utility Theory"), however, gives a balanced account of the matter:

"it is preferable to derive a given set of propositions from externally or 'objectively' observable facts, if it can be done, than to derive the same set of propositions from premisses established by introspection. And, as we shall presently see, this can actually be done in the case of the utility theory of value, at least as long as we do not ask it to do more for us than to furnish the assumptions or 'restrictions' that we need within the equilibrium theory of values and prices."

Note here the crucial antecedent "at least as long as" Schumpeter writes elsewhere in the §4: "the efforts of psychologists to measure psychical quantities is not a matter of indifference to any economist who is not entirely lacking in scientific imagination."

§5, on cardinal utility, gives a fine historical account, would have been useful if I had read it before October 18, 1997. Top of p. 1061 there writes that it was Edgeworth who did away with additively separable utility of commodity bundles. §6 then goes into ordinal utility. §7 is on some consistency by Samuelson and §8 on wefare economics. Apparently, welfare economics is normative whereas positive economics is descriptive. %}

Schumpeter, Joseph (1954) "*History of Economic Analysis*." MacMillan, London.

{% **tradeoff method**: use this to measure utility of money; find that individuals who prefer to deliberate over decisions have more linear utility; N = 200 students, 15 outliers were discarded, arguing that they did not choose deliberately.

Use **random incentive system**; indifferences were elicited through pingpong choices.

random incentive system between-subjects (paying only some subjects); **real incentives/hypothetical choice**: One of every 17 subjects played one of their choices for real, however was paid only 1% of the real amounts, which can be taken as a distortion of the outcomes, in the first sample of 68 subjects. This was dropped in the second sample of 132 subjects, where it was only hypothetical choice. There were no differences in the results between the two samples. Half of their stimuli concerned losses and, although they don't comment on this point, I assume that the real incentives were only for gains.

The fitted power (α; median 0.91) for gains and (β; median 0.90) for losses. %}

Schunk, Daniel & Cornelia Betsch (2006) "Explaining Heterogeneity in Utility Functions by Individual Differences in Decision Modes," *Journal of Economic Psychology* 27, 386–401.

{% %}

Schwabish, Jonathan A. (2014) "An Economist's Guide to Visualizing Data," *Journal of Economic Perspectives* 28, 209–234.

{% %}

Schwartz, Alan J. (1998) "Rating Scales in Context," *Medical Decision Making* 18, 236.

{% **Prospect theory/Rank-Dependent Utility most popular for risk**: wrote in a prepublished version: "The impact of prospect theory has been substantial and broad. In addition to its place as the leading psychological descriptive utility theory, it has been a key impetus to the development of behavior economics. Indeed, Kahneman was recognized with the Nobel Prize in Economics in 2002, in part specifically for the contribution of prospect theory to the field of Economics (Tversky predeceased the awarding of the prize, but was also mentioned by the Nobel Foundation in this context.) In medical decision making, prospect theory has been studied as a descriptive utility theory and proposed as a correction to utility assessment procedures." %}

Schwartz, Alan J. (2015) "Prospect Theory." *In* Michael W. Kattan (ed.) *Encyclopedia of Medical Decision Making*, 922–925, SAGE Publications Inc., Thousand Oaks, CA. http://dx.doi.org/10.4135/9781412971980.n268

{% **real incentives/hypothetical choice**: The subjects had to discover a rule according to which choices between L or R would give money. Half of the subjects were paid according to correct choices each time, the other half not. The paid subjects resorted to myopic strategies and did not try to discover the general rule and, therefore, did not discover the general pattern as well as the not-paid subjects. %}

Schwartz, Barry (1982) "Reinforcement-Induced Behavioral Stereotype: How not to Teach People to Discover Rules," *Journal of Experimental Psychology: General* 111, 23–59.

{% **probability communication**: people who score higher in numeracy better understand probabilistic information given to them. %}

Schwartz, Lisa M., Steven Woloshin, William C. Black, & H. Gilbert Welch (1997) "The Role of Numeracy in Understanding the Benefit of Screening Mammography," *Annals of Internal Medicine* 127, 966–972.

{% **paternalism/Humean-view-of-preference**: Argues that general public will not accept it if their preferences are not taken just as they are (p. 272: "but a value question of democratic process." %}

Schwarz, Norbert (1999) "Defensible Preferences and the Public: Commentary on "Measuring Constructed Preferences: Towards a Building Code" by Payne, Bettman and Schkade," *Journal of Risk and Uncertainty* 19, 271–272.

{% **updating: mistakes in using Bayes' formula**: pp. 59-61 give references to papers showing how people make mistakes in using the formula of Bayes. %}

Schwartz, Steven & Timothy Griffin (1986) "*Medical Thinking, The Psychology of Medical Judgment and Decision Making*." Springer, Berlin.

{% %}

Schwartz, William B. (1979) "Decision Analysis: A Look at the Chief Complaints," *New England Journal of Medicine* 300, 556–559.

{% Argues that we should report power over alternative hypothesis rather than significance %}

Schweder, Tore (1988) "A Significance Version of the Basic Neyman-Pearson Theory for Scientific Hypothesis Testing," *Scandinavian Journal of Statistics* 15, 225–242.

{% Generate social reference points by telling wealth if group of peers, generating them high of low. The effects are in agreement with prospect theory's predictions of loss aversion and diminishing sensitivity. %}

Schwerter, Frederik (2024) "Social Reference Points and Risk Taking," *Management Science* 70, 616–632.
https://doi.org/10.1287/mnsc.2023.4698

{% **preferring streams of increasing income**;
questionnaire versus choice utility: p. 4 seems to have said that utility maximization "set back by generations all scientific inquiry into consumer behavior, for it seemed to rule out—any conflict between what man chooses to get and what will best satisfy him". %}

Scitovsky, Tibor (1965) "*The Joyless Economy*." Oxford University Press, New York.

{% %}

Scott, Dana (1961) "Measurable Cardinals and Constructible Sets," *Bulletin de lAcadémie Polonaise des Sciences* 9, 521–524.

{% A beautiful paper explaining how the theorem of the alternative can be used to characterize linear representations through **cancellation axioms**. Scott (1964) shows how this can give additively decomposable representations of preferences. %}

Scott, Dana (1964) "Measurement Structures and Linear Inequalities," *Journal of Mathematical Psychology* 1, 233–247.
https://doi.org/10.1016/0022-2496(64)90002-1

{% **strength-of-preference representation**: p. 121/122.
cancellation axioms: p. 126: no finite subset of cancellation axioms will suffice to imply the others; no finite statement in 1st order logic can capture all cancellation axioms. %}

Scott, Dana & Patrick Suppes (1958) "Foundational Aspects of Theories of Measurement," *Journal of Symbolic Logic* 23, 113–128.

{% This paper uses nice field data from 7,924 subjects in the 127 lotteries for elk hunting licenses in New Mexico. Here both risk and time play a role. If I understand well, they use the good method of Abdellaoui, Kemel, Panin, & Vieider (2019 GEB) where a joint estimation is done of probability weighting, discounting, and utility, with the deliberate assumption that utility is the same for risk and time (**risky utility u = strength of preference v**). It is controversial but I like it. The paper confirms common findings. Unfortunately, for motivation, it centrally cites the paper Andersen et al. (2008 Econometrica), about which I am very negative (see my annotations there). The paper uses the one-parameter family of Tversky & Kahneman (1992), logpower (CRRA) utility, and three discount families, and confirms common findings. Unfortunately, and probably misled by Andersen et al. (2008), the paper lets the terms risk aversion/seeking refer only to utility curvature, which is extra-unfortunate because they also use this utility curvature when analyzing intertemporal choice. %}

Scrogin, David (2023) "Estimating Risk and Time Preferences over Public Lotteries: Findings from the Field and Stream," *Journal of Risk and Uncertainty* 67, 73–106.
https://doi.org/10.1007/s11166-023-09404-4

{% **free will/determinism**: Seems to suggests that neurobiology might find out about free will. So, the author overestimates the role of neurobiology. %}

Searle, John R. (2004) "*Freedom and Neurobiology: Reflections on Free Will, Language, and Political Power*." Cambridge University Press, New York.

{% Risk-neutral agents with common priors cannot trade to mutual strict advantage; **common knowledge** %}

Sebenius, James K. & John Geneakoplos (1983) "Don't Bet on It: Contingent Agreements with Asymmetric Information," *Journal of the American Statistical Association* 78, 424–426.

{% **foundations of quantum mechanics**: why is probability given by the square of the amplitude? Derivations and discussions are given. It also discusses quantum sleeping beauty problems in quantum mechanics. %}

Sebens, Charles T. & Sean M. Carroll (2018) "Self-Locating Uncertainty and the Origin of Probability in Everettian Quantum Mechanics," *British Journal for the Philosophy of Science* 69, 25–74.

{% Argues, a.o., that derivations of subjective probabilities à la de Finetti implicitly and incorrectly assume that probabilities must add up to 1. (p. 291 3rd para). %}

Secchi, Luigi (2014) "The Main Two Arguments for Probabilism Are Flawed," *Synthese* 191, 287–295.

{% **updating under ambiguity with sampling**; %}

See, Kelly E., Craig R. Fox, & Yuval Rottenstreich (2006) "Between Ignorance and Truth: Partition Dependence and Learning in Judgment under Uncertainty," *Journal of Experimental Psychology: Learning, Memory and Cognition* 32, 1385–1402.

{% **random incentive system between-subjects** (paying only some subjects): Finds that people become more generous if only 25% of ultimatum games is paid than if all are paid. It is not very surprising that in such a situation the system works worse than in individual choice, because here clearly noneconomic psychological factors and perceptions of fairness play a role. Such perceptions can be different under different probability distributions, if they are affected by a priori fairness considerations as advanced in Trautmann (2006). %}

Sefton, Martin (1992) "Incentives in Simple Bargaining Games," *Journal of Economic Psychology* 13, 263–276.

{% %}

Segal, Uzi (1983) "A Theorem on the Additivity of the Quasi-Concave Closure of an Additive Convex Function," *Journal of Mathematical Economics* 11, 261–266.

{% my handwritten notebook p. 403
ordering of subsets %}

Segal, Uzi (1984) "Representation and Measurement of Qualitative Conditional Probability," University of Pennsylvania, Dept. of Economics, Philadelphia, USA.

{% %}

Segal, Uzi (1985) "On the Separability of the Quasi Concave Closure of an Additively Separable Function," *Journal of Mathematical Economics* 14, 129–134.

{% §2 (Condition c in the first definition) %}

Segal, Uzi (1986) "On Lexicographic Probability Relations," *Mathematical Social Sciences* 11, 195–199.

{% Theorem 2 has GAP condition. %}

Segal, Uzi (1987) “Some Remarks on Quiggin’s Anticipated Utility,” *Journal of Economic Behavior and Organization* 8, 145–154.

{% **second-order probabilities to model ambiguity**; Many authors write that Segal was the first to abandon RCLA to model ambiguity, but this is not the case. My keyword gives preceding papers.

Segal’s model of ambiguity is two-stage. Uncertainty about 1st order probabilities (on the outcome-relevant events) is modeled through 2nd order probabilities. Backwards induction is used at each stage. All of this is as the smooth model (KMM 2005). The difference is that at each stage Segal uses a nonEU functional, whereas the smooth model uses EU at each stage. Further, Segal assumes the same nonEU risk functional at each stage (“time neutrality”), whereas the smooth model has a different EU functional at each stage. A pro of Segal’s model is that it is empirically more realistic. A con is that, at least to my knowledge, it does not distinguish between ambiguity and two-stage risk (+ backward induction …). This is also stated by Evren (2019, p. 298, 5th para): “Obviously, ambiguity attittudes are also non-separable from risk preferences in Segal’s (1987) theory.”

p. 194: empirical tests of Ellsberg paradox; %}

Segal, Uzi (1987) “The Ellsberg Paradox and Risk Aversion: An Anticipated Utility Approach,” *International Economic Review* 28, 175–202.

{% %}

Segal, Uzi (1988) “Probabilistic Insurance and Anticipated Utility,” *Journal of Risk and Insurance* 55, 287–297.

{% %}

Segal, Uzi (1988) “Does the Preference Reversal Phenomenon Necessarily Contradict the Independence Axiom,” *American Economic Review* 78, 233–236.

{% **ordering of subsets**. Comonotonic independence characterizes the measure approach, which is like Green & Jullien (1988), kind of RDU with **state-dependent utility** function. The special case where the measure is a product

measure, so that RDU results, is characterized through projection independence, a geometric condition for the measures. In the proof of the latter result, the definition of utility and probability transformation are given, but it is claimed without proof that these indeed give the RDU representation. A proof of this claim will essentially need the continuum richness of the probability dimension, because projection independence operates in this dimension. %}

Segal, Uzi (1989) “Anticipated Utility: A Measure Representation Approach,” *Annals of Operations Research* 19, 359–373.

Before:

Segal, Uzi (1988) “Anticipated Utility: A Measure Representation Approach,” Working paper 8803, University of Toronto, Department of Economics and Institute for Policy Analysis, Toronto, Canada. Rewritten version of Segal, Uzi (1984) “Nonlinear Decision Weights with the Independence Axiom,” Working paper 353, University of California, Department of Economics, Los Angeles, USA.

{% **second-order probabilities to model ambiguity**; **dynamic consistency: favors abandoning RCLA.** %}

Segal, Uzi (1990) “Two-stage Lotteries without the Reduction Axiom,” *Econometrica* 58, 349–377.

{% RCLA %}

Segal, Uzi (1992) “The Independence Axiom versus the Reduction Axiom: Must We Have Both?” *In* Ward Edwards (ed.) *Utility Theories: Measurement and Applications*, 165–183, Kluwer Academic Publishers, Dordrecht.

{% %}

Segal, Uzi (1992) “Additively Separable Representations on Non-Convex Sets,” *Journal of Economic Theory* 56, 89–99.

{% **restricting representations to subsets**; **ordering of subsets** %}

Segal, Uzi (1993) “The Measure Representation: A Correction,” *Journal of Risk and Uncertainty* 6, 99–107.

{% %}

Segal, Uzi (1993) “Order Indifference and Rank-Dependent Probabilities,” *Journal of Mathematical Economics* 22, 373–397.

{% %}

Segal, Uzi (1994) “A Sufficient Condition for Additively Separable Functions,” *Journal of Mathematical Economics* 23, 295–303.

{% **quasi-concave so deliberate randomization** %}

Segal, Uzi (1994) “Stochastic Transitivity and Quadratic Representation Functions,” *Journal of Mathematical Psychology* 38, 102–114.

{% **dynamic consistency**; like Border & Segal (1994), it considers the special case of long-run events going to 0 where event E has probability p, its complement E^c has probability 1–p, p goes to 0, and all else remains the same. It assumes dynamic consistency only for the optimally-chosen strategy. That is, pref between that strategy and other available strategies should remain unaffected. In addition, it assumes that prefs between optimal strategy and nonavailable strategies should also be unaffected. All other prefs are, however, permitted to change freely after updating. (**updating under ambiguity**) Thus, only the indifference class of optimal choice is EU. Rest is free.

Then comes, on p. 214, the question of what those other prefs mean. They are not related to hypothetical choices as in decision analysis or consumer demand theory. They are related to “reconsidered choice” because of earlier mistakes in modeling. In counterfactual nodes the agent would have acted believing in the wrong tree. %}

Segal, Uzi (1997) “Dynamic Consistency and Reference Points,” *Journal of Economic Theory* 72, 208–219.

{% This paper considers the vNM axiomatization of expected utility. Given the common axioms of weak ordering and continuity in probability mixing, consider the independence axiom: $\forall$P,Q,C, $0<\lambda<1$: $P \succcurlyeq Q \Rightarrow \lambda P+(1-\lambda)C \succcurlyeq \lambda Q+(1-\lambda)C$. It can be weakened to $\forall$P,Q,C, $\exists 0<\lambda<1$: $P \succcurlyeq Q \Rightarrow \lambda P+(1-\lambda)C \succcurlyeq \lambda Q+(1-\lambda)C$.

Then still, with the other axioms available, it is strong enough to imply expected utility. A very nice reinforcement of a classical result!

criticizing the dangerous role of technical axioms such as continuity: the result illustrates it once more. By continuity the weak ∃ axiom is turned into the strong ∀ axiom.

The result is very similar to Observation 88 of Hardy, Littlewood, & Polya (1934), and the proofs are very similar, as indicated by the author.

Similar results are provided for betweenness and mixture symmetry. Discussions of observability of axioms are added.

I felt that there was dilution in this paper. It could better have focused on the above theorem than add the further results. %}

Segal, Uzi (2023) "∀ or ∃ ?," *Theoretical Economics* 18, 1–13.
https://doi.org/10.3982/TE4946

{% Theorem 1 characterizes a result for partial separability, the weakening of joint independence that only excludes reversals of strict preferences after replacement of common outcomes, a condition studied by Blackorby, Primont, & Russell, and some others. For three or more dimensions, monotonicity, symmetry, indifference monotonicity (kind of same degree of strict monotonicity all along indifference curves), and partial separability hold if and only if there exists a representation that kind of maximizes a kind of additively decomposable multiplicative form with one degenerate origin-point, and min everywhere below the origin-point, or a dual representation, with max. representation above an origin and additive decomposability below. Fig. 1 on p. 137 gives a good idea.

The authors equate linearity with the combination of invariance under adding a constant (like constant absolute risk aversion) and multiplying by a positive constant (like constant relative risk aversion), but linearity is stronger. RDU with linear utility satisfies constant absolute and relative risk aversion, but is not a linear functional. %}

Segal, Uzi & Joel Sobel (2002) "Min, Max, and Sum," *Journal of Economic Theory* 106, 126–150.
http://dx.doi.org/10.1006/jeth.2001.2859

{% %}
Segal, Uzi & Avia Spivak (1987) "Non-Expected Utility Risk Premiums: The Cases of Probability Ambiguity and Outcome Uncertainty," *Journal of Risk and Uncertainty* 1, 333–347.

{% %}
Segal, Uzi, Avia Spivak, & Joseph Zeira (1988) "Precautionary Saving and Risk Aversion: An Anticipated Utility Approach," *Economics Letters* 27, 223–227.

{% That 1st order risk aversion is 0 under EU, but not under nonEU, was also demonstrated by Montesano (1988). However, that paper is not easy to read. %}
Segal, Uzi & Avia Spivak (1990) "First-Order versus Second-Order Risk-Aversion," *Journal of Economic Theory* 51, 111–125.

{% Some puzzles IN retirement behavior can nicely be explained by plausible reference points. %}
Seibold, Arthur (2021) "Reference Points for Retirement Behavior: Evidence from German Pension Discontinuities," *American Economic Review* 2021, 1126–1165. https://doi.org/10.1257/aer.20191136

{% My handwritten notebook pg. 665.; **Dutch book**; **foundations of statistics** %}
Seidenfeld, Teddy (1979) "*Philosophical Problems of Statistical Inference*." Reidel, Dordrecht.

{% **dynamic consistency**; Provides an argument for independence that is well known among philosophers. %}
Seidenfeld, Teddy (1988) "Decision Theory without "Independence" or without "Ordering," What is the Difference?," *Economics and Philosophy* 4, 267–290.

{% **foundations of statistics** %}
Seidenfeld, Teddy (1992) "R.A. Fisher's Fiducial Argument and Bayes' Theorem," *Statistical Science* 7, 358–368.

{% **dynamic consistency** %}

Seidenfeld, Teddy (2000) “Substitution of Indifferent Options at Choice Nodes and Admissibility: A Reply to Rabinowicz,” *Theory and Decision* 4, 305–310.

{% **dynamic consistency** %}

Seidenfeld, Teddy (2000) “The Independence Postulate, Hypothetical and Called-off Acts: A further Reply to Rabinowicz,” *Theory and Decision* 4, 319–322.

{% On expert aggregation: Show, apparently as first, an analog of Arrow’s impossibility theorem for SEU. That is, there is no aggregation rule where all individuals maximize SEU, so, does the group preference relation, there are at least two agents who differ both in subjective probability and in utility, weak Pareto (if all subjects strictly prefer x to y, then so does the group) holds, and it is nondictatorial. %}

Seidenfeld, Teddy, Joseph B. Kadane, & Mark J. Schervish (1989) “On the Shared Preferences of Two Bayesian Decision Makers,” *Journal of Philosophy* 86, 225–244.

{% **Dutch book**; **finite additivity**

Some nice examples. Further that [pointwise monotonicity] and [finite-partition-conditional-preference-monotonicity] follow, but not [countable-partition-conditional-preference-monotonicity]. %}

Seidenfeld, Teddy & Mark J. Schervish (1983) “A Conflict between Finite Additivity and Avoiding Dutch Book,” *Philosophy of Science* 50, 398–412.

{% Expected utility can violate [x(s) ≻ y(s) for all s then x ≻ y] under finite additivity, as is well known. The authors show that this violation can happen while x and y generate the same probability distribution over outcomes. It is playing with the trickeries of finite additivity. %}

Seidenfeld, Teddy, Mark J. Schervish, & Joseph B. Kadane (2009) “Preference for Equivalent Random Variables: A Price for Unbounded Utilities,” *Journal of Mathematical Economics* 45, 329–340.
https://doi.org/10.1016/j.jmateco.2008.12.002

{% **proper scoring rules**: seem to show that no strict proper scoring rules exist for imprecise probabilities (sets of priors). %}

Seidenfeld, Teddy, Mark J. Schervish, & Joseph B. Kadane (2012) "Forecasting with Imprecise Probabilities," *International Journal of Approximate Reasoning* 53, 1248–1261.

{% %}

Seidenfeld, Teddy & Larry Wasserman (1993) "Dilation for Sets of Probabilities," *Annals of Statistics* 21, 1139–1154.

{% Reviews preference reversals. %}

Seidl, Christian (2002) "Preference Reversal," *Journal of Economic Surveys* 16, 621–655.

{% Nice references on history of St. Petersburg paradox.

Gives results and inequalities on the degree of decreasingness of outcomes for whether or not infinite EU can result. On p. 259 he does transformation of separate-outcome probabilities (separable prospect theory), normalizing by dividing by the sum of all probability weights. It is well known that this violates stochastic dominance. P. 259 writes that a referee called the author's attention to Yaari's dual theory. %}

Seidl, Christian (2013) "The St. Petersburg Paradox at 300," *Journal of Risk and Uncertainty* 46, 247–264.

{% %}

Seidl, Christian & Ulrich Schmidt (1997) "Pareto on Intra- and Interpersonal Comparability of Utility," *History of Economic Ideas* 5, 19–33.

{% **survey on nonEU**: well, on EU it is

P. 208 brings up nice point that bisection may give better results than matching simply because subjects spend more time. Conclusion: "The response mode bias exceeds the effect of probability dependence."

utility elicitation; Extensive references are given. Certainty equivalents are compared with probability equivalents, using matching elicitation. Dependency of utility on the probability used is less for probability equivalents but does not disappear. (**PE doesn't do well**: well, here may be OK) %}

Seidl, Christian & Stefan Traub (1999) "Biases in the Assessment of von Neumann-Morgenstern Utility Functions," *Journal of Economics* Suppl. 8, 203–239.

{% **intuitive versus analytical decisions**: consider combinations of analytic and intuitive decisions, and give many references on the topic. %}

Seifert, Matthias & Andreas Eisingerich (2010) "The Role of Ambiguity and Complexity in Judgmental Forecasting,"

{% %}

Selart, Marcus, Tommy Gärling, & Henry Montgomery (1998) "Compatibility and the Use of Information Processing Strategies," *Journal of Behavioral Decision Making* 11, 59–72.

{% Give evidence that probability is the prominent dimension in risky choice. %}

Selart, Marcus, Ole Boe, & Tommy Gärling (1999) "Reasoning about Outcome Probabilities and Values in Preference Reversals," *Thinking and Reasoning* 5, 175–188.

{% %}

Selden, Lawrence (1978) "A New Representation of Preferences over 'Certain x Uncertain' Consumption Pairs: The 'Ordinal Certainty Equivalent' Hypothesis," *Econometrica* 46, 1045–1060.

{% %}

Selden, Lawrence (1979) "An OCE Analysis of the Effect of Uncertainty on Saving under Risk Independence," *Review of Economic Studies* 45, 73–82.

{% **Z&Z** %}

Selden, Thomas M. (1998) "Risk Adjustment for Health Insurance: Theory and Implications," *Journal of Risk and Uncertainty* 17, 167–180.

{% %}

Selender, Arthur K. & Liang Zou (1994) "Limited Liability and the Underlying Asset Constraint: On the Use of Share-Derivative Contracts to Resolve Agency Problems," *Journal of Economics* 59, 149–166.

{% %}

Selim, Asli (2013) "Is the Description-Experience Gap Real?: A Review of The Decisions from Experience Research," working paper.

{% %}

Selim, Asli (2014) "An Examination of Uncertainty from a Psychological and Economic Viewpoint," Ph.D. thesis, Erasmus School of Economics, Erasmus University, Rotterdam.

{% **Harsanyi's aggregation** %}

Selinger, Stephen (1986) "Harsanyi's Aggregation Theorem without Selfish Preferences," *Theory and Decision* 20, 53–62.

{% %}

Selten, Reinhard (1965) "Spieltheoretische Behandlung eines Oligopolmodells mit Nachfragetragheit," *Zeitschrift für die Gesamte Staatswissenschaft* 12, 301–324. (667–689 kan eventueel worden toegevoegd)

{% %}

Selten, Reinhard (1967) "Die Strategiemethode zur Erforschung des Eingeschränkt Rationalen Verhaltens im Rahmen eines Oligopolexperimentes," *Beiträge zur Experimentellen Wirtschaftsforschung*, J.C.B. Mohr, Tübingen, 136–168.

{% Uses "trick" of considering selves at different timepoints as different agents. %}

Selten, Reinhard (1975) "Reexamination of the Perfectness Concept for Equilibrium Points in Extensive Games," *International Journal of Game Theory* 4, 25–55.

{% %}

Selten, Reinhard (1994) "New Challenges to the Rationality Assumption: Comment," *Journal of Institutional and Theoretical Economics* 150, 42–44.

{% **probability elicitation** %}

Selten, Reinhard (1998) “Axiomatic Characterization of the Quadratic Scoring Rule,” *Experimental Economics* 1, 43–62.

{% Four revolutions in economics: (1) Mathemization; (2) Game theory; (3) Experiments assuming preference optimization; (4) bounded rationality. %}

Selten, Reinhard (2014) Lecture in Haifa Jan.24, 2014.

{% **Christiane, Veronika & I**: they pay in probabilities unit.

linear utility for small stakes: if payment is not in money but in probability for a prize, then by any rational theory with RCLA and stochastic dominance, subjects should maximize expected probability. This point has often been observed under the assumption of subjective expected utility. It is a nice observation, which the paper starts with, that it in fact holds for every probabilistically sophisticated (meaning (additive) subjective probabilities are used and decisions are based on only those; the paper does not use this term) agent under the minimal assumptions of preferring the highest probability at a good outcome and RCLA.

However, extensive violations have been found empirically that are farther apart from expectation maximization than for real money. Payments vary between 0 and 500 pfennig, which is between \$0 and \$2.50, with one loss gamble for about −\$1 added. The common ratio effect, the “reference point effect” (I assume loss aversion), preference reversals, and violations of stochastic dominance persist and seem to be even stronger.

Backward induction seems to be natural in the paper’s setup.

Goeree, Holt, & Palfrey (2003, p. 105 2nd para) also list evidence against paying in probabilities. %}

Selten, Reinhard, Abdolkarim Sadrieh, & Klaus Abbink (1999) “Money Does not Induce Risk Neutral Behavior, but Binary Lotteries Do even Worse,” *Theory and Decision* 46, 211–249.

{% **revealed preference** %}

Sen, Amartya K. (1971) "Choice Functions and Revealed Preference," *Review of Economic Studies* 38, 307–317.

{% %}
Sen, Amartya K. (1973) "*On Economic Inequality*." Clarendon Press, Oxford.

{% P. 390 seems to have written, related to Arrow's impossibility theorem: "armed with only an n-tuple of individual orderings, we can hardly expect to say much of interest on inequality." (**Arrow's voting paradox ==> ordinality does not work**) %}
Sen, Amartya K. (1974) "Informational Bases of Alternative Welfare Approaches. Aggregation and Income Distribution," *Journal of Public Economics* 3, 387–403.

{% Seems that he argued that in prisoner's dilemma the players should confess because otherwise they'd be lying and one should not lie. If he wrote this (I did not check), then it would be similar to a PD where the strategies are not called "confess" or "not confess" but "push red button" and "push black button" and it is argued that buttons of color red shoulf never be pushed. %}
Sen, Amartya K. (1974) "Choice, Ordering and Morality." *In* Stephan Körner (ed.) *Practical Reason*, Blackwell, Oxford.

{% %}
Sen, Amartya K. (1977) "Rational Fools: A Critique of the Behavioral Foundations of Economic Theory," *Philosophy and Public Affairs* 6, 317–344.

{% P. 121 seems to say that consequences should describe "everything in the real world (except in [the] mind)." %}
Sen, Amartya K. (1985) "Rationality and Uncertainty," *Theory and Decision* 18, 109–127.

{% P. 36 points out that the IIA condition in Arrow's voting theorem may be criticized for losing information about strength of preference. (**Arrow's voting paradox ==> ordinality does not work**) %}
Sen, Amartya K. (1986) "Information and Invariance in Normative Choice." *In* Walter P. Heller, Ross M. Starr, & David A. Starrett (eds.) *Social Choice Public*

Decision Making: Essays in Honor of Kenneth J. Arrow, Vol. I, 29–55, Cambridge University Press, Cambridge.

{% Survey of welfare theory. %}
Sen, Amartya K. (1986) "Social Choice Theory." *In* Kenneth J. Arrow & Michael D. Intriligator (eds.) *Handbook of Mathematical Economics* III, 1073–1181, North-Holland, Amsterdam, Ch. 22.

{% This is followed by reply by Broome. %}
Sen, Amartya K. (1991) "Utility: Ideas and Terminology," *Economics and Philosophy* 7, 277–283.

{% %}
Sen, Amartya K. (1992) "*Inequality Reexamined.*" Harvard University Press, Cambridge, MA.

{% **coherentism**
Argues that internal consistency conditions are unconvincing if not related to external criteria. While essentially true, I disagree with the presentation in this paper. Internal consistency is never all of it, indeed, but still it is worthwhile to study it. The more so as, for any external consistency requirement, one can require further external justification (to every answer one can ask again "why"), so, external consistency need not be principally more sound.

P. 498: the necessity of bringing in something outside choice behavior is the issue.

P. 500, fortunately, uses the terms contraction consistency and expansion consistency instead of Sen's earlier unfortunate terms property α or property γ.

Many many examples of all kinds of violations of IIA etc.

§3 gives a long list of examples of context-dependence, always arguing for the one side of the coin that that can happen and never for the other side of the coin that then not much theory can be developed or predictions be made.

I also disagree with the use of the social choice theory analysis of the author. He first argues that for a social choice relation there is less reason for consistency

than individual. Well, OK. Then he revisits Arrow's impossibility theorem without imposing internal consistency conditions (such as transitivity) on social preference. He does impose Pareto and some other conditions invoking individual preferences. He then says that the conditions invoking individual preferences are external consistency conditions for social preference. Under this heading he derives a few formal axiomatic variations on Arrow's result. I think that taking the individual prefs as external and not as part of the internal system is ad hoc and the "external consistency" of Pareto, for instance, is not more convincing than the internal consistency condition of transitivity of group preference in a fundamental way.

Gives nice example of violation of IIA: from {b,c} you take c, from {a,b,c} you take b. Reason: these are slices of cake and you were taught not to take the largest slice but only the second-largest. %}

Sen, Amartya K. (1993) "The Internal Consistency of Choice," *Econometrica* 61, 495–521.

{% Abstract last sentence shows enthusiasm that one often sees: "These differences have considerable relevance in studies of economic, social, and political behavior."

P. 765: Buridan's ass; paper gives further examples where basic principles of revealed pref. such as IIA are violated, and distinguishes many reasons for those violations. Term menu-independence is used as a nice alternative for Tversky's context-dependence. Elementary results on revealed pref are given; they don't seem to be new. Variation of the Luce & Raiffa restaurant example: {t,O} where t is take tea invitation from friend, O is going home. You're inclined to take t. Then comes {t,O,H} where friend also offers H (heroin) ...

P. 759, Footnote 30 is quite favorable to EU.

P. 764 footote 40 is quite against completeness (**completeness criticisms**). %}

Sen, Amartya K. (1997) "Maximization and the Act of Choice," *Econometrica* 65, 745–779.

{% **foundations of probability**: well, its history. How Lewis Carroll and others struggled with the maths of Bayes law and the choice of noninformative priors in many calculation problems. %}

Seneta, Eugene (2012) “Victorian Probability and Lewis Carroll,” *Journal of the Royal Statistical Society: Series A* 174, 435–451.

{% **discounting normative**: seems to argue against discounting. %}

Senior, Nassau W. (1836) “*An Outline of the Science of Political Economy*.” Clowes and Sons, London, UK.

{% %}

Sennetti, John T. (1976) “On Bernoulli, Sharpe, Financial Risk and the St. Petersburg Paradox,” *Journal of Finance* 31, 960–962.

{% **foundations of statistics** %}

Sennetti, John T. (1995) “On the Incoherent Use of Evidence: Why Subjective Bayesian Evidence Is not Held Probative,” *Auditing* 14, 193.

{% Axiomatizes basically the same model as Klibanoff, Marinacci, & Mukerji (2005) (KMM), but assumes an extra stage with objective extraneous probabilities prior to the model. He thus also considers probability distributions over acts. In this respect he is as the original three-stage of Anscombe & Aumann (1963); they also assumed such a third prior stage. He assumes EU within the extra stage, as he does within all stages of his model (same as KMM), but he abandons RCLA so as to have deviations from EU and to have ambiguity and Ellsberg behavior (with multistage modeling). That is, he abandons the reversal-of-order axiom of Anscombe-Aumann. That reversal-of-order axiom justifies assuming the third prior stage away and moving it into the afterwards-stage. (Most papers using the Anscombe-Aumann framework since the 1980s take it, following Fishburn, in the latter sense, and have only objective-probabilities afterwards and not prior.) Seo can use the extra prior probabilities to calibrate, à la matching probabilities, the subjective probabilities over the states. In this way we can recover info about μ, although μ need not be unique. (This is a problem: the prior μ cannot be uniquely separated from the utility transformation function φ.) Seo thus does not need the unobservable second-order acts of KMM, but in return is less general. He has the same parameters and modeling of ambiguity as KMM.

As regards the calibration procedure: if receiving some roulette lottery (that is how I refer to probability distributions over deterministic prizes resulting after the horse-race/states) under event E is equivalent to receiving it over the whole state space with prior probability 1/3, then the second-order integrated subjective probability (μ) over E must also be 1/3.

Halevy & Ozenoren have a similar model with probabilistic sophistication instead of EU within each stage, where they put the calibration idea central. %}

Seo, Kyoungwon (2009) "Ambiguity and Second-Order Belief," *Econometrica* 77, 1575–1605.

{% A well-written survey. %}

Serra, Daniel (2021) "Decision-Making: From Neuroscience to Neuroeconomics—an Overview," *Theory and Decision* 91, 1–80.

{% %}

Sertel, Murat R. (1972) "A Four-Flagged Lemma," *Review of Economic Studies* 39, 487–490.
https://doi.org/10.2307/2296516

{% Similar to the repetitions approach in Wakker (1986, Theory and Decision). %}

Sertel, Murat R. & Arkadii Slinko (2007) "Ranking Committees, Income Streams of Multisets," *Economic Theory* 30, 265–287.

{% **updating: discussing conditional probability and/or updating**; **foundations of statistics**; ancillary statistics defined regarding "no information about theta" %}

Severini, Thomas A. (1995) "Information and Conditional Inference," *Journal of the American Statistical Association* 90, 1341–1346.

{% P. 251 writes: "I suggest, therefore, that when he contemplates this inner range of outcomes each of which carries no potential surprise, the entrepreneur does in fact concentrate his attention exclusively on the best and the worst hypotheses in this range." However, it is only within a set of outcomes that are not at all surprising to occur. Too vague to be related to inverse S. %}

Shackle, George L.S. (1941) "A Means of Promoting Investment," *Economic Journal* 51, 249–260.

{% Introduces his idea of nonadditive probability ("potential surprise"). The derived decision model does not seem to be interesting (you should group, for a given act, all outcomes with same degree of surprise, and then consider of them only the highest????????).

Ch. II insists on differentiating between gains and losses; says that sign-dependence: people first assess gains-part, then losses-part, then aggregate.

Seems to argue that statistical information is not relevant to single-shot decisions: (**principle of complete ignorance**): P. 8 seems to ask as a meant-to-be rhetoric question: "Suppose the captains in a Test Match have agreed that instead of tossing a coin for a choice of innings they will decide the matter by this next throw of a die, and that if it shows an ace Australia shall bat first, if any other number, then England shall bat first. Can we now give any meaningful answer whatever to the question, "Who will bat first?" except "We do not know?" " Shackle is making elementary mistakes!

Arrow (1951 Econometrica p. 419) criticizes Shackle's theory for it being impossible to incorporate any sense of updating after repeated trials. It seems that Shackle was a student of Keynes. %}

Shackle, George L.S. (1949) "*Expectation in Economics.*" Cambridge University Press, Cambridge.

{% Shackle was early to argue for using nonadditive probabilities and sign dependence (gains different than losses), ideas central in prospect theory, and deserves some credit for that. But he seems to suggest theories or formulas that are incomprehensible to me and, I guess, everyone, and, therefore, he does not deserve much credit I think.

Nonadditivity is taken to express amount of information, somewhat like belief functions. Says beliefs must sum to 1 but potential surprise need not. Draws sharp distinction between indivisible experiment (unique event) and divisible (repeatable).

P. 71 seems to argue that probabilities are irrelevant for single events

P. 72 claims as self-evident ("The reader will at once, I think, concede") that, among a number of hypotheses with equal degree of surprise, only the one with the highest gain is of concern to the agent. That makes sense to me only if the hypotheses are choice options. Apart from this strange claim of max-only-concern, repeated several times, it always seems that hypotheses are uncertain events.

Shackle seems to favor a max-max approach to uncertainty, but discusses also an “integral” solution that he does not like. P. 72/73 argues that you cannot integrate over mutually exclusive hypotheses, which seems absurd to me. He describes an integral idea that was described by a Professor Svennilson, but only in Swedish, and was reported to Shackle by a Mr. Turvey. I thought for some time that maybe it referred to a rank-dependent form, but in Copenhagen in 1997, with the help of Jacob Gyntelberg who has Danish as his mother language and therefore can understand some Swedish, read in Svennilson’s work and came to conclude that he probably does not have it.

P. 73 ℓ. -14/-10 seems to derive decision weights as differences betweencumulative weights, bit similar to rank dependence. %}

Shackle, George L.S. (1949) “A Non-Additive Measure of Uncertainty,” *Review of Economic Studies* 17, 70–74.

{% Review of Shackle’s work is presented in Ford (1993). %}

Shackle, George L.S. (1968) “*Expectations, Investment and Income*;” 2nd edn. Oxford University Press, Oxford.

{% %}

Shackley, Phil & Cam Donaldson (2002) “Should We Use Willingness to Pay to Elicit Community Preferences for Health Care? New Evidence from Using a ‘Marginal’ Approach,” *Journal of Health Economics* 21, 971–991.

{% **inverse S:** find it, with overestimation of low probabilities and underestimation of high, but for probability estimates and not for decisions. %}

Shaefer, Ralf E. & Katrin Borcherding (1973) “The Assessment of Subjective Probability Distributions: A Training Experiment,” *Acta Psychologica* 37, 117–129.

{% %}

Shafer, Glenn (1976) "*A Mathematical Theory of Evidence.*" Princeton University Press, Princeton NJ.

{% %}

Shafer, Glenn (1978) "Non-Additive Probabilities in the Work of Bernoulli and Lambert," *Archive of History of Exact Sciences* 19, 309–370.

{% %}

Shafer, Glenn (1979) "Allocations of Probability," *Annals of Probability* 7, 827–839.

{% **updating: discussing conditional probability and/or updating** %}

Shafer, Glenn (1982) "Bayes's Two Arguments for the Rule of Conditioning," *Annals of Statistics* 10, 1075–1089.

{% **updating: discussing conditional probability and/or updating** %}

Shafer, Glenn (1985) "Conditional Probability," *International Statistical Review* 53, 261–277.

{% %}

Shafer, Glenn (1986) "Savage Revisited" (including comments) *Satistical Science* 1, 463–501.

{% %}

Shafer, Glenn (1987) "Probability Judgement in Artificial Intelligence and Expert Systems," *Statistical Science* 2, 3–16.

{% %}

Shafer, Glenn (1988) "The St. Petersburg Paradox." *In* Samuel Kotz & Norman J. Johnson (eds.) *Encyclopedia of Statistical Sciences,* Vol 8, 865–870, Wiley, New York.

{% %}

Shafer, Glenn (1990) "Perspectives on the Theory and Practice of Belief Functions," *International Journal of Approximate Reasoning* 4, 323–362.

{% **foundations of probability** %}
Shafer, Glenn (1993) "Can the Various Meanings of Probability be Reconciled?" *In* Gideon B. Keren & Charles Lewis (1993, eds.) *A Handbook for Data Analysis in the Behavioral Sciences: Methodological Issues*, 165–196, Lawrence Erlbaum Publishers, Hillsdale, NJ.

{% Nice historical references %}
Shafer, Glenn (1996) "*The Art of Causal Conjecture*." MIT Press.

{% **foundations of probability**; history of family of Bernoulli; discussing foundations of probability, but at times pleaing for own views and papers. %}
Shafer, Glenn (1996) "The Significance of Jacob Bernoulli's *Ars Conjectandi* for the Philosophy of Probability Today," *Journal of Econometrics* 75, 15–32.

{% Formulates a betting criterion that leads to Dempster-Shafer belief functions. %}
Shafer, Glenn (2011) "A Betting Interpretation for Probabilities and Dempster-Shafer Degrees of Belief," *International Journal of Approximate Reasoning* 52, 127–136.

{% Proposes a decision theory where utility maximization is replaced by the fulfillment of goals. %}
Shafer, Glenn (2016) "Constructive Decision Theory," *International Journal of Approximate Reasoning* 79, 45–62.

{% %}
Shafer, Glenn & Roger Logan (1987) "Implementing Dempster's Rule for Hierarchical Evidence," *Artificial Intelligence* 32, 271–298.

{% %}
Shafer, Glenn & Amos Tversky (1985) "Languages and Designs for Probability Judgment," *Cognitive Science* 9, 309–339.

{% **revealed preference** %}

Shafer, Wayne J. (1977) "Revealed Preference Cycles and the Slutsky Matrix," *Journal of Economic Theory* 16, 293–309.

{% **ratio-difference principle**: seem to have it.

real incentives/hypothetical choice: they use hypothetical choice not real, defend it on p. 350. %}

Shafir, Eldar, Peter A. Diamond, & Amos Tversky (1997) "Money Illusion," *Quarterly Journal of Economics* 112, 341–374.

{% A short summary of models with (deviations from) rationality. %}

Shafir, Eldar & Robyn A. LeBoeuf (2002) "Rationality," *Annual Review of Psychology* 53, 491–517.

{% **conservation of influence**; This analysis of prisoner's dilemma is nice illustration, there is apparently perceived to be influence on opponent's choice prior to his strategy choice ("magical thinking") but not after. P. 463 on quasi-magical thinking: Although people know they can't influence things, they still act as if: Ao about Newcomb's problem; show that people may cooperate in the prisoner dilemma if uncertain about the strategy choice of the opponent, but defect both if they know that their opponent defects and if they know that their opponent cooperates. In modified experiment, 35% chose both boxes, 65% only one. Funnily, subjects who committed at least two conjunction fallacies (so, were more irrational), chose only one box way more often than others.

Also about Samuelson's game, a fifty-fifty lottery for $200 or −$100 is done twice. Both if the first gives a win, and if it gives a loss, do people want to take the second. But if they don't yet know what the first will give they don't want the second. Similar things for prisoners dilemma. %}

Shafir, Eldar & Amos Tversky (1992) "Thinking through Uncertainty: Nonconsequential Reasoning and Choice," *Cognitive Psychology* 24, 449–474.

{% Consider repeated decisions with outcomes paid each time (experience). If human beings cannot discriminate well between different rewards, then they exhibit the certainty effect. If they can, they exhibit the reversed certainty effect. Animals that can discriminate exhibit the certainty effect. %}

Shafir, Sharoni, Taly Reich, Erez Tsur, Ido Erev & Arnon Lotem (2008) "Perceptual Accuracy and Conflicting Effects of Certainty on Risk-Taking Behaviour," *Nature* 453, 917–920.

{% **revealed preference**: show violations of revealed preference conditions for animals. %}

Shafir, Sharoni, Tom A. Waite, & Brian H. Smith (2002) "Context-Dependent Violations of Rational Choice in Honeybees [Apis Mellifera] and Gray Jays (Perisoreus Canadensis)," *Behavioral Ecology and Sociobiology* 51, 180–187.

{% Subjects can sample from a distribution as in the experienced approach (DFE) by Erev et al., but in addition get the probability distribution given. Despite the latter, they still sample quite some. %}

Shafran, Aric P. (2011) "Self-Protection against Repeated Low Probability Risks," *Journal of Risk and Uncertainty* 42, 263–285.

{% Tested probability matching for four subjects, using real incentives. No probability matching was found; i.e., three out of four subjects did the rational thing of always choosing the most likely alternative. %}

Shah, Kshitija, Christopher M. Bradshaw, & Elemer Szabadi (1989) "Performance of Humans in Concurrent Variable-Ratio Variable-Ratio Schedules of Monetary Reinforcement," *Psychological Reports* 65, 515–520.

{% %}

Shalev, Jonathan (1997) "Loss Aversion in a Multi-Period Model," *Mathematical Social Sciences* 33, 203–236.

{% **equilibrium under nonEU**; brings in prospect theory-like loss aversion. %}

Shalev, Jonathan (2000) "Loss Aversion Equilibrium," *International Journal of Game Theory* 29, 269–287.

{% Brings in prospect theory-like loss aversion; does assume invariance w.r.t. scale and location; **game theory for nonexpected utility**; endogenizes reference point. Its modeling of loss aversion is valuable (with an axiomatization by Peters (2012).

March 20, 2014: Only now, when rereading Tversky & Kahneman (1991 QJE), a paper I read before around 1990, giving comments to Tversky, I realize that this basic modeling was already in TK91. In particular, their constant sensitivity (p. 1049) serves to keep curvature the same except for the moving of the kink when the reference point moves. %}

Shalev, Jonathan (2002) "Loss Aversion and Bargaining," *Theory and Decision* 52, 201–232.

Probably the published version of:

Shalev, Jonathan (1998) "Loss Aversion in Repeated Games," CORE discussion paper 9814.

{% **cognitive ability related to discounting**: Seems to be a review. When the authors discuss chacen, they mean random incentive system. When they mention reasons for RIS they only mention reduction of payments (p. 298), and do not understand apparently that the main reason is to avoid income effects. %}

Shamos, Noah A. & Jeremy R. Gray (2008) "Delay Discounting and Intelligence: A Meta-Analysis," *Intelligence* 36, 289–305.

{% P. 344: in multiattribute setting (jobs with attributes: salary, authority, interest, influence, status), tradeoffs are weighed more heavily when formulated as losses than as gains. %}

Shapira, Zur (1981) "Making Trade-offs between Job Attributes," *Organizational Behavior and Human Performance* 28, 331–335.

{% %}

Shapira, Zur & Itzhak Venezia (1992) "Size and Frequency of Prizes as Determinants of the Demand for Lotteries," *Organizational Behavior and Human Decision Processes* 52, 307–318.

{% **Z&Z**; Experiments with students etc. where they play role of insurer or insured. Self-selection occurs to some extent, screening only if there are repetitions and learning. %}

Shapira, Zur & Itzhak Venezia (1999) "Experimental Tests of Self-Selection and Screening in Insurance Decisions," *Geneva Papers in Risk and Insurance Theory* 24, 139–158.

{% Professional managers of investments also display the disposition effect, be it weaker than nonprofessional investors. %}

Shapira, Zur & Itzhak Venezia (2001) "Patterns of Behavior of Professionally Managed and Independent Investors," *Journal of Banking & Finance* 25, 1573–1587.

{% **dynamic consistency**: in an optimization model, with Artzner et al. risk measures involved, time consistency is defined as optimization that does not depend on counterfactual options. %}

Shapiro, Alexander (2009) "On a Time Consistency Concept in Risk Averse Multistage Stochastic Programming," *Operations Research Letters* 37, 143–147.

{% **restricting representations to subsets**: Shows that characterizing SEU on finite structures is extremely difficult. Many people who, erroneously, think that this amounts to simply restricting Savage's axioms to the finite case can learn from this paper that it is way more complex.

I like the opening in Sections 1 & 2, with good criteria specified: The axiomatization should be on finite sets and for incomplete preferences there. This is what one should do to really understand a model. Such an axiomatization is not yet available for subjective expected utility, so, we do not really know what this model means.

When I reread this paper March 2011 I was disappointed to see that the author involves artificial compound prospects (he calls them compound tickets) involving repetitions and extendability of the preference relation to these, e.g. in the theorem on p. 1295, no 6.0. Extendability arguments can be used to assume any desired structural richness, and are of limited interest only. Once you have

compound prospects and sequences of outcomes, then easier axiomatizations become possible than provided in this paper. %}

Shapiro, Leonard (1979) “Necessary and Sufficient Conditions for Expected Utility Maximizations: The Finite Case, with a Partial Order,” *Annals of Statistics* 7, 1288–1302.

{% **measure of similarity** %}

Shapiro, Monte B. (1961a) “A Method of Measuring Changes Specific to the Individual Psychiatric Patient,” *British Journal of Medical Psychology* 34, 151–155.

{% **measure of similarity** %}

Shapiro, Monte B. (1961b) “The Personal Questionnaire. Abbreviated Manual.” Unpublished manuscript.

{% Nice citation on ambiguity. Interviewed managers. Ch. 4 p. 49, one manager said: “Risk, unlike uncertainty, is manageable.” %}

Shapiro, Zur (1995) “*Risk Taking: A Managerial Perspective*.” Russell Sage Foundation, New York.

{% %}

Shapley, Lloyd S. (1965) “Notes on n-Person Games VII: Cores of Convex Games,” The RAND Corporation R.M.

Reprinted as: Shapley, Lloyd S. (1971) “Cores of Convex Games,” *International Journal of Game Theory* 1, 11–26.

{% %}

Shapley, Lloyd S. (1967) “On Balanced Sets and Cores,” *Naval Research Logistics Quarterly* 14, 453–460.

{% %}

Shapley, Lloyd S. (1971) “Cores of Convex Games,” *International Journal of Game Theory* 1, 11–26.

{% **strength-of-preference representation**, for convex subset of reals, with crossover property. When Shapley discovered that others had presented preference foundations of intensity comparisons before, he decided that his paper had too little novelty and did not seek a journal outlet anymore. I regret this because his axiomatization then was still new and a valuable alternative. Fortunately, it was later published in Shubik (1982); see below. %}

Shapley, Lloyd S. (1975) "Cardinal Utility Comparisons from Intensity Comparisons." Report R-1683-PR, The Rand Corporation, Santa Monica, California.

Reprinted as Appendix 3 to Martin Shubik (1982) "*Game Theory in the Social Sciences.*" The MIT Press, Cambridge, MA.

{% Says that in truncated version of St. Petersburg paradox with 47 tosses and cent as unit, one should pay 24.5 cents and that that price is not at all unreasonable. So, in a truncated version of the St. Petersburg paradox risk neutrality is not unreasonable. %}

Shapley, Lloyd S. (1977) "The St. Petersburg Paradox: A Con Game?," *Journal of Economic Theory* 14, 439–442.

{% Criticizes Aumann (1977). %}

Shapley, Lloyd S. (1977) "Lotteries and Menus: A Comment on Unbounded Utilities," *Journal of Economic Theory* 14, 446–453.

https://doi.org/10.1016/0022-0531(77)90144-2

{% **Dutch book** %}

Shapley, Lloyd S. (1988) "Axiomatization of Interpersonally Comparable Utilities," MATH 261, LECTURE NOTES, 1/6/88.

{% Views on how to teach the concept of probability to students. %}

Sharma, Sashi (2015) "Teaching probability: A Socio-Constructivist Perspective," *Teaching Statistics* 37, 78–84.

{% The paper discusses, and axiomatizes, the following ambiguity model. Assume that W is a convex weighting function and a probability measure P in the core of

W* (i.e., P(E) ≥ W*(E) for each E). The author interprets W as objective info. Since it is convex, it can be interpreted as a lower probability of a set of priors, which can be taken as its core. The P chosen is subjective. The author assumes W and P given, exogenous.

One example of the model of this paper is if the decision maker defines the convex combination W* = αP + (1–α) W* and maximizes rank-dependent utility (= Choquet expected utility). We can interpret W* as resulting from taking the objective W in full, but discounting the extra subjective belief P–W by a factor α ≤ 1. It can accommodate the Ellsberg paradox. But it is not very new, just using the convex W*.

This paper generalizes by also considering nonlinear combinations of W and P (or P–W). Those can also accommodate Machina's counterexamples to rank-dependent utility. The paper axiomatizes its model. The requirement of having W and P as inputs is not easy to implement, and the nonlinear combination of W and P are also general. %}

Sharpe, Keiran (2023) "On the Ellsberg and Machina Paradoxes," *Theory and Decision* 95, 539–573.
https://doi.org/10.1007/s11238-023-09935-x

{% Consider a necessity and possibility measure. The ambiguity measure is the difference between the possibility and necessity measure. These can be taken as special cases of upper and lower probabilities. So, then the degree of ambiguity of an event is the difference between the upper and lower probability. Walley (1991) called this the imprecision spread. It satisfies all five axioms for ambiguity as a primitive of Fishburn (1993). The measure can similarly be defined for any set of priors other than necessity/possibility, but then not all axioms of Fishburn are satisfied. %}

Shattuck, Mark & Carl Wagner (2016) "Peter Fishburn's Analysis of Ambiguity," *Theory and Decision* 81, 153–165.

{% Prior to a risky activity (such as sky diving), inexperienced people are more subject to immediacy effect. This paper studies more kinds of impact of risky decisions on intertemporal preference. %}

Shavit, Tal, Mosi Rosenboim, & Yaniv Shani (2014) "Time Preference before and after a Risky Activity – A Field Experiment," *Journal of Economic Psychology* 43, 30–36.

{% r**eal incentives/hypothetical choice, for time preferences**: seems to be on it %}
Shavit, Yael, Yefim Roth, Jerome Busemeyer, & Kinneret Teodorescu (2022) "Intertemporal Decisions from Experience versus Description: Similarities and Differences," *Decision* 9, 131–152.

{% Seems to have written: "Lack of money is the root of all evil," as a variation of the quote from the bible's new testament: "Love of money is the root of all evil." The quote is also sometimes assigned to Mark Twain. %}
Shaw, George Bernard (1905) "*Man and Superman: A Comedy and a Philosophy*." 2012 edition: The Floating Press, Portland, OR, USA.

{% **survey on nonEU**: more precisely, it does what title says, not delving very deep into risk and ambiguity theories themselves. %}
Shaw, W. Douglass (2016) "Environmental and Natural Resource Economics Decisions under Risk and Uncertainty: A Survey," *International Review of Environmental and Resource Economics* 9, 1–130.

{% Use **tradeoff method**. %}
Shaw, W. Douglass, Rodolfo M. Nagya Jr., & Andres Silva (2006) "Health Benefits and Uncertainty: An Experimental Analysis of the Effects of Risk Presentation on Auction bids for a Healthful Product," *Economics Bulletin* 4, 1–8.

{% Find that risk aversion for losses correlates with risk aversion for gains. No relation with discounting. **losses from prior endowment mechanism;** do random incentive system but repeatedly with income effect. %}
Shead, N. Will & David C. Hodgins (2009) "Probability Discounting of Gains and Losses: Implications for Risk Attitudes and Impulsivity," *Journal of the Experimental Analysis of Behavior* 92, 1–16.

{% **dynamic consistency**; survey of traditional economic discussions, Strotz, Peleg & Yaari, etc. %}

Shefrin, Hersh M. (1998) "Changing Utility Functions." *In* Salvador Barberà, Peter J. Hammond, & Christian Seidl (eds.) *Handbook of Utility Theory, Vol. 1, Principles,* 569–626, Kluwer Academic Publishers, Dordrecht.

{% Ch. 26 gives a clear definition of Lopes' SP/A theory. P. 429 last line, incorrectly, claims that probability weighting in SP/A theory would not be sign-dependent. Ch. 27 discusses it more. Unfortunately, there are several confusions. P. 453 2nd para, for instance, writes that in SP/A, with linear utility, risk attitude is captured by probability weighting, which is fine. But the preceding line writes that in prospect theory, where there is both probability weighting and utility curvature, it is different and risk attitude is captured by utility (**equate risk aversion with concave utility under nonEU**). Why probability weighting would suddenly stop to impact risk attitude under prospect theory, as is suggested here, whereas !the same! probability weighting does under SP/A, is hard to understand, and obviously untrue. There are several confusions of this kind. Never a tradeoff between parsimony and fit is tried. %}

Shefrin, Hersh M. (2008) "*A Behavioral Approach to Asset Pricing Theory*; 2nd edn." Elsevier, Amsterdam.

{% **risk averse for gains, risk seeking for losses**: Coin the term disposition effect for the phenomenon described in the title. It suggests risk seeking for losses and risk aversion for gains. %}

Shefrin, Hersh M. & Meir Statman (1985) "The Disposition to Sell Winners too Early and Ride Losers too Long: Theory and Evidence," *Journal of Finance* 15, 777–790.

{% Seems to show that individual stocks and underdiversified portfolios have positive skewness. %}

Shefrin, Hersh M. & Meir Statman (2000) "Behavioral Portfolio Theory," *Journal of Financial and Quantitative Analysis* 35, 127–151.

{% **time preference** %}

Shelley, Marjorie K. (1993) “Outcome Signs, Question Frames and Discount Rates,” *Management Science* 39, 806–815.

{% Consider a probabilty space (Ω,Σ,P), where P is given by a regulator, or by nature. And, thus, can be used as primitive in axioms, as in decision under risk in the eonomic literature. However, this paper is in the literature on risk measures, where a quantitative risk measure ρ is the primitive, rather than a preference relation as often in economics. *Law-invariance* of the risk measure ρ means that $\rho(X) = \rho(Y)$ whenever the random variables X and Y generate the same probability distribution over $\mathbb{R}$. It is similar to how economists define decision under risk. This paper considers partial law invariance: $\mathcal{G}$-law-invariance means that there exists a sub-sigma algebra $\mathcal{G}$ such that law-invariance only holds for $\mathcal{G}$-measurable random variables. The idea is that P is reliable (or whatever term one uses) on $\mathcal{G}$ but not outside. Economists might say that there is ambiguity (unertainty about true probability) outside $\mathcal{G}$, but the field of risk measures will interpret it differently I guess. A proper term is yet to be invented here. The paper derives several mathematical results, such as, if I understand right, continuity conditions sufficient that quasi-convexity plus translation invariance implies that ρ is maxmin, but expectation on $\mathcal{G}$, and conditions that imply, for X and Y, that their conditional expectations given $\mathcal{G}$ have a pointwise dominance relation. If a risk measure ρ satisfies conditions such as (quasi)convexity, then its conditional expectation give $\mathcal{G}$ will inherit many of these properties. Taking conditional expectation in itself is expected-value based, treating the conditional uncertainty linearly, which does not fit nicely with this conditional uncertainty taken as ambiguous.

The paper considers sets of priors with $\mathcal{G}$ independent, meaning that the priors all agree on $\mathcal{G}$. ρ is a sup over a set of priors and is $\mathcal{G}$-law invariant, if and only if the set of priors satisfies some sort of law-invariance w.r.t. $\mathcal{G}$ %}

Shen, Yi, Zachary Van Oosten, & Ruodu Wang (2023) “Partially Law-Invariant Risk Measures,” working paper.

{% **cognitive ability related to discounting**: extensive study showing that steeper discounters are more impulsive. Use hypothetical choice. %}

Shenhav, Amitai, David G. R., & Joshua D. Greene (2017) "The Relationship between Intertemporal Choice and Following the Path of Least Resistance across Choices, Preferences, and Beliefs," *Judgment and Decision Making* 12, 1–18.

{% %}
Shenoy, Prakash P. (1998) "Game Trees for Decision Analysis," *Theory and Decision* 44, 149–171.

{% **measure of similarity** %}
Shepard, Roger N. (1962) "The Analysis of Proximities: Multidimensional Scaling with an Unknown Distance Function, I & II," *Psychometrika* 27, 125–140, 219–246.

{% **measure of similarity** %}
Shepard, Roger N. (1987) "Toward a Universal Law of Generalization for Psychological Science," *Science* 237, September 11, 1317–1323.

{% %}
Shephard, Ronald W. (1970) "*Theory of Cost and Production Functions.*" Princeton University Press, Princeton NJ.

{% Shows that the Herstein & Milnor (1953) axioms still work on the set of rational (and also dyadic) numbers with one modification: The independence axiom (only for mixture 0.5) has to be imposed with weak preference rather than just indifference. Given generalizations to incomplete preference and to non-Archimedean (Hausner 1954). %}
Shepherdson, John C. (1980) "Utility Theory Based on Rational Probabilities," *Journal of Mathematical Economics* 7, 91–113.

{% Information leakage is a nice term to designate much of what goes on in framing. %}
Sher, Shlomi & Craig R.M. McKenzie (2006) "Information Leakage from Logically Equivalent Frames," *Cognition* 101, 467–494.

{% %}

Sherrick, Bruce J., Steven T. Sonka, Peter J. Lamb, & Michael A. Mazzocco (2000) "Decision-Maker Expectations and the Value of Climate Prediction Information: Conceptual Considerations and Preliminary Evidence," *Meteorological Applications* 7, 377–386.

{% Subjects can choose: (1) a sure amount of money but they pay ¥0.10 for it (0.10 Chinese yuan is about about $0.01); (2) a lottery but they pay ¥0.10 for it; (3) let the computer randomly choose between the money amount or the lottery, where they pay nothing. Fixing the lottery and varying the money amount, as in CE choice lists, the values for which computer-random-choice is chosen can be taken as an area of indecisiveness or deliberate preference for randomization. The authors consider various models of stochatic choice and find deliberate randomization plausible. They also measure probability equivalents (PE) using choice lists, and find different preferences for randomization there. They also consider implications for preference reversals, with choices between two nondegenerate lotteries, and those repeated nine times, giving probabilistic choices there. P. 258 bottom: the cost of PE choices is higher than of CE choices. %}

Shi, Liu, Jianying Qiu, Jiangyan Li, & Frank Bohn (2024) "Consciously Stochastic in Preference Reversals," *Journal of Risk and Uncertainty* 68, 255–297. https://doi.org/10.1007/s11166-024-09430-w

{% They use Rohde's (2018) index of time inconsistency, to measure it for both gains and losses. Confirm usual findings and find relations between gains and losses. Even, differences between gains and losses are nonsignificant. Remarkable is that the authors do not use choice lists but direct matching, discussed in §3.3 and §5.2. All choices are hypothetical. Whereas many experimental economist are strongly against that, I think it is better for losses and for intertemporal choice. %}

Shiba, Shotaro & Kazumi Shimizu (2020) "Does Time Inconsistency Differ between Gain and Loss? An Intra-Personal Comparison Using a Non-Parametric Elicitation Method," *Theory and Decision* 88, 431–452. https://doi.org/10.1007/s11238-019-09728-1

{% Positions prospect theory and behavioral findings in economics.

P. 1308: "Prospect theory [Kahneman and Tversky (1979), Tversky and Kahneman (1992) has probably had more impact than any other behavioral theory on economic research. Prospect theory is very influential despite the fact that it is still viewed by much of the economics profession at large as of far less importance than expected utility theory. Among economists, prospect theory has a distinct, though still prominent, second place to expected utility theory for most research." (**PT/RDU most popular**) %}

Shiller, Robert J. (2000) "Human Behavior and the Efficiency of the Financial System." *In* John B. Taylor & Michael Woodford (eds.) *Handbook of Macroeconomics*, Vol. 1c, Ch. 20, 1305–1340, Elsevier, Amsterdam.

{% Surveys, asking people from firms in Japan and the US what they expected about the DJ and Nikkei indexes, and did so for several years. Compare expectations to real performance of indexes. Find that people are strongly more optimistic about their own homestock than the foreigners are. So, at least one group is considerably misjudging. P. 163 argues for importance of asking subjective probability estimates on top of seing real markets. %}

Shiller, Robert J., Fumiko Kon-Ya, & Yoshiro Tsutsui (1996) "Why Did the Nikkei Crash? Expanding the Scope of Expectations Data Collection," *Review of Economics and Statistics* 78, 156–164.

{% **value of information**: psychological investigation into value of information. One value is instrumental; i.e., when you can improve your future actions because of information. Another value is emotional. That is, also if there is no future action to be influenced by info (no control), still people have preferences or dispreferences over info for its own sake. Many different attitudes are described (coping ("secondary control")…), and many many references are given. %}

Shiloh, Shoshana, Ronit Ben-Sinai, & Giora Keinan (1999) "Effects of Controllability, Predictability, and Information-Seeking Style on Interest in Predictive Genetic Testing," *Personality and Social Psychology Bulletin* 25, 1187–1195.

{% **Dutch book** %}

Shimony, Abner (1955) “Coherence and Axioms of Confirmation,” *Journal of Symbolic Logic* 20, 1–28.

{% %}
Shimony, Abner (1967) “Amplifying Personal Probability Theory: Comments on L.J. Savage’s “Difficulties in the Theory of Personal Probability” ,” *Philosophy of Science* 34, 326–332.

{% Discusses equilibria in games from perspective of trembling hand versus counterfactuals. %}
Shin, Hyun Song (1991) “A Reconstruction of Jeffrey’s Notion of Ratifiability in Terms of Counterfactual Beliefs,” *Theory and Decision* 31, 21–47.

{% %}
Shin, Hyun Song (1991) “Optimal Betting Odds against Insider Traders,” *Economic Journal* 101, 1179–1185.

{% %}
Shin, Hyun Song (1992) “Prices of State-Contingent Claims with Insider Traders, and the Favourite-Longshot Bias,” *Economic Journal* 102, 426–435.

{% %}
Shin, Hyun Song (1993) “Measuring the Incidence of Insider Trading in a Market for State-Contingent Claims,” *Economic Journal* 103, 1141–1153.

{% %}
Shioji, Naoki & Wataru Takahashi (1988) “Fan’s Theorem Concerning Systems of Convex Inequalities and Its Applications,” *Journal of Mathematical Analysis and Applications* 135, 383–398.

{% **updating under ambiguity**: the authors study dilation: receipt of info turns risk into ambiguity.

Assume that a fair coin is flipped giving H or T, 50-50. Also, a ball is randomly drawn from an unknown Ellsberg urn, containing R(e(eds.)d) and B(lack) balls in

unknown proportion, giving R or B as result. Assume the gamble is that one receives $1 if H and $0 if T:

	B	R
H	1	1
T	0	0

The gamble is risk, not ambiguity. But assume one gets informed whether {(HB), TR)} happened or {(HR, TB)}, so, which diagonal. After receipt of the info, there is ambiguity. (It could be increased by letting the draw of ball be done AFTER the toss of coins, but a different urn after H than after T.) For Bayesians, who are ambiguity neutral, the info has no value, and they will be indifferent to receiving it or not. But ambiguity averse people will dislike it and ambiguity seeking people will like it. Such info is called dilation, borrowing this term from statistics where it concerns the fact that extra observations can increase the variance of estimators.

This paper uses the above example in an experiment, but it interprets B as correctness of a signal, R as incorrectness, {(HB), TR)} as signal "H" and {(HR, TB)} as signal "T". The interpretation of signal makes it easier to remember for subjects but has the drawback of arousing nonneutral emotions. Results: ambiguity-seeking subjects evaluate the info positively and after like the gamble more, but ambiguity-averse subjects neither like not dislike these things.

The theoretical claims do depend on attitude to dynamic decisions. Under McClennen's resolute choice, i.e., Machina's (1989) dynamic consistency, one simply adheres to one's preferences when born and is indifferent to info if worthless, i.e., the value of free info is never negative. The authors discuss this briefly on p. 16 middle.

At the end of the paper, the authors point out that their findings are negative for most current ambiguity models.

Kops & Pasichnichenko (2023) suggest that the formulation of unreliable signal generates aversion. %}

Shishkin, Denis & Pietro Ortoleva (2023) "Ambiguous Information and Dilation: An Experiment," *Journal of Economic Theory* 208, 105610. https://doi.org/10.1016/j.jet.2023.105610

{% Seems to give arguments against efficient market hypothesis. %}

Shleifer, Andrei (2000) "*Claredon Lectures: Inefficient Markets.*" Oxford University Press, Oxford.

{% Lists many biases.

P. 1080: "The broad field of behavioral economics—perhaps the most important conceptual innovation in economics over the last thirty years—might not have existed without Kahneman and Tversky's fundamental work."

P. 1081: "My feeling is that the most profound influence of Kahneman and Tversky's work on economics has been in finance, on what has now become the field of behavioral finance"

P. 1081: "large and costly errors people make in important choices. Let me illustrate. First, individuals pay large multiples of actuarially fair value to buy insurance against small losses, as well as to reduce their deductibles (Sydnor 2010)." (**small risks overinsured**)

P. 1081: "Second, the standard economic view that persuasion is conveyance of information seems to run into a rather basic problem that advertising is typically emotional, associative, and misleading—yet nonetheless effective (Bertrand et al. 2010; DellaVigna and Gentzkow 2010; Mullainathan, Schwartzstein, and Shleifer 2008)."

"The second objection holds that market forces eliminate the influence of psychological factors on prices and allocations. One version of this argument, made forcefully by Friedman (1953) in the context of financial markets, holds that arbitrage brings prices, and therefore resource allocation, to efficient levels. Subsequent research has shown, however, that Friedman's argument— while elegant—is theoretically (and practically) incorrect. Real-world arbitrage is costly and risky, and hence limited (see, e.g., Grossman and Miller 1988, DeLong et al. 1990, Shleifer & Vishny 1997). Dozens of empirical studies confirm that, even in markets with relatively inexpensive arbitrage, identical, or nearly identical, securities trade at different prices. With costlier arbitrage, pricing is even less efficient."

P. 1086 writes that reference dependence is the most radical assumption of prospect theory. On the reference point of Kahneman & Tversky versus Köszegi & Rabin: "The reference point is thus left as a rather unspecified part of Kahneman and Tversky's theory, their measure of "context" in which decisions are made. Köszegi and Rabin (2006) suggest that reference points should be rational expectations of future consumption, a proposal that brings in calculated thought." This is exactly the point where Köszegi and Rabin (2006) deviate from earlier thoughts. %}

Shleifer, Andrei (2012) "Psychologists at the Gate: A Review of Daniel Kahneman's Thinking, Fast and Slow," book review of: Kahneman, Daniel (2011) "*Thinking:*

Fast and Slow," Penguin Books, London. *Journal of Economic Literature* 2012, 50(4) 1080–1091.

{% They consider what happens in experiments on decision under uncertainty if subjects from their own initiative add assumptions about the experiment, as with experimenter demand. Of course, at first almost everything can then be accommodated. They give a theoretical model and look into restrictions. %}

Shmaya, Eran Leeat Yariv (2016) "Experiments on Decisions under Uncertainty: A Theoretical Framework," *American Economic Review* 106, 1775–1801.

{% Argue that Chen, Lakshminarayanan, & Santos's (2006) finding of loss aversion in Capuchin monkeys may have a different cause, having to do with delay in consumption. Do experiments to confirm it. %}

Silberberg, Alan, Peter G. Roma, Mary E. Huntsberry, Frederick R. Warren-Boulton, Takayuki Sakagami, Angela M. Ruggiero & Stephen J. Suomi (2009) "On Loss Aversion in Capuchin Monkeys," *Journal of the Experimental Analysis of Behavior* 92, 145–155.

{% Stevens, McCabe, & Brazier (2006) is criticized. %}

Shmueli, Amir (2007) "It Might be Premature to Reject the Assumption of a Power Curve Relationship between VAS and SG Data: Three Comments on Stevens, McCabe and Brazier's "Mapping between VAS and SG Data; Results from the UK HUI Index 2 Valuation Survey"," *Health Economics* 16, 755–758.

{% For a number of statements, proposes the ratio of the probability of their intersection by the product of their separate probabilities as index of coherence. It is 1 if the statements are statistically independent. The proposal gave rise to many reactions. %}

Shogenji, Tomoji (1999) "Is Coherence Truth-Conducive?," *Analysis* 59, 338–345.

{% Finds overestimation of small probabilities for losses. Decreases with exposure to market. %}

Shogren, Jason F. (1990) "The Impact of Self-Protection and Self-Insurance on Individual Response to Risk," *Journal of Risk and Uncertainty* 3, 191–204.

{% Study, with usual mug-chocolate stimuli, but also health outcomes, the WTP-WTA discrepancy. Experimentally confirm Hahneman's (1991) conjecture that substitutable goods, like mugs and chocolates that one can buy everywhere, the discrepancy is smaller than with health outcomes that are not substitutable. For mugs and chocolates, the discrepancy disappears in repeated markets. I did not check the implementations, how those generate reference points. %}

Shogren, Jason F., Seung Y. Shin, Dermot J. Hayes, & James B. Kliebenstein (1994) "Resolving Differences in Willingness to Pay and Willingness to Accept," *American Economic Review* 84, 255–270.

{% %}

Shortliffe, Edward H. & Bruce G. Buchanan (1975) "A Model of Inexact Reasoning in Medicine," *Mathematical Biosciences* 23, 351–379.

{% Subjects do not take certainties provided by experimenter but replace them by their own probability estimates. See also Ryazanov et al. (2018). %}

Shou, Yiyun & Fei Song (2017) "Decisions in Moral Dilemmas: The Influence of Subjective Beliefs in Outcome Probabilities," *Judgment and Decision Making* 12, 481–490.

{% Psychological study of optimism and pessimism, focusing on higher or on lower outcomes. Self-report questionnaires were used to classify the subjects as pessimistic or optimistic. The paper studies which attitude leads to better performances for all kinds of tasks.

Could possibly be a ref. for optimism and pessimism in rank-dependence. %}

Showers, Carolin (1992) "The Motivational and Emotional Consequences of Considering Positive and Negative Possibilities for an Upcoming Event," *Journal of Personality and Social Psychology* 63, 474–484.

{% %}

Showers, Carolin (1992) "Compartmentalization of Positive and Negative Self-Knowledge: Keeping Bad Apples out of the Bunch," *Journal of Personality and Social Psychology* 62, 1036–1049.

{% %}
Shubik, Martin (1975) "Competitive Equilibrium, the Core, Preferences for Risk and Insurance Markets," *Economic Records* 51, 73–83.

{% %}
Shubik, Martin (1982) "*Game Theory in the Social Sciences.*" The MIT Press, Cambridge, MA.

{% Propose **proper scoring rules** for multiple choice questions in teaching. Seem to have been the first to show that only the logarithmic proper scoring rule has the property that for more than two events its payment contingent on an event depend only on the subjective probability assigned to that event (pp. 136-137). %}
Shuford, Emir H., Arthur Albert, & H. Edward Massengill (1966) "Admissible Probability Measurement Procedure," *Psychometrika* 31, 125–145.

{% Loss aversion makes prices more rigid. %}
Sibly, Hugh (2002) "Loss Averse Customers and Price Inflexibility," *Journal of Economic Psychology* 23, 521–538.

{% **discounting normative**: seems to write: "the time at which a man exists cannot affect the value of his happiness from a universal point of view; and […] the interests of posterity must concern a utilitarian as much as those of his contemporaries." %}
Sidgwick, Henry (1874) "*The Methods of Ethics*." 7th edn. 1907. MacMillan, London.

{% P. 96 seems to explain that bookmaking was common term in British race betting. %}
Sidney, Charles (1976) "*The Art of Legging.*" Maxline International, London.

{% %}
Siebenmorgen, Niklas, Elke U. Weber, & Martin Weber (1999) "Risk Perception in the Short Run and in the Long Run," Arbeitsbericht, SFB 504, Universität Mannheim.

{% **information aversion**

David Pearce pointed out the following reference:

Consider the decision whether to be tested for an incurable genetic disorder. A director of a genetic counseling program recently told the New York Times that "there are basically two types of people. There are 'want-to-knowers' and there are 'avoiders.' There are some people who, even in the absence of being able to alter outcomes, find information of this sort beneficial. The more they know, the more their anxiety level goes down. But there are others who cope by avoiding, who would rather stay hopeful and optimistic and not have the unanswered questions answered." %}

Siebert, Charles (1995) "Living with Toxic Knowledge: The DNA We've Been Dealt," *New York Times Magazine*, Sept 17.

{% P. 1340 suggests that reporting undiscounted results is also worthwhile. %}

Siegel, Joanna E., Milton C. Weinstein, Louise B. Russell, Marthe R. Gold (1996, for the Panel on Cost-Effectiveness in Health and Medicine) "Recommendations for Reporting Cost-Effectiveness Analyses," *JAMA* 276, 1339–1341.

{% **risky utility u = strength of preference v (or other riskless cardinal utility, often called value)** %}

Siegel, Sidney (1956) "A Method for Obtaining an Ordered Metric Scale," *Psychometrika* 21, 207–216.

{% **real incentives/hypothetical choice**: seems to write: "Because of our belief in the central importance of employing payoffs which are meaningful to subjects, rewards which in fact they covet, we have little confidence in experiments in which the 'payoffs' are points, credits, or tokens. Or perhaps it would be more accurate to say that we have little confidence in the use of the term payoff to label such trivia. The relevance of such experiments to any theoretical notions about reward, payoff, or utility seems to be dubious." (p. 148) %}

Siegel, Sidney (1964) "*Choice, Strategy, and Utility.*" McGraw-Hill, New York.

{% **foundations of statistics**: criticizes hypothesis testing. %}

Siegfried, Tom (2010) "Odds Are, It's Wrong: Science Fails to Face the Shortcomings of Statistics," *Science News* 177, 26.

https://www.sciencenews.org/article/odds-are-its-wrong

{% %}
Sikorski, Roman (1969) "*Boolean Algebras*;" 3rd edn. Springer, Berlin.

{% The authors did crowdsourcing analysis. It means that one same dataset is given to different teams that separately (or in communication) analyze it statistically. They did it with 29 teams, investigating the hypothesis that players in football with a dark skin get more red cards. 20 teams find the result significantly, and 9 teams not. The basic idea may be interesting. Problem is that the result found is unsurprising and uninformative. If one study finds something significant, and another study does not, then this is not a contradictory finding because finding H_0 does not mean much and may be just coincidence (unless a good power analysis if added). Whereas for simple t-tests and the like (with simple monotone distributions) there is a clearly best test, for many more complex distributions there is no clearly best statistical test, and different tests have different pros and cons. Comes to it that always subjective choices have to be made in the data analyses, such as what to consider missing.

Of the version that I saw (undated, around October 2015) the opening sentence suggests that these authors restrict the scientific process and creativity to empirical/experimental studies: "In the scientific process, creativity is mostly associated with the generation of testable hypotheses and the development of suitable research designs." %}
Silberzahn, Raphael, Eric Luis Uhlmann, Dan Martin, Pasquale Anselmi, Frederik Aust, Eli C. Awtrey, Štepán Bahník, Feng Bai, Colin Bannard, Evelina Bonnier, Rickard Carlsson, Felix Cheung, Garret Christensen, Russ Clay, Maureen A. Craig, Anna Dalla Rosa, Lammertjan Dam, Mathew H. Evans, Ismael Flores Cervantes, Nathan Fong, Monica Gamez-Djokic. Andreas Glenz, Shauna Gordon-McKeon, Tim J. Heaton, Karin Hederos Eriksson, Moritz Heene, Alicia Hofelich Mohr, Kent Hui, Magnus Johannesson, Jonathan Kalodimos. Erikson Kaszubowski, Deanna Kennedy, Ryan Lei, Thomas Andrew Lindsay, Silvia Liverani, Christopher Madan, Daniel Molden, Eric Molleman, Richard D. Morey, Laetitia Mulder, Bernard A. Nijstad, Bryson Pope, Nolan Pope, Jason M. Prenoveau, Floor Rink, Egidio Robusto, Hadiya Roderique, Anna Sandberg, Elmar Schlueter, Felix S Martin Sherman, S. Amy Sommer, Kristin Lee Sotak, Seth Spain, Christoph Spörlein, Tom Stafford, Luca Stefanutti, Susanne Täuber, Johannes Ullrich, Michelangelo Vianello, Eric-Jan Wagenmakers, Maciej

Witkowiak, SangSuk Yoon, & Brian A. Nosek (2018) "Many Analysts, One Dataset: Making Transparent how Variations in Analytical Choices Affect Results," *Advances in Methods and Practices in Psychological Science* 1, 337–356.
https://doi.org/10.1177/2515245917747646

{% Textbook on topology. Has an elementary chapter on connected spaces (copy in my archive). Seems to be well written. %}
Simmons, George F. (1963) "*Introduction to Topology and Modern Analysis.*" McGraw-Hill, inc., New York.

{% **foundations of statistics**
Didactical paper showing how one can maximize chance of getting significant results using inappropriate tricks, and giving recommendations such as that one should specify stopping rule beforehand. Something that is unverifiable (brings benefits to the dishonest people at the cost of the honest peope), and that works differently in the Bayesian approach … %}
Simmons, Joseph P., Leif D. Nelson, & Uri Simonsohn (2011) "False-Positive Psychology: Undisclosed Flexibility in Data Collection and Analysis Allows Presenting Anything as Significant," *Psychological Science* 22, 1359–1366.
http://dx.doi.org/10.1177/0956797611417632

{% Together with his '56 paper the classics that introduce bounded rationality. On informational and computational limits on rationality. (**calculation costs incorporated**) %}
Simon, Herbert A. (1955) "A Behavioral Model of Rational Choice," *Quarterly Journal of Economics* 69, 99–118.

{% %}
Simon, Herbert A. (1956) "Rational Choice and the Structure of the Environment," *Psychological Review* 63, 129–138.

{% **coherentism**: seems to have that %}
Simon, Herbert A. (1957) "*Models of Man.*" Wi;ey, New York.

{% **coherentism**: seems to have that %}

Simon, Herbert A. (1986) "Rationality in Psychology and Economics," *Journal of Business* 59, S209–S224.

{% %}

Simon, Herbert A. (1982) "*Models of Bounded Rationality*, Vols 1 and 2." The MIT Press, London.

{% **conservation of influence**: seems to argue that a fundamental goal of science is to find invariants: constant mathematical relationships that hold between different variables (Simon, 1990). %}

Simon, Herbert A. (1990) "Invariants of Human Behavior," *Annual Review of Psychology* 41, 1–20.

{% %}

Simon, Leo K. & Maxwell B. Stinchcombe (1995) "Equilibrium Refinement for Infinite Normal-Form Games," *Econometrica* 63, 1421–1443.

{% Although most replications of the uncertainty effect of Gneezy, List, & Wu (2006) did not find it, this paper apparently does. It also uses the uninformative term "uncertainty effect" for the phenomenon. The term internality, used by Luce and others, is better. The paper uses the term direct risk aversion to designate an aversion to risk irrespective of outcomes, putting that forward as the main explanation. %}

Simonsohn, Uri (2009) "Direct Risk Aversion," *Psychological Science* 20, 686–692.

{% **Prospect theory/Rank-Dependent Utility most popular for risk**: PT is most cited in economics. %}

Simonsohn, Uri (2014) "Citing Prospect Theory." Data Colada. http://datacolada.org/15

{% %}

Simonsohn, Uri (2025) "Complexity": 75% of Participants Missed Comprehension Questions in AER Paper Citiquing Prospect Theory.” No 124, 14 March 2025, on https://datacolada.org/124.

{% Imagine that journals only accept significant results (publication bias), and other than that all rules are satisfied (no p-value hacking for instance). What is the real value of a p-value? If for all studies a single (containing only one parameter) null hypothesis H_0 is true, then there will be equally many p-values between 0.05 and 0.04 as between … 0.01 and 0.00. So, their distribution is homogenous. The more the alternative hypothesis is true, the more skewed it will be. We can observe the distribution of p-values published in the journal, and then, making all kinds of distributional assumptions, can do simulations that reproduce that distribution of p-values, and then see what the real p-values are to correct for the publication bias. One problem is that this correction does not handle p-hacking and even may reinforce the distortions due to p-hacking. %}

Simonsohn, Uri, Leif D. Nelson, & Joseph P. Simmons (2014) “p-Curve and Effect Size: Correcting for Publication Bias Using Only Significant Results,” *Psychological Science* 9, 666–681.

{% 16Mar2020: paper will apparenty not be published. %}

Simonsohn, Uri, Joseph P. Simmons, & Leif D. Nelson (2014) “Anchoring is Not a False-Positive: Maniadis, Tufano, and List’s (2014) “Failure-to-Replicate” is Actually Entirely Consistent with the Original,” working paper.

{% %}

Simonson, Itamar (1989) “Choice Based on Reasons: The Case of Attraction and Compromise Effects,” *Journal of Consumer Research* 16, 158–174.

{% %}

Simonson, Itamar & Amos Tversky (1992) “Choice in Context: Tradeoff Contrast and Extremeness Aversion,” *Journal of Marketing Research* 29, 281–295.

{% **PT, applications**: nonadditive measures, portfolio inertia %}

Simonsen, Mario H. & Sérgio R.C. Werlang (1991) "Subadditive Probabilities and Portfolio Inertia," *Revista de Econometria* 11, 1–19.

{% Use Mazur (1987) discounting function, use hypothetical questions, assume linear utility, and fitted data at an individual level, for N = 17 subjects. Did two measurements separated by one week, and found stable results. %}

Simpson, Cathy A., & Rudy E. Vuchinich (2000) "Reliability of a Measure of Temporal Discounting," *Psychological Record* 50, 3–16. https://doi.org/10.1007/BF03395339

{% Writes that EU is normative and nonEU may only be "shortcut," so, not right to be used for policy making. %}

Sims, Christopher A. (2001) "Pitfalls of a Minimax Approach to Model Uncertainty," *American Economic Review, Papers and Proceedings* 91, 51–54.

{% %}

Singh, Jagbir & William A. Thompson, Jr. (1968) "A Treatment of Ties in Paired Comparisons," *Annals of Mathematical Statistics* 39, 2002–2015.

{% Theoretical textbook on Bayesian statistics, with introductory chapters on decision foundation of Bayesian statistics. %}

Singpurwalla, Nozer (2006) "*Reliability and Risk: A Bayesian Perspective*." Wiley, New York.

{% **conservation of influence**: discuss intentionality %}

Sinhababu, Neil (2013) "The Desire-Belief Account of Intention Explains Everything," *Nous* 47, 680–696. http://dx.doi.org/10.1111/j.1468-0068.2012.00864.x

{% Paper presented at FUR VII conference in Oslo, 1994 %}

Siniscalchi, Marciano (1997) "Conditional Preferences, Ellsberg Paradoxes and the Sure Thing Principle." *In* Pierpaolo Battigalli, Aldo Montesano, & Fausto Panunzi (eds.) *Decisions, Games and Markets. Studies in Risk and Uncertainty*, 31–53, Kluwer Academic Publishers, Dordrecht.

{% This paper assumes the Anscombe-Aumann framework, where maxmin EU was axiomatized by Gilboa & Schmeidler (1989). What this paper adds is a necessary and sufficient condition for a prior to be contained in the set of multiple priors. Such a prior is characterized by the existence of a convex subset of acts such that on this convex subset EU is satisfied w.r.t. the prior, and such that there is no other probability measure with respect to which this holds. In the main result, axiom 6 (no local hedging in the sense that for each sequence of acts converging to an act there is a subsequence of acts that, losely speaking, provide no hedge against each other) characterizes the existence of a finite coverage of acts such that within each coverage, EU holds.

While this paper characterizes whether or not a single probability measure is contained in the set of priors, it does not provide a verifiable characterization of the set of priors. For the latter one would have to check for every single probability measure whether or not it is contained, which is an infinite task. The author formulates this point in Ghirardato & Marinacci (2012 p. 2832) as: "that plausible priors are identified individually, rather than as element of a set." %}

Siniscalchi, Marciano (2006) "A Behavioral Characterization of Plausible Priors," *Journal of Economic Theory* 128, 91–135.

{% Last para pleas for doing descriptive research into ambiguity:

"Ultimately, however, I think NW's critique can be interpreted constructively by proponents of ambiguity. NW's paper does show that it is difficult to debate the appeal of different approaches to dynamic choice under ambiguity from a purely abstract ("normative") point of view. New empirical and experimental evidence concerning how individuals actually behave in dynamic situations under ambiguity may provide more effective guidance for theoretical development in this exciting field." %}

Siniscalchi, Marciano (2008) "Two out of Three Ain't Bad: A Comment on "The Ambiguity Aversion Literature: A Critical Assessment"," *Economic Philosophy* 25, 335–356.

{% S is state space, f is act from S to outcomes. It is Anscombe-Aumann framework with outcomes being probability distributions over prizes, which mathematically amounts to utility being linear in outcomes. P denotes the subjective probability measure on state space S used in EU and elsewhere.

$$V(f) = EU_P(f) + A\Big(\big(E_P\big(\zeta_i(s)\cdot u(f(s))\big)\big)_{0\le i\le n}\Big)$$

where ζ_i is a random variable, density of a signed measure if you want, with P-expectation 0, and the dot following ζ denotes inner product. Because ζ has P expectation 0, the inner product gives the P covariance between ζ_i and $u\big(f(s)\big)$. Can simplify some by taking ζ and P together as just one signed measure with total measure 0. (Keeping absolute continuity w.r.t. P in the back of one's mind, primarily to avoid violations of monotonicity.) The ζ depend on the states and not only on their probabilities implying that we do not have probabilistic sophistication. A deviation from probabilistic sophistication is needed to accommodate Ellsberg. $A(x) = A(-x)$ for all $x \in \mathbb{R}^n$. So, A is a generalized Absolute value function. The idea is that each ζ_i captures an informational interaction (ambiguity) between events. And that A is mostly negative and punishes for variance over ambiguous events. So, in Ellsberg 3-color with red know color and black and yellow the unknown colors, P assigns 1/3 to all colors, $\zeta(R) = 0$, $\zeta(B) = 1$, $\zeta(Y) = -1$, and A punishes for nonzero covariance with ζ.

Big descriptive problem of the model is that $A(x) = A(-x)$ excludes inverse S because, with outcomes in utils, for an unlikely event E the prospect 1_E0 is undervalued as much as $1_{E^c}0$ is $\big($turn 1_E0 into -1_E0 and then use weak certainty independence to add 1 util to all outcomes, which does not affect A$\big)$, whereas inverse S implies that the former is overvalued but the latter is undervalued. This makes the model descriptively problematic (in addition to the problems of the Anscombe-Aumann framework).

The ζs are not unique but become so if sharpness is imposed: then they are required to be orthonormal (linearly independence + orthogonality) and to assign value 0 to any crisp act (crisp means informally entailing no ambiguity or hedge against it, formalized by being replacable in any mixture by its certainty equivalent).

The model can be related to anchoring and adjustment à la Einhorn & Hogarth (properly cited by the author on p. 802). The model chosen here with interaction captured through inner product with complementarity between positive and negative part of ζs primarily captures n "binary" complementarities in a natural way. If the urn contains k exchangeable ambiguous colors with k > 2, then I don't see an easy way to model this. Maybe many ζ's must be defined (for each color one?) and A must capture the k-interactions? Not clear.

The axioms characterizing the model are some usual ones: weak ordering (A1), monotonicity (A2), continuity in outcomes (A3), nondegeneracy (A4), weak certainty independence (A5: only mixing with sure prospects to give independence under translations but not under rescalings), monotone continuity (A6) to give countable additivity of P, a probably redundant Complementary translation axiom (A8; only needed to handle two-sided bounded utility), and the crucial axiom of Complementary independence (A7), which I reformulate:

Assume that f and f* are complete hedges (their sum is constant as is their 50-50 mixture; the author calls it complementary), and so are g and g*. Assume that f ~ f* and g ~ g*. Then for all mixture weights α,

$\alpha f + (1-\alpha)g \sim \alpha f^* + (1-\alpha)g^*$.

Key in this model is pairs of acts that are perfect hedges (complementary) for each other, meaning that they sum to a constant act. Particularly useful are such pairs if they are indifferent (obtainable by adding constant utility to the worst of a pair of perfect hedges). Then their sum gives a constant act equal to the value of the two acts if EU were to hold; i.e., if A were 0. How much this constant act exceeds the certainty equivalent of the acts is how big −A is. Thus, we can measure the EU functional and also A. Being able to measure EU means that we can also measure P. Complementary independence will ensure, I expect, that the P measured this way is additive.

The model holds together with CEU (Choquet expected utility) if and only if there is a probability measure P such that, with W the weighting function, W underweights each event as much as its complement: $W(E) - P(E) = W(E^c) - P(E^c)$ for all events E. This property contradicts inverse S.

More ambiguity averse results are derived implying same subjective probability P and utility u, characterized by one A function always dominating the other.

biseparable utility violated: The model is not biseparable utility, although it does intersect with the latter (see above intersection with CEU). The main reason is that the function A can be too general and nonlinear. For example, take S =

$\{s_1,s_2\}$, payment in vNM utility (for instance prizes are [0,100], u is the identity on prizes, and for known probabilities we have EV). $p_1 = P(s_1) = p_2 = P(s_2) = 0.5$, and only one $\zeta_0 = \zeta$, defined by $\zeta(s_1) = 1/3 = -\zeta(s_2)$. $A(\alpha) = -|\alpha|$ if $|\alpha| \leq 37/3$, and $A(\alpha) = -|\alpha-37/3|/2 - 37/3$ if $|\alpha| > 37/3$. It means that, as long as outcomes within an act differ by no more than 37, then we have RDU with linear utility and $\pi(s_j)^b$ (the decision weight of state s_j when having the best outcome) = 1/3 and $\pi(s_j)^w$ (the decision weight of state s_j when having the worst outcome) = 2/3. In other words, $W(s_1) = W(s_2) = 1/3$. If the difference in outcomes exceeds 37, then whatever the best outcome has more than the worst + 37, is weighted only half as much. Then (using stimuli of Wakker 2010, §4.1) we have, with (x_1,x_2) denoting the act that yields vNM utility x_1 under s_1 and x_2 under s_2,

(38,1) ~ (24,8) and

(24,1) ~ (10,8)

implying, in Wakker's (2010, Eq. 10.5.2) notation, $38 \ominus 24 \sim^t_c 24 \ominus 10$.

However,

(39,0) ~ (24,7) and

(24,0) ~ (10,7)

imply, $39 \ominus 24 \sim^t_c 24 \ominus 10$. We have a violation of rank-tradeoff consistency (Wakker 2010 Def. 10.5.5), and RDU is violated by Wakker (2010, Theorem 10.5.6). %}

Siniscalchi, Marciano (2009) "Vector Expected Utility and Attitudes toward Variation," *Econometrica* 77, 801–855.

{% **dynamic consistency**: f**avors abandoning time consistency, so, favors sophisticated choice**; %}

Siniscalchi, Marciano (2011) "Dynamic Choice under Ambiguity," *Theoretical Economics* 6, 379–421.

{% Prooses a variation of sequential rationality in sequential games, involving trembling hand assumptions and the strategy method, also giving a new way to elicit preferences and beliefs off the equilibrium path. %}

Siniscalchi, Marciano (2022) "Structural Rationality in Dynamic Games," *Econometrica*, 90, 2437–2469.

{% %}
Sinn, Hans-Werner (1983) "*Economic Decisions under Uncertainty*," North Holland, Amsterdam.

{% p. 1 writes, on the combination of no-arbitrage with risk aversion: "The problem of valuation of a nontraded contingent claim has always been of central importance in mathematical finance ... Given a nonreplicable security, the market mechanism is not sufficient to determine an interval I of "threshold" prices such that any agent should buy at a price smaller than every p ∈ I, sell at a price greater than every p ∈ I, and *do nothing at any price* p ∈ I. Indeed, since the buying or selling at any *arbitrage-free price* could lead both to a loss or to a gain, the attitude of the agent toward risk must be taken into consideration to decide what he should do at any such price. Intuitively, the interval of threshold prices should depend on the investor and his initial wealth, and it should be contained in the interval of arbitrage-free prices. The classical approach in mathematical finance is to assume that the preferences of the agent are determined by the maximal expected utility u(x, q) that he can obtain by investing in the market an initial capital x if holding an endowment consisting of q illiquid contingent claims. Pricing rules derived from u(x, q) are called utility-based" [italics from original] %}
Siorpaes, Pietro (2016) "Do Arbitrage-Free Prices Come from Utility Maximization?," *Mathematical Finance* 26, 602–616.

{% Here is the ASCII spelling of the author's name, for searching purposes: Sipos.
Already proposes, in §3, a variation of the symmetrical Choquet integral à la prospect theory. Here the 0 outcome plays a central role, with an integral symmetrical about it. The negative part is integrated with respect to the dual capacity; i.e., it is the PT functional with reflection that also appeared in Starmer & Sugden (1989). Lemma 6.(i) explains that this integral is a sum of the positive and negative part. Does not refer to Choquet, apparently did not know it? %}
Šipoš, Ján (1979) "Integral with Respect to a Pre-Measure," *Mathematica Slovaca* 29, 141–155.

{% Here is the ASCII spelling of the author's name, for searching purposes: Sipos. %}
Šipoš, Ján (1979) "Non Linear Integrals," *Mathematica Slovaca* 29, 257–270.

{% **probability communication** & **ratio bias**: Reconsider Pighin et al. (2011), who argued that 1 in X is a bad way to communicate risk. This paper does a more extensive study and finds that the effect is weaker than in Pighin et al., but is existing. %}

Sirota, Miroslav, Marie Juanchich, Olga Kostopoulou, & Robert Hanak (2014) "Decisive Evidence on a Smaller-than-You-Think Phenomenon: Revisiting the "1-in-X" Effect on Subjective Medical Probabilities," *Medical Decision Making* 34, 419–429.

{% Considers nonarchimedean EU. %}

Skala, Heinz J. (1975) "*Non-Archimedean Utility Theory.*" Wiley, New York.

{% Considers Choquet integrals on Riesz spaces. %}

Skala, Heinz J. (1999) "Comonotonic Additive Operators and Their Representations," *Glasgow Mathematical Journal* 41, 191–196.

{% fuzzy set theory %}

Skala, Heinz J., Settimo Termini, & Enric Trillas (1984) "*Aspects of Vagueness.*" Reidel, Dordrecht.

{% **criticisms of Savage's basic framework**: Takes acts and events as primitive, consequences are act-event pairs. In beginning of paper, value of consequence can depend on counterfactual consequence and context, leading to a general model (Theorem 1) that can accommodate regret, disappointment, and most other things. §4 considers additive aggregation that in itself does not yet seem restrictive but in presence of "separability" (which does not relate solely to global prefs so might better be called something like forgone-branch independence (often called consequentialism)) it becomes restrictive. It results from making the structure preferentially isomorphic to Debreu (1960). The appendix extends to infinitely many events. Because the model is in fact **state-dependent utility**, the probability measure, which is indeed used, is pointed out to identify only null events (Example 1, (a), in the appendix, p. 362)

The technique is as follows. A general model is assumed for DUU. A substructure is assumed, however, that satisfies the SEU assumptions (say; in fact, the paper does it for state-dependent SEU). Say the substructure concerns all acts with monetary outcomes and here SEU is satisfied. Let us call this substructure the canonical structure. Next, for a general act where all interactions whatsoever between outcomes are permitted, we make a corresponding canonical act that is such that for each state of nature it yields the monetary amount that is equally good for that state of nature as the outcome resulting there for the general act. In this manner, the SEU representation from the canonical structure is extended to all acts, while permitting for all interactions thinkable. %}

Skiadas, Costis (1997) "Conditioning and Aggregation of Preferences," *Econometrica* 65, 347–367.

{% **tradeoff method**: it builds on his 1997 Econometrica paper but restricts the additive (state-dependent) functional there further by means of an indifference tradeoff consistency condition (Axiom A10, p. 257), to obtain an SEU model. %}

Skiadas, Costis (1997) "Subjective Probability under Additive Aggregation of Conditional Preferences," *Journal of Economic Theory* 76, 242–271.

{% %}

Skiadas, Costis (1998) "Recursive Utility and Preferences for Information," *Economic Theory* 12, 293–312.

{% Has a nice variation of the Anscombe-Aumann framework with a finite roulette-event space and a finite horse-event space, and uncertainty joint. The resulting product structure of the state space can nicely be used. One can better discuss the order of resolution of uncertainty (done in final para of main text, p. 73). Assumes quasi-convexity/uncertainty aversion. Weak certainty independence now more clearly amounts to constant relative risk aversion. The paper examines the role of weak certainty independence in detail. The sure-thing principle together with weak certainty independence imply SEU with log-power utility. This is proved in Appendix B.1, but it had been known before (Blackorby & Donaldson 1982, *International Economic Review;* Corollary 1.1; Wakker 1989, Theorem VII.7.5). The main Theorem 5 (p. 65) embeds this in a maxmin EU framework.

Theorem 11 has an SEU representation with power utility both for horses and for roulette, but they are only linked through an ordinal monotonicity and CE substitution, so they can have different powers, leading to source-dependent SEU (**event/outcome driven ambiguity model: outcome driven**). Can refer to this as Skiadas' source-dependence CRRA model. The author assumes the usual (but restrictive!) monotonicity of Anscombe-Aumann, called R-monotonicity here, meaning that we condition on horses. This result can, therefore be taken as recursive expected utility in the Anscombe-Aumann framework, which is the smooth ambiguity model but with the two stages exogenous.

criticism of monotonicity in Anscombe-Aumann (1963) for ambiguity: P. 63 penultimate para, ℓ. 6 writes, appropriately on monotonicity in the Anscombe-Aumann framework, called R-monotonicity here: "This is not an innocuous assumption" %}

Skiadas, Costis (2013) "Scale-Invariant Uncertainty-Averse Preferences and Source-Dependent Constant Relative Risk Aversion," *Theoretical Economics* 8, 59–93. https://doi.org/10.3982/TE1004C

{% The paper is a variation of Epstein-Zin by having several sources of uncertainty and then "local" EU, within each source, with a source-dependent utility function. It is like Chew et al.'s (2008) source-dependent EU. (**source-dependent utility**) (**event/outcome driven ambiguity model: outcome driven**) Time separability is assumed. This is like Abdellaoui et al.'s (2011 American Economic Review) source method, with local within-source but no global between-source probabilistic sophistication. The author assumes SEU within each source and captures source preference (my term) through source-dependent utility, as in the smooth model.

I regret that, if there is source dependence of preference, the author calls it different risk attitude. If a first source has more concave utility than a second (so, lower certainty equivalents), the author says that the first source has more risk aversion. This same unfortunate terminology was used by Chew et al. (2008) and Kilka & Weber (2001). It may be easier to sell to noninitiated audiences at first acquaintance, but this terminology cannot survive. Risk attitude should only concern known OBJECTIVE probabilities. The difference between the unknown and the known Ellsberg urns is due to ambiguity attitude, and not due to changed risk attitude.

In the axiomatization, SEU within each source comes from separability giving state-dependent SEU, and then constant relative risk aversion which is known to then imply SEU (Wakker 1989-book Theorem VII.7.5), and give CRRA (logpower) utility. %}

Skiadas, Costis (2015) "Dynamic Choice with Constant Source-Dependent Relative Risk Aversion," *Economic Theory* 60, 393–422.
https://doi.org/10.1007/s00199-015-0920-9

{% This book follows Keynes (1937) (more than Keynes (1936) general theory, which is what Paul Krugman seems to prefer). Most of economics assumes that uncertainty can be reduced to risk, so that we can calculate expectations, correlations, and so on with certainty, and can use Lucas' rational expectations. The efficient market hypothesis is based on it. A spokesman of Goldman Sachs' (chief financial officer David Viniar ?), seems to have declared August 17 2007, at the beginning of the financial crisis, that events were occurring that according to the best models around should happen once in 10^{140} times. It shows that uncertainty isn't like risk, a point raised forcefully before by Keynes (1921) (better than Knight 1921), and reiterated by Keynes (1937). The author even argues that macroeconomics should be dedicated to the study of uncertainties that cannot be reduced to risks. %}

Skidelsky, Robert (2009) "*Keynes: The Return of the Master.*" Penguin, London.

{% **conservation of influence**: Deviates from Watson's behaviorism, who took living beings as no more than mechanistacally reacting to stimuli, and added to that "operant gedrag" where the living being has influence. That is, Skinner added agent's influence! %}

Skinner, Burrhus F. (1971) "*Beyond Freedom and Dignity.*" Knopf, New York.

{% Seems to be last text he wrote, knowing he would die. It is a very opiniated text, arguing against the cognitive approach and favoring behaviorism. So, he wants to keep things simple at the level of directly observable phenomena and predictions directly in terms of them and their (cor)relations. Wants no abstractions such as cognitive concepts. I did not understand several parts, conjecturing that they are not clearly written. In several parts he puts up straw men. His expectations of neurology are naïve, and of a physicism-ubiquity-fallacy type. Thus, p. 293 end of para −3: "In a behavioural account the whole organism responds, and it responds to the world around it — for reasons which neurology, not cognitive science, will eventually discover." P. 295: "What is happening inside is a question to be answered by neurology, with its appropriate instruments and methods." P. 300: "Cognitive science is often only premature neurology." (**ubiquity fallacy**)

P. 294 has a nice text: "Mrs. E. Craster (d. 1874) suggested that when the toad asked the centipede: 'Pray, which leg goes after which?' the centipede worked her mind to such a pitch/She lay distracted in the ditch/Considering how to run."

P. 295: "A similar mistake is made when cognitive psychologists call operant behaviour purposive or goal-oriented. Features suggesting direction toward a goal are the products of consequences experienced in the past." (**conservation of influence**) and p. 300: "I accuse cognitive scientists of reviving a theory in which feelings and states of mind observed through introspection are taken as the causes of behaviour rather than as collateral effects of the causes." %}

Skinner, Burrhus F. (1985) "Cognitive Science and Behavourism," *British Journal of Psychology* 76, 291–301.

{% **probability intervals**: pp. 192-193 mentions the difference between multiple priors and interval probabilities. Unfortunately, it takes combinations of Dempster-Shafer belief/plausibility functions, and of convex-concave capacities, as an example of interval probabilities. This is not formally incorrect, but can be confusing because, if the concave capacity is to be taken as the dual of the convex one (similarly as a plausibility function is the dual of the belief function), then the convex capacity alone captures all the info, and this capcity can in turn be related uniquely to a set of priors. So, this is a case where the interval probabilities can be uniquely related to multiple priors, and the two models are not fundamentally different. Essential differences do arise if we relax some assumptions, such as allowing for nonconvex-nonconcave capacities. Full generality is achieved if we further allow the lower capacity not to be the dual of the upper capacity. %}

Škulj, Damjan (2006) "Jeffrey's Conditioning Rule in Neighbourhood Models," *International Journal of Approximate Reasoning* 42, 192–211.

{% Seems to argue that the difference between known objective probabilities and unnown subjective probabilities is there but only so with updating, which is also my opinion. (**updating: discussing conditional probability and/or updating**) %}

Skyrms, Brian F. (1977) "Resiliency, Propensities, and Causal Necessity," *Journal of Philosophy* 74, 704–713.

{% %}

Skyrms, Brian F. (1980) Book Review of: Arthur W. Burks (1977) "Cause, Chance, and Reason," University of Chicago Press, Chicago; *Theory and Decision* 12, 299–309.

{% **second-order probabilities to model ambiguity** %}

Skyrms, Brian F. (1980) "Higher Order Degrees of Belief." *In* David H. Mellor (1980, ed.) *Prospects for Pragmatism. Essays in Memory of F.P. Ramsey*, 109–137, Cambridge University Press, Cambridge.

{% It seems that he lets states of nature be mappings from acts to outcomes. %}

Skyrms, Brian F. (1980) "*Causal Necessity*." Yale University Press, New Haven.

{% **foundations of probability** %}

Skyrms, Brian F. (1988) "Probability and Causation," *Journal of Econometrics* 39, 53–68.

{% Ch. 4 discusses Ramsey (1926). %}

Skyrms, Brian F. (1990) "*The Dynamics of Rational Deliberation*." Harvard University Press, Cambridge, MA.

{% **Dutch book**s; **interpretations of sigma-additivity** %}

Skyrms, Brian F. (1995) "Strict Coherence, Sigma Coherence, and the Metaphysics of Quantity," *Philosophical Studies* 77, 39–55.

{% Keynes distinguished the balance of evidence and the weight, arguing that the latter can matter, and it underlies the modern ambiguity theories. This paper

seems to argue that that weight of evidence indeed plays a role, but only when it comes to the dynamic point of updating. This is surely my opinion. Weight of evidence plays no role in static decisions, but in updating. The term “resilience” seems to refer to this idea. (**updating: discussing conditional probability and/or updating**) %}

Skyrms, Brian F. (2011) “Resiliency, Propensities and Causal Necessity.” *In* Antony Eagle (ed.) *Philosophy of Probability: Contemporary Readings*, 529–536, Routledge, London.

{% The authors observe that addition of ratio scales is not meaningful, but multiplication is, with one or two more observations of this kind. These observations are the contribution of this paper. It adds many nice, but basically unrelated, classical citations. %}

Skyrms, Brian & Louis Narens (2019) “Measuring the Hedonimeter,” *Philosophical Studies* 176, 3199–3210.
https://doi.org/10.1007/s11098-018-1170-z

{% %}

Slater, Patrick (1961) “Inconsistencies in a Schedule of Paired Comparisons,” *Biometrika* 48, 303–312.

{% Patients will accept more risks to choose for chemotherapy than doctors/nurses will recommend. (Explanation I suggest: doctors & Nurses care more about costs/time which means, indirectly, interests of other patients.) %}

Slevin, Maurice L., Linda Stubbs, Hilary J. Plant, et al. (1990) “Attitudes to Chemotherapy: Comparing Views of Patients with Cancer and Those of Doctors, Nurses, and General Public,” *British Medical Journal* 300, 1458–1460.

{% Compare subjective probability estimates of people regarding health impairments with their objectivew probabilities, and find no systematic differences. I would expect that small probabilities are overestimated and large ones are underestimated, mainly because of regression to the mean, but did not find a distinction between small and large probabilities in the paper. %}

Sloan, Frank A. (2024) “Subjective Beliefs, Health, and Health Behaviors,” *Journal of Risk and Uncertainty* 69, 105–144.
https://doi.org/10.1007/s11166-024-09435-5

{% **utility depends on probability**: seem to argue that in sports the utility of a result depends on its probability. %}
Sloane, Peter J. (1976) “Restrictions on Competition in Professional Team Sports,” *Bulletin of Economics Research* 28, 3–22.

{% %}
Sloman, S., Yuval Rottenstreich, Edward Wisniewski, Constantinides Hadjichristidis, & Craig R. Fox (2004) “Typical versus Atypical Unpacking and Superadditive Probability Judgment,” *Journal of Experimental Psychology: Learning, Memory & Cognition* 30, 573–582.

{% Elementair boek over statistiek, speciaal geschikt voor psychologen; het legt allerlei termen uit !zonder! formules. %}
Slotboom, Anke M. (1987) “*Statistiek in Woorden.*” Wolters-Noordhof, Groningen.

{% **real incentives/hypothetical choice**: For gain-loss gambles, more risk aversion for real payment. Gives nice early references. Feather (1959), for one, preceded this study.

All gambles have one gain and one loss. Subjects are more risk seeking for hypothetical lotteries than for real-payment lotteries. Not clear if this is caused by loss aversion or by other factors of risk aversion.

losses from prior endowment mechanism: Subjects received $1.50 prior to participation but could lose more. Subjects in real play did play several of the gambles, so there is an income effect. %}
Slovic, Paul (1969) “Differential Effects of Real versus Hypothetical Payoffs on Choices among Gambles,” *Journal of Experimental Psychology* 80, 434–437.

{% Seems to argue against risk-aversion as a generalized characteristic of individuals, invariant over different settings. %}

Slovic, Paul (1972) "Information Processing, Situation Specificity, and the Generality of Risk-Taking Behavior," *Journal of Personality and Social Psychology* 22, 128–134.

{% Seems to argue against risk-aversion as a generalized characteristic of individuals, invariant over different settings. %}
Slovic, Paul (1972) "Psychological Study of Human Judgment: Implications for Investment Decision Making," *Journal of Finance* 27, 779–799.

{% Shows choice-matching discrepancy. Introduces prominence effect. Argues that probability is the prominent attribute in lotteries with one nonzero outcome. %}
Slovic, Paul (1975) "Choice between Equally Valued Alternatives," *Journal of Experimental Psychology: Human Perception and Performance* 1, 280–287.

{% Factor analysis and review of introspective perceptions of riskiness. P. 282 ℓ. 4: people are willing to take 1000 times greater risk if due to voluntary activities than if due to involuntary hazards, given same benefits. (**violation of risk/objective probability = one source**) %}
Slovic, Paul (1987) "Perception of Risk," *Science* 236(4799), 280–285.

{% Easy, accessible review of preference reversals and constructive viewpoint; cites Maclean (unpublished) for medical decision making who argues that preference measurement should be more involved and interactive than the normal approach.
P. 369 writes, on the prescriptive purpose of preference construction: "truth ultimately resides in the process, rather than in the outcome." %}
Slovic, Paul (1995) "The Construction of Preference," *American Psychologist* 50, 364–371.

{% %}
Slovic, Paul (2010) "*The Feeling of Risk: New Perspectives on Risk Perception*." Earthscan, London.

{% **risk averse for gains, risk seeking for losses**. Find that stating a problem with risky losses as an insurance question, changes risk seeking attitudes into risk aversion attitudes. (**insurance frame increases risk aversion**) %}

Slovic, Paul, Baruch Fischhoff, & Sarah Lichtenstein (1982) "Response Mode, Framing, and Information-Processing Effects in Risk Assessment." *In* Robin M. Hogarth (ed.) *New Directions for Methodology of Social and Behavioral Science: Question Framing and Response Consistency* no. 11, 21–36, Josssey-Bass, San Francisco.

{% **PE higher than CE**: Study 5 shows that probability equivalent method gives higher utility than certainty equivalent method

Pp. 22-23 suggest that probability is a "prominent dimension" in choices between one-nonzero-outcome-gambles: "In terms of the prominence factor, the more important dimension (i.e., probability) is expected to loom larger in choice than in either matching procedure... both compatibility and prominence are present in the data." This is contrary to Tversky, Sattath, & Slovic (1988), p. 382. %}

Slovic, Paul, Dale Griffin, & Amos Tversky (1990) "Compatibility Effects in Judgment and Choice." *In* Robin M. Hogarth (ed.) *Insights in Decision Making, A Tribute to Hillel J. Einhorn*, 5–27, The University of Chicago Press, Chicago.

{% %}

Slovic, Paul & Sarah Lichtenstein (1968) "Importance of Variance Preferences in Gambling Decisions," *Journal of Experimental Psychology* 78, 646–654.

{% P. 3 2nd para: S**EU = SEU** This paper gave inspiration for the later discovery of preference reversals; nonlinearity in probabilities. %}

Slovic, Paul & Sarah Lichtenstein (1968) "Relative Importance of Probabilities and Payoffs in Risk Taking," *Journal of Experimental Psychology Monograph* 78 (no.3, Pt. 2) 1–18.

{% %}

Slovic, Paul & Sarah Lichtenstein (1983) "Preference Reversal: A Broader Perspective," *American Economic Review* 73, 596–605.

{% **(very) small probabilities**: Seem to say that small probabilities may be ignored. Seems to have: **insurance frame increases risk aversion** %}

Slovic, Paul, Sarah Lichtenstein, Bernard Corrigan, & Barbara Combs (1977) "Preference for Insuring against Probable Small Losses: Insurance Implications," *Journal of Risk and Insurance* 44, 237–258.

{% **survey on nonEU**

P. 674: "Perhaps the most important of these activities is problem structuring,"

ubiquity fallacy: p. 674: "Perhaps the most important of these activities is problem structuring, in which the decision maker specifies the possible actions, the states of the world relevant to the decision, and the outcomes contingent on both the chosen action and the states of the world that can occur." Although the authors suggest that this is a text on general decision making, they only consider decision under uncertainty, and, narrowing further, then only the Savage way of structuring it. **criticisms of Savage's basic framework**: it is the opposite here. The authors do not even know that Savage's framework is not the only one.

P. 675 lists some experimental studies into subjects' structuring of a problem.

P. 699 lists falsifications of moment-based decision theories.

P. 699 discusses a forgotten nonEU theory, developed by Coombs: Preferences are determined by two things. 1. EV; 2. a perception of riskiness (seems to be assumed single-peaked in some sense)

lists falsifications of moment-based decision theories.

risky utility u = strength of preference v (or other riskless cardinal utility, often called value): p. 714 and many other parts follow this idea.

Pp. 717-726 have a nice line: first models called algebraic. Then models with the term process contained. P. 718 top discusses paramorphic modeling.

P. 628: "Deeper understanding of framing effects, which used car salespeople have had for a long time and psychologists are beginning to acquire, …" McFadden (2006 p. 12) has a similar text on people from hotelling. %}

Slovic, Paul, Sarah Lichtenstein, & Baruch Fischhoff (1988) "Decision Making." *In* Richard C. Atkinson, Richard J. Herrnstein, Gardner E. Lindzey, & R. Duncan Luce (eds.) *Stevens Handbook of Experimental Psychology* 2, 673–738, Wiley, New York.

{% No real incentives, only hypothetical, and too few subjects to do statistics. Humphrey & Kruse (2024) redo the experiment fixing all these problems, and confirm the findings of this paper.

In Allais paradox (also Ellsberg paradox), the authors present subjects with arguments for/against Savage/Allais. Some more are convinced by Allais' arguments than by Savage's. The authors conclude that Savage's sure-thing principle is not as generally convincing to people as has been thought before. The authors never state explicitly what their own personal opinion is on the normative status of the axiom. This paper reacts to a similar study by MacCrimmon (1968) that did find most subjects convinced by Savage's axioms.

Curley, Yates, & Abrams (1986) also gave subjects arguments for and against ambiguity aversion, after which 80% wanted to be ambiguity averse. %}

Slovic, Paul & Amos Tversky (1974) "Who Accepts Savage's Axiom?," *Behavioral Science* 19, 368–373.
https://doi.org/10.1002/bs.3830190603

{% Stigler (1950) is enthusiastic about this paper.

coherentism: p. 1 (where "it" refers to economics) "we must make it completely independent of psychological assumptions and philosophical hypothesis."

According to Stigler, §V, just above A., with Slutsky's development, introspection no longer plays a significant role in utility theory. He, obviously, makes this claim for economics. %}

Slutsky, Evgeny E. (1915) "Sulla Teoria del Bilancio del Consumatore," *Giornale degli Economisti* series 3, 51, 1–26. Translated into English by Olga Ragusa (1952) as:
"On the Theory of the Budget of the Consumer."
In George J. Stigler & Kenneth E. Boulding (eds.) *Readings in Price Theory*, 27–56, Americal Economic Association; RD Irwin Inc, Chicago.

{% As nice as its title says. Expectation is projection on constant functions, so, special case of conditional expectation, etc. %}

Small, Christopher G. & Don L. McLeish (1994) "*Hilbert Space Methods in Probability and Statistical Inference.*" Wiley, New York.

{% People give more donations to dramatic castrophes such as earth quake than to bigger catastrophes such as malaria because they, because of reference point effects, perceive the former as bigger than the latter. %}

Small, Deborah A. (2010) “Reference-Dependent Sympathy,” *Organizational Behavior and Human Decision Processes* 112, 151–160.

{% Seems to be the first publication explaining Smet’s pignistic transformation and giving its justification. %}

Smets, Philippe (1989) “Constructing the Pignistic Probability Function in a Context of Uncertainty.” *In* Max Henrion, Ross D. Shachter, Laveen N. Kanal, & John F. Lemmer (eds.) “U*ncertainty in Artificial Intelligence* 5,” 29–40, North-Holland, Amsterdam.

{% %}

Smets, Philippe (1991) “The Transferable Belief Model and Other Interpretations of Dempster-Shafer’s Model.” *In* Piero P. Bonissone, Max Henrion, Laveen N. Kanal, & John F. Lemmer (eds.) *Uncertainty in Artificial Intelligence* 6, 375–383, Elsevier, Amsterdam.

{% **Dutch book**; **updating: discussing conditional probability and/or updating**: Seems to propose a model of dynamic choice within Smets transferable belief model that avoids sure losses and Dutch books. %}

Smets, Philippe (1993) “No Dutch Book Can Be Built against the TBM even though Update Is not Obtained by Bayes Rule of Conditioning.” *In* Romano Scozzafava (ed.) *Workshop on Probabilistic Expert Systems*, 181–204, Società Italiana di Statistica, Rome, Italy.

{% **updating: discussing conditional probability and/or updating**: seems to explain the transferable belief model and to re-explain the pignistic transformation. %}

Smets, Philippe & Robert Kennes (1994) “The Transferable Belief Model,” *Artificial Intelligence* 66, 191–234.

{% **risky utility u = transform of strength of preference v**; 253 farmers were interviewed, face to face, during two consecutive years for risky utility of the price for poratoes, ranging from 10 cents/kg to 70 cents/kg (by CE (certainty equivalent) method) and by direct strength of preference. Thus, the total gains or losses depend on how many kgs of potatoes the farmer had, and what the expenses were. For both u and v, exp. functions fitted better than powers. u is exponential transformation of v, remarkably u is less concave than v.

remarkably, u is less concave than v.

CE bias towards EV: that can support the hypothesis that CE questions contain not only biases that enhance risk aversion but also biases in themselves to enhance risk seeking.

P. 362 does cross-checks, finds deviations of approximately 8% in cross-checks questions, and concludes from that that internal consistency is good.

P. 362: Majority exhibited concave utility, it was plausible that they took outcomes as gains. Note that there was one-parameter fitting. %}

Smidts, Ale (1997) "The Relationship between Risk Attitude and Strength of Preference: A Test of Intrinsic Risk Attitude," *Management Science* 43, 357–370.

{% **free will/determinism**: free will illusionism: although we have no free will, it is important that we keep the illusion of it. %}

Smilansky, Saul (2002) "*Free Will and Illusion*." Oxford University Press, Oxford.

{% P. 44 seems to argue for diminishing marginal utility. %}

Smith, Adam (1759-1790) "*The Theory of Moral Sentiments*" [1976 edn. by David D. Raphael & Alec L. Macfie], Clarendon Press, Oxford.

{% **coherentism**: They argue/show that preferences can be predicted from neurodata. P. 2 writes: "Furthermore, since there may also be stable relationships between real choices and a much broader class of nonchoice variables, there is no a priori reason to limit a prediction exercise to elicited preferences." They use the nice term nonchoice variables. This general point was also central in Abdellaoui, Barrios, & Wakker (2007). %}

Smith, Alec, B. Douglas Bernheim, Colin F. Camerer, & Antonio Rangel (2014) "Neural Activity Reveals Preferences without Choices," *American Economic Journal: Microeconomics* 6, 1–36.

{% Has the concept of utility, between Bernoulli (1738) and Bentham (1789).

Put forward the famous water-diamond paradox; i.e., the paradoxical difference between value in use and value in exchange. Water exceeds diamond as regards the former but not the latter.

equate risk aversion with concave utility under nonEU: Smith does not do this but clearly distinguishes.: Book I, Ch. X, §1 on risky choices between "lotteries" is interesting. Bréban & Lapidus (2019) nicely argue that Smith assumes diminishing marginal utility (1759-1790) "*The Theory of Moral Sentiments*" [1976 edn., p. 44 seems to be clear on it) but risk seeking, which is a good motivation for RDU. Smith clearly ascribes the risk seeking to overestimation of chance of good fortune. "The chance of gains is by every man more or less overvalued, and the chance of loss is by most men undervalued."

inverse S (although it does not specify small probability as relevant to inverse S) P. 210 seems to write: "That the chance of gain is naturally over-valued we may learn from the universal success of lotteries … The vain hope of gaining some of the great prizes is the sole cause of this demand. The soberest people scarce look upon it as a folly to pay a small sum for the chance of gaining ten or twenty thousand pounds."

Smith nicely distinguishes probability overestimation from overestimating own abilities, and seems to write: "The over-weening conceit which the greater part of men have of their own abilities, is an antient evil remarked by the philosophers and moralists of all ages. Their absurd presumption in their own good fortune, has been less taken notice of. It is, however, if possible, still more universal. There is no man living who, when in tolerable health and spirits, has not some share of it. The chance of gain is by every man more or less over-valued, and the chance of loss is by most men under-valued, and by scarce any man, who is in tolerable health and spirits, valued more than it is worth." (pp. 124-5)

On other-regarding preferences, seems to write: "How selfish soever man may be supposed, there are evidently some principles in his nature, which interest him in the fortune of others, and render their happiness necessary to him, though he derives nothing from it except the pleasure of seeing it." %}

Smith, Adam (1776) "*An Inquiry into the Nature and Causes of the Wealth of Nations*" [1976 edn. by Roy H. Campbell & Andrew S. Skinner], Clarendon Press, Oxford.

{% **probability intervals**; **Dutch book**; §13, p. 13, introduced lottery-prizes as quantitative outcomes alternative to money, to avoid utility curvature. The story is funny: a very small diamond is put in beeswax, you get y gram, it will be melted, and you find or do not find the diamond. %}

Smith, Cedric A.B. (1961) "Consistency in Statistical Inference and Decision," *Journal of the Royal Statistical Society B* 23, 1–25.

{% Seems to have probability intervals. %}

Smith, Cedric A.B. (1965) "Personal Probability and Statistical Analysis," *Journal of the Royal Statistical Society A* 128, 469–499.

{% %}

Smith, Edward E. & Douglas L. Medin (1981) "*Categories and Concepts*." Harvard University Press, Cambridge, MA.

{% **SPT instead of OPT**: p. 1548 %}

Smith, Gary, Michael Levere, & Robert Kurtzman (2009) "Poker Player Behavior After Big Wins and Big Losses," *Management Science* 55, 1547–1555. https://doi.org/10.1287/mnsc.1090.1044

{% **dynamic consistency**: Examines errors induced by failing to account for possibilities to borrow and lend in risk analyses of cash flows. It is a nice case where the timing of the resolution of uncertainty can rationally matter because of intermediate decisions. %}

Smith, James E. (1998) "Evaluating Income Streams: A Decision Analysis Approach," *Management Science* 44, 1690–1708.

{% Assume the usual QALY model, but add that in addition to health quality per se, there are other things, being consumption of commodities. The model is L-QALY = $\mathrm{SUM}_j q_j u(c_j)$, where q_j is quality of life index, $u(c_j)$ utility of consumption of commodity bundle c_j, and the person can enjoy the latter only partially, part q_j, if in impaired health state. L-QALY designates life-QALY as opposed to health QALY. Analyze some optimization problems under this model.

Figure 14 has decision tree for aneurysm. Maybe: s**imple decision analysis cases using EU** %}

Smith, James E. & Ralph L. Keeney (2005) "Your Money or Your Life: A Prescriptive Model for Health, Safety, and Consumption Decisions," *Management Science* 51, 1309–1325.

{% **Conservation of influence**: flexibility is future influence.

They use a consultancy with an oil/gas company to compare standard option pricing techniques (where often a discount rate higher than the risk-free market discount rate is used to reflect extra risks borne) and decision analysis techniques, and show how to integrate them.

P. 15 endnote 6: discusses as-if risk-neutral evaluation by market in presence of risk aversion.

The paper illustrates several points for applied decision analysis:

(1) The major issue in practice is to get the right model.

(2a) One should pay attention to future decision options ("flexibility;" (P. 1 1st column ℓ. –4 and throughout).

(2b) The finance techniques of pricing the future choice flexibility of options can be useful to evaluate future decisions.

(3) One has to trade off completeness of a model and tractability. (P. 3 2nd column 2nd para, that Figure 2 is much too large. 3rd para about 52,500 end points in simplified tree. P. 4 2nd para, discussing for instance getting amount of computer programming).

(4) When to use market expectation and when own subjective (p. 9 2nd para penultimate para). P. 9 ℓ. –3: option valuation for market risks and DA for private risks.

(5) Instead of lognormal distributions assumed in finance, here mean-reverting distributions were better (p. 6 2nd para). This reduces the impact of incorporating flexibility (p. 7 1st column ℓ. –3). %}

Smith, James E. & Kevin F. McCardle (1999) "Options in the Real World: Lessons Learned in Evaluating Oil and Gas Investments," *Operations Research* 47, 1–15.

{% %}

Smith, James E. & Canan Ulu (2017) "Risk Aversion, Information Acquisition, and Technology Adoption," *Operations Research* 65, 1011–1028.

{% P. 570: 60% of decision analysis applications is in health. %}

Smith, James E. & Detlof von Winterfeldt (2004) "Decision Analysis in Management Science," *Management Science* 50, 561–574.

{% When choosing a best option, its expected utility is usually overestimated (the optimizer's curse), so that usually some disappointment will follow. %}

Smith, James E. & Robert F. Winkler (2006) "The Optimizer's Curse: Skepticism and Postdecision Surprise in Decision Analysis," *Management Science* 52, 311–322.

{% Made brain scans of subjects (N = 9, all medical students) while doing Ellsberg paradox etc. These subjects had electrodes in themselves and got radio-active liquids injected every two minutes ...

risk averse for gains, risk seeking for losses: This they find, the subjects are risk averse for gains and risk seeking for losses when probabilities are known. Figure 2 shows more risk aversion for gains than risk seeking for losses.

ambiguity seeking for losses: They do find less ambiguity avoidance for losses than for gains, but subjects are still ambiguity averse also for losses. The reason may be, first, the contrast effect, the choice is directly between known and unknown probability. There is a second reason: Subjects cannot choose their color in the unknown urn, so they may be suspicious (**suspicion under ambiguity**). This also occurred in Lan, Cherng-Horng, Peter Ayton, & Nigel Harvey (2010).

reflection at individual level for ambiguity %**}**

Smith, Kip, John W. Dickhaut, Kevin McCabe, & José V. Pardo (2002) "Neuronal Substrates for Choice under Ambiguity, Risk Certainty, Gains and Losses," *Management Science* 48, 711–718.

{% To what extent desires (motivated or not, normative or not) are causes of acts. %}

Smith, Michael (1987) "The Humean Theory of Motivation," *Mind* 96, 36–61.

{% %}

Smith, Richard D. (1996) “Is Regret Theory an Alternative Basis for Estimating the Value of Health care Interventions?,” *Health Policy* 37, 105–115.

{% P. 324 & 325: Considers EU to be normative. But does not want to qualify deliberate violations to be mistakes.

event/outcome driven ambiguity model: outcome driven: The title already indicates this. Further, p. 325 writes: “But I do not care for the probabilistic interpretation of the violations. To me probabilities are probabilities in the sense of nonnegativity, additivity and the property of the unit measure over the whole event space. I grant the right of a man to have systematic and deliberate preferences for rewards based on dice game contingencies over the same rewards based on Dow-Jones stock price contingencies. But if he insists also that he is less than certain that the Dow-Jones average will either rise or not rise by five points or more tomorrow, then so far as I am concerned he is now making a “mistake.” He does not understand what is (or should be) meant by probability. He is entitled to his tastes, but not to any new definitions of probability.”

P. 325, on Ellsberg-like situations: “…, there may be real or imagined elements of skill which increase or reduce the subjective value of the outcomes “lose” or “win.” ” So, he thinks that in, say, Ellsberg two-color paradox, the utility of an outcome can be lower if it results from a color from the unknown urn than from the known urn. I find this a very very weird idea. In the same way as Smith writes on p. 325 ℓ. 6: “probabilities are probabilities” I will say “a dollar is a dollar” where “is” is in the sense of giving the same utility. You can do the same with a dollar if you have it after a black ball from a known urn as after a black ball from an unknown urn. Then he brings in, on p. 325 2/3, the competence effect, with social effects of being blamed brought in.

second-order probabilities to model ambiguity: p. 329 closing para, suggests that ambiguity is the same as 2^{nd} order probability.

%}

Smith, Vernon L. (1969) “Measuring Nonmonetary Utilities in Uncertain Choices: The Ellsberg Urn,” *Quarterly Journal of Economics* 83, 324–329.

{% **real incentives/hypothetical choice**

Kachelmeier & Shehata say: the “dominance postulate” has induced incentives in the economics literature (clarified in Smith & Walker, 1993). %}

Smith, Vernon L. (1976) "Experimental Economics: Induced Value Theory," *American Economic Review, Papers and Proceedings* 66, 274–279.

{% Much cited, and sometimes given a sort of bible status. But I find it a weird paper. It formulates conditions for microeconomic experiments:

saliency: rewards should be linked to actions of subjects;

Payoff dominance: reward structure dominates (subjective) costs of participation (e.g., calculation costs).

The paper is best understood from a historical perspective. Smith wanted to convince mainstream orthodox classical theoretical economists that experiments are to be taken seriously. So, he wanted everything to look solid and strict. This is why he had an obsession for calling experimental economics "science" rather than research. And this is why this paper puts up formal observations and theorems. And precepts. I do not find them useful. In many situations, a precept is trivially satisfied and then no need to think about it. In other situations, the precept is violated, but then it just is no good. For instance, Precept 1, nonsatiation, requires monotonicity of utility in payoff. But if we study a payoff that is not monotonic, such as amount of wine drunk per day (utility first increasing, then decreasing), then it is just not satisfied. No reason to forbid studying such. Or privacy, where subjects are supposed not to know the payoffs of others. Well, in game theory we usually want all payoffs to be common knowledge. Or we want to study reactions to repeated payoffs given to others. %}

Smith, Vernon L. (1982) "Microeconomic Systems as an Experimental Science," *American Economic Review* 72, 923–955.
https://www.jstor.org/stable/1812014

{% P. 159, footnote 8, argues for a behavioral preference assumption (constant relative risk aversion) that market data are not well suited to refute it because they are too complex:

> I have been asked: "How do you react to criticisms which say that from market data we can reject the assumption of constant relative risk aversion? We can look at how individuals change their portfolio with wealth, and it does not conform even to a much looser specification of the utility function? Why test a theory which has been rejected by

> market data?" Here are my reactions. (1) We can't reject the theory from this kind of market data. The data tells us how portfolios change with some measure of "wealth," confounded with changes in time, income, expectations, information, unmeasured probability assessments, and so on *ad infinitum*. We can't learn what we want to know from this sort of exercise independently of some rigorous tests, although market evidence and experimental evidence can illuminate each other. (2) … (3) [(2) and (3) describe two empirical findings that do support constant relative risk aversion] (4) Constant relative risk aversion need not be valid over the entire interval of positive income to yield predictive accuracy over the relevant range of observations. Probably no functional form will be satisfactory everywhere.

P. 164 argues that the vNM axioms do not speak to what the outcomes are, apparently taking EU as branch of abstract mathematics rather than as an empirical science:

"The axioms of the theory do not tell us what the prizes are." %}

Smith, Vernon L. (1989) "Theory, Experiments and Economics," *Journal of Economic Perspectives* 3, 151–169.

{% **real incentives/hypothetical choice**; advances the experimental-economics arguments. Is sometimes highly critical of psychologists, in particular Kahneman & Tversky. For instance, footnote 5 cites a referee saying: "It seems to me that the psychologists have not done their homework." Such aggressive and unworthy texts have contributed to the inefficient animosity between experimental and behavioral economists that arose in following decades. %}

Smith, Vernon L. (1991) "Rational Choice: The Contrast between Economics and Psychology," *Journal of Political Economy* 99, 878–897.

{% %}

Smith, Vernon L. (1994) "Economics in the Laboratory," *Journal of Economic Perspectives* 8, 113–131.
https://doi.org/10.1257/jep.8.1.113

{% Discusses, a.o., the Duhem-Quine problem: result of experiments can always have been distorted because of confounds due to other assumptions presupposed. %}

Smith, Vernon L. (2002) "Method in Experiment: Rhetoric and Reality," *Experimental Economics* 5, 91–110.

{% %}
Smith, Vernon L. (2008) "*Rationality in Economics: Constructivist and Ecological Forms*." Cambridge University Press, Cambridge.

{% **real incentives/hypothetical choice**: paying subjects reduces variance %}
Smith, Vernon L. & James M. Walker (1993) "Monetary Rewards and Decision Cost in Experimental Economics," *Economic Inquiry* 31, 245–261.

{% %}
Smith, Vernon L. & Bart J. Wilson (2017) "Sentiments, Conduct, and Trust in the Laboratory," *Social Philosophy & Policy* 34, 25–55.

{% A pop singer and movie star.
conservation of influence: seems to have written on twitter: "If you got a problem, try to fix it. If you can't fix it, it's probably not your problem." %}
Smith, Will

{% Conflicting evidence is if two experts give different probability estimates. I want to add that special attention should be given to a case where one expert estimates an extreme probability 0 or 1. Say one expert says p = 1 and the other p = 0.8. Then it is natural that subjects give more weight to the sure expert, and taking the probability-midpoint 0.9 as representative of this state of info is not reasonable. Provided subjects with hypothetical info in the form of interval estimates, and asked them to judge introspectively what constituted conflicting evidence, what ambiguity, what uncertainty, and so on. %}
Smithson, Michael J. (1999) "Conflict Aversion: Preference for Ambiguity vs Conflict in Sources and Evidence," *Organizational Behavior and Human Decision Processes* 79, 179–198.

{% %}

Smorodinsky, Rann (2000) "The Reflection Effect for Constant Risk Averse Agents," *Mathematical Social Sciences* 40, 265–276.

{% **measure of similarity** %}

Sneath, Peter H.A. & Robert R. Sokal (1973) "*Numerical Taxonomy: The Principles and Practice of Numerical Classification*." Freeman, San Francisco.

{% %}

Sneddon, Robert (2001) "Bias in a PEST Procedure,"

{% Seems that they measured probability weighting, and found that two-parameter family fits best. %}

Sneddon, Robert & Robert Duncan Luce (2001) "Empirical Comparisons of Bilinear and Non-Bilinear Utility Theories," *Organizational Behavior and Human Decision Processes* 84, 71–94.

{% %}

Sneed, John D. (1971) "*The Logical Structure of Mathematical Physics*." Reidel, Dordrecht.

{% %}

Sniedovich, Moshe (1986) "C-Programming and the Minimization of Pseudolinear and Additive Concave Functions," *Operations Research Letters* 5, 185–189.

{% **intuitive versus analytical decisions**; computer program outperforms professional purchasing managers in predicting likelihood of purchasing transactions. %}

Snijders, Chris, Frits Tazelaar, & Ronald Batenburg (2003) "Electronic Decision Support for Procurement Management: Evidence on whether Computers can Make Better Procurement Decisions," *Journal of Purchasing & Supply Management* 9, 191–198.

{% **anonymity protection** %}

Snijkers, Gert J.M.E. (1988) "Privacy Protection of Statistical Data: Suppressing Cells in Two-Dimensional Tables," *Netherlands Official Statistics* 3, 46–47.

{% Some theorems where ambiguity averse people will like reduction of ambiguity and the info that generates it, but ambiguity seeking people may not like info that reduces ambiguity. Uses KMM model.

P. 134 considers only complete info when discussing info for risk. The claims presented in this paper only consider particular forms of info. For example, for each violation of EU there are situations of ambiguity aversion, but those are not considered in this paper (cf. footnote 5).

P. 136 2nd para: Note that p. 1863 of KMM only writes that their measure μ is subjective and not objective, and not in general. The concluding sentence argues that for banking policies such as the recent appointment of Ben Bernanke, the direct effect on welfare is determined by the value of changing ambiguity and that we can infer this from the mathematical formulas of this paper. %}

Snow, Arthur (2010) "Ambiguity and the Value of Information," *Journal of Risk and Uncertainty* 40, 133–145.

{% The author uses recursive expected utility. P. 30 argues that Choquet expected utility cannot separate ambiguity from ambiguity attitude, but this is not so. There are similar discussions of related models. %}

Snow, Arthur (2011) "Ambiguity Aversion and the Propensities for Self-Insurance and Self-Protection," *Journal of Risk and Uncertainty* 42, 27–43.

{% Seems to find violation of **RCLA**. %}

Snowball, Dough & Clif Brown (1979) "Decision Making Involving Sequential Events: Some Effects of Disaggregated Data and Dispositions toward Risk," *Decision Sciences* 10, 527–546.

{% Use data on bets on US horse races between 1992 and 2001 to test whether utility curvature alone, or probability weighting alone, better fits the data, and find that it is the latter. More precisely, for merely the data from win bets, both models can fit data equivalently, but for predictions in wider sets probability weighting does

better, confirming prospect theory.

dynamic consistency & **RCLA**: They are well aware of the problematic nature of this for nonEU. They argue empirically for backward induction and violation of RCLA. %}

Snowberg, Erik, & Justin Wolfers (2010) "Explaining the Favorite-Long Shot Bias: Is It Risk-Love or Misperceptions?," *Journal of Political Economy* 118, 723–746.

{% **cognitive ability related to discounting**: they have it in tables, but do not discuss it much.

cognitive ability related to risk/ambiguity aversion: they have it in tables, but do not discuss it much.

Impressively big experiments. $n \approx 800$, 90% of all CalTech students, $n = 97$ self-selected student sample, a $n = 1000$ representative sample from the US population, and an $n = 995$ MTurk sample. Measure many decision attitudes, e.g., risk aversion (from choices and introspectively), discounting, overconfidence, altruism, over-precision, attitudes towards race and gender, several games, cognitive measures (Raven matrices & cognitive reflection). Compare between-sample differences and correlations.

This paper focuses on between-group comparisons. Many other interesting things can be studied in this beautiful data set. I trust that that will come in follow-up papers.

They usually find the student populations and representative samples most extreme opposite, and M-Turk in between, closer to representative sample. Students are less noisy,

Although averages between groups are different, correlations and comparatize statics usually are the same, though sometimes insignificant due to noise.
No observer effect (students in lab versus being observed by experimenter). Other studies on accountability did find differences.

Self-selected students are slightly less generous, more risk averse, more likely to lie, and better in cognitive tests. These differences are statistically significant but small in size. %}

Snowberg, Erik & Leeat Yariv (2021) "Testing the Waters: Behavior across Participant Pools," *American Economic Review* 111, 687–719.

{% **foundations of probability**; **foundations of quantum mechanics**; %}
Snyder, Douglas M. (1993) "Quantum Mechanics is Probabilistic in Nature," *Journal of Mind and Behavior* 14, 145–154.

{% Gekregen van Hans Peters. A la Existence of utility functions for the Nash bargaining problem. %}
Sobel, Joel (1981) "Distortion of Utilities and the Bargaining Problem," *Econometrica* 49, 597–619.

{% Survey with discussion of altruism, group selection, etc. %}
Sobel, Joel (2005) "Interdependent Preferences and Reciprocity," *Journal of Economic Literature* 43, 392–436.

{% Section I argues that neuroeconomics isn't yet at the level of maturity and standards of other fields, but this may come. Section II discusses normative economics, and expresses opinions that I fully agree with, being that economics should be open to inputs other than revealed preference, but these inputs should prove their relevance to preference. Also that sometimes there is consensus favoring paternalism, e.g. for young/incompetent agents. %}
Sobel, Joel (2009) "Comments on Neuroeconomics," *American Economic Journal: Microeconomics* 1, 60–67.

{% Considers Newcomb's problem. %}
Sobel, Jordan H. (1988) "Metatickles, Ratificationism, and Newcomb-like Problems without Dominance." *In* Bertrand R. Munier (ed.) *Risk, Decision and Rationality*, 483–501, Reidel, Dordrecht.

{% Considers Newcomb's problem. %}
Sobel, Jordan H. (1988) "Defenses and Conservative Revisions of Evidential Decision Theories: Metatickles and Ratificationism," *Synthese* 75, 107–131.

{% %}
Sobel, Jordan H. (1994) "Two Envelopes," *Theory and Decision* 36, 69–96.

{% %}
Sobel, Jordan H. (2004) "On Wakker's Critique of Allais Preferences," *Croatian Journal of Philosophy* 4, 253–272.

{% Survey Discrete choice experiments (DCEs) for measuring quality of life. Criticize many for not reporting properly. %}
Soekhai, Vikas, Esther W. de Bekker-Grob, Alan R. Ellis, & Caroline M. Vas (2019) "Discrete Choice Experiments in Health Economics: Past, Present and Future," *PharmacoEconomics* 37, 201–226.
https://doi.org/10.1007/s40273-018-0734-2

{% In a survey, identify 32 qualitative and quantitative methods for measuring patient preferences. %}
Soekhai, Vikas, Chiara Whichello, Bennett Levitan, Jorien Veldwijk, Cathy Anne Pinto, Bas Donkers, Isabelle Huys, Eline van Overbeeke, Juhaeri Juhaeri, & Esther W. de Bekker-Grob (2019) "Methods for Exploring and Eliciting Patient Preferences in the Medical Product Lifecycle: A Literature Review," *Drug Discovery Today* 24, 1324–1331.
https://doi.org/10.1016/j.drudis.2019.05.001

{% **foundations of statistics** %}
Sohlberg, Staffan & Gerhard Andersson (2005) "Extracting Maximum of Useful Information from Statistical Research Data," *Scandinavian Journal of Psychology* 46, 69–77.

{% Parody on nonsensiceal bluffing texts. %}
Sokal, Alan D. (1996) "Transgressing the Boundaries: Toward a Transformative Hermeneutics of Quantum Gravity," *Social Text* 46/47, 217–252.

{% Nice that the author knows Theorems 7.1 & 7.2.2 in Luce & Narens (1985), showing that RDU is the most general interval scale for two states of nature. Many further results are given, using the n-point homogeneity and n-point

uniqueness of Luce & Narens. Related results are in Ghirardato, Maccheroni, & Marinacci (2005) but they don't state them as clearly. %}

Sokolov, Mikhail V. (2011) "Interval Scalability of Rank-Dependent Utility," *Theory and Decision* 70, 255–282.

{% %}

Sokol-Hessner, Peter, Ming Hsu, Nina G. Curley, Mauricio R. Delgado, Colin F. Camerer, & Elizabeth A. Phelps (2009) "Thinking Like a Trader Selectively Reduces Individuals' Loss Aversion," *Proceedings of the National Academy of Sciences* 106, 5035–5040.

{% P. 7423: "In decision analysis, the two types of uncertainty can be assessed separately and then combined according to Bayesian principles (Pate-Cornell ´ 1996). The end result of combining aleatory and epistemic uncertainty is generally a subjective distribution that is less concentrated than the aleatory distribution." %}

Soll, Jack B., Asa B. Palley, Joshua Klayman, & Don A. Moore (2024) "Overconfidence in Probability Distributions: People Know They Don't Know, but They Don't Know What to Do About It," *Management Science* 70, 7422–7442.
https://doi.org/10.1287/mnsc.2019.00660

{% **crowding-out**: seems he cannot believe what Titmuss claimed on payment for blood. %}

Solow, Robert M. (1971) "Blood and Thunder," *Yale Law Journal* 80, 170–183.

{% %}

Soman, Dilip, George Ainslie, Shane Frederick, Xiuping Li, John Lynch, Page Moreau, Andrew Mitchell, Daniel Read, Alan Sawyer, Yaacov Trope, Klaus Wertenbroch, & Gal Zauberman (2005) "The Psychology of Intertemporal Discounting: Why are Distant Events Valued Differently from Proximal Ones?,"*Marketing Letters* 16, 347–360.

{% This paper derives analytical results for regret theory, and tests them empirically. The authors decompose the risk premium (taken in the feedback situation) into

two premiums: (1) the resolution premium, which is how much the agent would pay for uncertainty not to be resolved (**information aversion**). The rest is the regret premium, which is what he pays extra relative to an expected utility maximizer. In the absence of transitivity, such concepts are tricky to interpret. The experiment confirms earlier findings on regret aversion, but other findings are less clear. %}

Somasundaram, Jeeva & Enrico Diecidue (2017) "Regret Theory and Risk Attitudes," *Journal of Risk and Uncertainty* 55, 147–175.

{% **inverse S:** confirmed

decreasing/increasing impatience: find both, with decreasing not prevailing though

As the title says, this paper studies the interaction between risk and time. It cites much preceding literature, and adds many refinements. It confirms the general finding that adding time reduces many risk-attitude effects and vice versa. They find no time dependence of utility, but strong time dependence of probability weighting. In general, they find that models that allow for time-risk interaction fit better (with AIC) than models that have no such interaction. %}

Somasundaram, Jeeva & Vincent Eli (2022) "Risk and Time Preferences Interaction: An Experimental Measurement," *Journal of Risk and Uncertainty* 65, 215–238. https://doi.org/10.1007/s11166-022-09394-9

{% %}

Sommer, Richard & Patrick Supps (1997) "Dispensing with the Continuum," *Journal of Mathematical Psychology* 41, 3–10.

{% Study the Fatou property for Choquet integrals. %}

Song, Yongsheng & Jia-An Yan (2009) "Risk Measures with Comonotonic Subadditivity or Convexity and Respecting Stochastic Orders," *Insurance: Mathematics and Economics* 45, 459–465.

{% %}

Sonnemans, Joep (2006) “Price Clustering and Natural Resistance Points in the Dutch Stock Market: A Natural Experiment,” *European Economic Review* 50, 1937–1950.

{% %}

Sonnemans, Joep & Theo Offerman (2001) “Is the Quadratic Scoring Rule Really Incentive Compatible?,” CREED, Dept. of Economics, University of Amsterdam, the Netherlands.

{% %}

Sonnenberg, Frank A. & Stephen G. Pauker (1987) “Decision Maker: An Advanced Personal Computer Tool for Clinical Decision Analysis.” Pr*oceedings of the Eleventh Annual Symposium on Computer Applications in Medical Care,* Washington D.C., IEEE Computer Society.

{% %}

Sonnenschein, Hugo F. (1965) “The Relationship between Transitive Preference and the Structure of the Choice Space,” *Econometrica* 33, 624–634.

{% %}

Sonnenschein, Hugo F. (1971) “Demand Theory without Transitive Preferences, with Applications to the Theory of Competitive Equilibrium.” *In* John S. Chipman, Leonid Hurwicz, Marcel K. Richter, & Hugo F. Sonnenschein (eds.) “*Preferences, Utility, and Demand,*” 215–223, Hartcourt, New York.

{% %}

Sono, Masazo (1945) “The Effect of Price Changes on the Demand and Supply of Separable Goods” (in Japanese), *Kokumin Keisai Zasshi* 74, 1–51.

Translated into English as:

{% %}

Sono, Masazo (1961) “The Effect of Price Changes on the Demand and Supply of Separable Goods,” *International Economic Review* 2, 239–271. https://doi.org/10.2307/2525430

{% Show that subjects prefer simple prospects more than complex ones. Complexity here is a broad term, where number of timepoints plays a role.

Their first experiment is single-period, and may speak to event splitting. The authors have one preference switch that they claim supports complexity aversion. However, the result is only marginally significant, with 17 switches (of 97 subjects) supporting their hypothesis but 7 going opposite, then have p = 0.065. (Footnote 14 writes: The hypotheses that the probability of switching from choosing A in problem I (I =b 1,2) to choosing B in problem j (j = 3,40 is equal to the probability of switching from B to A is similarly rejected at p ≤ 0.05.) They claim that "generalized prospect theory" with overweighting of small probabilities cannot explain it, but never define generalized prospect theory, and I guess it is separable OPT. The lotteries are quite different and there can be many explanations. I guess that CPT can accommodate the results. %}

Sonsino, Doron, Uri Benzion, & Galit Mador (2002) "The Complexity Effects on Choice with Uncertainty—Experimental Evidence," *Economic Journal* 112, 936–965.
https://doi.org/10.1111/1468-0297.00073

{% Individual stocks and underdiversified portfolios have positive skewness.

Consider investment products and analyze mispricing using the source method (not using this term, but calling it the exchangeability method). Measure, in lab, certainty equivalents of 20 simple individually tailored deposits. Use source method, to first measure additive subjective probabilities, and then apply transformations (§5). They use Prelec's (1998) one-parameter family for probability weighting (what I'd call source function). I regret that no two parameters. *§5.5: source method does best in AIC measure, better than alternative models, including α maxmin!* **PT falsified**: well, source method (which uses prospect theory) in fact does best, but with unconventional parameters. Subjects are optimistic in overweighting gain tail events but, and this is deviating, they are also optimistic for loss tail events in the sense of underweighting them. This also happens when they do regular risky choices.

The authors, interestingly, repeat the experiment but now with known probabilities. Comparisons capture ambiguity attitudes. The certainty equivalents have a trend of being higher for risk, suggesting ambiguity aversion, but do not reach significance. The strange optimism of underweighting tail loss events, found under ambiguity, disappears.

Loss aversion is there, but is lower for risk, and lower than in other studies. %}

Sonsino, Doron, Yaron Lahav, & Yefim Roth (2022) “Reaching for Returns in Retail Structured Investment,” *Management Science* 68, 466–486. https://doi.org/10.1287/mnsc.2020.3932

{% **preference for flexibility** %}

Sonsino, Doron, & Marvin Mandelbaum (2001) “On Preference for Flexibility and Complexity Aversion: Experimental Evidence,” *Theory and Decision* 51, 197–216. https://doi.org/10.1023/A:1015555026870

{% %}

Sonsino, Doron, Mosi Rosenboim, & Tal Shavit (2017) “The Valuation “By-Tranche” of Composite Investment Instruments,” *Theory and Decision* 82, 353–393.

{% %}

Sono, Masazo (1961) “The Effect of Price Changes on the Demand and Supply of Separable Goods,” *International Economic Review* 2, 239–271.

{% **free will/determinism**: Subjects could at will push one of two buttons. Whenever they made a decision to do it they indicated so; however, brain activities showed the decision to come some 8 seconds before subjects said they took the decision. %}

Soon, Chun Siong, Marcel Brass, Hans-Jochen Heinze, & John-Dylan Haynes (2008) “Unconscious Determinants of Free Decisions in the Human Brain,” *Nature Neuroscience* 11, 543–545.

{% **probability triangle**. Test fanning out in probability triangle. Find that on the border it happens, but inside the triangle, EU is good (**Probability weighting linear in interior**:). %}

Sopher, Barry & Gary Gigliotti (1993) "A Test of Generalized Expected Utility Theory," *Theory and Decision* 35, 75–106.

{% Argue that observed intransitivities in Loomes, Starmer & Sugden is only random error. %}

Sopher, Barry & Gary Gigliotti (1993) "Intransitive Cycles: Rational Choice or Random Error? An Answer Based on Estimation of Error Rates with Experimental Data," *Theory and Decision* 35, 311–336.

{% Seem to find evidence for quasi-convexity w.r.t. probabilistic mixing, supporting convex probability weighting in RDU. %}

Sopher, Barry & J. Mattison Narramore (2000) "Stochastic Choice and Consistency in Decision Making under Risk: An Experimental study," *Theory and Decision* 48, 323–349.

{% **decreasing/increasing impatience**: find constant discounting
real incentives/hypothetical choice, for time preferences: seems to be. %}

Sopher, Barry & Arnav Sheth (2006) "A Deeper Look at Hyperbolic Discounting," *Theory and Decision* 60, 219–255.

{% Newcomb's problem; my handwritten notebook p. 407 %}

Sorensen, Roy A. (1983) "Newcombs Problem: Recalculations for the One-Boxer," *Theory and Decision* 15, 399–404.

{% %}

Sosa, E. David (1993) "Consequences of Consequentialism," *Mind* 102, 101–122.

{% %}

Sosonko, Genna & Paul van der Sterren (1998) "*New in Chess Yearbook 46; The Grandmaster Guide to Openings.*" Interchess BV, Alkmaar.

{% %}

Souchek, Julianne, James R. Stacks, Baruch Brody, Carol M. Ashton, R. Brian Giesler, Margaret M. Byrne, Karon Cook, Jane M. Geraci, Nelda P. Wray (2000)

“A Trial for Comparing Methods for Eliciting Treatment Preferences from Men with Advanced Prostate Cancer,” *Medical Care* 38, 1040–1050.

{% Discusses minsum functions; i.e., multiattribute utility functions that are constructed by min and addition operations, such as min{ x_1,x_2} + x_3. %}

Sounderpandian, Jayavel (1991) “Value Functions when Decision Criteria are not Totally Substitutable,” *Operations Research* 39, 592–600.

{% Shows how theorem of Kolmogorov is of use for additive conjoint measurement. %}

Sounderpandian, Jayavel (1992) “Transforming Continuous Utility into Additive Utility Using Kolmogorov’s Theorem,” *Journal of Multi-Criteria Decision Analysis* 1, 93–99.

{% %}

Sox, Harold C., Marshall A. Blatt, Michael C. Higgins, & Keith I. Marton (1986) “*Medical Decision Making.*” Buttersworths, Boston.

{% %}

Spalt, Oliver G. (2011) “Small Chances and Large Gains: Why Riskier Firms Grant more Employee Stock Options,” Dept. of Finance, Tilburg University, the Netherlands.

{% **foundations of probability**: proposes an interpretation, discussing counterarguments such as circularity in definition and impossibility to assign probability to single events. %}

Spanos, Aris (2013) “A Frequentist Interpretation of Probability for Model-Based Inductive Inference,” *Synthese* 190, 1555–1585.

{% Studies aversion to compound lotteries, and relate it to wealth, in India and El Salvador. %}

Spears, Dean (2013) “Poverty and Probability: Aspiration and Aversion to Compound Lotteries in El Salvador and India,” *Experimental Economics* 16, 263–284.

{% **small worlds** idea? %}

Spence, Michael & Richard J. Zeckhauser (1972) "The Effect of the Timing of Consumption Decisions and the Resolution of Lotteries on the Choice of Lotteries," *Econometrica* 40, 401–403.

{% **utility measurement**: c**orrect for probability distortion**: criticize Oliver (2005) for correcting only for loss aversion and not for probability weighting. %}

Spencer, Anne, Judith Covey, Susan Chilton, & Matthew J. Taylor (2005) "Testing the Internal Consistency of the Lottery Equivalents Method Using Health Outcomes: A Comment to Oliver," *Health Economics* 14, 161–167.

{% Utility independence is mostly verified. %}

Spencer, Anne & Angela Robinson (2007) "Tests of Utility Independence when Health Varies over Time," *Journal of Health Economics* 26, 1003–1013.

{% %}

Spencer, Brue D. & Lincoln E. Moses (1990) "Needed Data Expenditure for an Ambiguous Decision Problem," *Journal of the American Statistical Association* 85, 1099–1104.

{% **probability elicitation** %}

Spetzler, Carl S. & Carl-Axel S. Staël von Holstein (1975) "Probability Encoding in Decision Analysis," *Management Science* 21, 340–358.

{% **probability elicitation**; referaat Rene Eijkemans, April '94 %}

Spiegelhalter, David J. (1986) "Probabilistic Prediction in Patient Management and Clinical Trials," *Statistics in Medicine* 5, 421–433.

{% Some journals, such as Quarterly Journal of Economics, do not publish proofs of mathematical results but put them in Online Appendixes. I think that this is bad policy, essentially making all mathematical results published there unreliable. One better avoids citing such results. Fortunately, other journals have better views on this. Here is a statement of the journal Theoretical Economics.

"We will also continue to minimize the use of supplementary appendices because we do not think they are typically a good solution to ultra-long papers. … Refrain from suggesting the transfer of proofs or extensions to supplementary appendices.” %}

Spiegler , Ran (2023) “Statement by the Editors of Theoretical Economics Regarding the Length of Submissions,” *Theoretical Economics* 18.

{% This paper seems to give an alternative justification for Jaffray’s updating rule. (**updating under ambiguity**) %}

Spies, Marcus (1991) “Combination of Evidence with Conditional Objects and Its Application to Cognitive Modeling.” *In* Goodman, Irwing R. et al. (eds.) *Conditional Logic in Expert Systems*, North-Holland, Amsterdam.

{% %}

Spies, Marcus (1995) “Uncertainty and Decision Making - Expert Treatment of Human Expertise.” *In* Jean-Paul Caverni, Maya Bar-Hillel, Francis Hutton Barron, & Helmut Jungermann (eds.) *Contributions to Decision Making*—I, 51–79, Elsevier, Amsterdam.

{% The authors take data from six other empirical studies on decision from description (DFD) and decision from experience (DFE). They do data fitting with a mean-variance-skewness model (MVS), and with prospect theory (PT), the latter with power utility and the Goldstein-Einhorn probability weighting family. The authors point out that PT can also capture preference for skewness. For simple prospect, with 1/2 outcomes, they find for both DFD and DFE that a mix of PT and MVS does best. For complex prospects (2-3 outcomes) in DFD 100% PT is best, and in DFE 100% MVS is best. In DFD, the authors take the observed empirical frequencies as probabilities. They do not discuss that this involves ambiguity.

Note that Hertwig always uses the term “statistical probability” for probability that is not objectively known, and always cites Knight (1921) for this, whereas Knight contributed less to this than Keynes in quantity, and much less in quality. %}

Spiliopoulos, Leonidas & Ralph Hertwig (2019) “Nonlinear Decision Weights or Moment-Based Preferences? A Model Competition Involving Described and Experienced Skewness,” *Cognition* 183, 99–123.

https://doi.org/10.1016/j.cognition.2018.10.023

{% This paper examines decisions under risk and uncertainty. Decision under risk is done the usual way, what is also called decision from description. Uncertainty is implemented with what is called decision from experience (DFE). It should be noted that the subjects then know that the gambles have objective probabilities (even that those are multiples of 0.05), only those are unknown to the subjects. It is not clear to me whether subjects also know that their samples are IID samples. The authors consider choices between simple lotteries, witih no more than two outcomes per lottery, and what they call complex choices, where the two lotteries to be chosen from together involve more than four outcomes. They properly (e.g., sentence pp. 1188-1189) point out that complexity can involve other things, where I add that many outcomes also triggers other emotions such as spit-event effects.

For uncertainty they use what I call the source method, i.e., they assume what I call a-neutral probabilities (have to be additive!) over events and then apply probability weighting functions to these. The authors call it the two-stage model of Tversky and co-authors but this is not correct. They are instead using Abdellaoui et al.'s (2011) source method. Both models consider a decomposition w(P). However, in the source method ambiguity is captured through w, which can be source dependent, and P is additive capturing nothing of ambiguity. In the two-stage model, to the contrary, P can be nonadditive capturing ambiguity, and w (surely as Tversky intended) is the risky-probability weighting function, not capturing ambiguity. This difference is crucial. This paper captures uncertainty attitude through w and not through P, as in the source method and not the two-stage model.

P. 1198 properly explains that most of the popular ambiguity models in the economic literature are too general, involving for instance sets of priors or 2nd order distributions over 1st order probability distributions. Big question for the source method: where get a-neutral probabilities from? For DFE, the authors consider three candidates: (1) the true objective probabilities (unknown to subjects); (2) subjective introspective assessments of beliefs; (3) relative frequencies observed in the sampling that the subjects did. (2) has been used in what Tversky and co-authors called the two-stage model, apart from (non)additivity as discussed above. They find that (3) works best. (P. 1202 2nd para) P. 1197 1st para points out that taking a-neutral probabilities as subjective parameters may be too general and give identifiability problems.

It is remarkable that these psychological authors distinguish between statistical significance and *economic* significance.

The decision theories that the authors consider are expected utility (EU), new 1992 prospect theory (CPT), separable prospect theory (N-CPT), a three-moment model which is a linear combination of expected value, variance, and skewness, and Blavatskyy's (2018) generalization of the latter in terms of utility rather than money. Mean-variance is popular in finance but never worked well in decision theory, for one reason because it violates stochastic dominance.

P. 1191 end of 2nd para, to my joy, suggests expected value as normative.

P. 1196 2nd para has a strange text: "If the prospect with a desirable (undesirable) rare outcome is chosen more (less) often in description than in experience, this indicates a description-experience gap. *This corresponds to an "as-if" overweighting of rare events in description and an "as-if" underweighting of rare events in experience with respect to the objective probabilities.*" [italics added] The italicized part is out of the blue. I think that this was overselling by the field of DFE.

For parametric fitting, the authors use the commonly used power utility and, for probability weighting, the Goldstein-Einhorn family. (They also consider a cubic family but that does not perform well.)

As mentioned above, p. 1198 properly points out that most models of ambiguity in the economic literature are (too) general: "Theoretical models of decision-making under uncertainty (often referred to as ambiguity in the economics literature) are typically extremely complex, for instance, requiring multiple priors over first-order beliefs (e.g., Ghirardato et al., 2004; Gilboa & Schmeidler, 1989) or second-order beliefs over priors (e.g., Klibanoff et al., 2005). These would be computationally expensive in complex decisions from experience as a large set of beliefs would have to be updated dynamically and simultaneously with sampling. Furthermore, to experimentally compare these models is particularly challenging as the multiple priors and/or second-order beliefs need to be inferred or elicited and a learning process stipulated—even the elicitation of first-order beliefs is already relatively daunting. Therefore, we are not optimistic that, in a sampling paradigm of complex lotteries, multiple priors and second-order beliefs can be reliably and soundly elicited or are strongly identifiable if estimated as latent variables. For this reason, we focus on a model that does not raise such complex measurement issues, the two-stage model of decisionmaking under uncertainty (Fox & Hadar, 2006; Fox & Tversky, 1998; Tversky & Fox, 1995). According to this model, decision makers first form subjective beliefs from the experienced evidence before transforming them through a rank-dependent nonlinear PWF that is typically subadditive, as is the case in CPT."

P. 1199 2nd para is misled by Bernheim & Sprenger (2020) to erroneously claim that rank dependence had not been tested extensively.

P. 1199 describes separable prospect theory (N-CPT). It defends against my criticism of it in Footnote 13 but I disagree: they write that a counterexample put up by me can be avoided by allowing the functions in N-CPT to depend on the number of outcomes. However, this generalization is not a minor modification but a drastic generalization making the whole theory to general and worthless, as pointed out in the literature several times in history, e.g. by Kahneman & Tversky (1979). Probably the authors were again misled by Bernheim & Sprenger (2020), who also tried to push this idea in ways that I think are very wrong. They also have some remarks on normative-descriptive that are irrelevant because Wakker's criticism is descriptive. True that they test independence of number of outcomes empirically, but testing independence of A from B is a far cry from having an interesting theory on depence of A on B.

P. 1199 top of second column discusses reference dependence supporting some claims in the literature on utility of income that I disagree with. However, because this experiment has no variable reference point, this discussion is irrelevant for this paper.

The authors find that allowing for different parameters in simple choices than in complex choices does not help much (p. 1204 - 1205). I interpret this as negative evidence for dependence on number of outcomes.

The authors sometimes mention that ranking outcomes, as required for rank dependence, takes much calculation power. (p. 1299 1st column 2nd para & p. 1208 2nd column 1st para), thanking Bruhin for this in footnote 12.

Psychologists, including the authors, are inclined to go for context dependence, and the main conclusion of this paper is that there is not one theory that works well in all contexts. Economists like me rather go for context independence. My reading of the results is that CPT is best. In most contexts considered it is best or second-best. Further, EU and N-CPT (p. 16) perform poorly. Good to see that separable prospect theory, with I think is not viable anyhow, also performs poorly empirically. One reason why I prefer CPT is that besides EU there is no serious decision-theory contender. Contrary to the authors'

Footnote 13, N-CPT can be disqualified beforehand, and the moment theories don't work well for decision theory for one reason because of their violations of stochastic dominance. %}

Spiliopoulos, Leonidas & Ralph Hertwig (2023) "Variance, Skewness and Multiple Outcomes in Described and Experienced Prospects: Can One Descriptive Model Capture It All?," *Journal of Experimental Psychology: General* 152, 1188–1222. https://dx.doi.org/10.1037/xge0001323

{% %}

Spiliopoulos, Leonidas & Andreas Ortmann (2018) "The BCD of Response Time Analysis in Experimental Economics," *Experimental Economics* 21, 383–433.

{% Published postuum. **free will/determinism**: Seems (wikipedia is my source) that Spinoza does not think that God is an outside power, or something personalized, but rather than God is everything and not personalized, which may not be far from my atheist view that God does not exist. Third part of Ethica (De Origine et Natura Affectuum - about the origin and nature of emotions) is relevant for decision theory, and the fifth part (De Potentia Intellectus, seu de Libertate Humana - about the power of mind; i.e., human free will).

Seems that Spinoza takes the world as deterministic, but still sees a role for our free will. That it is something like confirmation of what will happen anyhow. We suffer from wrong ideas and get happy if right ideas. Every being wants to prolong its existence (sound like Darwin's evolution) and will is where our mind is aware of us trying to do so. Gladness and sadness (positive and negative utility I economist would say) drive our actions/signal to us if actions are good. So, there is no good or bad but just being closer to your real nature or not. %}

Spinoza, Baruch (1678) *Ethica*.

{% %}

Spinu, Vitalie & Peter P. Wakker (2013) "Expected Utility without Continuity: A Comment on Delbaen, Drapeau, and Kupper (2011)." *Journal of Mathematical Economics* 49, 28–30.
http://dx.doi.org/10.1016/j.jmateco.2012.09.005
Direct link to paper

{% Give criteria that must be fulfilled by an optimal quality of life test (most important: simple, clear meaning, adequate range of dimensions of quality of life, valid and acceptable to the patient) %}

Spitzer, Walter O., Annette J. Dobson, Jane Hall, Esther Chesterman, John Levi, Richard Shepherd, Renaldo N. Battista, Barry R. Catchlove (1981) "Measuring the Quality of Life of Cancer Patients," *Journal of Chronic Disease* 34, 585–597.

{% **R.C. Jeffrey model**: seems to argue that one cannot assign a probability to one's own choice. %}

Spohn, Wolfgang (1977) "Where Luce and Krantz Do Really Generalize Savage's Decision Model," *Erkenntnis* 11, 113–134.

{% **Newcomb's problem** %}

Spohn, Wolfgang (2012) "Reversing 30 Years of Discussion: Why Causal Decision Theorists Should One-Box," *Synthese* 187, 95–122.

{% How stopwatch time is related to absolute time, depends on the starting point of the stopwatch time. Philosopers call this an indexical meaning, where the starting time is the index. Exponential discounting can be justified if one uses stopwatch time plus some other assumptions. This is essentially what this paper writes I guess. %}

Spohn, Wolfgang (2025) "Indexical Utility: Another Rationalization of Exponential Discounting," *Economics & Philosophy* 41. 65–78. https://doi.org/10.1017/S0266267124000129

{% A short evaluation, documented below: This paper finds more risk aversion in probability equivalents (PEs) than in certainty equivalents (CEs). This is not new, has been known since the 1980s, and has been extensively documented since. Positive is that the experiment is done with great care here. Further positive is that the paper points out, interestingly, that this discrepancy can be accommodated by the Köszegi-Rabin (2006) model. The latter one-sentence contribution is, frankly, all that I learn from this paper. So, it is very very thin. There are many weak points, revealing theoretical weakness. The citation of

preceding literature is very incomplete. There have been many alternative good explanations of the discrepancy, not cited. The claim that prospect theory would assume just one fixed reference point is a blunder. A crucial novelty of prospect theory is reference dependence, which has meaning only if one considers several reference points. Prospect theory can well accommodate the discrepancy and is not violated here. The discrepancy found violates every reference-independent transitive theory. This can be said in one sentence, and does not need pages of analyses for each theory separately, putting one of them (Gul's disappoinbtment aversion), arbitrarily chosen, central. The writing is repetitive. Below, I document the claims in detail.

DETAILS:

The experiment in this paper has been done particularly carefully, with between- and within-subject comparisons, many controls, and of course real incentives, as is common by the high experimental standards of experimental economics. The finding can be accommodated by the Köszegi-Rabin model if we make the plausible assumption that in the PE question the certain outcome is chosen as reference point and in the CE question the lottery. Under reference dependence, the reference outcome is favored relative to others (whose cons are overweighted and pros are underweighted) and, hence, choosing the lottery as reference point, as in CE questions, brings more preference for the lottery and more risk seeking. The observation similarly holds for any theory that allows the (noncertain) lottery to be a reference point, such as the PT^3 theory cited for this by the author.

I have two MAIN difficulties with this paper:

(1) P. 1463 last para claims that prospect theory would assume the same reference point for CE as for PE and, hence, would be violated by the discrepancy between PE and CE: "A similar argument can be made for cumulative prospect theory, which establishes loss-averse utility relative to some fixed referent and relaxes the independence axiom's implied linearity in probability … Under such a utility formulation, certainty and probability equivalents again yield identical risk attitudes as the reference point is fixed at some known value.". This is absolutely not true. Bleichrodt, Pinto, & Wakker (2001 *Management Science*; received the Decision Analysis Society Publication award of 2003) gives detailed experimental and numerical analyses showing that prospect theory can explain the discrepancies between PE and CE *because it*

assumes different reference points here. It shows that this works for the commonly found parameters for PT.

This para cites Kahneman & Tversky (1979) to show that variability of reference points is a crucial component of prospect theory. In their Problems 11 & 12, K&T carefully choose a framing that generates different reference points in their subjects' perception, whereas in terms of final wealth the two problems are identical. The difference found must have been caused by the different reference points. It is only from that that the authors conclude: "the carriers of value or utility are changes of wealth, *rather than final asset positions*" (p. 273) [italics added here]. The novelty is in the second part of the sentence, explicitly breaking the relationship with final wealth. A more detailed discussion of changes of reference points is in Kahneman & Tversky (1979 pp. 286 ff.).

(2) The first 35 pages do not cite the extensive preceding literature on the CE-PE discrepancy. Makes superficial readers such as busy editors and narrow-read within-clan referees believe that it is all completely new. Then the paper cites some initial papers that reported the CE-PE discrepancy before in the early 1980s, but only does so at the back, p. 1494 2nd para. **Prospect theory not cited**: I am glad that the author, unlike experimental economists such as Holt & Laury (2002), took note of papers written by others than experimental economists, but it would have been more proper had this work been cited up front. Also, there is much more literature on this, with satisfactory alternative explanations for the discepancy already long available. If I may start with papers written by my students, besides the paper cited under (1) above, there is Bleichrodt (2002 Health Economics) who offers a careful explanation of the discrepancy using prospect theory, and van Osch, van den Hout, & Stiggelbout (2006) who let subjects do speak-aloud to investigate what reference points they used. For other literature, my bibliography here, sometimes using the term standard gamble (SG) instead of PE, has some keywords: **PE doesn't do well**, **PE higher than CE**, **PE higher than others**, **CE bias towards EV**, giving some 40 references on the topic. The author calls the topic a "long-standing issue" in the literature and writes: "The present results and use of the KR model may help to resolve this longstanding issue." This is incorrect because it ignores the explanations provided before. Similarly, p. 1462 writes "the KR preference model, under the assumption of an alterned referent, outperforms leading alternative explanations in terms of predictive power." Again, the author is simply

ignoring the explanations provided before.

Some further details that I found problematic:

p. 1460 writes: "Given the potential confounds of prior experimental methods, it is important to move away from hypothetical choice, physical endowments, and ownership-related language. Hence, I opt not to follow the prior endowment effect style literature and choose a design without an explicit form of endowment." This is misleading. There is nothing wrong with inducing referencce point by prior endowment, for instance. (The preceding citation of Plott & Zeiler is too gratuit.)

P. 1462 writes: "Fourth, the KR preference model, under the assumption of an altered referent, outperforms leading alternative explanations in terms of predictive power." This overstatement is solely based on the author ignoring most preceding explanations.

p. 1472: Although I did not study in detail, I did not understand something in Table 1 on p. 1471. In this experiment, it is crucial whether subjects are risk neutral or not. Choice lists are usually most refined in the area of maximal interest. However, choice lists here are least refined around risk neutrality. See, for instance., the last column. There is also a tendency for subjects to just always switch in the middle of the choice list, the middle-switching tendency. It seems that the midpoints are different for different stimuli. Could middle-switching explain the findings of this paper? I did not inspect in detail. %}

Sprenger, Charles (2015) "An Endowment Effect for Risk: Experimental Tests of Stochastic Reference Points," *Journal of Political Economy* 123, 1456–1499.

{% **foundations of statistics** %}

Sprenger, Jan (2009) "Statistics between Inductive Logic and Empirical Science," *Journal of Applied Logic* 7, 239–250.

{% **three-doors problem**; criticizes Baumann and defends the commonly accepted solution, defending the relevance of probability theory in single cases. %}

Sprenger, Jan (2010) "Probability, Rational Single-Case Decisions and the Monty Hall Problem," *Synthese* 174, 331–340.

{% **inverse S**?; argues so on the basis of French, Spanish, and Mexican lotteries. %}

Sprowls, R. Clay (1953) "Psychological-Mathematical Probability in Relationships of Lottery Gambles," *American Journal of Psychology* 66, 126–130.

{% %}

Sprumont, Yves & Lin Zhou (1999) "Pazner-Schmeidler Rules in Large Societies," *Journal of Mathematical Economics* 31, 321–339.

{% %}

Spurrier, Michael & Alexander Blaszczynski (2014) "Risk Perception in Gambling: A Systematic Review," *Journal of Gambling Studies* 30, 253–276.

{% The author replicates the Ellsberg tasks. He finds much noise in the data, and a bit ambiguity aversion. In the Ellsberg task, a coin toss decides what the winning color is, thus à la Raiffa (1961) explicitly making the ambiguous option quite a 0.5 probability option. Inspired by the theoretical literature on ambiguity, he assumes EU and even EV for risk. %}

Stahl, Dale O. (2014) "Heterogeneity of Ambiguity Preferences," *Review of Economics and Statistics* 96, 609–617.

{% Safe is a journal for clients of Robeco investment Engineers and the Rabobank. %}

Stallinga, Rob & Peter P. Wakker (2013) "Wie nooit Wil Verliezen, Mist veel Kansen," *Safe* 2013#02, p. 26.

Direct link to paper

{% **PE doesn't do well**: in the TTO and PE (if I remember well, he calls it SG) measurements, subjects do not sufficiently adjust responses if the best outcome perfect health is replaced by a lower outcome not-perfect health. That is, subjects give too much the same p answer in PE and too much give up the same proportion in TTO. Closer inspection of the data (p. 62 top) shows that about 25% of subjects does not trade off at all, which seems to suggest appropriate normative adaptation which is then zero, but in fact reflects total insensitivity. Among the other 75%, 3/5 (so, 45% of the total) does not change the answer at all if the best outcome perfect health is replaced by a worse outcome.

P. 55 3rd para of first column suggests insufficient numerical sensitivity of

subjects, judging a variation in risk of 0%-8% as equally important as a variation in risk of 0%-4%. %}

Stalmeier, Peep F.M. (2002) "Discrepancies between Chained and Classic Utilities Induced by Anchoring with Occasional Adjustments," *Medical Decision Making* 22, 53–64.

{% **risky utility u = strength of preference v (or other riskless cardinal utility, often called value)**: this paper gives beautiful support for the hypothesis that risky utility = riskless utility.

Measure utility, of health outcomes (# days migraine), through direct strength-of-preference and through CE (certainty equivalent). Correction for probability transf. reconciles partly but not completely, CE utility remains more concave. They propose that this is caused by framing + loss aversion. They then strongly frame outcomes as losses so that loss aversion plays no more role. In the latter case, indeed, the discrepancy between risky and riskless utility disappears.

They let subjects write down probabilities and outcomes in a figure to verify that the subjects took notice of probabilities/outcomes. Do few subjects (8 + 6), but very thorough treatment, several session, hours, repeated measurements, of each subject, videos to show the subjects effects of migraine etc.

inverse S: they find that probability weighting is inverse S.

P. 19 bottom of version of October 1998: "Thus, it appears that a prescriptive choice needs to be made as to which framing effect is desired …"

Seems to find, as do Hershey & Schoemaker (1982), that in standard gamble choices people focus on the sure outcome as their reference point. %}

Stalmeier, Peep F.M. & Thom G.G. Bezembinder (1999) "The Discrepancy between Risky and Riskless Utilities: A Matter of Framing?," *Medical Decision Making*, 19, 435–447.

{% %}

Stalmeier, Peep F.M., Thom G.G. Bezembinder, & Ivana J. Unic (1996) "Proportional Heuristics in Time Tradeoff and Conjoint Measurement," *Medical Decision Making* 16, 36–44.

{% %}

Stalmeier, Peep & Bram Roudijk (2024) “What Makes the Time Tradeoff Tick? A Sociopsychological Explanation,” *Medical Decision Making* 44, 974–985. https://doi.org/10.1177/0272989X241286477

{% %}

Stalmeier, Peep F.M., Peter P. Wakker, & Thom G.G. Bezembinder (1997) “Preference Reversals: Violations of Unidimensional Procedure Invariance,” *Journal of Experimental Psychology, Human Perception and Performance* 23, 1196–1205.
https://doi.org/10.1037/0096-1523.23.4.1196
Direct link to paper

{% %}

Stalpers, Lucas J.A. (1991) “Clinial Decision Making in Oncology,” Ph.D. thesis, Institute of Radiotherapy, University of Nijmegen, Nijmegen, the Netherlands.

{% %}

Stalpers, Lucas J.A., & Arne Maas (1991) “Utiliteitsmeting met Behulp van Additief Conjunct Meten ten Behoeve van the Klinische Besluitvorming,” *Nederlands Tijdschrift voor de Psychologie* 46, 139–145.

{% Show the exponential growth bias: People do not understand how quickly constant discounting weights become smaller over time and, hence, overestimate the future discount factors. This can be one explanation of decreasing impatience. People, similarly, underestimate the compounding effects of interests on savings, taking exponential growth too much as linear. %}

Stango, Victor & Jonathan Zinman (2009) “Exponential Growth Bias and Household Finance,” *Journal of Finance* 64, 2807–2849.
https://doi.org/10.1111/j.1540-6261.2009.01518

{% **correlation risk & ambiguity attitude**; **cognitive ability related to discounting**; **cognitive ability related to risk/ambiguity aversion**:
A beautiful representative USA data set, measuring 21 behavioral biases and many demographics, relations between them, factor analyses on the biases, and so

on. Unfortunately, the authors do not explain how they measured the biases. I, therefore, decided not to study the paper. Seems that risk aversion was measured using mostly introspective questions rather than (hypothetical) choice. %}

Stango, Victor & Jonathan Zinman (2023) “We Are All Behavioural, More, or Less: A Taxonomy of Consumer Decision-Making,” *Review of Economic Studies* 90, 1470–1498.
https://doi.org/10.1093/restud/rdac055

{% Seems to be good book on Möbius inverse. %}

Stanley, Richard P. (1986) “*Enumerative Combinatorics. Vol. I.*” Wadsworth & Brooks/Cole, Monterey, CA.

{% **real incentives/hypothetical choice**: uses random incentive system; **violation of certainty effect**: set 1, Questions 4 and 1 give it.

For five probabilities not denoted here, the paper considers choices between S = (c,b,b,b,a) and R = (c,c,b,a,a) for outcomes c ≻ b ≻ a. Thus, it can test all kinds of violations of (comonotonic) independence within the **probability triangle**. This study was done more or less simultaneously with Camerer (1989), but the processing/rewriting with RESTUD went slowly.

P. 817: I do not understand the choice of A = for PT.

Paper tests PT only for convex probability weighting w, not for inverse S for instance. P. 818 top erroneously suggests that Kahneman & Tversky (1979) had suggested that w be convex. This is a widespread misunderstanding. Tversky told me that they drew their 1979 curve loosely by hand, and that people paid too much attention to the particular shape in the middle. The convexity in the middle indeed is not at all pronounced or important, but the jumps at 0 and 1 are. The jump at p = 0 entails a violation of convexity. %}

Starmer, Chris (1992) “Testing New Theories of Choice under Uncertainty Using the Common Consequence Effect,” *Review of Economic Studies* 59, 813–830.

{% Considers approach where subjects do not maximize a transitive preference, but based on some cognitive dissonance model. Pp. 185-186 discuss the Shackle model. %}

Starmer, Chris (1993) "The Psychology of Uncertainty in Economic Theory: A Critical Appraisal and a Fresh Approach," *Review of Political Economy* 5, 181–196.

{% Constructive view of preference. Presented at the conference on Incommensurability and Value in Caen, April 1994. %}

Starmer, Chris (1996) "Explaining Risky Choices without Assuming Preferences," *Social Choice and Welfare* 13, 201–213.

{% %}

Starmer, Chris (1997) "The Economics of Risk." *In* Peter Callow (ed.) *The Handbook of Environmental Risk Assessment and Management*, Ch. 12, 319–344, Blackwell, Oxford.

{% P. F5: "Like it or not, economists have a bad reputation for being relatively unmoved by facts about the world."

P. F7: "Good news it seems, but here is the rub: further testing suggests that regret theory is not the correct explanation for the new phenomena whose discovery it prompted."

Paper ends with suggesting that maybe in the end economics and market-behavior is not seriously affected by all the biases that empirical studies in the lab find, but that, at present, we do not know and that, therefore, we should continue to investigate these things. %}

Starmer, Chris (1999) "Experimental Economics: Hard Science or Wasteful Tinkering," *Economic Journal* 109, F5–F15.

{% Pp. 1-2: Many nice citations of people arguing that controlled experiments are difficult in economics. Argues for the usefulness of experimental economics. %}

Starmer, Chris (1999) "Experiments in Economics: Should We Trust the Dismal Scientists in White Coats?," *Journal of Economic Modeling* 6, 1–30.

{% **real incentives/hypothetical choice**: uses random incentive system;

PT falsified: when OPT (1979-prospect theory) predicted particular violations of transitivity and monotonicity (if no editing), the theory was widely criticized for it. This paper, however, tests such violations of transitivity (or monotonicity) and

finds them confirmed. It, thus, gives empirical support to OPT.

Details:

Prospect A = $14_{0.20}0$; Prospect B = $8_{0.30}0$; Prospect C = (0.15:8, 0.15:7.75, 0.70:0). By monotonicity, B ≻ C, but by subadditivity of probability weighting under OPT (which does not amount to event splitting here because lotteries are always collapsed) we can have C ≻ B. OPT predicts C ≻ A ≻ B (including C ≻ B) because the evaluating function implies these prefs. It, however, predicts B ≻ C because of monotonicity and editing, and thus intransitivity results.

Testing number of cycles C ≻ A ≻ B ≻ C versus number of reversed cycles C ≺ A ≺ B ≺ C would not be very satisfactory because simple error theories could predict fewer errors in B ≻ C because of salience of monotonicity, and thus predominance of former cycles, without genuine intransitivity underlying it. This paper, therefore, tests only frequency of A ≻ C versus A ≻ B, and finds the former dominating. This is enough, under any plausible error theory, to ensure that either monotonicity or transitivity must be violated. Data find few violations of monotonicity and, hence, transitivity must be violated. These data were found for many stimuli A,B,C similar to the above ones. %}

Starmer, Chris (1999) "Cycling with Rules of Thumb: An Experimental Test for a New Form of Non-Transitive Behavior," *Theory and Decision* 46, 141–158. https://doi.org/10.1023/A:1004930205037

{% **survey on nonEU**;

P. 347: "One of the best-known models of this type is rank-dependent expected utility theory, which was first proposed by John Quiggin (1982). Machina (1994) describes the rank-dependent model as "the most natural and useful modification of the classical expected utility formula" and, as testament to this, it has certainly proved to be one of the most popular among economists." (**PT/RDU most popular**)

P. 348 1st para: drawback of rank-dependence is drastic change of decision weight when rank-ordering changes, and no change at all otherwise.

P. 350: "The most widely discussed of these is Kahneman and Tversky's (1979) prospect theory."

P. 358: "A second general lesson in the data seems to be don't impose betweenness." %}

Starmer, Chris (2000) "Developments in Non-Expected Utility Theory: The Hunt for a Descriptive Theory of Choice under Risk," *Journal of Economic Literature* 38, 332–382.
https://doi.org/10.1257/jel.38.2.332

{% Well-organized and accessible discussion of the normative/descriptive debate about the Allais paradox, with nice references and citations, focusing on Friedman & Savage (1948) arguments. Starmer argues that normative appeal need not imply descriptive plausibility. P. 297 bottom: his paper takes EU axioms as normatively appealing, only for the sake of argument.

Pp. 281-282 give the formula SUMw(p_j)U(x_j) as "This is essentially the type of value function assumed in prospect theory of Kahneman and Tversky (1979)". For two-nonzero-outcome prospects K&T79 used a different formula, and there have been many misunderstandings about it. The above formula has sometimes been called separable prospect theory.

P. 287 has Raiffa argument that prescriptive theory would have nothing to offer if no descriptive violations.

On two points I disagree with the author.

1. We may be DESCRIPTIVELY interested in the behavior and preferences of people only at a level of thinking where, what we have chosen to designate as elementary mistakes, are avoided. (Starmer calls our choosing a precommitment to a descriptive viewpoint.) We may think that preferences and value system are per definition transitive so that, if we observe a violation, it is a mistake and not preference or value. This point is propagated by many experimental economists. Then normative considerations do enter a purely DESCRIPTIVE enterprise. Savage did Allais paradox upon first acquaintance but not after thinking. If we want to know descriptively what Savage would do from some time in history on, then it is: not violating EU in the Allais paradox!

2. I think that normative status of something does make it empirically plausible. Only in very exceptional situations such as the Allais paradox are what I consider mistakes likely to arise and a majority may deviate from what is normative. This is a very exceptional situation that does not invalidate the descriptive plausibility implied by a normative status. Starmer seems to impicitly focus his attention to those very exceptional situations. %}

Starmer, Chris (2005) "Normative Notions in Descriptive Dialogues," *Journal of Economic Methodology* 12, 277–289.

{% **real incentives/hypothetical choice**: **random incentive system**, explained on p. 93; this is same experiment as their 1989 JRU paper, so see there for further explanation.

PT falsified: They find a necessary condition of PT and RDU violated. The necessary condition, explained on pp. 86-90, was found by accident (explained on p. 95 bottom), but actually is really clever.

Define the cumulative prospect theory functional (so, rank- and sign-dependent utility) for decision under risk, in the appendix. Preceded Tversky & Kahneman (1992) and Luce & Fishburn (1991). Well, they don't take a general probability transformation for losses but the dual of the one for gains (as reflection would have it), but still it is clear that the rank- and sign-dependent idea is there. This paper was, in turn, preceded by Šipoš (Sipos) (1979) who also defines the symmetrical integral. %}

Starmer, Chris & Robert Sugden (1989) "Violations of the Independence Axiom in Common Ratio Problems: An Experimental Test of Some Competing Hypotheses," *Annals of Operations Research* 19, 79–102.

{% **coalescing; part-whole bias**

real incentives/hypothetical choice: **random incentive system**, explained on p. 166-167; also for losses (though there subjects had a prior choice of whether or not they wanted to have the random incentive system actualized, with the loss gambles surrounded by more gain-gambles; virtually all subjects preferred to really play.) They received prior endowment (**losses from prior endowment mechanism**) but not enough to compensate all potential losses.

They don't report raw data, and not even all of the stimuli they used. They show that with juxta-position manipulation they can confirm predictions of regret theory.

inconsistency in repeated risky choice: about 26% %}

Starmer, Chris & Robert Sugden (1989) "Probability and Juxtaposition Effects: An Experimental Investigation of the Common Ratio Effect," *Journal of Risk and Uncertainty* 2, 159–178.

{% **backward induction/normal form, descriptive**; Shows, in reaction to Holt (1986, American Economic Review), that the isolation effect works for the **random incentive system**. Shows that **RCLA** is violated more than compound independence. Thus, gives evidence in favor of backward induction; also positive evidence for isolation effect.

They consider a standard test of the common consequence effect. That is, a choice between (0.2:10, 0.75:7, 0.05:0) versus (1:7) and a choice between (0.2:10, 0.8:0) versus (0.25:7), 0.75;0). Several subjects got only one choice. Others got both, knowing it was fifty-fifty which one would be implemented for real (RIS). Under single choice the authors found, between-subject of course, significant violation of expected utility, with the common Allais paradox (AP) pattern more frequent than its reverse. Under RIS they found the same (so, isolation). Complete RCLA would predict as many AP patterns as their reverses. So, they significantly reject complete RCLA to the favor of isolation. Other violations of isolation are not ruled out of course, the more so as confirmation of isolation is only a H_0 not-rejected. %}

Starmer, Chris & Robert Sugden (1991) "Does the Random-Lottery Incentive System Elicit True Preferences? An Experimental Investigation," *American Economic Review* 81, 971–978.

{% **coalescing;** Found that a prospect generally becomes more attactive when an event that yields a positive outcome is unpacked into two components. They thus undermine the regret-theory explanation of violations of monotonicity, and cast doubt upon regret theory. %}

Starmer, Chris & Robert Sugden (1993) "Testing for Juxtaposition and Event-Splitting Effects," *Journal of Risk and Uncertainty* 6, 235–254. https://doi.org/10.1007/BF01072613

{% Paper investigates various explanations for the preference cylces, originally explained by regret theory. Somewhat surprisingly, it finds that event splitting (**coalescing**) does not do much, and does not explain things. It is not clear what the degree of event splitting is (maybe unless one studies the data in detail). They

find more agreement with regret theory for matrix-presentations than for other presentations, and argue that framing is doing much. %}

Starmer, Chris & Robert Sugden (1998) "Testing Alternative Explanations of Cyclical Choices," *Economica* 65, 347–361.

{% %}

The Statistician 42 (1993) no.3: Special issue: Conference on Practical Bayesian Statistics

{% %}

Statistical Science 7, no. 1, Febr. 1992, "Editorial."

{% Investigates equilibria with regular Bayesian beliefs, then distortions of those beliefs leading to ambiguity, and then situations in which this does not change the equilibrium. So, the equilibrium should be robust against such distortions of beliefs. %}

Stauber, Ronald (2011) "Knightian Games and Robustness to Ambiguity," *Journal of Economic Theory* 146, 248–274.

{% Beginning has nice discussion, and references, on counterfactual reasoning underlying backward induction. The paper considers the approach where deviations from BI (also to be analysed if BI is satisfied) are due to "crazy types" who choose completely randomly. This is taken as ambiguity, and then à la maxmin he goes by the worst scenario. Then probability of crazy types is taken to tend to 0, and the resulting equilibria are considered. Those need not satisfy subgame perfectness, for instance. %}

Stauber, Ronald (2017) "Irrationality and Ambiguity in Extensive Games," *Games and Economic Behavior* 102, 409–432.

{% They wrote a computer program that generates ambiguity. So, it produces random numbers, but with ambiguity, so, not with probabilities. If one has observed 10,000 numbers generated by the program, one has no clue what the next number or future distribution will be. The drawings are not IID or independent. Still no convergences within sight. The program keeps changing "regime." They heavily

use Cauchy distributions throughout the generating process. An original idea!

Here is a website for using it:

http://ambiguity.typesofnote.com

Stecher emailed, Oct. 2017: "There are links to source code on a GitHub site, which is all in Haskell and therefore should be free of side effects. The GitHub site also has the MIT license, which was the most permissive one we could find." %}

Stecher, Jack D., Timothy Shields, & John W. Dickhaut (2011) "Generating Ambiguity in the Laboratory," *Management Science* 57, 705–712. https://doi.org/10.1287/mnsc.1100.1307

{% Use Brouwer's view on maths to explain puzzle in finance. %}

Stecher, Douglas & Mark van Atten (2015) "Using Brouwer's Continuity Principle to Pick Stocks," *Annals of Operations Research* 225, 161–171.

{% **foundations of statistics**; discussed different interpretations of the llh principle. In particular it considers a version that says that different observations give the same evidence for a given hypothesis if same llh (LP1), and another version that says that different hypotheses get the same evidence from an observation if the same llh (LP2). The paper considers LP1 to be plausible but LP2 less so. %}

Steel, Daniel (2007) "Bayesian Confirmation Theory and the Likelihood Principle," *Synthese* 156, 53–77.

{% Confuses several things. P. 192 top seems to think that there being no specified probability in Ellsberg three-color means that it is not a violation of the sure-thing principle. P. 199 footnote 25 shows little understanding of Broome (1991), who has subtle and careful discussions of whether our not outcomes can become too general, using the term individuation in such discussions. %}

Steele, Katie (2007) "Distinguishing Indeterminate Belief from "Risk-Averse" Preferences," *Synthese* 158, 189–205.

{% Contains probably example of the "long line." Seems that pp. 67-68 show that preference relation is continuous w.r.t. a connected topology iff the order topology is connected. %}

Steen, Lynn A. & J. Arthur Seebach Jr. (1970) “*Counterexamples in Topology*.” Holt, Rinehart and Winston, New York.

{% %}
Steenhoff, Paul & Peter P. Wakker (2008) “Verliesangst is Drijfveer voor Afsluiten Verzekeren,” *Postbank NL* 10 no. 1, 27–29.
Direct link to paper

{% %}
Stefan, Simona & Daniel David (2013) “Recent Developments in the Experimental Investigation of the Illusion of Control. A Meta-Analytic Review,” *Journal of Applied Social Psychology* 43, 377–386.

{% Considers ambiguity aversion in Harsanyi’s veil of ignorance. %}
Stefánsson, H. Orri (2021) “Ambiguity Aversion behind the Veil of Ignorance,” *Synthese* 198, 6159–6182.
https://doi.org/10.1007/s11229-019-02455-8

{% Chance neutrality: Tastes are independent of beliefs. May be similar to state independence. In their model (I assume with some dynamic principles implicitly) it leads to linearity in probability, i.e., EU for risk. The authors argue that the latter need not be rational and, hence, chance neutrality is not. %}
Stefansson, H. Orri & Richard Bradley (2015) “How Valuable Are Chances?,” *Philosophy of Science* 82, 602–625.

{% **measure of similarity** %}
Steffens, Timo (2007) “*Enhancing Similarity Measures with Imperfect Rule-Based Background Knowledge*.” IOS Press, Fairfax, VA.

{% %}
Stegmüller, Wolfgang (1973) “Probleme und Resultate der Wissenschaftstheorie und Analytischen Philosophie, Band IVa, Personelle und Statistische Warscheinlichkeit,” Springer, Berlijn.

{% %}

Stehling, Frank (1975) "Eine Neue Characterisierung der CD- und ACMS-Produktionsfunktionen," *Operations Research-Verfahren* 21, 222–238.

{% This paper points out that in lottery choices, as in fact in all choices, there is a winner's curse going on. Not only will the lottery be good, but also the error probably was favorable. So, one should lower one's evaluation of one's preferred choice somewhat. Note that this can only reduce the lead of the most-preferred option over the others, and never reverse the ranking, and in this sense it is choice-irrelevant.

For every first bias/error, one can imagine situations where other errors occur and such that the first bias/error reduces the others. Then the first bias/error happens to be useful there. This paper shows that, thus, under particular errors in observations, the overestimation of small probabilities can mitigate the consequences of those errors. One reasoning is that for the most preferred prospect the probability of a good outcome is probably high so that overweighting the small probability lowers the evaluation (p. 1603 2nd para). The result of course depends much on the errors assumed. (Here, as in the formal model, the authors implicitly assume the same support of outcomes so that a good lottery cannot result from having better outcomes but only from having better probabilities.) If an agent knows about an error in observation, may also mitigate the error there rather than overweight small probabilities. The authors often link their result to evolution (e.g. p. 1604 mid).

The two observations above were provided before in the same journal by van den Steen (2004), not cited here, which seems though to be a thorough work. Benoît & Dubra (2011 Econometrica) also describe situations where probability distortion can be rational.

P. 1608 middle: The small corrections considered here only matter for decisions that are perceived close to indifferent. (But then the change of choice does not matter much.) From this the authors come to a most remarkable conclusion (P. 1620 end of Section V): "Put differently, debiasing may be beneficial in certain circumstances, but only in those that, from an evolutionary perspective, rarely result in a tie." Wow! Every biologist ever working on evolution (and still alive) should be informed about this insight, as should be every still-living person who ever

worked on debiasing. Note how evolution is used here as when putting sugar in every dish because, supposedly, sugar makes everything taste better.

P. 1617: the choice problem considered is that from a set of options a fixed fraction κ is chosen. %}

Steiner, Jakub & Colin Stewart (2016) "Perceiving Prospects Properly," *American Economic Review* 106, 1601–1631.

{% Discusses problems with conveying statistics, based on group observations, to individual patients for treatment decision. A t the end of p. 619 author seems to mix up things himself: "How many patients are sufficiently committed to the health of the population that they will take medications for years, knowing that some will benefit if all comply?" %}

Steiner, John F. (1999) "Talking about Treatment: The Language of Populations and the Language of Individuals," *Annals of Internal Medicine* 130, 618–622.

{% %}

Steingrimssona, Ragnar & R. Duncan Luce (2007) "Empirical Evaluation of a Model of Global Psychophysical Judgments: IV. Forms for the Weighting Function," *Journal of Mathematical Psychology* 51, 29–44.

{% Is there a world outside us?? %}

Steinhoff, Gordon (1989) "Putnam on "Empirical Objects" ," *Dialectica* 43, 231–248.

{% **foundations of statistics**: Mayo proposed a new approach to statistical inference combining Popper's falsificationalism with frequentism. Her book is positively reviewed here, though with the suggestion that we have to look further. %}

Sterkenburg, Tom F. (2020) Book Review of: Deborah G. Mayo (2018): "Statistical Inference as Severe Testing: How to Get beyond the Statistics Wars, Cambridge University Press, Cambridge," *Journal for General Philosophy of Science* 51, 507–510.

{% **Christiane, Veronika & I**; %}

Stenkula, Mikael (2004) "The Euro Cash Changeover Process," *Kyklos* 57, 265–286.

{% **discounting normative**: Seems to argue that discounting is irrational. %}
Stern, Nicholas (2008) "The Economics of Climate Change," *American Economic Review* 98, 1–37.
https://doi.org/10.1257/aer.98.2.1

{% Seem to recommend ambiguity aversion for climate change decisions. %}
Stern, Nicholas, Siobhan Peters, Vicki Bakhshi, Alex Bowen, Catherine Cameron, Sebastian Catovsky, Di Crane, Sophie Cruickshank, Simon Dietz, Nicola Edmonson, Su-Lin Garbett, Lorraine Hamid, Gideon Hoffman, Daniel Ingram, Ben Jones, Nicola Patmore, Helene Radcliffe, Raj Sathiyarajah, Michelle Stock, Chris Taylor, Tamsin Vernon, Hannah Wanjie, Dimitri Zenghelis (2006) "*Stern Review: The Economics of Climate Change*." Cambridge University Press, Cambridge, UK.

{% Reference many studies into intertemporal choice for animals, and adds an observation for lemurs. %}
Stevens, Jeffrey R. & Nelly Mühlhoff (2012) "Intertemporal Choice in Lemurs," *Behavioural Processes* 89, 121–127.

{% **questionnaire versus choice utility**: Argue that a cubic function better fits the relation between VAS and PE (they call it SG) than a power transformation. Shmueli (2007) criticizes the paper. %}
Stevens, Katherine J., Christopher J. McCabe, & John E. Brazier (2006) "Mapping between Visual Analogue Scale and Standard Gamble Data; Results from the UK Health Utilities Index 2 Valuation Survey," *Health Economics* 15, 527–533.

{% **questionnaire versus choice utility**: use power transformation from VAS to PE (if I remember well, they call it SG). %}
Stevens, Katherine J., Christopher J. McCabe, & John E. Brazier (2007) "Multi-Attribute Utility Function or Statistical Inference Models: A Comparison of Health State Valuation Models Using the HUI2 Health State Classification System," *Journal of Health Economics* 26, 992–1002.

{% Uses subjective bisection. %}

Stevens, Stanley S. (1936) "A Scale for the Measurement of a Psychological Magnitude: Loudness," *Psychological Review* 43, 329–353.

{% May have been the first to introduce meaningfulness.
social sciences cannot measure: wrote his text as reaction to the Ferguson et al. (1940) report. **%}**

Stevens, Stanley S. (1946) "On the Theory of Scales of Measurement," *Science* 103 no. 2648, 677–680.

{% Argues that instead of Fechner's logarithmic law, often power functions fit data better, citing data from 14 different perceptual continua.

standard-sequence invariance: p. 159 discusses subjective standard sequence measurement of loudness where first hearing highest sound or first hearing lowest sound gave different results, citing Garner (1954).

standard-sequence invariance: p. 166 cites J.C. Stevens on tradeoff comparisons (taking multiplicatively, as ratios) to measure subjective loudness.

just noticeable difference: in several places, e.g. p. 172, Stevens argues against using just noticeable differences/ratios as basis of cardinal or ratio scales. He writes:

"It is improper simply because it is wrong."

P. 173 2nd para discusses adding a little term to power functions, similar to one of the solutions to defining negative powers at 0.

P. 176 1st para discusses that measuring equalities a/b = b/c = c/d will not identify the whole ratio scale, similar to Bleichrodt, Rohde, & Wakker's (2009) time tradeoff sequences identifying discounting only up to a power.

P. 178 2nd para: "One occasionally gets the impression that there are more people with a method who are looking for a problem to use it on than there are searchers with a problem looking for a method."

The paper throughout criticizes Fechner, e.g. in final para. %}

Stevens, Stanley S. (1957) "On the Psychophysical Law," *Psychological Review* 64, 153–181.

{% **decreasing ARA/increasing RRA**: gives psychological arguments for power utility. %}

Stevens, Stanley S. (1959) "Measurement, Psychophysics, and Utility." *In* C. West Churchman & Philburn Ratoosh (eds.) *Measurement: Definitions and Theories*, Wiley, New York.

{% %}

Stevens, Stanley S. (1968) "Measurement, Statistics, and the Schemapiric View," *Science* 161, 849–856.
https://doi.org/10.1126/science.161.3844.849

{% **ratio-difference principle**: seem to have it. %}

Stevens, Stanley S. & Hallowell Davis (1938) "*Hearing: Its Psychology and Physiology*." Wiley, New York.

{% Prothetic continua are scales that are perceived in a concave manner, e.g. duration, loudness, etc. Their perceptions are usually power functions, less curved than the logarithm (so, power between 0 and 1). Metathetic continua can in principle be perceived in a linear manner, e.g. visual position.

P. 388: "Despite pride of ownership, at least one of the authors is prepared to admit that this function is probably too steep to be representative."

Pp. 389-390 has two nice paras on validity being difficult and subjective that I reproduce below:

"The question of validity.—An equation such as the one proposed above may be expected to hold under some set of "standard conditions," e.g., lifting weights of standard, uniform size under a standard method of lifting. It will not necessarily hold for the lifting of weights that differ in size, or weights presented in different ways. As in all scientific endeavor we have to start with some set of "standard conditions," determine the empirical rules, and then explore the problem of the invariance of the rules under transformations of the conditions. Contrary to what some authors seem to imply, the failure of invariance to hold does not invalidate the rules or the equations that hold for the standard conditions. Our aspiration, of course, is to formulate rules of wide invariance, for that is the chief aim of the scientific enterprise. The demonstration that the outcome of an experiment depends on "conditions" is a way of showing that invariance is limited, but this fact has no necessary bearing on the problem of validity.

The validity of a subjective scale, or of any other scale, is always a matter of opinion. Valid is what makes sense to the scientific community in terms of the problems before it, and, unfortunately, when we push the problem back to where we have to make fundamental choices, there are no external criteria to guide the ultimate value judgments that have to be made.

Reliability is a tempting criterion, but sometimes we find that agreement among experimental results is due to the operation of factors that force agreement, as when all Os give identical ratings to the three weights shown by the squares in Fig. 4D. Predictive power is another tempting criterion, but it occasionally happens that prediction succeeds for wrong reasons, as when Fechner's law predicts the outcome of some types of category judgments. What we consider to be valid measures of things is subject to constant revision because we are always up against the uncertain task of deciding, without firm external criteria, that the given measures do or do not assess the things we are interested in."

P. 390 2nd para describes history how Stevens run into nonlinear subjective perceptions.

P. 397: the oldest subjective category scale available is judgments of brightness of stars by astronomers. %}

Stevens, Stanley S. & Eugene Galanter (1957) "Ratio Scales and Category Scales for a Dozen Perceptual Continua," *Journal of Experimental Psychology* 54, 377–411.

{% **time preference**; **discounting normative**: interprets positive time preference as an implicit risk value in lotteries with one nonzero outcome. %}

Stevenson, Mary K. (1986) "A Discounting Model for Decisions with Delayed Positive or Negative Outcomes," *Journal of Experimental Psychology: General* 115, 131–154.

{% **time preference**; %}

Stevenson, Mary K. (1993) "Decision Making with Long-Term Consequences: Temporal Discounting for Single and Multiple Outcomes in the Future," *Journal of Experimental Psychology: General* 122, 3–22.

{% **conservation of influence**? Edgeworth (1881) refers to this work without dating it. Seems to discuss mechanism of life. %}

Stewart, Balfour, (1873) "*The Conservation of Energy Being an Elementary Treatise on Energy and Its Laws.*" Henry S. King, London. (4th edn. 1878)

{% Seems to cite a number of empirical studies into the utility of money that usually find that square-root utility works well. %}

Stewart, Neil (2009) “Decision by Sampling: The Role of the Decision Environment in Risky Choice,” *Quarterly Journal of Experimental Psychology* 62, 1041–1062.

{% **PT falsified**: Propose a theory that is a kind of mix of CBDT of Gilboa & Schmeidler, Arducci’s range-frequency theory, and Erev’s Decision-from-Experience-theory (DFE). Choice alternatives are evaluated by comparison to related alternatives stored in memory, and binary comparisons with those. It leads to alternative explanations for some of the main empirical findings, such as concave utility, **inverse S** probability weighting, loss aversion, and hyperbolic discounting. The title of their final section, 6.6, providing the final lines of the paper, is “Unifying normative and contextual models of decision making.” %}

Stewart, Neil, Nick Chater, & Gordon D.A. Brown (2006) “Decision by Sampling,” *Cognitive Psychology* 53, 1–26.

{% %}

Stewart, Neil, Nick Chater, Henry P. Stott, & Stian Reimers (2003) “Prospect Relativity: How Choice Options Influence Decision under Risk,” *Journal of Experimental Psychology: General* 132, 23–46.

{% **SEU = SEU**: p. 688 2nd para lists Savage (1954) as one of the nonEU theories for risk.

PT falsified: This paper gives further evidence on the theories of Stewart et al, that decisions, utility, and so on are influenced by stimuli seen before. The authors use pessimistic words such as “there is no stable mapping between attribute values and their subjective equivalents.” I have a different DESCRIPTIVE opinion coming from the NORMATIVE view (not central among psychologists) that such subjective equivalents should exist for rational decisions, and then the descriptive goal to find them as good as possible despite the big biases and noise that exist. %}

Stewart, Neil, Stian Reimers, & Adam J.L. Harris (2015) “On the Origin of Utility, Weighting, and Discounting Functions: How They Get Their Shapes and how to Change Their Shapes,” *Management Science* 61, 687–705.

{% The MINDACT trial, published in NEJM (2016), was a big trial with N=6693 patients with early-stage breast cancer. A 70-gene signature (Mammaprint) was used to estimate genomic risk, and clinical risk was estimated, suggesting positive value. This paper adds a decision analysis, estimating the risk distributions and benefits individually. Then the value of the mammaprint turns out to be much lower. %}

Steyerberg, Ewout W., Liesbeth C. de Wreede, David van Klaveren, & Patrick M. M. Bossuyt (2021) “Personalized Decision Making on Genomic Testing in Early Breast Cancer: Expanding the MINDACT Trial with Decision-Analytic Modeling,” *Medical Decision Making* 41, 354–365.

{% **three-doors problem** %}

Stibel, Jeffrey M., Itiel E. Dror & Talia Ben-Zeev (2009) “The Collapsing Choice Theory: Dissociating Choice and Judgment in Decision Making,” *Theory and Decision* 66, 149–179.

{% P. 122 about idea that policy making can do expected value maximization because it is like repeated games, giving ref to Elstein & Chapman (1994). %}

Stiggelbout, Anne M. (1995) “Trade-offs between Quality and Quantity of Life,” Ph.D. Thesis in Medicine, Leiden University, the Netherlands.

{% **questionnaire versus choice utility**: survey on QALY etc., many references to people who empirically relate utility measurements to psychometric measurements and people using power transformations to relate VAS to TTO.

P. 303: “Many authors have assessed the relationship between descriptive (or psychometric) methods for the assessment of quality of life and preference-based (or valuation) methods.” %}

Stiggelbout, Anne M. (2000) “Assessing Patients’ Preferences.” *In* Gretchen B. Chapman & Frank A. Sonnenberg (eds.) *Decision Making in Health Care. Theory, Psychology, and Applications*, 289–312. Cambridge University Press, New York.

{% P. 221 discusses whether policies should be based on patients’ utilities or general public’s utilities, bringing the pros (public should decide in the end) and cons (public does not know disease well) as I like them. P. 228 3rd para discusses the

same issue but claims that for meso decisions patients' utilities are to be used, for individual level individual utilities prior to the decision. Here the nuances that I like are missing.

P. 221 2nd column gives short discussion of EuroQol and its transformation to utilities.

risky utility u = strength of preference v (or other riskless cardinal utility, often called value): p. 222 first column penultimate para equates the two without further ado, as commonly done in medical decision making.

P. 222 Fig. 1 gives a decision tree of laryngeal cancer, 65 year old man with T3N0M0 cancer.

P. 224 criticizes the PE (if I remember well, they call it SG) for probability distortion plus ceiling effects (**PE doesn't do well**).

P. 226/227 reviews the effect of experience with health state on evaluation.

P. 228 bottom of first column, on utility measurement: "For decisions for the individual patient, the methods are not sufficiently reliable," %}

Stiggelbout, Anne M. & Hanneke C.J.M. de Haes (2001) "Patient Preference for Cancer Therapy: An Overview of Measurement Approaches," *Journal of Clinical Oncology* 19, 220–230.

{% %}

Stiggelbout, Anne M., Marinus J.C. Eijkemans, Gwendoline M. Kiebert, Job Kievit, Jan-Willem H. Leer, & Hanneke C.J.M. de Haes (1996) "The Utility of the Visual Analogue Scale in Medical Decision Making and Technology Assessment: Is it an Alternative to the Time Trade-Off?," *International Journal of Technology Assessment in Health Care* 12, 291–298.

{% In the Netherlands the price of one QALY is between 25.000 and 50.000 Euros. %}

Stiggelbout, Anne M. (2000), Interview in Cicero.

{% **PE higher than CE**: p. 87 argues for it through indirect data (direct PE (they call it SG)) for health states is higher than TTO-with-utility-correction-for- CE (certainty equivalent) %}

Stiggelbout, Anne M., Gwendoline M. Kiebert, Job Kievit, Jan-Willem H. Leer, Gerrit Stoter, & Hanneke C.J.M. de Haes (1994) "Utility Assesment in Cancer Patients: Adjustment of Time Tradeoff Scores for the Utility of Life Years and Comparison with Standard Gamble Scores," *Medical Decision Making* 14, 82–90.

{% %}

Stiggelbout, Anne M., Gwendoline M. Kiebert, Job Kievit, Jan-Willem H. Leer, J. Dik F. Habbema, & Hanneke C.J.M. de Haes (1995) "The "Utility" of the Time Trade-Off Method in Cancer Patients: Feasibility and Proportional Trade-Off," *Journal of Clinical Epidemiology* 48, 1207–1214.

{% People mention attributes most important for their quality of life, score them, and then determine weights to aggregate them into an overall value. The scoring is sometimes done with direct weighting (DW), i.e., direct subjective assessment, but this does not work well. Judgment analysis (JA) does not ask for direct assessement but uses simple binary choices to assess decision weights. Still the method has many drawbacks. This paper proposes adaptive conjoint analysis (ACA) as a more sophisticated method, with more elaborate choices between n-tuples, based on conjoint analysis of marketing (and mathematical psychology), and asking for direct scalings of strengths of preferences. Although problems remain, it works considerably better. %}

Stiggelbout, Anne M., Elsbeth Vogel-Voogt, Evert M. Noordijk, Thea P.M. Vliet Vlieland (2008) "Individual Quality of Life: Adaptive Conjoint Analysis as an Alternative for Direct Weighting?," *Quality of Life Research* 17, 641–649.

{% This is a highly impressive work that I enjoyed immensely and spent much time on. I have one major criticism. Stigler is often overly negative on others. It seems that he does not try to understand what others did, but rather seeks to ascribe mistakes to others, to show that he understands things better.

Here are some examples of points where Stigler did not seem to be accurate.

(1) In §I (first citation of Bentham) he cites Bentham and thinks that it is about interpersonal comparison. I think it isn't. When Bentham speaks about two individuals it is only his way of expressing dependence on !one! individual. I

think that Bentham is discussing consequentialism there, properly pointing out that one cannot incorporate “everything relevant” because then the model becomes intractable. (Note: Becker goes in the opposite direction.)

(2) In §V (p. 94) he cites Fisher on ordinal nature of utility and criticizes Pareto for being inconsistent in using cardinal utility elsewhere. However, in the cited part of Fisher, Fisher does not say utility is ordinal. He says: Utility is ordinal !!if!! we only seek ... Similarly for Pareto, his commitment will depend on context and antecedent assumptions. It seems that Bruni & Guala (2001) point out this mistake of Stigler.

(3) On p. 77, footnote 82, he suggests that §VII will demonstrate that Slutsky had seen something on quasi-concavity versus concavity of additively decomposable utility. However, I think §VII does not give that. (I didn’t check very carefully.)

(4) §VIII C argues that people do not gamble and that this should have been used to ... For this purpose, the claim of no gambling is armchair.

coherentism

Outline:

- §I on Bentham and others who posited utility.

- Then the Ricardians who did not adopt Bentham’s utility.

- Then §II on people who stated diminishing marginal utility but did not do anything with it.

- Gossen was nice, first to derive optimality condition (marginal utility divided by price should be same for all commodities).

- §III on marginal-revolution people (Jevons, Menger, Walras) who used utility and did things with it and to measure it in ways not-too-convincing.

- §IV on shape of utility, additive decomposability, concavity, competing and completing commodities, here also the earlier Bernoulli is mentioned. Also **just noticeable difference**.

- §V on (non)measurability, Fisher and Pareto, and Slutsky who banned psychology from economics

- §VI on complementarity (saying it’s hard to reconcile with ordinalism)

- §VII more on utility versus demand; Part A does abandonment of utility.

- §VIII, the final one, does general comments on parsimony versus generality and empirical reality.

Beginning of §II refers to several people who assume: m**arginal utility is diminishing**

utility families parametric: §IV.C: "The precise shape of the utility function received little attention in the main tradition of utility theory."

Mentions many people who, on the one hand, say interpersonal utility comparisons are impossible, but on the other hand do need and use them in their analysis.

§IV describes much of assumption of additively decomposable utility function among economists in the preceding section.

§V, ascribes to p. 11 ff of Fisher (1982) a reasoning that is not present in Fisher's work in this form. Stigler's reasoning reflects the idea of **tradeoff method** measurement in the additively decomposable MAU context, and of a standard sequence, but Fisher's original text does not:

> "Select arbitrarily a quantity of any commodity, say, 100 loaves of bread. Let the marginal utility of this quantity of commodity be the unit of utility (or util). Grant the ability of the individual to order the utilities of specified amounts of two goods, i.e. to indicate a preference (if one exists) or indifference between the two quantities. Then it is possible to construct the utility schedule of (say) milk. Start with no milk and find the increment of milk (δm_1) equivalent to the hundredth loaf of bread, i.e. the minimum amount of milk the individual would accept in exchange for the hundredth loaf of bread. Find a second increment (δm_2), given the possession of δm_1, equivalent to the hundreth loaf, etc. We obtain thus a schedule (or function) such as that given"

The procedure described gives a sequence 0, δm_1, δm_2, δm_3, δm_4, ... of amounts of milk that are equally-spaced in utility units, a "standard sequence," based on indifferences $(100,0) \sim (99,\delta m_1)$, ..., $(100,\delta m_i) \sim (99,\delta m_{i+1})$, ... etc.
Fisher (1892) only shows that marginal utilities can be compared under additive representation (even, more restrictively, independence of marginal utility of a commodity from the levels of other commodities) by assuming that in optimum chosen the marginal utility of money for each commodity is the same (so, Gossen's 2nd law), but he does not construct a standard sequence. And Fisher never considers direct tradeoffs between bread and milk.

Blaug (1962), §9.2 ascribes to Fisher (1927) what Stigler ascribes to Fisher (1892). I spent many hours checking out the two Fisher works, and the idea is not there. Blaug (Feb. 12, 2002, personal communication) explained that he had taken the reference from Stigler (1950) without checking the original.

§VII, on Marshall, discusses assumptions of linear utility for money.

P. 381 seems to ascribe to Pareto, incorrectly, that strengths of preferences cannot be measured (Ellingsen 1994 footnote 18). %}

Stigler, George J. (1950) "The Development of Utility Theory: I; II," *Journal of Political Economy* 58, 307–327; 373–396.
Reprinted in Alfred N. Page (1968) *Utility Theory: A Book of Readings*, Wiley, New York, 55–119.

{% %}

Stigler, George J. (1961) "The Economics of Information," *Journal of Political Economy* 69, 213–225.

{% Seems to point out that it makes little sense to cite separate texts from works that are ambiguous or self-contradictory. %}

Stigler, George J. (1965) "Textual Exegesis as a Scientific Problem," *Economica* 32, 447–450.

{% %}

Stigler, George J. (1965) "*The History of Economics.*" University of Chicago Press, Chicago.

{% P. xiv, about the risk/uncertainty distinction assigned to Knight: "Fortunately this is an extreme caricature of his work, because modern analysis no longer views the two classes [risk and uncertainty] as different in kind." It is not clear whether Stigler means here that risk is a special, extreme, case of uncertainty (the interpretation that I like) or that he means that people should satisfy the Savage axioms and then wants to interpret subjective probabilities as objective probabilities (**SEU = risk**). The latter is an, I think unfortunate, interpretation of the term risk that deviates from the traditional and still most common terminology. People who use the deviating terminology may write things such as "Savage showed that we need not distinguish between risk and uncertainty." In the common terminology, risk refers to objective probability, and Savage's SEU model with additive subjective probabilities is uncertainty and not risk. I prefer the traditional common terminology because I prefer that whether something is decision under risk or under uncertainty does not depend on the decision attitude of the agent. %}

Stigler, George J. (1971) "Introduction." *In* Frank H. Knight, *Risk, Uncertainty, and Profit*. Chicago University Press, Chicago.

{% Can be cited for strict ordinalist view of economics.

U(x) depends on past consumption y and, hence, that should be added in the formula. Many people add past consumption as an index to U and then have the utility function $U_y(x)$ depending on past consumption. This paper adds past consumption as an index to x, U(x,y) and then has nonchanging U: voilà! I don't think that the paper, often considered a classic, really has more to say than this.

"Market good" is the tangible object you consume, "commodity bundle" is the consequentialist thing that simply comprises "everything relevant" such as your secret admiration of your wife etc.

P. 76: "tastes (do) neither change capriciously nor differ importantly between people ... one does not argue over tastes for the same reason that one does not argue over the Rocky mountains - both are there, will be there next year, too, and are the same to all men." P. 89: "Indeed, given additional space, we would argue that the assumption of **time preference** impedes the explanation of life cycle variations in the allocation of resources, the secular growth in real incomes, and other phenomena."

P. 78, **discounting normative**: Uses formula with discounting, but footnote 4 says that "A consistent application of the assumption of stable preferences implies that the discount rate is zero; that is, the absence of time preference" It seems that they do not distinguish between ageing effect and discounting: D**C = stationarity**. When they say somewhere that discounting means that your taste for 1984 consumption changes as you move closer, they are confusing a number of things. (For example, tradeoff between 1984 and 1980 remains constant, also between 1984 and 1981, but "present" is not well defined if you assume it moving.) %}

Stigler, George J. & Gary S. Becker (1977) "De Gustibus non Est Disputandum," *American Economic Review* 67, 76–90.

{% **foundations of probability** %}

Stigler, Stephen M. (1988) "The Dark Ages of Probability in England: The Seventeenth Century Work of Richard Cumberland and Thomas Strode," *International Statistical Review* 56, 75–88.

{% **foundations of probability**; **foundations of statistics** %}

Stigler, Stephen M. (1986) "*The History of Statistics, The Measurement of Uncertainty before 1900*." Harvard University Press, Cambridge, MA.

{% In 1693 the 1st application of probability theory was in medicine and took place in Leiden. %}

Stigler, Stephen M. (March 26, 1999) lecture honoring Willem van Zwet's 65th birthday, Leiden.

{% **foundations of statistics** %}

Stigler, Stephen M. (2012) "Stigler Studies in the History of Probability and Statistics, L: Karl Pearson and the Rule of Three," *Biometrika* 99, 1–14.

{% **Z&Z**: shows that adverse selection can be detrimental for competitive markets. %}

Stiglitz, Joseph E. & Andrew Weiss (1981) "Credit Rationing in Markets with Imperfect Information," *American Economic Review* 71, 393–410.

{% Uses differentiability assumptions along the diagonal. %}

Stigum, Bernt P. (1972) "Finite State Space and Expected Utility Maximization," *Econometrica* 40, 253–259.

{% %}

Stigum, Bernt P. (1990) "*Toward a Formal Science of Economics*." MIT Press, London.

{% %}

Stigum, Bernt P. & Fred Wenstop (1983) "*Foundations of Utility and Risk Theory with Applications*." Reidel, Dordrecht.

{% Gives references to Savage's probability measure not being countably additive in lotteries with one nonzero outcome. %}

Stinchcombe, Maxwell B. (1997) "Countably Additive Subjective Probabilities for Expected and Non-Expected Utility," *Review of Economic Studies* 64, 125–146.

{% First version 2010 %}

Stinchcombe, Maxwell B. (2018) "Learning Finitely Additive Probabilities: An Impossibility Theorem,"

{% The author repeatedly emphasizes that we should not reduce uncertainty to risk, i.e., to single additive probabilities, citing Knight. I as Bayesian think that in the end uncertainties should be expressed in terms of probabilities. But this happens only in the last five seconds before the final decision is taken by the ultimate agent. I agree that in the preceding years of analyzing the situation, subjective probabilities do not play much of a role. I do not agree that in the last five seconds of the final decision one should go violating the sure-thing principle, and I see no role for ambiguity *decision* theories for rational decisions. %}

Stirling, Andy (2010) "Keep it Complex," *Nature* 468, December 2010, 1029–1031.

{% Deals with convex sets of probability measures, refers to Shafer, Levi etc. Gives heuristics on how to use it. %}

Stirling, Wynn C. & Darryl R. Morrell (1991) "Convex Bayes Decision Theory," *IEEE Transactions on Systems, Man, and Cybernetics* 21, 173–183.

{% %}

Stock, James H. & Mark W. Watson (2015) "*Introduction to Econometrics*" 3rd edn. Pearson Education, Reading, Mass.

{% Nice display of probabilities; references to studies in belief in luck %}

Stockman, Carol K. & Mark S. Roberts (2005) "Risk Preferences over Health and Monetary Domains in a Patient Population,"

{% Theoretical speculations. %}

Stodder, James (1997) “Complexity Aversion: Simplification in the Herrnstein and Allais Behaviors,” *Eastern Economic Journal* 23, 1–15. https://www.jstor.org/stable/40325750

{% **ubiquity fallacy**: Physicalism, a variation of materialism, claims that everything can be explained from physical processes, and that also mental processes can be reduced to it. My categorizing it under the ubiquity fallacy may give away my opinion on it. %}

Stoljar, Daniel (2010) “*Physicalism*.” Routledge, London

{% %}

Stomper, Alex & Marie-Louise Vierø (2015) “Iterated Expectations under Rank-Dependent Expected Utility and Model Consistency,” working paper.

{% %}

Stone, Bob & Ron Jacobs (1988) “*Successful Direct Marketing Methods*;” 4th edn. Lincolnwood, Illinois: NTC Business Books.

{% **probability communication**: Showing only “foreground risk” (bad outcome) and not “background risk” (the good outcome) makes the former more salient. The authors investigate further details and combinations of numerical/graphical, where graphical is by pie charts in experiment 1, and pie charts and bar graphs in study 2. %}

Stone, Eric R., Winston R. Sieck, Benita E. Bull, J. Frank Yates, Stephanie C. Parks, & Carolyn J. Rusha (2003) “Foreground: Background Salience: Explaining the Effects of Graphical Displays on Risk Avoidance,” *Organizational Behavior and Human Decision Processes* 90, 19–36.

{% **probability communication** %}

Stone, Eric R., J. Frank Yates, & Andrew M. Parker (1997) “Effects of Numerical and Graphical Displays on Professed Risk-Taking Behavior,” *Journal of Experimental Psychology: Applied* 3, 243–256.

{% Showed that every algebra is isomorphic to an algebra of subsets. Such a result does not hold for sigma-algebras. %}

Stone, Marshall H. (1936) "The Theory of Representation for Boolean algebras," *Transactions of the American Mathematical Society* 40, 37–111. https://doi.org/10.2307/1989664

{% **Dutch book** %}

Stone, Marshall H. (1949) "Postulates for the Barycentric Calculus," *Annali di Matematica Pura ed Applicata* 29, 25–30.

{% **Dutch book** %}

Stone, Mervyn (1976) "Strong Inconsistency from Uniform Priors," *Journal of the American Statistical Association* 71, 114–116.

{% real incentives: **random incentive system**. Average outcome in experiment was £2130, but when paying subjects it was divided by 1000 (brr!) (p. 113 top).

error theory for risky choice: central;

inverse S: Almost not found, Prelec's one-parameter family fits best with parameter 0.94, which is very close to linear and has almost no inverse S. (Utility $x^{0.19}$ is very concave.)

Data are nonrepresentative because it is always a choice between two two-outcome prospects where one of the two has one outcome equal to 0 (p. 112 3rd para). Birnbaum, Slovic, and others have shown that the 0 outcome generates many special biases.

Is impressive data fitting using PT. The data-fitting uses Akaike's method to discount for the number of parameters used.

P. 104 bottom: error theories always have choice probability depend only on preference value, and not on other aspects such as monotonic configurations.

90 prospect choices were elicited from N = 96 subjects, combining several parametric families for utility, probability weighting, and error theory.

P. 112 middle has discussion of interactions between parameters in parametric fitting ("multicollinearity"), and P. 121 ff. (Subsection 5.3) has results on it.

BEST FIT: power utility $U(x) = x^r$ for r = 0.19, Prelec's one-parameter family

$$w(p) = exp\left(-\,(-ln(p))^{r}\right) \text{ for } r = 0.94 \text{ (very close to linear),}$$

and a logit error function using Luce’s (1959) probabilistic choice theory. $(V(f)^{\varepsilon}/(V(f)^{\varepsilon}+V(g)^{\varepsilon})$ for ε = ? (I did not find it).

P. 102, and p. 123 top: the mean-variance model behaves very poorly in fitting data.

P. 101 last para claims that to fit one parameter, the others must be assumed. This need not be so for specially constructed data sets. For instance, when using data from the tradeoff method for parametric fitting, the parameter of utility can be fit irrespective of what weighting-function parameter is taken. Arguments in favor of nonparametric fitting will be given on p. 125.

The author uses the term “nonparametric” to refer solely to the approach where the utility of each outcome considered and the probability weight of each probability considered is taken as a separate parameter, without the stimuli targeted much to optimally give the parameters (p. 107 6th para). Then it will not perform well because it has too many parameters (each charged by Akaike’s formula) that, accordingly, mostly pick up noise.

The author is a psychologist and theoretical parts sometimes deviate from economic conventions. The author uses the term normative to indicate that a preference foundation (“axiomatization”) has been given, irrespective of whether this foundation is supposed to have a normative status.

equate risk aversion with concave utility under nonEU: as do most economists, in absence of EU as working hypothesis he confuses risk attitude with utility curvature, writing for instance on p. 106 that linear utility reflect risk neutrality.

P. 106: The HARA family in Table 2 is not correct. The formula for Luce’s theory in Table 4b $(V(f)^{\varepsilon}/(V(f)^{\varepsilon}+V(g)^{\varepsilon})$ is the probability of prospect f being preferred to g), the one found to perform best, is unacceptable for zero or negative values of V, and will already misbehave for positive V values close to 0.

P. 108, top: The author incorrectly suggests that power probability transformation could not satisfy quasi-concavity and quasi-convexity. Wakker (1994) and Wakker & Yang (2021 IME) prove that quasi-concavity holds if and only if w is convex, and quasi-convex if and only if w is concave, which shows that these things go together well with power utility. The 2nd displayed formula on p. 108 has probabilities not summing to 1.

P. 111 middle has a strange claim that indifference data cannot be used to investigate choice functions (i.e., error theories). Glenn Harrison also has sometimes written so (e.g., Harrison & Rutström 2009 p. 139 end of §2). Indifference data is way more informative than choice data. It is only that these authors use statistical techniques that only work for binary choice.

P. 114: $e^{-64.2}$ = 0.49??? %}

Stott, Henry P. (2006) "Cumulative Prospect Theory's Functional Menagerie," *Journal of Risk and Uncertainty* 32, 101–130.

{% Ambiguity aversion is related to the degree of violation of independence of irrelevant alternatives, using an Anscombe-Aumann setup. %}

Stoye, Jörg (2011) "Axioms for Minimax Regret Choice Correspondences," *Journal of Economic Theory* 146, 2226–2251.

{% **foundations of statistics**: points out analogy between maxmin EU and models in statistics. %}

Stoye, Jörg (2012) "New Perspectives on Statistical Decisions under Ambiguity," *Annual Review of Economics* 4, 257–282.

{% Proposes weighted average between upper and lower expectations. %}

Strat, Thomas M. (1990) "Decision Analysis Using Belief Functions," *International Journal of Approximate Reasoning* 4, 391–418.

{% **dynamic consistency** (?); biconvergence and tail insensitivity resemble truncation-continuity of Wakker (1993, MOR) but are more restrictive because they require that after some timepoint the tail is cut down to either 0 or some other value, à la de Finetti.

Unfortunately, some notation such as ${}_1c$ is not defined; is as in Koopmans (1960, 1972). Takes production function F, programs start from c_1 and then at each time t, the capital available, say x_t, is divided into c_t, consumption at t, and $F(x_t - c_t)$, the capital left for t+1. The whole paper is conditional on this process, with some fixed F assumed.

Theorem G shows that for time-additivity, *discounted* utility is bounded in the domain considered if and only if bi-convergence holds. The result depends on the production function F assumed, which determines the domain. %}

Streufert, Peter A. (1990) “Stationary Recursive Utility and Dynamic Programming under the Assumption of Biconvergence,” *Review of Economic Studies 57*, 79–97.

{% %}

Streufert, Peter A. (1991) “Nonnegative Stochastic Dynamic Preferences,” Stanford Institute for Theoretical Economics.

{% %}

Streufert, Peter A. (1992) “An Abstract Topological Approach to Dynamic Programming,” *Journal of Mathematical Economics* 21, 59–88.

{% %}

Streufert, Peter A. (1993) “Abstract Recursive Utility,” *Journal of Mathematical Analysis and Applications* 175, 169–185.

{% Extends the results of Gorman (1968) to countable product sets. A node is a separable set that is not overlapped by any other separable set. There are simple, complex, and envelope nodes. Assumes, like Gorman, arcconnected topologically-separable components. The main condition driving the extension from finite to infinite separability is continuity with respect to the product topology, which given the weakness of this topology is a very restrictive assumption. Basically, continuity w.r.t. the product topology entails that for every open set R in the range we need to specify open domains for only finitely many coordinates, and can leave all other coordinates completely free, to already be in the inverse of R. So, it lets tails be unimportant. %}

Streufert, Peter A. (1995) “A General Theory of Separability for Preferences Defined on a Countably Infinite Product Space,” *Journal of Mathematical Economics* 24, 407–434.

{% %}

Strickland, Lloyd H., Roy J. Lewicki, & Arnold M. Katz (1966) "Temporal Orientation and Perceived Control as Determinants of Risk-Taking," *Journal of Experimental Social Psychology* 2, 143–151.

{% **risky utility u = strength of preference v (or other riskless cardinal utility, often called value)**: p. 84: utility is "as a psychological entity measurable in its own right" %}

Strotz, Robert H. (1953) "Cardinal Utility," *American Economic Review* 43, 384–397.

{% **dynamic consistency**: f**avors abandoning time consistency, so, favors sophisticated choice,** because he considered precommitment only viable if an extraneous device is available to implement it.

First to note the problem of time inconsistency (called the "intertemporal tussle").

P. 165 bottom & p. 167 bottom distinguish between time distance and calendar time.

Mistake in derivation of optimal path was pointed out by Pollak (1968): According to Epstein & Le Breton (1993) beginning of changing tastes literature, which provides a number of ways to describe dynamic inconsistent approaches.

P. 165 describes two solutions to myopic (called "spendthrifty"), firstly, precommit future behavior ("resoluteness," in the terminology of McClennen), secondly, take account of future disobedience (in modern terminology, "**sophisticated choice"**)

P. 168 1st para again discusses the difference between calendar time vs. stopwatch time in discounting.

Sentence on p. 170-171 clearly favors sophisticated choice as the rational thing. P. 173 penultimate para expresses amazement that precommitment devices are not more wide-spread than they are. Time-inconsistency is accepted without further ado by Strotz.

P. 177 writes: "Special attention should be given, I feel, to a discount function ... which differs from a logarithmically linear one in that it "overvalues" the more proximate satisfactions relative to the more distant ones."

Takes commitment for the future in sense of committing to debts

discounting normative: argues that only constant discounting is DC (dynamic

consistency): p. 178, footnote 1 gives tongue-in-cheek text argument against zero discounting.

P. 177:

"There is a rationale for discounting at a constant rate of interest."

Olson & Bailey (1981, p. 20) claim that Strotz calls positive **time preference** "myopia" and that he argues for zero discounting, and that "consumer sovereignty has no meaning in the context of the dynamic decision making problems" (p. 179). %}

Strotz, Robert H. (1955) "Myopia and Inconsistency in Dynamic Utility Maximization," *Review of Economic Studies* 23 (Issue 3, June 1956) 165–180.

{% He nicely begins by considering consumer preferences over commodity bundles and assuming a partition of the commodities where all sets of commodities in that partition are separable. He then points out that the consumer can then work with a (two-stage) decision tree to be optimized. This is nice for me. But, bad luck for me, he then goes entirely into consumption budget allocation with first-order optimality, Lagrangians and all that. %}

Strotz, Robert H. (1957) "The Empirical Implications of a Utility Tree," *Econometrica* 25, 269–280.

{% %}

Strotz, Robert H. (1958) "How Income Ought to be Distributed: A Paradox in Distributive Ethics," *Journal of Political Economy* 66, 189–205.

{% %}

Strotz, Robert H. (1961) "How Income Ought to be Distributed: Paradox Regained," *Journal of Political Economy* 69, 271–278.

{% Nice introduction to nonstandard analysis, recommended to me on April 6, 1989 by Jan Jansen. %}

Stroyan, Keith D. & Wilhelm A.J. Luxemburg (1976) "*Introduction to the Theory of Infinitesimals.*" Academic Press, New York.

{% This paper takes the variational model of Maccheroni, Marinacci, & Rustichini (2005) as point of departure. It thus uses the Anscombe-Aumann framework. It

adds Savage's sure-thing principle to the pure horse-race acts. This gives exactly enough extra separability to reduce the variational model to a version of the robust Hansen & Sargent model, where the relation is if and only if. A pretty result!

§3.3 relates the model to recursive expected utility (called SOEU), for which I think that Kreps & Porteus (1978) is the primary reference. I guess that in general Savage's s.th.pr. in itself only gives a state-dependent generalization of recursive expected utility, but that the additional axioms, primarily certainty independence which is similar to constant absolute risk aversion, then reduce it to really recursive EU. This is similar to the one-stage models where constant absolute risk aversion, if added to state-dependent expected utility, not only implies linear-exponential utility but also, as an extra bonus so to say, implies state independence (Wakker 1989 book, Theorem VII.7.6).

On several occasions (e.g. Section 4) the paper uses Tversky's source idea. It mostly cites Chew & Sagi (2008), Ergin & Gul (2009), and Nau, but not Tversky, for this idea, although it is Tversky's idea.

P. 62 top points out that KMM's axiomatization of smooth ambiguity aversion is not behavioral and gives an alternative condition (quasi-concavity type) that is.

biseparable utility: satisfied if we focus on purely subjective acts, in which case we even have SEU (p. 57 footnote 10). %}

Strzalecki, Tomasz (2011) "Axiomatic Foundations of Multiplier Preferences," *Econometrica* 79, 47–73.

{% For variational preferences, probabilistic sophistication ⇔ EU if there exists an event for which independence holds. Extends Marinacci (2002). %}

Strzalecki, Tomasz (2011) "Probabilistic Sophistication and Variational Preferences," *Journal of Economic Theory* 146, 2117–2125.

{% Studies recursive decision under uncertainty. The author takes a convex set of outcomes X with an affine u on it. So, this can be Anscombe-Aumann, if X is let of lotteries, but the author does not commit to it. He refers to Anscombe-Aumann as one possible interpretation in §7.3. So, it can also be monetary outcomes with linear utility which, for moderate outcomes, is fine and is preferable to

Anscombe-Aumann. §7.2 does suggest that probabilistic mixtures are treated fundamentally differently than uncertainty mixtures, which may suggest Anscombe-Aumann type work, but I did not study enough to be sure. He does define ambiguity aversion in the Schmeidler (1989) mixture way, which can only be interpreted that way (rather than as pessimism) if one commits to the Anscombe-Aumann framework.

The author considers several kinds of ambiguity models that are popular today: Maxmin EU (Gilboa & Schmeidler 1989), recursive EU (Neilson), smooth (KMM; which he does not equate with recursive), variational (Maccheroni, Marinacci, & Rustichini 2006), multiplier preferences (Hansen & Sargent 2001), Strzalecki 2011), confidence as he calls it (Chateauneuf and Faro (2009). Footnote 10 suggests that RDU is a subclass of maxmin EU, referring to their overlap under convex weighting function, but I disagree, because convex weighting function is not the main subclass of interest in RDU.

The main finding is that only maxmin EU can be neutral to the timing of the resolution of uncertainty, through the independent product class of Sarin & Wakker (1998) and Epstein & Schneider (2003). In all other cases, ambiguity attitude interferes with timing attitude. %}

Strzalecki, Tomasz (2013) "Temporal Resolution of Uncertainty and Recursive Models of Ambiguity Aversion," *Econometrica* 81, 1039–1074. http://dx.doi.org/10.3982/ECTA9619

{% %}

Stucki, Gerold, Magnus Johannesson, & Matthew H. Liang (1996) "Use of Misoprostol in the Elderly: Is the Expense Justified?," *Drugs and Aging* 8, 84–88.

{% a famous poet from Song dynasty. Wrote the romantic sentence: "Although I am thousands of miles away from you, I will watch the same moon as you do." In Chinese it seems to be:

但愿人长久，千里共婵娟

来自我的华为手机

The title of the poem is below. The author is also known as Su Dongpo. %}

Su, Shi (1037–1101) "When Will the Bright Moon Come?"

{% %}
Suárez Garcìa F. & P. Gil Àlvarez (1986) "Two Families of Fuzzy Integrals," *Fuzzy Sets and Systems* 18, 67–81.

{% **foundations of quantum mechanics**: causation for Einstein–Podolsky–Rosen %}
Suárez, Mauricio (2014) "Interventions and Causality in Quantum Mechanics," *Erkenntnis* 78, 199–213.

{% Seems to review effects of cognitive biases on investor's behavior, so, part of behavioral finance. %}
Subrahmanyam, Avanidhar (2008) "Behavioral Finance: A Review and Synthesis," *European Financial Management* 14, 12–29.

{% Under Obama, Sunstein led the Office of Information and Regulatory Affairs. %}
Subramanian, Courtney (2013) " 'Nudge' Back in Fashion at White House," TIME.com (August 9, 2013),

{% **state space derived endogeously**: When can set with ordering be considered a Cartesian product? That is, this paper derives a product structure endogenously. %}
Suck, Reinhard (1990) "Conjointness as a Derived Property," *Journal of Mathematical Psychology* 34, 57–80.
https://doi.org/10.1016/0022-2496(90)90012-X

{% %}
Suck, Reinhard (1994) "A Theorem on Order Extensions: Embeddability of a System of Weak Orders to Meet Solvability Constraints," *Journal of Mathematical Psychology* 38, 128–134.

{% Assumes relations R and R_1, ..., R_n given on a set X and then considers conditions such that the set X can be considered an n-fold product set with the

R_js coordinate orderings and independence (so, monotonicity) satisfied.
Continues on Suck (1990). %}
Suck, Reinhard (1998) "Ordering Orderings," *Mathematical Social Sciences* 36, 91–104.

{% **confirmatory bias** People prefer like-minded advisors with coarse info. If info is costly, bias can become perpetual. A theoretical model and simulations illustrate the point. %}
Suen, Wing (2004) "The Self-Perpetuation of Biased Beliefs," *Economic Journal* 114, 377–396.

{% %}
Sugaya, Takuo & Alexander Wolitzky (2018) "Maintaining Privacy in Cartels," *Journal of Political Economy* 126, 2569–2607.

{% Gives examples of context-dependence leading to violations of revealed preference conditions. For example, regret theory. Uses term contraction consistency. Context-dependence is nicely explained through sports that are interactive or noninteractive. Uses term basic utility for utility without regret incorporated. %}
Sugden, Robert (1985) "Why Be Consistent? A Critical Analysis of Consistency Requirements in Choice Theory," *Economica* 52, 167–183.

{% %}
Sugden, Robert (1986) "New Developments in the Theory of Choice under Uncertainty," *Bulletin of Economic Reserves* 38, 1–24.
Reprinted in John D. Hey & Peter J. Lambert (1987, eds.) *Surveys in the Economics of Uncertainty*, Basil Blackwell, Oxford.

{% %}
Sugden, Robert (1989) Book Review of: Peter C. Fishburn (1988) "Nonlinear Preference and Utility Theory," Johns Hopkins University Press, Baltimore, MD; *Economic Journal* 99, 1191–1192.

{% **Nash equilibrium discussion**;

P. 752: "within economics ... received theory of rational choice: expected utility theory."

game theory can/cannot be viewed as decision under uncertainty: Sugden's paper says that it has been generally accepted that Savage's SEU, with strategies as states, is appropriate for game theory. I think that this may be so in Aumann's papers but doubt if it is elsewhere. Sugden himself points out difficulties in that assumption, e.g. at the end of §V and also end of §VII. Seems to point out that opponent strategies cannot be modeled as extraneous states of nature because a player, when thinking about his own strategy, thus also affects his probabilities over opponents' strategies. §XI, p. 782 bottom, states the point in a crystal-clear manner.

P. 754, footnote 4: how indifference is a problem of revealed preference

P. 755 **free will/determinism**: on Kant who says humans are part of physical world and have physical explanations. But when we reason we cannot do other than conceive ourselves as autonomous ... Kant wants categorical imperatives, which are normative (more in ethical sense) principles to agree upon by reason with no concern of desires or Hume's passions.

paternalism/Humean-view-of-preference: p. 757: I regret that Sugden puts Savage forward as representative of the consistency view of rationality (also called coherentism). The consistency view says that rationality should require no more than consistency, i.e., consistency is sufficient for rationality. Savage, unlike his more narrow-minded colleague de Finetti, never committed to that, but only has consistency as necessary for rationality.

P. 758: that the interpretation of preference as binary choice, and nothing else, is in Sugden's opinion standard in economics.

P. 760: I disagree with the reasoning. It takes reason as fixed, and then says that it is an empirical question whether our passions, desires/beliefs, are such that reason can always maximize them. I take reason not as fixed. Whatever the passions, reasons/desires, are, reason must be such as to optimize them.

P. 760/761 says he finds it hard to formulate rationality of Savage's theory; I wonder if it is in the sense that Savage's conditions can at most be necessary for rrationality, never sufficient. This is well understood!

completeness criticisms: §IV pp. 760-761 gives criticism of completeness axiom as sort of indecisiveness, the argument I find unconvincing. Then discusses regret and transitivity. Assigns normative status to intransitivities resulting from regret.

"Savage's theory, of course, tells us nothing about how we should form probability judgements about states of nature; that is not its function."

P. 763 top claims that regret is just yet another passion in Hume's sense, but I disagree. Regret can be a silly, "nonfundamental," emotion.

The discussion on rationality in game theory centers around the paradoxes if infinite hierarchies of beliefs and common knowledge, but also brings in the view I like, that there is a meta-dependence generated by rationality (if a rational players decides on something it automatically implies that his rational opponent decides the same, bringing a meta-dependency). See also conclusion p. 783 top.

conservation of influence: §§I-IV give many nice refs etc. %}

Sugden, Robert (1991) "Rational Choice: A Survey of Contributions from Economics and Philosophy," *Economic Journal* 101, 751–785.

{% Preference axioms invoke complicated **utility elicitation** procedures %}

Sugden, Robert (1993) "An Axiomatic Foundation for Regret Theory," *Journal of Economic Theory* 60, 159–180.

{% **paternalism/Humean-view-of-preference**: seems to cite Hume for anti-paternalism. %}

Sugden, Robert (1998) "Measuring Opportunity: Toward a Contractarian Measure of Individual Interest," *Social Philosophy & Policy* 15, 34–60.

{% Presented in Amsterdam on March 12, 1998.

Takes descriptions of outcomes in game theory as referring to physical objects, takes utility as self-interest-valuation of those elicited through vNM utility or otherwise, at any rate referring to things outside the game. A similar explicit reference to utility measurement to get the utility in game theory is in Luce & Adams (1956). Then allows players to do other things than just maximize utility, e.g., consider moral considerations and, thus, cooperate in prisoner's dilemma.

He, thereby, explicitly disagrees with Binmore (1993). %}

Sugden, Robert (1998) "Convention and Courtesy: A Theory of Normative Expectations," School of Economics and Social Studies, University of East Anglia, Norwich, UK. Published as:

Sugden, Robert (2000) "The Motivating Power of Expectations." *In* Julian Nida-Rümelin & Wolfgang Spohn (eds.) *Rationality, Rules and Structure,* 103–129, Kluwer, Dordrecht.

{% Reference-dependent subjective expected utility evaluates, at reference point h, an act f by

the expectation of v(f(s),h(s)).

Imposing Savage's axioms for each separate h gives expectation of v(f(s),h) as representation with probability P depending on h. Having more-likely-than independent of h gives P independent of h. Separability of (f(s),h(s)) implies that v(f(s),h) depends only on h through h(s), so that the above representation results. It constitutes a desirable and appealing extension of classical models.

Theorem 2 considers the case v(f(s),h(s) = φ(u(f(s) − u(g(s)). This is obtained by ordering the separable pairs ((f(s),g(s)) and imposing preference-difference axioms on this ordering. Sugden's axioms S1-S4 amount to the axioms of Debreu (1960, Theorem 2), Köbberling (2003, "Preference Foundations for Difference Representations"), and Shapley (1975). In particular, Sugden's S4 is the crossover axiom.

u is called a satisfaction function and is interpreted as a riskless component, and φ is a gain/loss evaluation function. Risk attitude is composed of these two. It seems to me that φ affects more of risk attitude than only gains versus losses. For example, if we restrict attention to the subdomain of one fixed reference point and only gains, then the model φ(u(x)-u(0)) coincides with the value-utility model that was popular in decision analysis in the 1980s and 1990s (Dyer & Sarin 1982, etc.), where u is taken as riskless value function and φ adds risk attitude (and loss aversion plays no role). More concave φ generates more risk aversion in this domain where loss aversion plays no role.

If we consider variable reference points and reference-independence, then φ must be linear (so, "absent") and u governs all of risk attitude. Pp. 178 and 180 write that u(x) may reflect satisfaction from x. The interpretation can, for reference independence, be maintained only if vNM utility is taken as a riskless u, an interpretation that I am sympathetic to (**risky utility u = strength of preference v (or other riskless cardinal utility, often called value)**) although the common terminology in the field today deviates and it is too late now to change.

Schmidt (2003) also considers reference dependence, but only for constant (riskless) acts.

P. 173, para 2, incorrectly claims that prospect theory would have utility independent from the reference point. Footnote 2 weakens the mistake, but does not correct it. Kahneman & Tversky (1979, pp. 277-278) gives the right nuances.

P. 173, para 3, incorrectly claims that prospect theory has no states of nature. The ’92 version of prospect theory does have states of nature.

P. 175 1st para, f > g|h is interpreted as: if the agent is in h and can choose between f, g, and h, then he rather takes f than g. This interpretation is unrealistic if h is most preferred. Would be better not to leave the option of staying at h, or not to have his completeness axiom R1 and instead restrict the analysis to the acts preferred to h (requiring considerably more difficult proofs).

Savage (1954) used the term sure-thing principle in an informal sense, comprising his P2, P3, and P7. In its modern use, it refers only to Savage’s P2. Sugden’s verbal text on p. 177 relates it, however, to Savage’s P1 and P2.

Presenting so many valuable and sophisticated results in such a short space is an impressive achievement. The proofs then have to be concise, and many details must be skipped. Indeed, the latter happens in this paper, and many of the more complex technical steps in the proofs are claimed without justification. This makes it hard for the readers to verify correctness of the results. At some places, there are inaccuracies. Theorem 1 claims necessity of the preference axioms, but the richness axiom of state-space continuity, R.8, can never be implied by the representation. (Counterexample: SEU with two states of nature, equally likely, real outcomes, and expected value, so that also Sugden’s uniqueness requirements are fulfilled.) The last sentence of the proof of Theorem 1, p. 188, suggests an assumption of atomlessness that is, however, neither claimed nor defined in the main text. Atomlessness is complex under finite (contrary to countable) additivity as here. I conjecture that a convex-rangedness condition as in Gilboa (1987) and Savage (1954) (that I prefer to call solvability) can work, but this remains to be proved.

P. 178: in Def. 10, the domain of φ varies as u varies (discussed at the bottom of p. 188).

P. 179, Consequence-space continuity, S2, is hard to read because most of the "for all" quantifiers are in the wrong place. In Definition 13, it is not clear what "distinct" means for acts. I guess that acts that differ only on a null event are not distinct. No proof of Theorem 3 is given so that the confusion cannot be clarified. %}

Sugden, Robert (2003) "Reference-Dependent Subjective Expected Utility," *Journal of Economic Theory* 111, 172–191.

{% %}

Sugden, Robert (2004) "Alternatives to Expected Utility." *In* Salvador Barberà, Peter J. Hammond, & Christian Seidl (eds.) *Handbook of Utility Theory, Vol. II*, 685–755, Kluwer Academic Publishers, Dordrecht.

{% **conservation of influence**: opportunity = potential influence; **paternalism/Humean-view-of-preference**: Assigns an intrinsic value to opportunity sets; i.e., the very fact that one can choose from available options. So, will be against paternalism. Reminds me of intrinsic value of information in papers by Grant, Kajii, & Polak (1992). Sugden's work is in the spirit of liberty-of-choice literature. He says that, rather than getting optimal option, having opportunity set is central. Develops a model where arbitrageurs present choice sets and the economy benefits from competition between arbitrageurs. %}

Sugden, Robert (2004) "The Opportunity Criterion: Consumer Sovereignty without the Assumption of Coherent Preferences," *American Economic Review* 94, 1014–1033.

{% **conservation of influence**: Agent identifies herself with past, present, and future own decisions, as "locus of responsibility," also called "responsible agent." Sugden writes "she identifies with her own actions, past, present and future"

Sugden's set of opportunities is like my potential influence. Section 9.1 discusses Aristotle's telos (goal). Hasppiness (*eudaimonia*) comes from serving the goals. %}

Sugden, Robert (2017) "*The Community of Advantage: A Behavioural Defence of the Liberal Tradition of Economics.*" In preparation.

{% If I am among the most paternalistic workers in decision theory, Sugden, Bob henceforth, is amongs the least, and is the most anarchistic (my term) decision theorist I can think of. Famous is his and Loomes' regret theory that goes as far as just giving up transitivity. Every few years Bob and I have enjoyable email exchanges on it, although the many years haven't brought any convergence.

This paper shows how Bleichrodt, Pinto., & Wakker (2001), BPW hencceforth, can be reinterpreted subtly and then reconciled with Bob's views (though not endorsed; see end of §1) by avoiding any allusion to anything like true preference. Instead, it does what Bob calls regularization. There is a policy maker (PM) having to take policy decisions that affect persons, and seeking only to do best for the persons. The PM takes expected utility (EU) as normative for her decisions without any assumption that this would be best for the persons or about what true preferences for the persons are. This is the idea of regularization. First of all, it is not my opinion because I think EU is normative also for the persons, and I like to use the concepts of true preference and bias/error. But, second, even without that, I see little interest in assuming EU normative for the PM but not for the persons. If the PM does not consider the persons' deviations from EU irrational or bad, how can she defend changing them? I could be more sympathetic to a pragmatic interpretation, where the PM would say that nonEU is just (too) difficult to implement.

Further comments.

I disagree with the last sentence of the 2nd para on p. 772: "I conclude that the supposed normativity of the EU axioms does not justify the claim that behaviour that contravenes those axioms is evidence of error or bias." As I see it, if two choices are inconsistent with EU, then this proves that THERE EXISTS a bias. Only, EU does not say which or where. My preceding sentence makes me agree with all text preparing for the criticized sentence. But I disagree with that sentence. Bob's p. 781 end of 1st para, claiming misleading, follows from this, and I disagree with the

qualification of misleading there too.

P. 776: I do not equate normative utility with experienced utility, but this does not affect any other point here.

Regarding the point starting the second half of p. 776, Bob is right. Diminishing sensitivity of utility is a reference-dependent bias that BPW ignore. To prepare my defense, I have been fully aware of this point since my youth. Kahn & Sarin (1988) discussed it nicely. We only did not write about it because it is too far from the current state of the art in the field. I think that intrinsic utility should be concave throughout. The convex-concave shape found empirically is due to yet another bias, which may be general numerical (mis)perception. We did not mention it because no theory exists yet. Our phrase referring to the current state of the art may justify. Our phrase that Bob cites on pp. 777-778 was deliberately written to avoid this issue. I discussed the issue with Köbberling for Köbberling & Wakker (2003) and we decided to stay out of it. There is an empirical paper on it, Köbberling, Schwieren, & Wakker (2007), but this paper never received much attention.

P. 781 end of 1st para: I disagree with the "misleading" qualification about showing systematic biases, as explained before. %}

Sugden, Robert (2022) "Debiasing or Regularisation? Two Interpretations of the Concept of 'True Preference' in Behavioural Economics," *Theory and Decision* 92, 765–784.
https://doi.org/10.1007/s11238-022-09876-x

{% %}

Sugeno, Michio (1974) "Theory of Fuzzy Integrals and their Applications," Ph.D. Thesis, Tokyo Institute of Technology.

{% %}

Sugeno, Michio & Toshiaki Murofushi (1987) "Pseudo-Additive Measures and Integrals," *Journal of Mathematical Analysis and Applications* 122, 197–222.

{% %}

Sugeno, Michio & Toshiaki Murofushi (1988) "Choquet's Integrals as an Integral Form for the General Class of Fuzzy Measures," Preprints of 2nd IFSA Congress, 408–411.

{% Find house money effect (more risk seeking after gains), less risk seeking after losses, break-even effect which need not mean more risk aversion. %}

Suhonen, Niko & Jani Saastamoinen (2018) "How Do Prior Gains and Losses Affect Subsequent Risk Taking? New Evidence from Individual-Level Horse Race Bets," *Management Science* 64, 2797–2808.

{% Points out that people can be in better physical shape than regular perfect health, involving utility exceeding 1. It means that regression techniques need not reckon with truncating at 1. %}

Sullivan, Patrick W. (2011) "Are Utilities Bounded at 1.0? Implications for Statistical Analysis and Scale Development," *Medical Decision Making* 31, 787–789.

{% %}

Sumalee, Agachai, Richard D. Connors, Paramet Luathep, William H. K. Lam, Sze C. Wong, & Hong K. Lo (2009) "Network Equilibrium under Cumulative Prospect Theory and Endogenous Stochastic Demand and Supply." *In* William H.K. Lam, Sze C. Wong, & Hong K. Lo, eds.) *Transportation and Traffic Theory 2009*, 19–38, Springer, Berlin.

{% Use hypothetical choice, with delays of several years. Consider intertemporal choice with SS (small soon) versus LL (large late). But add additional common payments at other times, before, between, or after. The extra payments always reduce discounting. The authors ascribe this to the SS and LL payments becoming less salient. Although the authors do not seem to discuss it, it means that intertemporal separability is violated (**intertemporal separability criticized**). %}

Sun, Hong-Yue & Cheng-Ming Jiang (2015) "Introducing Money at Any Time Can Reduce Discounting in Intertemporal Choices with Rewards: An Extension of the Upfront Money Effect," *Judgment and Decision Making* 10, 564–570.

{% Simpler proof for Jaffray's and Fagin & Halpern's result. %}

Sundberg, Carl & Carl G. Wagner (1992) "Generalized Finite Differences and Bayesian Conditioning of Choquet Capacities," *Advances in Applied Mathematics* 13, 262–272.

{% %}

Sunstein, Cass R. (1991) "Preferences and Politics," *Philosophy and Public Affairs* 20, 3–38.

{% %}

Sunstein, Cass R. (1993) "Endogenous Preferences, Environmental Law," *Journal of Legal Studies* 22, 217–254.

{% Decribed utilitarianism as "Bentham not Kant." %}

Sunstein, Cass R. (2016) Lecture at SABE/IAREP.

{% %}

Sunstein, Cass R. & Richard H. Thaler (2003) "Libertarian Paternalism is not an Oxymoron," *University of Chicago Law Review* 7, 1159–1202.

{% Presents a variation of Hölder's lemma. %}

Suppes, Patrick (1951) "A Set of Independent Axioms for Extensive Quantities," *Portugaliae Mathematica* 10, 163–172.

{% %}

Suppes, Patrick (1956) "The Role of Subjective Probability and Utility in Decision Making." *Proceedings of the Third Berkeley Symposium on Mathematical Statistics and Probability,* 1954–1955, 5, 61–73.

{% %}

Suppes, Patrick (1957) "*Introduction to Logic.*" Van Nostrand, New York. (12th print 1969.)

{% Takes strength of preference as primitive, and then axiomatizes expected utility. Does in fact something Anscombe-Aumann like by allowing for fifty-fifty probabilistic (subjectively through) mixtures.

P. 63 writes, on small worlds: "since we are usually dealing with what Savage calls small-world situations, and not the fate of the whole universe."

P. 68 writes: "By way of summary my own feeling is that Savage's postulates are perhaps aesthetically more appealing than mine, but this fact is balanced by two other considerations: my axioms do not require an infinite number of states of nature, and their intuitive basis derives from ideas which have proved experimentally workable." %}

Suppes, Patrick (1961) "Behavioristic Foundations of Utility," *Econometrica* 29, 186–202.

{% %}

Suppes, Patrick (1970) "*A Probabilistic Theory of Causation.*" North Holland, Amsterdam.

{% Text of plenary lecture for statistical society.

criticizing the dangerous role of technical axioms such as continuity: §2 discusses the status of axioms, with what I would call intuitive versus technical axioms. The latter are about richness with existence quantifiers, such as Savage's (1954) P6. There are some interesting claims, but much is half-baked with nuances lacking. The para on p. 162-163 argues that, when a patient has to decide on a risky treatment with subjective probabilities involved, comparisons with objective probabilities (as in the Anscombe-Aumann framework) will not be useful. I think it depends too much, and sometimes it will be useful. But I agree with him that often it will just not be of use. As I argued on several occasions, for 999 out of 1000 diseases, decision theory is of no use at all. But for 1 out of 1000 diseases it is, and that is a good thing.

P. 164 points out that the Archimedean axiom is not first-order.

P. 167 3rd para, that axioms be about the appropriate degree of crudeness, comes out of the blue and is apparently an attempt to sell his axioms yet to come. The axioms consider the case of n equally likely events with crisp probability 1/n for calibration, which are used to provide upper and lower bounds for the probabilities of the other events in the obvious way. As regards the axiomatization, this is not very interesting.

§4 compares to geometry and quantum mechanics. An argument that can be advanced against upper and lower probability models (as against multiple priors) is that not only about probabilities, but also about anything else such as length, we can have uncertainties, so, if we should work with upper and lower probabilities should we then not just as well work with upper and lower lengths instead of deterministic lengths? Suppes argues that subjective probabilities are to be treated differently than physical length, and that subjective probabilities should rather be treated as physical scales in quantum mechanics, where often locations and so on are not deterministic but probabilistic. More precisely, they are intrinsically probabilistic. The physical laws of quantum mechanics require that sometimes location is probabilistic and not deterministic, and the laws would be invalid otherwise. So, it is not just probabilistic in the sense of not well known or having inaccurate measurement instruments, but it is intrinsically probabilistic. Heisenberg's uncertainty principle describes this. Suppes points out that the source of uncertainty—that any measurement will distort location/etc—also holds for subjective probability, where each measurement will distort it. Unlike most social scientists, Suppes does not start writing silly and exaggerated comparisons with quantum mechanics but keeps control and credibility, writing on top of p. 172: "I do not mean to suggest that the exact theoretical ideas of quantum mechanics carry over in any way to the measurement of belief, but I think the general conceptual situation does." I personally do not believe that the analogy holds. I think that the measurement of beliefs through certainty equivalents and so on does not meet the fundamental impossibility of quantum mechanics to reach high degrees of precision, but this is a matter of taste. Suppes is in fact favoring the constructive view of preference here!!! Nice. Interestingly Suppes compares not only with quantum physics, the standard example of a probabilistic theory, but also with memory from psychology, also well known for being affected by measurement and being constructive (probabilistic?).

P. 174, final para of paper, compares the indeterminacy of subjective probability with the impossibility to do perfect meteorological measurements. The latter cannot be done because of complexity, which is a different point than for the indeterminacy in quantum mechanics. Suppes ends, poetically, with: "Our beliefs, it seems to me, are rather like the leaves on a tree. They tremble and move under even a minor current of information. Surely we shall never predict in detail all of their subtle and evanescent changes.” %}

Suppes, Patrick (1974) “The Measurement of Belief,” *Journal of the Royal Statistical Society* 36, 160–191.
Reprinted in Patrick Suppes (1993) “*Models and Methods in the Philosophy of Science: Selected Essays*,” Ch. 14, pp. 181 ff., Kluwer Academic Publishers, Dordrecht.

{% **foundations of probability**, **foundations of statistics** %}
Suppes, Patrick (1976) “Testing Theories and the Foundations of Statistics.” *In* William L. Harper & Clifford A. Hooker (eds.) “*Foundations of Probability Theory, Statistical Inference, and Statistical Theories of Science*,” Vol. II, 437–455, Reidel, Dordrecht.

{% **foundations of quantum mechanics** %}
Suppes, Patrick (1980, ed.) “*Studies in the Foundations of Quantum Mechanics.*” Philosophy of Science Association, East Lansing, Michigan.

{% %}
Suppes, Patrick (1980) “Limitations of the Axiomatic Method in Ancient Greek Mathematical Sciences.” *In* K. Jaako J. Hintikka, C. David Gruender, & Evandro Agazzi (eds.) *Proceedings of the 1978 Pisa Conference on the History and Philosophy of Science*, Vol. I, 197–213. Reidel, Dordrecht.

{% **foundations of probability** %}
Suppes, Patrick (1983) “The Meaning of Probabilistic Statements,” *Erkenntnis* 19, 397–403.

{% **foundations of probability**; expresses views of Bayesianism; contains bibliography, of which my archive has copy. %}
Suppes, Patrick (1984) “*Probabilistic Metaphysics.*” Wiley, New York. (1st edn. 1974, published by the Philosophical Society and the Dept. of Philosophy, University of Uppsala.)

{% I have, read, and learned much from written text, which he presented 1989 in Nijmegen and I attended. %}

Suppes, Patrick (1988) “Determinism, Computation and Free Will,”, Ernest Nagel Memorial Lecture.

{% **foundations of probability**; **foundations of quantum mechanics**. Ch. 5 on general criteria for axiomatizations seems to be interesting. %}

Suppes, Patrick (1993) “*Models and Methods in the Philosophy of Science: Selected Essays*.” Kluwer Academic Publishers, Dordrecht.

{% **coherentism** %}

Suppes, Patrick (2005) “Where Do Bayesian Priors Come from?,” Stanford University.

{% %}

Suppes, Patrick & Colleen Crangle (1990) “Robots that Learn: A Test of Intelligence,” *Revue Internationale de Philosophie* 44, 5–23.

{% Crr 11: survey; Ch 12: vector space, affine geometry, Ch 13: ordered line, betweenness, projective planes; Ch 14: proximity measurement; multi-dimensional representation; Ch 15: Color and force measurement, Grassman structure (seems to concern convex cones rather than convex sets); Ch. 16: representations with thresholds;

Ch. 17: Survey on probabilistic choice. %}

Suppes, Patrick, R. Duncan Luce, David H. Krantz, & Amos Tversky (1989) “*Foundations of Measurement, Vol. II.* (*Geometrical, Threshold, and Probabilistic Representations)*.” Academic Press, New York.

{% **strength-of-preference representation**: representation uses absolute differences though.

All attempts to make strength of preference observable from actual decisions that I know are a special case of the following:

We consider two-attribute (x_1,x_2) and assume additive representation $V_1(x_1) + V_2(x_2)$. Under minimal continuity assumptions, V_1 and V_2, and their sum, are

interval scales, and their ordering of differences is meaningful. We can then for instance observe:

$(a_1,G_2) \sim (b_1,g_2)$ and

$(c_1,G_2) \sim (d_1,g_2)$

to conclude that the strength of preference of a_1 over b_1 is as big as that of c_1 over d_1, with V_1 differences correspondingly. That is, improving [a_1 into b_1] offsets the same gauge [improving g_2 into G_2] as improving [c_1 into d_1]. The additive representation means that there is no interaction between first and second coordinate, and this is necessary for things to work.

The authors consider on p. 260 the special case where the second coordinate x_2 refers to money, $g_2 = 0$, and G_2 is a positive side payment. The authors next consider the special case of a housewife who chooses between combinations of applyances. Say, starting from (a_1,a_2), that (b_1,a_2) is a better improvement than (a_1,b_2). Can we conclude that [from a_1 to b_1] is a better improvement than [from a_2 to b_2]? One again needs absence of interaction between the 1st and 2nd coordinate goods to derive strength of preference. If interactions then the improvement [from (a_1,a_2) to (b_1,a_2)] can be different than the improvement [from a_1 to b_1] (which we interpret as the improvement [from $(a_1,0)$ to $(b_1,0)$]). The improvement [from (a_1,a_2) to (a_1,b_2)] can be different than the improvement [from a_2 to b_2] (which we interpret as the improvement [from $(0,a_2)$ to $(0,b_2)$]). We could try to give more status to the improvement [from (a_1,a_2) to (b_1,a_2)] by assuming that $(0,a_2)$ instead of $(0,0)$ is the initial endowment, and we could give more status to the improvement [from (a_1,a_2) to (b_1,a_2)] by assuming that $(a_1,0)$ instead of $(0,0)$ is the initial endowment, but the two cannot be combined into one consistent initial endowment.

On p. 259 they consider the special case where (x_1,x_2) concerns a gamble yielding x_1 under one event and x_2 under its complement. Absence of interaction between the two coordinates holds under expected utility and is needed here.

On difficulty to disentangle different parameters, they write: "The interaction between probability and utility makes it difficult to make unequivocal measurements of either one or the other. The recent Mosteller and Nogee experiments (1951) may be interpreted as measuring utility if objective probabilities are assumed or as measuring subjective probabilities if utility is assumed linear in money." (p. 259)

P. 259 2nd para points out that measurements of utility under risk are distorted by interaction with probability weighting (they use the term subjective probability to indicate probability weighting), using this as argument to use introspective-based strengths of preferences.

questionnaire versus choice utility: p. 261 penultimate para of §1:

"It is also our opinion that many areas of economic and modern statistical theory do not warrant a behavioristic analysis of utility. In these domains, there seems little reason to be ashamed of direct appeals to introspection. For example, in welfare economics there are sound arguments for adopting a subjective view which would justify the determination of utility differences by introspective methods."

(**risky utility u = strength of preference v (or other riskless cardinal utility, often called value)**) %}

Suppes, Patrick & Muriel Winet (1955) "An Axiomatization of Utility Based on the Notion of Utility Differences," *Management Science* 1, 259–270.

{% **probability intervals;** deal only with prospects that are sums of indicator functions of events, meaning they are simple prospects taking only nonnegative integer values. %}

Suppes, Patrick & Mario Zanotti (1989) "Conditions on Upper and Lower Probabilities to Imply Probabilities," *Erkenntnis* 31, 323–345.

{% A formal exposition of measurement theory, fundamental versus derived measurement, meaningfulness, and other things. The presentation is abstract and the examples are not very interesting I found. The definition of scale types in §1.3 p. 11 is not very accurate. %}

Suppes, Patrick & Joseph L. Zinnes (1963) "Basic Measurement Theory." *In* R. Duncan Luce, Robert R. Bush, & Eugene Galanter (eds.) *Handbook of Mathematical Psychology*, Vol. I, 1–76, Wiley, New York.

{% **PT falsified; probability weighting depends on outcomes**: they investigate this. They confirm that affect-rich outcomes give more pronounced insensitivity (inverse S). On one point my interpretation is different than the authors'. I think that probability neglect is an extreme form of insensitivity, and not something different as the authors think, expressed in their title ("versus"), and what they have as a central theme throughout their paper. Figure 7.1.1, p. 205, of Wakker

(2010) shows the point, with to the left perfect sensitivity, in the middle partial sensitivity, and to the right extreme insensitivity which means probability neglect. Thus, what the authors take as evidence against inverse S, in my opinion is strong support.

They also find higher elevation of probability weighting for affect-rich outcomes. It was not clear to me from the text and the formulas if higher elevation was coupled with more or with less risk aversion. Also, with only one nonzero outcome, elevation may be determined only up to one joint power for utility and probability weighting. This need not affect inverse S but it does affect elevation. Adding assumptions about (the power of utility makes the power of probability weighting also indentifiable. %}

Suter, Renata, Thorsten Pachur, & Ralph Hertwig (2016) "How Affect Shapes Risky Choice: Distorted Probability Weighting versus Probability Neglect," *Journal of Behavioral Decision Making* 29, 437–449.

{% Show that category rating scales have been subject to the same internal inconsistencies as the standard gamble in lotteries with one nonzero outcome. %}

Sutherland, Heather J., Virginia Dunn, & Norman F. Boyd (1983) "Measurement of Values for States of Health with Linear Analogue Scales," *Medical Decision Making* 3, 477–487.

{% Seems to have introduced MET (maximum endurable time) %}

Sutherland, Heather J., Hillary A. Llewelynn-Thomas, Norman F. Boyd, James E. Till (1982) "Attitudes toward Quality of Life: The concept of "Maximal Endurable Time"," *Medical Decision Making* 2 299–309.

{% **(very) small probabilities**: This paper explains, and references (p. 183 last para), that people can as well overweight unlikely events as fully ignore them. The latter is referred to as the low probability, high consequence events bias (the paper, unfortunately, never defines the latter, but p. 186 following Eq. 6 states it casually). They investigate how house prices react to tornado risk. A 1/million extra annual chance of dying increases the house price by 3%. %}

Sutter, Daniel & Marc Poitras (2010) “Do People Respond to Low Probability Risks? Evidence from Tornado Risk and Manufactured Homes,” *Journal of Risk and Uncertainty* 40, 181–196.

{% Shows that in Gneezy & Potters (1997 QJE) the myopic loss aversion is reduced if people work in teams. %}

Sutter, Matthias (2007) “Are Teams Prone to Myopic Loss Aversion? An Experimental Study on Individual versus Team Investment Behavior,” *Economics Letters* 97, 128–132.

{% N = 661 children aged 10-18.

real incentives/hypothetical choice, for time preferences: Use real incentives for time preferences, as for all preferences. In a school they pay on a prearranged future time.

They use choice lists to observe indifferences.

They estimate risk aversion from one observed CE (certainty equivalent) of a fifty-fifty prospect, referring to the known Ellsberg urn. For ambiguity aversion, they observed the CE for the unknown two-color Ellsberg urn, and took the normalized difference between the risky and ambiguous CEs (certainty equivalents) as index of ambiguity aversion.

gender differences in risk attitudes: women more risk averse than men. (P. 517.) Gender is only demographic that correlates with risk aversion. For example, age does not (**relation age-risk attitude**). No demographic variable correlates with ambiguity aversion (**gender differences in ambiguity attitudes**).

Time preference: They fix a near and remote timepoint, fix the payment at the near timepoint, and determine the remote payment to generate indifference. Did so 4 times, where two have early time right now and two have early time later (upfront delay). Find mostly constant impatience, but once decreasing impatience.

correlation risk & ambiguity attitude: There is a negative relation, but it is not written in the paper. Is pointed out in survey chapter by Trautmann & van de Kuilen (2015).

P. 510 cites seven studies that relate risk/time preferences to actual behavior. This paper does it for 661 children age 10-18. More impatient children smoke more, drink more, have higher BMI (body-mass index), save less, violate more school codes, and have lower maths grades. Risk and ambiguity aversion do not correlate with much. Risk averse subjects have lower BMI, ambiguity averse smoke less. P. 511 cites literature that children are more risk averse and more impatient than adults. More risk aversion then more patience.

P. 527 mentions that intertemporal attitude correlates better with other things than risk/ambiguity attitudes, in agreement with what has been found more often I think. A little bit this may also be because they used four questions to measure intertemporal attitudes, and only one to measure risk attitude and only one to measure ambiguity attitude. %}

Sutter, Matthias, Martin G. Kocher, Daniela Glätzle-Rüetzler, & Stefan T. Trautmann (2013) "Impatience and Uncertainty: Experimental Decisions Predict Adolescents' Field Behavior," *American Economic Review* 103, 510–531. https://doi.org/10.1257/aer.103.1.510

{% %}

Sutter, Matthias, Martin G. Kocher, Sabine Strauss (2003) "Bargaining under Time Pressure in an Experimental Ultimatum Game," *Economics Letters* 81, 341–347.

{% **revealed preference** %}

Suzumura, Kotaro & Yongsheng Xu (2003) "Recoverability of Choice Functions and Binary Relations: Some Duality Results," *Social Choice and Welfare* 21, 21–37.

{% Ch 4 and p. 41 seem to be on probability. %}

Svennilson, Ingvar (1938) "*Ekonomisk Planering.*" Almqvist & Wiksell, Uppsala.

{% **Kirsten&I**: shows that for the countably-infinite consumption streams of Koopmans (1960) symmetry (such as in zero discounting) is possible in combination with continuity if the topology w.r.t. which continuity should hold is taken sufficiently coarse. %}

Svensson, Lars-Gunnar (1980) "Equity among Generations," *Econometrica* 48, 1251–1256.

{% Seems to be: d**ecision under stress**, with models of rational decision. %}

Svenson, Ola & A. John Maule (1993, eds.) "*Time Pressure and Stress in Human Judgment and Decision Making*." Plenum, New York.

{% "An optimist is just a misinformed pessimist." %}

Svidler, Peter (1998) "," *New in Chess*, 1998 no. 7.

{% On history of conflicts between experimental economists and behavioral economists. How behavioral economists and experimental economists, Vernon Smith, Plott, Kahneman, and others, discussed and how some hostilities came. On **Prospect theory not cited**: it explains why many experimental economists ignore prospect theory. Sidney Siegel initiated, independently of and simultaneously with Smith, the principles of experimental economics, emphasizing real incentives and no deception. Unfortunately, Siegel suddenly died at young age.

The author's writings on deception are shaky. P. 279 writes: "In general, deception in experiments occurs when the actual purpose of an experiment differs from the purpose announced to the test subjects." This is not the definition of deception commonly accepted. It is usually taken as giving false, untrue, information to subjects. For one thing, this is broader than just about the purpose of the experiment. For another, it allows for incomplete info. Often, subjects are not given complete info on an experiment and the purposes of the experimenter, e.g., "proving that theory X is superior to theory Y," or "showing that subjects overestimate probabilities." P. 290 ℓ. 4 erroneously writes: "the former group [behavioral] advocated allowing deception and hypothetical choices in economic experiments; the latter [experimental economists] avoided such experiments." Behavioral decision theorists do not just allow for deception. I don't remember that Kahneman & Tversky ever wrote about it, but I also do not remember any case where they used deception. Although I do not remember ever discussing deception with Tversky, I would be very surprised if he would not have thought that it should be avoided.

Another strange claim is on p. 288: "the emerging behavioral economics became less and less reliant on experimentation and was equally embracing other empirical as well as modeling approaches." I do not understand in which sense behavioral economics would care less about experiments. The author may think that psychology-type experiments are not to be called experiments? %}

Svorenčík, Andrej (2016) "The Sidney Siegel Tradition: The Divergence of Behavioral and Experimental Economics at the End of the 1980s," *History of Political Economy* 48, 270–294.
https://doi.org/10.1215/00182702-3619310

{% **ubiquity fallacy**: the title of this book expresses it. %}

Swaab, Dick. F. (2014) "*We Are Our Brains: A Neurobiography of the Brain, from the Womb to Alzheimer's*." Random House Usa Inc, New York.

{% Bibliographic info about the issue of the journal is essential, because each issue renumbers from zero.

Nice, enthusiastic, empirical study of utility functions, very well suited for students to understand what utility measurement is about.

Use CEs (certainty equivalents) of 50-50 gambles to measure utility, for both gains and losses.

P. 128, 2nd para brings the known claim of those days that choices from paradoxes (Ellsberg in this case) are exceptional laboratory findings, not very relevant to practical applications.

concave utility for gains, convex utility for losses: pp. 132-133: Utilities nicely exhibit the prospect-theory shapes of concave for gains, convex for losses, loss aversion, underlying prospect theory. These were incorporated in Fishburn & Kochenberger (1979). They are, however, not representative because they were a subselection chosen by the authors according to choice criteria not specified.

P. 134, 4th para, finds clear loss aversion.

utility elicitation: different EU methods give different curves: posed as a research question on p. 134 last para.)

P. 135, penultimate para, that utilities for losses are more erratic (**losses give more/less noise**). %}

Swalm, Ralph O. (1966) "Utility Theory. Insights into Risk Taking," *Harvard Business Review* 44, Issue 6, 123–136.

{% A nice intermediate between compensatory and noncompensatory tradeoffs. Subjects set thresholds but, then, violations of the thresholds are allowed and are

evaluated smoothly as losses of utility. It looks a bit like prospect theory with several reference points. %}

Swait, Joffre D. (2001) "A Non-Compensatory Choice Model Incorporating Attribute Cutoffs," *Transportation Research Part B* 35, 903–928.

{% Existence of God is derived using Bayesian reasoning. %}

Swinburne, Richard (1986) "*The Coherence of Theism*." Oxford University Press, New York.

{% Existence of God is derived using Bayesian reasoning. %}

Swinburne, Richard (2004) "*The Existence of God*." Clarendon Press, Oxford, 2004.

{% **small risks overinsured**;

Point out that according to traditional EU analyses, the commonly found insurance decisions regarding deductibles for home insurance would imply absurd degrees of risk aversion. The author has real data on these insurance decisions.

P. 178 puts some criticisms of Rabin (2000) right: "part of the importance of this insight rests on the assumption that people are significantly averse to moderate risks, a point which some have questioned (Richard Watt 2002; Ignacio Palacios-Huerta, Robert Serrano, and Oscar Volij 2006) There is extensive evidence that people do display risk aversion over small stakes in laboratory settings … Outside of laboratory settings, … "

P. 183 penultimate para: By taking $1000 deductible instead of $250 or $500 deductible, people could on average have saved $100 per year! The price people pay extra for having $500 deductible instead of $1000 is five times its average value! P. 187 bottom: $4.8 billion per year can the saved by all house-owners in the US by taking $1000 deductble. One individual can on average gain $6,300 until age 65.

P. 184 mentions consumer inertia, of people keeping insurance even though price has become much worse. Hence, better to estimate only for new customers (p. 189 end 3rd para).

P. 192 ff: for measuring relative risk aversion, proper level of initial wealth is discussed in detail.

P. 193 penultimate para: People have to overestimate probability of loss by factor 5 (18.3 instead of 3.7) to come to single-digit relative risk aversion index. P. 195-196: Common degrees of probability weighting thus neither can explain it well. Traditional loss aversion plays no role because insurance is all about losses.

P. 196: if we take premium paid as reference point (which is psychologically plausible), then loss aversion can explain it. The Köszegi-Rabin (2006) model also leads to this. %}

Sydnor, Justin (2010) "(Over)insuring Modest Risks," *American Economic Journal: Applied Economics* 2, 177–199.

{% **foundations of probability** %}

Synthese 55, 1983, special issue on theory of knowledge.

{% **foundations of probability & foundations of statistics**: special issue dedicated to the memory of Henry Kyburg. %}

Synthese 186, 2012, Number 2.

{% Shows that every partial order can be extended to an order, which is an easy application of Zorn's lemma.

An accessible (English) account seems to be in Joseph G. Rosenstein (1982) "*Linear Orderings, Pure and Applied Mathematics,*" 98, Academic Press, New York. %}

Szpilrajn, Edward (1930) "Sur l'Extension de l'Ordre Partiel," *Fundamenta Mathematicae* 16, 386–389.

{% %}

Szpiro, George G. (1985) "Optimal Insurance Coverage," *Journal of Risk and Insurance* 52, 704–710.

{% **utility elicitation**?; **decreasing ARA/increasing RRA**: seem to find constant RRA (consequently, decreasing absolute). %}

Szpiro, George G. (1986) "Measuring Risk Aversion: An Alternative Approach," *Review of Economics and Statistics* 68, 156–159.

{% %}

Szpiro, George G. (1987) "Optimal Insurance Coverage: Reply," *Journal of Risk and Insurance* 54, 813–815.

{% %}

Szpilrajn, Edward (1930) "Sur l'Extension de l'Ordre Partiel," *Fundamentà Mathematicae* 16, 386–389.

{% **utility depends on probability**: seems to argue that in sports the utility of a result depends on its probability. %}

Szymanski, Stefan (2003) "The Economic Design of Sporting Contests," *Journal of Economic Literature* 41, 1137–1187.

{% **utility depends on probability**: seems to argue that in sports the utility of a result depends on its probability. %}

Szymanski, Stefan (2004) "Professional Team Sports Are only a Game: The Walrasian Fixed-Supply Conjecture Model, Contest-Nash, and the Invariance Principle," *Journal of Sports Economics* 5, 111–126.

{% %}

Tadelis, Steven (2013) "*Game Theory: An Introduction*." Princeton University Press, Princeton, NJ.

{% **equity-versus-efficiency** %}

Tadenuma, Koichi (1996) "Trade-off between Equity and Efficiency in a General Economy with Indivisible Goods," *Social Choice and Welfare* 13, 445–450.

{% **equity-versus-efficiency** %}

Tadenuma, Koichi (2002) "Efficiency First or Equity First? Two Principles and Rationality of Social Choice," *Journal of Economic Theory* 104, 462–472.

{% Tests many discount families, both for group average and individual. Finds that generalized hyperbolic is best, with unit invariance second. Assumes linear utility. %}

Takahasi, Taiki (2005) "Loss of Self-Control in Intertemporal Choice May be Attributable to Logarithmic Time-Perception," *Medical Hypotheses* 65, 691–693.

{% **nonconstant discount = nonlinear time perception**;
Eq. 6 proposes the unit invariance discounting family, with the nice interpretation that this is constant discounting with, however, Stevens-type power perception of time. %}

Takahasi, Taiki (2006) "Time-Estimation Error Following Weber–Fechner Law May Explain Subadditive Time-Discounting," *Medical Hypotheses* 67, 1372–1374.

{% %}

Takahasi, Taiki, Hidemi Oono, & Mark H.B. Radford (2008) "Psychophysics of Time Perception and Intertemporal Choice Models," *Physica A: Statistical Mechanics and its Applications* 387, 2066–2074.
http://dx.doi.org/10.1016/j.physa.2007.11.047

{% Let people choose, hypothetically, between an amount received immediately with certainty, and a risky amount received with delay. With general probability weighting one then cannot determine the power, but they assume EU and use a random-choice model with constant discounting and power utility to fit data. They find usual powers of utility (around 0.8) and usual discount rates (around 6%). They correlate with smoking, drinking, and two kinds of gambling. Smokers and gamblers are more impatient and less risk averse. For drinkers it is, overall, opposite. Bu the opposite is only for moderate drinkers (p. 615 bottom). Extreme drinkers are again more impatient and less risk averse. The authors defend rationality of moderate drinking (p. 615, jokingly: "Sake is the best medicine"). The writing and self-praising is sometimes naïve, with English-language limitations as likely excuse. %}

Takanori, Ida & Rei Goto (2009) "Interdependency among Addictive Behaviours and Time/Risk Preferences: Discrete Choice Model Analysis of Smoking, Drinking, and Gambling," *Journal of Economic Psychology* 30, 608–621.

{% Seems to retest book-making tests of Tversky & Kahneman (1981), showing that it disappears if subjects have to justify. %}

Takemura, Kazuhisa (1993) "The Effect of Decision Frame and Decision Justification on Risky Choice," *Japanese Psychological Research* 35, 36–40.

{% Seems to retest book-making tests of Tversky & Kahneman (1981), showing that it disappears if subjects have to justify, adding in this paper that it also gets less if they get more decision time. %}

Takemura, Kazuhisa (1994) "Influence of Elaboration on the Framing of Decision," *Journal of Psychology* 128, 33–39.

{% On endogenous state spaces. %}

Takeoka, Norio (2007) "Subjective Probability over a Subjective Decision Tree," *Journal of Economic Theory* 136, 536–571.

{% **nonconstant discount = nonlinear time perception**: this point was stated nicely in the working paper version but, unfortunately, as the author explained to me in personal communication, a referee had him take it out in the published version.

decreasing/increasing impatience: finds counter-evidence against the commonly assumed decreasing impatience and/or present effect.

First part of paper tests stationarity qualitatively as often done before, which can be called utility free because it needs not know utility. Second part first uses decision under risk and the standard gamble method to measure utility, assuming expected utility, and then measures discounting in utility rather than in money. The author suggests that this part does not measure utility at all (p. 460, §2.2, 2nd sentence), but measuring the standard gamble probabilities is equivalent to measuring utility. All of this conditional on assuming expected utility, which the author does. Similar things have been done by Andersen et al. (2008, Econometrica) and partly by Chapman (1996). The author calls his method utility-free because it works, given his assumptions, whatever utility is. The idea to pay in probability and then under EU have linear utility has been used before (Allen 1987; Anscombe & Aumann 1963; Berg et al. 1986 QJE; Roth & Malouf 1979; Cedric Smith 1961). Its drawbacks are that EU is extensively violated, with Selten, Sadrieh, & Abbink (1999) finding that the deviations from EU are bigger than those from linear utility, and that cardinal utility under risk need not be the same as cardinal intertemporal utility, as established after the ordinal revolution

(Baumol 1959).

Given the assumptions made, the author can in fact measure a model D(t,x)u(x), with discounting D(t,x) outcome dependent, as he points out on p. 457.

The experiment finds quite some future bias.

P. 471 "When does the *future* really start?" (Italics from original.) %}

Takeuchi, Kan (2011) "Non-Parametric Test of Time Consistency: Present Bias and Future Bias," *Games and Economic Behavior* 71, 456–478.

{% (**(very) small probabilities**) %}

Taleb, Nassim Nicholas (2007) "*The Black Swan: The Impact of the Highly Improbable*." Random House, New York.

{% **PT, applications**: nonadditive measures, sunspot equilibria %}

Tallon, Jean-Marc (1998) "Do Sunspots Matter when Agents Are Choquet-Expected-Utility Maximizers," *Journal of Economic Dynamics and Control* 22, 357–368.

{% Using nonadditive measures and belief interpretations of those. Knowing E negative means that E^c has belief zero but E need not have belief one. %}

Tallon, Jean-Marc (1998) "Asymmetric Information, Nonadditive Expected Utility, and the Information Revealed by Prices: An Example," *International Economic Review* 39, 329–342.

{% **games with incomplete information** %}

Tan, Tommy Ch.-Ch. (1988) "The Bayesian Foundations of Solution Concepts of Games," *Journal of Economic Theory* 45, 370–391.

{% **real incentives**: Average payment was $11, roughly 7-day labor wage for casual unskilled labor. Random incentive system with one choice played for real.

Use prospect theory, power utility and 1-parameter Prelec weighting function, and loss aversion, with same parameters for gains and losses. So, then the unit of payment assumed does not matter for the definition of loss aversion.

Choice stimuli: No sure prospects. Find indifference by choice list: $40_{0.30}10 \sim x_{0.10}5$; $40_{0.90}30 \sim x_{0.70}5$. The third choice list was more complex, with losses involved for both options. So, basically, three indifferences are used to fit three parameters. They use the first two indifferences to elicit utility power and probability weighting, and the third, given the first two, to elicit loss aversion. Find power 0.61 and weighting-function parameter 0.74.

real incentives/hypothetical choice, for time preferences: They implemented using again random incentive system. Future payments for subjects were left to one of the subjects, a specially chosen “trusted agent,” who was asked to deliver the money on the days promised. I find it hard to believe that this would work well. Actually, I think that it would be immoral for the trusted agent NOT to deliver the money immediately. He is then causing money (interest and opportunities) to be lost for the people in his village just because some American told him so, with no use for the research (already over) or anything else, other than tribute to an abstract ethical principle of “never break a promise also if completely useless and to someone you will never see again.”

The stimuli for intertemporal choice concerned immediate rewards versus rewards delayed by 3 days up to 3 months.

For discounting they use a 3-parameter discount function, combining generalized hyperbolic discounting with also presence-effect à la quasi-hyperbolic. I regret that the two parameters besides exponent overlap in generating decreasing impatience, but they cannot fit increasing impatience which will surely be found for part of the subjects. It is like fitting risky data allowing only for risk aversion for every individual. The families by Bleichrodt, Rohde, & Wakker (2009, GEB) can handle increasing impatience.

Subjects invited had participated in a demographic study 3 years before, so that things could be correlated.

Richer villages are less loss averse and more patient. Richer households are more patient but no risk attitude effects. %}

Tanaka, Tomomi, Colin F. Camerer, & Quang Nguyen (2010) “Risk and Time Preferences: Linking Experimental and Household Survey Data from Vietnam,” *American Economic Review* 100, 557–571.

{% **value of information** %}

Taneja, Harish C. & Sanju Sihmar (1994) “An Axiomatic Characterization of the Quantitative-Qualitative Measure of Information Improvement,” *Information Sciences* 78, 209–214.

{% Discuss interpretations of loss aversion. Put forward the most common interpretation, that losses are felt more intensively than gains. One aspect of this they question in a way that I did not understand. They say that, contrary to the common view that gains reduce loss aversion and losses increase it (this I already do not understand), gains and losses may work in the same direction and both increase loss aversion. They seem to instead favor a sort of holistic evaluation. Peeters & Czapinski (1990) is a nice discussion of different interpretations of loss aversion. %}

Tang, Hui, Zhe Liang, Kun Zhou, Gui-Hai Huang, Li-Lin Rao & Shu Li (2016) “Positive and Negative Affect in Loss Aversion: Additive or Subtractive Logic?,” *Journal of Behavioral Decision Making* 29, 381–391.

{% **foundations of probability** & **conservation of influence**: discusses teleological theories of belief, and the role of objective and subjective probabilities in those. %}

Tang, Weng Hong (2014) “Intentionality and Partial Belief,” *Synthese* 191, 1433–1450.

{% For the meaning of epistemic vs. aleatory, see my annotations at Walters et al. (2023, Management Science) who discuss it themselves on pp. 2762-2763. This paper examines extremity (close to 0 or 1; overconfidence) of introspective probability judgments while correcting for what I interpret as a-neutral probabilities. The paper uses Tversky’s support theory. Several experiments show that there is more extremity for epistemic. Extremity is like the insensitivity that I examine in many papers, but in my papers it concerns decision weights and not judged probabilities. %}

Tannenbaum, David, Craig R. Fox, & Gülden Ülkümen (2017) “Judgment Extremity and Accuracy under Epistemic vs. Aleatory Uncertainty,” *Management Science* 63, 497–518.
http://dx.doi.org/10.1287/mnsc.2015.2344

{% %}
Tännsjö, Torbjörn (2002) “Why We Ought to Accept the Repugnant Conclusion,” *Utilitas* 14, 339–359.

{% **foundations of statistics**: pp. 6-7 takes the subjective view of probability and discusses other views. This paper argues in fact for the likelihood principle, where statistical info is completely captured by the likelihood ratio. It argues against p-value-type info. It does all these things in the legal context. There are two comments and a rejoinder in this issue of the journal. %}

Taroni, Franco, Silvia Bozza, Alex Biedermann, & Colin Aitken (2016) “Dismissal of the Illusion of Uncertainty in the Assessment of a Likelihood Ratio,” *Law, Probability and Risk* 15, 1–16. https://doi.org/10.1093/lpr/mgv008

{% **foundations of quantum mechanics** %}

Tarozzi, Gino & Alwyn van der Merwe (1988) “*The Nature of Quantum Paradoxes.*” Kluwer, Dordrecht.

{% They use an American life panel that contains many measurements of time preference and risk attitude from many studies. Big limitation: They measure risk attitude only by fitting EU with CARA or CRRA utility. So, they only have an estimation of risk aversion and not of insensitivity and all the violations of EU are bugging this study.

They see how those are related to other variables and real-life decisions. They find that one choice-list type (actually, adaptive titration) works well and predicts much, quite suggesting that time preference is quite driven by one factor. For risk attitudes it does not work so easily, and risk attitude consists of several components it seems. Not measuring decision risk attitude, but direct introspection, predicts real-life behavior much better, something also found and emphasized by Dohmen et al. (2011). As I wrote on some occasions, this is not very surprising or interesting because, first, it is like twice asking the same and, second, the introspective measure, unlike attitude questions, is not related to normative concepts useful for cost-effectiveness studies and so on. %}

Tasoff, Joshua & Wenjie Zhang (2022) "The Performance of Time-Preference and Risk-Preference Measures in Surveys," *Management Science* 68, 1149–1173. https://doi.org/10.1287/mnsc.2020.3939

{% %}

Taylor, Kimberley A. (1995) "Testing Credit and Blame Attributions as Explanation for Choices under Ambiguity," *Organizational Behavior and Human Decision Processes* 54, 128–137.

{% **real incentives/hypothetical choice**: seems to be on it

cognitive ability related to risk/ambiguity aversion: Subjects of high cognitive ability are more risk seeking in hypothetical choice than with real incentives. For others it makes no difference. Overall, there is no significant difference between risk aversion in real and hypothetical choice.

The author seems to think that Holt & Laury (2002) invented the price list to measure risk aversion, citing a handful of studies that used it after in footnote 8, and not citing the 100s who used it before. (**Prospect theory not cited**) %}

Taylor, Matthew P. (2013) "Bias and Brains: Risk Aversion and Cognitive Ability across Real and Hypothetical Settings," *Journal of Risk and Uncertainty* 46, 215–246.

{% r**eal incentives/hypothetical choice**: seems to be on it %}

Taylor, Matthew P. (2017) "Information Acquisition under Risky Conditions across Real and Hypothetical Settings," *Economic Inquiry* 55, 352–367. https://doi.org/10.1111/ecin.12386

{% Reconsiders Grossman and Eckel's (2015, JRU) study of skewness while correcting for loss aversion. It dampens but does not remove the effects. %}

Taylor, Matthew P. (2020) "Liking the Long-Shot … but just as a Friend," *Journal of Risk and Uncertainty* 61, 245–261.

{% Seems to survey studies of optimism. %}

Taylor, Shelley E. (1989) "*Positive Illusions: Creative Self-Deceptions and the Healthy Mind*." Basic Books, New York.

{% Argues that for optimal mental health it is often good not to be realistic, but to be ("too") optimistic and self-confident, and so on. In my diagonal reading, I saw no pros mentioned of being too pessimistic and overdoubting oneself, although in my amateur view those should also often be beneficial. %}

Taylor, Shelley E. & Jonathan D. Brown (1988) "Illusion and Well-Being: A Social Psychological Perspective on Mental Health," *Psychological Bulletin* 103, 193–210.

{% **intuitive versus analytical decisions**; replicate findings of Snijders, Tazelaar, & Batenburg (2003); add puzzling finding: purchasing managers predict worse the more experienced they are; %}

Tazelaar, Frits & Chris Snijders (2004) "The Myth of Purchasing Professionals' Expertise. More Evidence on whether Computers Can Make Better Procurement Decisions," *Journal of Purchasing & Supply Management* 10, 211–222.

{% %}

Teigen, Karl H. (1983) "Studies in Subjective Probability III: The Unimportance of Alternatives," *Scandinavian Journal of Psychology* 24, 97–105.

{% **EU+a*sup+b*inf**: Uses Choquet expected utility with this model. Leads to recommendations for negligence and against liability in unilateral accident cases. %}

Teitelbaum, Joshua C. (2007) "A Unilateral Accident Model under Ambiguity," *Journal of Legal Studies* 36, 431–477.

{% **updating: discussing conditional probability and/or updating** %}

Teller, Paul (1973) "Conditionalization and Observation," *Synthese* 26, 218–258.

{% Gathered 154 quality of life measurements, %}

Tengs, Tammy O. & Amy Wallace (2000) "One Thousand Health-Related Quality-of-Life Estimates," *Medical Care* 38, 583–637.

{% Measures utility, assuming EU, through hypothetical choices under risk, conditional on having two legs paralized or being healthy. This is entirely state-dependent utility à la Karni, with Anscombe-Aumann too. %}

Tengstam, Sven (2014) “Disability and Marginal Utility of Income: Evidence from Hypothetical Choices,” *Health Economics* 23, 268–282.

{% Deviations from subgame perfect Nash equilibrium are independent of size of stake, and are of an omission-commission type. The errors do increase with the difficulty of the task. In my words, this means that cognitive rather than motivational factors cause the deviation from rationality here. (**cognitive ability related to likelihood insensitivity (= inverse S)**) %}

Tenorio, Rafael & Timothy N. Cason (2002) “To Spin or not to Spin? Natural and Laboratory Experiments from *THE PRICE IS RIGHT*,” *Economic Journal* 112, 170–195.

{% Considers evaluation of prospect (act) if there is only a probability measure on some subalgebra and the prospect is not measurable with respect to it, using a model for this by Lehrer, taking either expected utilty of Choquet expected utility as point of departure. It considers such a preference for each timepoint and then analyzes continuity properties with time going to infinity, which is called time continuity. %}

Teper, Roee (2009) “Time Continuity and Nonadditive Expected Utility,” *Mathematics of Opertions Research* 34, 661–673.

{% %}

Teper, Roee (2010) “On Comparison of Non-Bayesian Experts,” *Mathematical Social Sciences* 60, 119–122.

{% %}

Terlouw, Pieter (1989) “Subjective Probability Distributions: A Psychometric Approach.” Ph.D. Dissertation, University of Groningen.

{% **proper scoring rules**: For many years he interviewed many politicians etc., asking them for probability judgments. Then he evaluated it all through proper scoring rules. Much in the spirit of Hofstee (1980).

The book also shows that specialists do not perform better than others because specialists want to impress using bold estimates. %}

Tetlock, Philip E. (2005) "*Expert Political Judgment*." Princeton University Press, Princeton, NJ.

{% %}

Tetlock, Philip E., Ferdinand M. Vieider, Shefali V. Patil, & Adam Grant (2013) "Accountability and Ideology: When Left Looks Right and Right Looks Left," *Organizational Behavior and Human Decision Processes* 122, 22–35.

{% Many nice real-world examples about endowment effect, e.g. pp. 45-46.

P. 50 suggests that Weber-Fechner law says that **just noticeable difference** is proportional to the absolute value, leading to logarithmic evaluation.

ratio-difference principle: People do more effort to save $4 on a $25 radio, than on a $500 tv. P. 51 footnote 15 describes nice add where man takes $37 from $5000, says "It may not seem like a lot here" pointing to the pile of $5000, and then says "but it will feel like a lot here" pointing to his wallet.

Many more on precommitment, billiard player who subconsciously follows sophisticated mathematical laws.

Thaler extended Kahneman & Tversky's loss aversion to riskless choice, and has been extensively praised for this by Kahneman and others. But I must say that I find this a straightforward move.

A citation: 'Until recently, credit card companies banned their affiliated stores from charging higher prices to credit card users. A bill to outlaw such agreements was presented to Congress. When it appeared likely that some kind of bill would pass, the credit card lobby turned its attention to form rather than substance. Specifically, it preferred that any difference between cash and credit card customers take the form of a cash discount rather than a credit card surcharge. This preference makes sense if consumers would view the cash discount as an opportunity cost of using the credit card but the surcharge as an out-of-pocket cost." %}

Thaler, Richard H. (1980) "Towards a Positive Theory of Consumer Choice," *Journal of Economic Behavior and Organization* 1, 39–60.

{% **dynamic consistency**; **time preference**; seems to also find sign-dependence of discounting, with smaller discounting for losses than for gains.

DC = stationarity: some texts may suggest so, but p. 202 $\ell\ell$. 12-14 put things exactly right: "[Dynamic inconsistency arises if (B.2) is selected now and when the choice is reconsidered in 364 dayts (B.1) is selected.]" %}

Thaler, Richard H. (1981) "Some Empirical Evidence of Dynamic Inconsistency," *Economics Letters* 8, 201–207.

{% Argues in favor of value function of prospect theory, for one reason because it captures the psychophysics of quantity. P. 201: "… captures the basic psychophysics of quantity. The difference between $10 and $20 seems greater than the difference between $110 and $120, irrespective of the signs of the amounts in question." The paper distinguishes between acquisition utility (intrinsic utility) and transaction utility (process utility). %}

Thaler, Richard H. (1985) "Mental Accounting and Consumer Choice," *Marketing Science* 4, 199–214.

{% **real incentives/hypothetical choice**: p. 96 seems to suggest that there is little improvement of rationality when real monetary rewards are introduced. %}

Thaler, Richard H. (1987) "The Psychology and Economics Conference Handbook: Comments on Simon, on Einhorn and Hogarth, and on Tversky and Kahneman." *In* Robin M. Hogarth & Melvin W. Reder (eds.) "*Rational Choice: The Contrast between Economics and Psychology,*" 95–100, University of Chicago Press.

{% P. 138 writes: "illusions demonstrate the need for rulers" %}

Thaler, Richard H. (1991) "*Quasi Rational Economics.*" Russell Sage Foundation, New York.

{% %}

Thaler, Richard H. (2015) "*Misbehaving: The Making of Behavioral Economics.*" W. W. Norton & Company, New York.

{% A general discussion arguing for the importance of behavioral economics. Unfortunately, the author desires too much to show that other researchers are

dumb and wrong, with the implicit implication that he himself is more clever. And, unfortunately, he does not try to properly position views other than his own, but he tries to make them look ridiculous using puns (p. 1579: "explainawaytions"), which does not advance communication and exchange of ideas, even if primitive readers (the type that enjoys watching violent movies) may enjoy it. It is good in writing and for clarity to skip some nuances, but this paper does it too much. P. 1579 beginning of §II: "In the process of making economics more mathematically rigorous after World War II, the economics profession appears to have lost its good intuition about human behavior." P. 1579 footnote 1 is characteristic of the sense of humor of the author.

In the beginning of the paper, and in several other places (p. 1578 middle: "Indeed, Ashraf, Camerer, and Loewenstein (2005) convincingly document that Adam Smith, often considered the founder of economics as a discipline, was a bona fide behavioral economist."), the author tries to argue that the behavioral approach means simply returning to the preordinal period. I will explain that I disagree. First I note that, unfortunately, the author never uses the term ordinal or refers to the ordinal revolution, but this is the crucial dividing line. P. 1580 seems to confuse the ordinal and the marginal revolution, apparently putting the marginal revolution in the 1940s. The marginal revolution was in the 1870s. He sometimes refers to "after World War II." Now to why I disagree. It is for the same reason that I disagree with the idea expressed in "Back to Bentham" (elsewhere). The ordinal revolution added much good, giving a clear and firm basis to economics. The behavioral revolution (using this term, also sometimes used in this paper) does not mean throwing these ideas away. It means extending these ideas, keeping the formal concepts but extending the empirical domain (a) by incorporating irrational phenomena studied before in psychology; (b) relaxing the restriction to revealed-preference data. Those extensions should be linked to the firm basis thanks to the ordinal revolution. Fortunately, in one place the author puts this right, being p. 1592 1st para: "A second general point is that we should not expect some new grand behavioral theory to emerge to replace the neoclassical paradigm. We already have a grand theory and it does a really good job of characterizing how optimal choices and equilibrium concepts work. Behavioral theories will be more like engineering, a set of practical enhancements that lead to better predictions about behavior. So far, most of these behavioral enhancements focus on two broad topics: preferences and beliefs."

Unfortunately, in the conclusion p. 1597 the author returns to the unnuanced statement: "Rather, behavioral economics should be considered simply a return to the kind of open-minded, intuitively motivated discipline that was invented by Adam Smith and augmented by increasingly powerful statistical tools and datasets."

P. 1581, ℓ. −4 presents EU as normative: "Prospect theory was intended to be a descriptive alternative to von Neumann and Morgenstern's (1947) expected utility theory, which is rightly considered by most economists to characterize how a rational agent should make risky choices."

P. 1582 ℓ. −3 lists Thaler's 1980 paper together with the work of Kahneman & Tversky.

P. 1583 2nd para shows how the desire to show others wrong (end of 3rd para: "So critics can't have it both ways. Either the real world is mostly high stakes or it offers myriad opportunities to learn—not both.")
blinds the author: his point that decisions with large stakes usually cannot be repeated much is irrelevant and in no way weakens the argument that both large stakes and repetition/learning increase rationality.

real incentives/hypothetical choice: p. 1585 end of 2nd para: "In the nearly 40 years since Grether and Plott's seminal paper, I do not know of any findings of "cognitive errors" that were discovered and replicated with hypothetical questions but then vanished as soon as significant stakes were introduced." Many studies, also some with me as co-author, find more noise with hypothetical choice (and less risk aversion). This usually means that any pattern is weakened and, hence, also violations of preference conditions. Still, it is clear that real incentives, other things equal, gives higher quality of data.

P 1585, §C, can be briefly summarized as:
"market mechanisms will often but not always reduce irrationalities."
The play with words of "invisible handwave" p. 1585 3rd para is typical of this paper's style.

P. 1591 bottom: Theory and empirics ALWAYS go hand in hand, so, things are way more universal than in the following citation: "Some might worry about basing theories on empirical observation, but this methodology has a rich tradition in science. The Copernican revolution, which placed the sun at the center of our solar system rather than the earth, was based on data regarding the movement of the planets, not on some first principles."

P. 1592 footnote 9: utility of income has more to do with reference dependence than with mental accounting.

P. 1597 last para: "If economics does develop along these lines the term "behavioral economics"will eventually disappear from our lexicon." The ambitious idea is that everyone will be doing behavioral, so, no more need to use the adjective. %}

Thaler, Richard H. (2016) "Behavioral Economics: Past, Present, and Future," *American Economic Review* 106, 1577–1600.

{% The authors got some firms to implement a program, called SMarT, to automatically make their employees save each month, in a percentage that they could influence. It led to considerably more savings.

People save too little (p. 166 2nd para: As can be inferred from their answers if asked. A lternative explanation of their answer can be social desirability.). Four biases are advanced to be underlying this (summarized and listed briefly on p. 170 2nd para ("In summary … these households.")):

1. Bounded rationality. People cannot calculate what is optimal for them.
2. Lack of self-control (time inconsistency/hyperbolic discounting).
3. (Much like 2): procrastination.
4. Loss aversion (the authors also involve money illusion).

This lead to the following aspects of the SMarT program (§III pp. 170-1st para of 171):

Because of 1, SMarT does not ask the clients but determines itself to what level it tries to make clients increase payment, and then stop there. Because of 2 and 3, clients are asked to commit to payment way before the first payment comes. Because of 4, let payment be raised only after salary rises. Further loss aversion and the implied inertia (which will be generated much by incompleteness of preference rather than loss aversion) should serve to imply that clients do not opt out of the program once being in. Relying on this, clients at each stage had the possibility to opt out if they wanted.

paternalism/Humean-view-of-preference: All actions stay within the boundaries of libertarian paternalism, of not doing anything people do not want by their gut feelings.

P. 167 last para: D**C = stationarity**;

P. 169 penultimate para: Loss aversion underlies inertia which, in turn, underlies why people don't save enough. P. 185: "One reason why the SMarT plan works so well is that inertia is so powerful."

P. 170 end of 1st para: The authors suggest that a 7 percent wage cut under no inflation should be as fair as a 5% salary raise under 12% inflation. This is not correct because 12% inflation means that the economy is doing badly, making it more “fair” to get worse off by oneself.

paternalism/Humean-view-of-preference: Conclusions on p. 185 ff. discuss it. Refer to Thaler & Sunstein (2003) on libertarian paternalism. P. 186: “we plead guilty to the charge of trying to be paternalistic. ... we have used behavioral principles to design a plan to increase savings rates and tested the ideas in the real world.” %}

Thaler, Richard H. & Shlomo Benartzi (2004) “Save More tomorrow: Using Behavioral Economics to Increase Employee Saving,” *Journal of Political Economy* 112, S164–187.

{% Subsections 5.1 and 5.2: house money effect: A prior gain increases the willingness to accept gambles, as long as they do not risk loosing the entire recent winnings. So, it is a kind of decreasing ARA (absolute risk aversion). (In a casino you are then gambling with the money you already won, so, with the “house money.”) A prior loss decreases the willingness to gamble (so, again decreasing ARA), except if it can generate breaking even (or turn losses to gains). Subsection 6.1 discusses some alternative explanations.

They give evidence against the isolation effect; i.e., prior gains etc. can matter. It’s a kind of income effect.

real incentives/hypothetical choice: p. 652 beginning of Subsection 4.1: “However, an experiment in which subjects can lose money creates some ethical dilemmas.”

P. 653: subjects who lose money can pay by hours of clerical work, if they want.

utility concave near ruin: seems that they have a quasi-hedonic editing rule that suggests this. %}

Thaler, Richard H. & Eric J. Johnson (1990) “Gambling with the House Money and Trying to Break Even: The Effects of Prior Outcomes on Risky Choice,” *Management Science* 36, 643–660.

{% Christmas and diet clubs to help self-control %}

Thaler, Richard H. & Hersh M. Shefrin (1981) “An Economic Theory of Self-Control,” *Journal of Political Economy* 89, 392–410.

{% **paternalism/Humean-view-of-preference**: Libertarian paternalism means not trying to change preference held by clients. Only in situations where it is all the same to the client and the client has no preference (as with situations where default has so much impact), libertarian paternalisms takes it the way the analyst thinks best for the client. So, libertarian paternalism plays in the space left by incomplete preferences.

paternalism/Humean-view-of-preference:

"we clearly do not always equate revealed preference with welfare." %}

Thaler, Richard H. & Cass R. Sunstein (2003) "Libertarian Paternalism," *American Economic Review, Papers and Proceedings* 93, 175–179. https://doi.org/10.1257/000282803321947001

{% P. 6 seems to write, defining a nudge: "an aspect of choice architecture that alters people's behavior in a predictable way, without forbidding any options or significantly changing their economic incentives" Here the "without forbidding:" part expresses libertarian. Changing economic incentives can trivially change people's behavior but is not a nudge. Later on the book seems to write that a nudge should "make people better off as judged by themselves." %}

Thaler, Richard H. & Cass R. Sunstein (2008) "*Nudge: Improving Decisions about Health, Wealth, and Happiness*." Yale University Press, New Haven.

{% %}

Thaler, Richard H. & Amos Tversky (1996) "Myopic Loss Aversion in Financial Investment," unpublished manuscript, University of Chicago.

{% **PT, applications**, loss aversion

decreasing ARA/increasing RRA: use power utility. %}

Thaler, Richard H., Amos Tversky, Daniel Kahneman, & Alan Schwartz (1997) "The Effect of Myopia and Loss Aversion on Risk Taking: An Experimental Test," *Quarterly Journal of Economics* 112, 647–661.

{% Opening sentence: "Economics can be distinguished from other social sciences by the belief that most (all?) behavior can be explained by assuming that agents have stable, well-defined preferences and make rational choices consistent with those preferences in markets that (eventually) clear."

Discuss biases in bets and lotteries, where sometimes one can even have positive expectation if knowing the biases.

inverse S: The *favorite-longshot bias* in horse racing: People underestimate the winning probabilities if they are high and overestimate them when they are low. So, they bet too much on outsiders and too little on favorites, to the extent even that for favorites with 0.7 probability or more of winning the expectation of gambling is positive. P. 171 Reason 5 lists that people gamble on horses for reasons such as name etc., unrelated to the winning chances. This looks like likelihood insensitivity.

P. 172: Lotteries only became popular when New Jersey let people choose their own numbers, speculating on illusion of control.

Dutch book: p. 167 discusses and references cross-track gambling where different bookmakers had dramatically-different odds.

In lotto 6/49, they list numbers that are overchosen (7 most) and those that are underchosen.

P. 170 discusses the problems of the Friedman & Savage (1948) utility curve. %}

Thaler, Richard H. & William T. Ziemba (1988) "Parimutual Betting Markets: Racetracks and Lotteries," *Journal of Economic Perspectives* 2 no. 2, 161–174.

{% Alfabetisch onder "T"

Describes the result of Rabin & Thaler (2001, JEP 15), arguing against expected utility and in favor of loss aversion. %}

The Economist (2001) "Economics Focus Averse to Reality," *Economist*, August 11, p. 61.

{% On loss aversion. %}

The Economist (2003) "To Have and to Hold," *Economist*, August 30, p. 56.

{% **updating: discussing conditional probability and/or updating**: Bayes formula.

Describes research by Griffiths & Tenenbaum on updating. Text is overly

simplistic about Bayes formula simply working well with negative statements about frequentists. %}
The Economist (2006) "Bayes Rules," *Economist*, January 7, p. 70–71.

{% %}
The Economist (2008) "Anti-Terrorist Spending: Feel Safer now?," *Economist*, March 8. p. 69.

{% That Keynes and Knight pointed out that uncertainty is really different than risk. Then goes into rent policies when market does bad. %}
The Economist (2009) (written by Chris F. Masse) "Bribing the Markets; The Impossible Task of Eliminating Uncertainty," *Economist*, November 11.

{% This paper discusses CPT debiasing. CPT debiasing means that one takes expected utility, denoted EUT in this paper, as the right normative theory. To find the utility function to be used in EUT, one uses 1992 prospect theory, denoted CPT in this paper, as the best descriptive theory, to measure basic utility (utility but with loss aversion taken out), and then uses that as the utility function to be used in EUT. It means that probability weighting and loss aversion of CPT are taken as irrational. Somewhat circularly, a kink in utility at the reference point that is "genuine" is incorporated into basic utility. Genuine kinks can be distinguished from irrational ones (loss averion) because they, unlike the irrational ones, do not move with the reference point but stay at a fixed final-wealth level. The most explicit paper on CPT debiasing is Bleichrodt, Pinto, & Wakker (2001). The paper by Thoma carefully and slowly lays down the various arguments, citing much related literature.

The author disagrees with CPT debiasing for two reasons. Both assume, correctly, that CPT debiasing wants the utility function to cardinally capture goodness, i.e., to be the neo-classical cardinal utility of economics. The first reason for disagreement argues that the utility function resulting from CPT (so, its basic utility) may just be any ordinal transformation of neo-classical utility, and there is no reason that the two should be the same. The second reason for disagreement argues that the utility function to be used in EUT may just be any ordinal transformation of neo-classical utility, and there is no reason that the two

should be the same. The latter is in the spirit of the Dyer & Sarin (1982) distinction between value and utility, cited by the author. The rumerous "there is no reason that not" argument is stated on p. 212+8 2nd para ℓℓ. 2-3 and p. 216 ℓ. -3.

My first counter is that there neither is a reason that these functions should be different. Further, pragmatic after years of work in a hospital, allowing any ordinal transformation is too general and unspecific to be very useful. The author does add specificity. She argues that one should take the EUT model that is closest (in some sense) to the observed CPT model. That is, one should deviate as little as possible. I disagree. One should make one's *best* guess of the biases, and that does not need to be the *closest* guess. If I know a person is weighting probabilities simply because of misunderstanding them then I should not try to stay as close as possible but just fully correct.

I disagree with p. 212 §4 first line: "CPT debiasing can only be means paternalist if the basic utility function identified in CPT models in fact provides us with a reliable and complete measure of all the agent's relevant ends." It is not about reliable and complete. It is about *most* reliable and *most* complete that is possible. Which may be very unreliable and incomplete. Again, after having done applied work in a hospital, one often only has dirty data but one HAS TO decide.

The author defines means paternalism as paternalism where one accepts the final ends of an agent and only seeks to improve the agent's means to get them.

P. 205 ℓ. -3: "But the would-be means paternalist has no way of telling which way of resolving the inconsistency is more authentically the agent's own."

P. 211 ℓ. -4: "The mere observation of behavioral inconsistency points to no particular way of resolving that inconsistency that would honor the agent's ends, and do so better than the agent's own choices."

Section 4 has a long discussion on requiring (utility of) outcomes to be complete and also incorporate global properties of the lottery.

P. 214 suggests that a "genuine" kink in basic utility and a kink due to loss aversion are hard to separate. I counter: It is easy by comparing different reference points to see if the kink is genuine and travels with final-wealth level, or travels with the reference point.

P. 219 penultimate para: for justifying risk neutrality in terms of utility units

one can use no-arbitrage conditions or, better, additivity preference conditions, as in Wakker (2010 Ch. 1). %}

Thoma, Johanna (2024) "Merely Means Paternalist? Prospect Theory and "Debiased" Welfare Analysis," *Philosophy of Science* 91, 204–224. https://doi.org/10.1017/psa.2023.106

{% **foundations of statistics** %}

Thomas, Hoben (2000) "What Statistical Evidence Is and What it Is Not," Book Review of: Richard Royall (1997) Statistical Evidence: A Likelihood Paradigm, Chapman & Hall, New York; *Journal of Mathematical Psychology* 44, 480–487.

{% %}

Thomsen, Gerhard (1927) "Un Teorema Topologico sulle Schiere di Curve e una Caratterizzazione Geometrica delle Superficie Isotermo-Asintotiche," *Bolletino della Unione Matematica Italiana* 6, 80–85.

{% Detailed discussion of many aspects of axiomatizations for game theory and resource allocation. The paper is mostly oriented towards applications in other economic theories, so, with theoretical requirements such as continuity, and less towards empirical or practical prescriptive applications, in which continuity plays no role. There are some comments on operationalism in §10.1, and p. 372 point 4 of §12.2 has a nice discussion.

§4.1.1 argues that axioms should be independent. Related to this is the principle that axioms should be as weak as possible. This need not hold in descriptive studies that want axioms to be as strong as possible so as to test theories as much as possible.

criticizing the dangerous role of technical axioms such as continuity: §4.1.3 p. 338 penultimate para discusses the point that continuity can add empirical content to other axioms, but is completely optimistic and positive about it without seeing dangers. For instance, Pfanzagl (1968 §6.6) discusses this point but is more negative on there being dangers, and I agree. See also §9.1 of Krantz et al. (1971).

I like §4.3, that axioms should be conceptually compatible. As I see it, in Arrow's voting paradox IIA and group-preference-transitivity are conceptually incompatible, the former requiring that a choice between two alternatives have no info about a third, and the latter requiring that all choices between pairs of alternatives be made in same states of info.

§4.4 is strong on it not being bad to have many axioms, a point that I don't really understand.

A point that I missed in the discussion is that axiomatizations can give empirical meaning to theoretical constructs, and justify the use of the latter, for instance in the way that de Finetti justified subjective probabilities. %}

Thomson, William (2001) "On the Axiomatic Method and Its Recent Applications to Game Theory and Resource Allocation," *Social Choice and Welfare* 18, 327–386.

{% %}

Thomson, William & Lin Zhou (1993) "Consistent Solutions in Atomless Economies," *Econometrica* 61, 575–587.

{% **foundations of statistics** %}

Thorburn, Daniel (2005) "Significance Testing, Interval Estimation or Bayesian Inference: Comments to "Extracting a Maximum of Useful Information from Statistical Research Data," by S. Sohlberg & G. Anderss," *Scandinavian Journal of Psychology* 46, 79–82.

{% r**eal incentives/hypothetical choice, for time preferences**: seems to be on it %}

Thornton, Jeremy, Sara H. McCarty, & Charles E. Stokes (2017) "Divine Restraint: An Experimental Analysis of Religious Preference and Intertemporal Discounting," *Journal of Behavioral and Experimental Economics* 67, 99–110. https://doi.org/10.1016/j.socec.2016.12.002

{% **foundations of statistics**: give decision foundation for the use of inversion of credible sets to test point-hypotheses. %}

Thulin, Måns (2013) "Decision-Theoretic Justifications for Bayesian Hypothesis Testing Using Credible Sets," *Journal of Statistical Planning and Inference* 146, 133–138.

{% Conjunction fallacy %}
Thüring, Manfred & Helmut Jungermann (1990) "The Conjunction Fallacy: Causality vs. Event Probability," *Journal of Behavioral Decision Making* 3, 61–74.

{% **error theory for risky choice**; Generally credited for introducing random utility, also developed by McFadden. %}
Thurstone, Louis L. (1927) "A Law of Comparative Judgment," *Psychological Review* 34, 273–286.

{% Points out some sophisticated problems in an equal-interval-judgment experiment. %}
Thurstone, Louis L. (1929) "Fechner's Law and the Method of Equal Appearing Intervals," *Journal of Experimental Psychology* 12, 214–224.

{% Famous paper, measuring utility empirically through hypothetical choice over coats and hats. Can be credited for introducing hypothetical choice to measure preference. Can be credited for introducing experimental economics, being the first lab experiment, albeit using hypothetical choice. Thurstone was a prominent psychologist. He was criticized for using hypothetical choice rather than real incentives by Mayer (1933), among others. %}
Thurstone, Louis L. (1931) "The Indifference Function," *Journal of Social Psychology* 2, 139–167.

{% %}
Tian, Guoqiang (1993) "Necessary and Sufficient Conditions for Maximization of a Class of Preference Relations," *Review of Economic Studies* 60, 949–958.

{% **information aversion**: For genetic diseases such as Huntington's disease people can have themselves tested but there is no cure for the disease. For example, if your father has it you have .5 probability of also having it. Some want to have that test, others really do not want to know if they have the bad gene. %}
Tibben, Aad, Petra G. Frets, Jacques J.P. van de Kamp, et al. (1993) "Presymptomatic DNA-Testing for Huntington Disease: Pretest Attitudes and Expectations of

Applicants and Their Partners in the Dutch Program," *Am. J. Med. Genet.* 48, 10–16.

{% **information aversion** %}

Tibben, Aad, Petra G. Frets, Jacques J.P. van de Kamp, et al. (1993) "On Attitudes and Appreciation 6 Months after Predictive DNA Testing for Huntington Disease in the Dutch Program," *Am. J. Med. Genet.* 48, 103–111.

{% **probability communication**:

Abstract first sentence: "Graphical representation formats (e.g., icon arrays) have been shown to lead to better understanding of the benefits and risks of treatments compared to numbers." This study shows a drawback of graphical info: it requires more cognitive effort. %}

Tiede, Kevin E. & Wolfgang Gaissmaier "How Do People Process Different Representations of Statistical Information? Insights into Cognitive Effort, Representational Inconsistencies, and Individual Differences," *Medical Decision Making* 43, 803–820.
https://doi.org/10.1177/0272989X231202505

{% **three-doors problem**: shows that many empirical studies of cognitive dissonance are simply making the known three-prisoners mistake in their statistics. Very funny! %}

Tierney, John (2008) "And behind Door No. 1, a Fatal Flaw," *New York Times*, Science, April 8, 2008.

{% con. probability; Formula of Bayes etc. in legal affairs. Many discussing contributers, a.o. Ward Edwards. %}

Tillers, Peter & Edward D. Green (1988) "*Probability and Inference in the Law of Evidence: The Uses and Limits of Bayesianism*." Kluwer Academic Publishers, Dordrecht.

{% %}

Tilling, Carl, Nancy Devlin, Aki Tsuchiya, & Ken Buckingham (2010) “Protocols for Time Tradeoff Valuations of Health States Worse than Dead: A Literature Review,” *Medical Decision Making* 30, 610–619.

{% **probability communication** %}

Timmermans, Daniëlle R.M., A.C. Molenwijk, Anne M. Stiggelbout, & Job Kievit (2004) “Different Formats for Communicating Risks to Patients and the Effects on Choices of Treatment,” *Patient Education and Counseling* 54, 255–263.

{% %}

Timmermans, Daniëlle R.M., Peter Politser, & Peter P. Wakker (1995) “Aggregation, Rationality, and Risk Communication: Three Current Debates in Medical Decision Making.” *In* Jean-Paul Caverni, Maya Bar-Hillel, Francis Hutton Barron, & Helmut Jungermann (eds.) *Contributions to Decision Making -I*, 111–117, Elseviers Science, Amsterdam.

{% %}

Timmermans, Daniëlle R.M., Arwen J. Sprij, & Chris E. de Bel (1996) “The Discrepancy between Daily Practice and the Policy of a Decision Analytic Model: The Management of Fever without Focus,” *Medical Decision Making* 16, 357–367.

{% Gives techniques for optimizing a Choquet integral. %}

Timonin, Mikhail (2012) “Maximization of the Choquet Integral over a Convex Set and Its Application to Resource Allocation Problems,” *Annals of Operations Research* 196, 543–579.

{% **coherentism** %}

Tinbergen, Jan (1991) “On the Measurement of Welfare,” *Journal of Econometrics* 50, 7–13.

Abstract. The author believes in the measurability of welfare (also called satisfaction or utility). Measurements have been made in the United States (D.W. Jorgenson and collaborators), France (Maurice Allais), and the Netherlands (Bernard M.S. Van Praag and collaborators). The Israeli sociologists S. Levy and

L. Guttman have shown that numerous noneconomic variables are among the determinants of welfare. The determinants are numerous; the author proposes a list of about fifty. Various mathematical functions have been proposed, of which the logarithm of the determinants shows the highest correlation with welfare, as measured.

{% **conservation of influence**: known for putting forward four "why" questions for actions, which are cornerstone of modern ethology:

1st is immediately preceding history: Bird sings because its nerves … etc. So, causal, as a physical phenomenon.

2nd concerns longer past. Bird sings because learned from father. So, this is development at individual level.

3rd concerns even longer past. Bird sings because genes make it do so. Is evolutionary (but still basically causal as were the preceding two).

4th concerns purpose: Bird (say male) sings to attract female. Is functional, about purpose. Good singing improves survival. Fourth question requires consideration of: What would have happened had the bird not sung? Tinbergen did experiments in this spirit. Birds clean nest from remainders of shells. Tinbergen put up artificial nests with remainders of shells, to find out that craws etc. then came to steal. %}

Tinbergen, Niko (1963) "On the Aims and Methods of Ethology," *Zeitschrift für Tierpsychologie* 20, 410–433.

{% %}

Tinghög, Gustav, David Andersson, Caroline Bonn, Harald Böttiger, Camilla Josephson, Gustaf Lundgren, Daniel Västfjäll, Michael Kirchler, Magnus Johannesson (2013) "Intuition and Cooperation Reconsidered," *Nature* 498 (06 June 2013) pp. E1–E2.

{% %}

Tinghög, Gustav, David Andersson, Caroline Bonn, Magnus Johannesson, Michael Kirchler, Lina Koppel, & Daniel Västfjäll (2016) "Intuition and Moral Decision-Making– The Effect of Time Pressure and Cognitive Load on Moral Judgment and Altruistic Behavior," *PLoS ONE* 10, e0164012.

{% P. 152: classical problem that the discounted expected utility model cannot separate risk and time attitude, is explained nicely. %}
Tirole, Jean (1990) "In Honor of David Kreps, Winner of the John Bates Clark Medal," *Economic Perspectives* 4 no. 3, 149–170.

{% %}
Tirole, Jean (2002) "Rational Irrationality: Some Economics of Self-Management," *European Economic Review* 46, 633–655.

{% **crowding-out**: Seems to have argued that monetary incentives could undermine the sense of civic duty. The example of blood donation seems to have been given in Titmuss (1971). %}
Titmuss, Richard M. (1970) "*The Gift Relationship.*" Allen and Unwin, London.

{% **crowding-out** for blood donation. %}
Titmus, Richard M. (1971) "*The Gift of Relationship: From Human Blood to Social Policy*." New York: Pantheon Books.
Reprinted in Richard M. Titmus, Brian Abel-Smith, & Kay Titmuss (1987, eds.) *The Philosophy of Welfare*, Allen and Unwin, London.

{% %}
Toda, Masanao & Emir H. Shuford, Jr. (1965) "Utility, Induced Utility, and Small Worlds," *Behavioral Sciences* 10, 238–254.

{% Cites a man called Buffon who argued that all probabilities smaller than the probability for a man of sixty-five to die on a given day (was .0001 then) should be ignored (says Stigler) %}
Todhunter, Isac (1865) "*A History of the Mathematical Theory of Probability from the Time of Pascal to That of Laplace.*" Cambridge. (New prints 1949, 1965, Chelsea Publication Co, New York.)

{% Asset-pricing models are examined assuming fat-tail rather than normal distributions. %}

Tokat, Yesim, Rachev, Svetlozar T., & Eduardo S. Schwartz (2003) "The Stable Non-Gaussian Asset Allocation: A Comparison with the Classical Gaussian Approach," *Journal of Economic Dynamics and Control* 27, 937969.

{% **foundations of statistics**: likelihoodism = likelihoodprinciple. Argues for only using comparative beliefs. %}

Tokhadze, Tamaz (2022) "Likelihoodism and Guidance for Belief," *Journal for General Philosophy of Science* 53, 501–517. https://doi.org/10.1007/s10838-022-09608-3

{% "All happy families are alike; each unhappy family is unhappy in its own way." %}

Tolstoy, Leo

{% **losses from prior endowment mechanism**; Unfortunately, they paid three choices (from each of three scanning runs) and not one, so that there is some income effect. Seems that some subjects received the prior endowment earlier than others, and then integrated less, but I should check this out.

Consider acceptance of rejection of 50-50 prospects such as $\$20_{0.5}$–\$10. Gains range from \$10 to \$40 and losses from –\$5 to –\$20. Subjects are asked if they find the prospects very acceptable, a bit acceptable, or very/a bit unacceptable. Acceptability rates (not distinguishing between very or a bit (un)acceptable, so, revealed-preference based) suggest, with linear utility, λ = 1.93 as median. So, in this sense no **risk seeking for symmetric fifty-fifty gambles.**

They do not have decisions immediately followed by payment, aiming to generate decision utility and not experienced utility. They find no activation of negative emotions in the brain such as fear (amygalda), but activation of parts of the brain associated with evaluation. %}

Tom, Sabrina M., Craig R. Fox, Christopher Trepel, & Russell A. Poldrack (2007) "The Neural Basis of Loss Aversion in Decision Making under Risk," *Science* 315, 515–518.

{% ISBN: 978-1-78471-991-3 %

Textbook on behavioral economics %}

Tomer, John F. (2017) "*Advanced Introduction to Behavioral Economics.*" Edward Elgar Publishing, Vermont.

{% %}
Tomoyuki, Nakajima & Herakles Polemarchakis (2005) "Money and Prices under Uncertainty," *Review of Economic Studies* 72, 223–246.

{% **EU+a*sup+b*inf**: Takes RDU for uncertainty as given. Then adds preference conditions, mainly strong null event consistency and extreme outcomes sensitivity (sure-thing principle for intermediate outcomes), which axiomatize the neo-additive case. %}
Toquebeuf, Pascal (2016) "Choquet Expected Utility with Affine Capacities," *Theory and Decision* 81, 177–187.

{% %}
Torgerson, Warren S. (1958) "*Theory and Methods of Scaling*." Wiley, New York.

{% **ratio bias**: if subjects are asked to produce sequences of equal distances (differences) or of equal ratios, they produce roughly the same sequences. P. 203: "It appears that the subject simply interprets this single relation in whatever way the experimenter requires. When the experimenter tells him to equate differences or to rate on an equal interval scale, he interprets the relation as a distance. When he is told to assign numbers according to subjective ratios, he interprets the same relation as a ratio." %}
Torgerson, Warren S. (1961) "Distances and Ratios in Psychophysical Scaling," *Acta Psychologica* 19, 201–205.

{% Proposes EU with $U(x) = x(1+k(x/(x+K))^2)$. The function is concave for losses, tending to $-\infty$ as x approaches $-K$ (K is total wealth). It is convex for gains, starting with derivative 1 at $x = 0$ tending to derivative (1+k) as x tends to ∞. The author does so to accommodate risk seeking for lotteries. This preceeds Friedman & Savage (1948) in seeking to use utility curvature to model risk attitudes, and not just do concave utility to have risk aversion. It has convexity for gains to accommodate gambling, and concavity for losses so as to accommodate insurance. It does not have a concave part for gains, as Friedman-Savage does.

risky utility u = strength of preference v: clearly uses this interpretation. %}

Törnqvist, Leo (1945) "On the Economic Theory of Lottery Gambles," *Skandinavisk Aktuarietidskrift* 28, 228–246.

{% **risky utility u = strength of preference v (or other riskless cardinal utility, often called value)**.: p. 132; **utility elicitation**;

Compares TTO, standard gamble, and category scaling.

PE doesn't do well: it is only done with the high education group, because it was too complex for the other members from the general public.

Category scaling behaves strangely, deviates from others, is judged difficult. %}

Torrance, George W. (1976) "Social Preferences for Health States: An Empirical Evaluation of Three Measurement Techniques," *Socio-Econ. Plan. Sci*. 10, 129–136.

{% **utility elicitation**; relates PE (if I remember well, he calls it SG) to TTO?; introduces adaptive method. Takes EU as gold standard with respect to validity. %}

Torrance, George W. (1986) "Measurement of Health State Utilities for Economic Appraisal: A Review," *Journal of Health Economics* 5, 1–30.

{% **utility elicitation**

P. 596 refers to dependence of health state utility on prognosis.

P. 599: PE **doesn't do well**, author recommends using either VAS or TTO, but not PE (if I remember well, he calls it SG). %}

Torrance, George W. (1987) "Utility Approach to Measuring Health-Related Quality of Life," *Journal of Chronic Diseases* 40, 593–600.

{% **utility elicitation**; **risky utility u = strength of preference v (or other riskless cardinal utility, often called value)**.: use vNM index for interpersonal aggregations.

questionnaire versus choice utility: they tranform direct judgment questions into vNM index by nonlinear transformation, and use the latter for interpersonal aggregations etc. %}

Torrance, George W., Michael H. Boyle, & Sargent P. Horwood (1982) "Application of Multi-Attribute Utility Theory to Measure Social Preferences for Health States," *Operations Research* 30, 1043–1069.

{% **PE gold standard**; p. 560 takes EU normative and PE (if I remember well, they call it SG) as gold standard.

Survey of QALYs; use MAUT techniques to combine dimensions in Health utilities index (vision, hearing, speech, dexterity, mobility, cognition, emotion, pain) and others into a QALY index; favor use of standard gamble. %}

Torrance, George W. & David H. Feeney (1989) "Utilities and Quality-Adjusted Life Years," *International Journal of Technology Assessment in Health Care* 5, 559–575.

{% %}

Torrance, George W., David H. Feeny, William J. Furlong, Ronald D. Barr, Yuemin Zhang, & Qinan Wang (1996) "Multiattribute Utility Function for a Comprehensive Health Status Classification System: Health Utilities Index Mark 2," *Medical Care* 34, 702–722.

{% %}

Torrance, George W., William J. Furlong, David H. Feeny, & Michael H. Boyle (1995) "Multi-Attribute Preference Functions. Health Utilities Index," *PharmacoEconomics* 7, 490–502.

{% I thought for some time that they introduced QALYs, together with Patrick, Bush, & Chen (1973). Later I found that Fanshel & Bush (1970, p. 1050) preceded them.

P. 121 points out how prognosis about future health affects the current quality of life. %}

Torrance, George W., David L. Sackett, & Warren H. Thomas (1973) "Utility Maximization Model for Program Evalution: A Demonstration Application, Health Status Indexes." *In* Robert L. Berg (ed.) *Health Status Indexes:*

Proceedings of a Conference Conducted by Health Services Research Tucson, Arizona, 1972. Hospital Research and Educational Trust, Chicago IL.

{% **utility elicitation**; Introduces Time Tradeoff; explains standard gamble for measuring health states. (Although Fanshel & Bush (1970, p. 1050) preceded them.)

P. 120 has the nice example where, for one day, you prefer bed confinement to kidney dialysis, but for five years your preference switches. %}

Torrance, George W., Warren H. Thomas, & David L. Sackett (1972) "A Utility Maximization Model for Evaluation of Health Care Programs," *Health Services Research* 7, 118–133.

{% **random incentive system between-subjects** (paying only some subjects): One of 100 subjects is paid one choice. Given that system is adaptive, it means that in principle it may not be incentive compatible. But for subjects it is totally impossible to recognize that it is adaptive, let be to see how to exploit it. So, theoretically it is not incentive compatible, but practically it is.

Use an adaptive system, well known in marketing, for measuring risk and time attitudes, which are measured through choice lists and indifferences derived from those. Adaptive means that for each subject, for each new question, it is calculated from the preceding questions what the most informative new question will be according to some minimization of some correlation-matrix's determinant or so, and that is asked as next question to the subject. The authors find that people with big debts on their houses discount more than others, but are not different in risk attitude.

They also do a traditional nonadaptive measurement in which they find no significant relation, but here they measured only two indifferences for time and two for risk (where it is not clear to me how they could calculate loss aversion from only two indifferences) so, they simply have less data and less power. %}

Toubia, Olivier, Eric Johnson, Theodoros Evgeniou, & Philippe Delquié (2013) "Dynamic Experiments for Estimating Preferences: An Adaptive Method of Eliciting Time and Risk Parameters," *Management Science* 59, 613–640.

{% Distinguishes between lack of self-control due to present bias and self-control costs. The latter even like restricting future choices if they know they will resist temptation (to save the costs). Part of the experimental test involves the measurement of beliefs about future actions. This is difficult because rewarding the belief usually interacts with the actual choice made. The solution proposed on p. 868 is not to ask beliefs about own actions, but beliefs about actions of other subjects who in some respects (other past choices) were similar. After all, it is natural to expect that those others will choose similarly as one-self so that one's own anticipated choice may be the best predictor. %}

Toussaert, Séverine (2018) "Eliciting Temptation and Self-Control through Menu Choices: A Lab Experiment," *Econometrica* 86, 859–889.

{% There are circularities in the definitions, and I think that this paper is basically unsound. A first problem is that sets $\mathcal{A}_0$, $\mathcal{A}_1$, $\mathcal{A}_2$ are not well defined: "can be compared" can be interpreted in several ways, none leading to correct results. A second problem is that she only considers one-side-unbounded utility, not two-sided. The latter is the most problematic case because integrals may not just be ∞ or $-\infty$, but may be really undefined ("$\infty - \infty$"). A third problem is that extending preferences by independence and monotonicity may lead to intransitivities. I wrote two letters about this to the author end 1980s but she was too busy to reply. %}

Toulet, Claude (1986) "An Axiomatic Model of Unbounded Utility Functions," *Mathematics of Operations Research* 11, 81–94. https://doi.org/10.1287/moor.11.1.81

{% %}

Toulet, Claude (1986) "Complete Ignorance and Independence Axiom: Optimism, Pessimism, Indecisiveness," *Mathematical Social Sciences* 11, 33–51.

{% **cognitive ability related to likelihood insensitivity (= inverse S)** & **inverse S (= likelihood insensitivity) related to emotions**: Hypothetical choices of WTP preceded by a task with images on the screen that either induced negative affect (fear) or neutral emotions. Probability weighting was derived assuming linear

utility, using the Goldstein-Einhorn (1987) family. Statistical numeracy was also measured. For subjects with low statistical numeracy, negative affect increased inverse S probability weighting. For subjects with high statistical numeracy, no effects were found. Optimism/pessimism never changed.

P. 38 1st-2nd column nicely states the the impact of emotions on probability weighting does not preclude taking it as cognitive: "Emotions are not only a consequence of choices but also often drive the cognitive process to arrive at a decision." Then it cites some papers on it, including, for probability weighting, Rottenstreich & Hsee (2001). %}

Traczyk, Jakub & Kamil Fulawka (2016) "Numeracy Moderates the Influence of Task-Irrelevant Affect on Probability Weighting," *Cognition* 151, 37–41. https://doi.org/10.1016/j.cognition.2016.03.002

{% **foundations of statistics**: An editorial saying that H_0 testing is not a valid method of inference and banning it from the journal. See also Trafimow & Marks (2015). %}

Trafimow, David (2014) "Editorial," *Basic and Applied Social Psychology* 36, 1–2. http://dx.doi.org/10.1080/01973533.2014.865505

{%

foundations of statistics: An editorial saying that H_0 testing is not a valid method of inference and banning it from the journal. I Bayesian could not agree more! If not H_0, then what alternative approach? The editors give no clear reply, and poiint to the problems of having prior probabilities in the Bayesian approach.. I agree with this. It is a difficult question to which we do not know a clear answer. Better no answer than the invalid Neyman-Pearson hypothesis testing. %}

Trafimow, David & Michael Marks (2015) "Editorial," *Basic and Applied Social Psychology* 37, 1–2. http://dx.doi.org/10.1080/01973533.2015.1012991

{% In experiment test how students, ranking various distributions over people, trade off between efficiency and equity, for lottery scenario and three social scenarios, with veil of ignorance in varying degrees.

Real incentives: 5 students (also 5 different income groups were distinguished) are randomly drawn (per group I guess) and then one allocation chosen is randomly selected and paid to the five students. Risky utility is not the same as welfare utility. %}

Traub, Stefan, Christian Seidl, & Ulrich Schmidt (2009) "An Experimental Study on Individual Choice, Social Welfare, and Social Preferences," *European Economic Review* 53, 385–400.

{% Point out the experimental flaw in Chechile & Cooke (1997). %}

Traub, Stephan, Christian Seidl, Ulrich Schmidt, & Peter Grösche (1999) "Knock-Out for Descriptive Utility or Experimental Error?," *Journal of Economics* 70, 109–126.

{% %}

Trautmann, Stefan T. (2009) "A Fehr-Schmidt Model for Process Fairness," *Journal of Economic Psychology* 340, 803–813.

{% %}

Trautmann, Stefan T. (2010) "Individual Fairness in Harsanyi's Utilitarianism: Operationalizing All-Inclusive Utility," *Theory and Decision* 68, 405–415.

{% They use hypothetical choice with large outcomes. Prospect theory and construal theory make opposite predictions for low-probability extreme outcomes (p. 256). Prospect theory fits data better than construal level theory. %}

Trautmann, Stefan T. & Gijs van de Kuilen (2012) "Prospect Theory or Construal Level Theory? Diminishing Sensitivity vs. Psychological Distance in Risky Decisions," *Acta Psychologica* 139, 254–260.

{% **probability elicitation**. Compare five belief elicitation methods: Through introspection, CE measurement, PE measurement, proper scoring rule assuming risk neutrality, and proper scoring fule with correction for risk attitude. Belief is about behavior of others in ultimatum game. It can serve as a: s**urvey on belief measurement**. They consider 4 criteria: two versions of internal validity: (1) additivity; (2) prediction of own behavior; and, further (3) external validity

(closeness to objective probability), (4) complexity.

They analyze CE measurement and proper scoring rules with and without correction for risk attitudes. Find that that correction improves, but may be not by very much, so on the one hand they say that increasing complexity does not help but on the other that risk-attitude correction does. A drawback of this analysis, at least from the descriptive perspective, is that the first internal validity criterion, additivity, ignores ambiguity attitude (they only write this in footnote 16, p. 2133, where the same point is implicit in footnote 5).

They do the measurement with and without explicitly saying to subjects that this is about belief measurement, and find that it makes no difference. They cite Offerman et al. (2009) for the same result. (Offerman et al. thought that only the treatment with explicit mention was natural, but had to add the control treatment because a referee and editor required it.)

Results are summerized in §6. §6.1: nonadditivity is strong in all measurements, least so in introspective. §6.2: truth serums improve prediction of own behavior, but it is not very good. §6.3: the methods are all similarly close to true probabilities. %}

Trautmann, Stefan T. & Gijs van de Kuilen (2015) "Belief Elicitation: A Horse Race among Truth Serums," *Economic Journal* 125, 2116–2135.

{% **survey on nonEU**: valuable survey on empirical studies of ambiguity.

ambiguity seeking for unlikely: p. 103 ff. documents and reviews this.

ambiguity seeking for losses: they document this.

They write in several places that ambiguity attitudes depend on the likelihood of events (p. 89 ℓ.9: "This literature has shown that attitudes towards ambiguity depend on the likelihood of the uncertain events."; also p. 104 penultimate para). I would state this differently, and say that ambiguity aversion depends on likelihood. The latter is true: Ambiguity aversion increases with likelihood. The former need not be: There is a-insensitivity everywhere, for all the events the same. It MEANS ambiguity seeking for unlikely and ambiguity aversion for likely.

P. 89 ℓ. −3: "Interestingly, the empirical literature has so far provided relatively little evidence linking individual attitudes toward ambiguity to behavior outside the laboratory in these, theoretically, ambiguity-sensitive decisions."

P. 94 middle (on 2nd order probabilities for generating ambiguity): "if the theory regards unknown probabilities it might be inappropriate to operationalize them with known-risk compound lotteries."

natural sources of ambiguity: P. 94 argues for its importance. Pp. 94-96, on it, list three ways to control for unknown beliefs: (1) bets on events and their complements (which in fact is detecting source preference); (2) the source method; (3) first measure subjective beliefs (I assume introspectively) and then compare with bets with same objective probabilities. They give no references, but here are some: Hogarth & Kunreuther (1995) Heath & Tversky (1991), Zeckhauser (2006).

P. 97 ℓ. 10 ff: "Thus, the three-color problem elicits much lower ambiguity aversion than the two-color problem."

P. 102 middle: "Given that many experiments use designs where risky and ambiguous bets are directly compared, while outside the laboratory there are often few truly unambiguous options, it is not clear how far quantitative laboratory measurements are representative of the preferences in potentially noncomparative real-world settings."

P. 102 $\ell\ell$. −2/−1: "Interestingly, ambiguity aversion does not seem more justifiable than ambiguity seeking nor vice versa." Here justifiability refers to group discussions.

P. 107 3rd para: it is correct that ambiguity aversion is a special case of source preference. The authors cite a paper where source preference relations measured for different (pairs of) sources were unrelated, which of course can happen. Then however they are confused to suggest that ambiguity aversion and source preference would be different concepts.

P. 107 end of penultimate para: "However, there is surprisingly little evidence yet in support of the assumed link from Ellsberg-urn ambiguity attitude to behavior outside the laboratory, and thus on the external validity of the ambiguity attitude concept."

P. 108 penultimate para: One Dimmock et al. paper finds significant relation with a-insensitivity and not with ambiguity aversion, and the other finds it the other way around. These findings are not contrary because finding a null of no relation does not mean much.

P. 109 2nd para: a careful consideration of these gain-loss differences seems warranted in applications in insurance of health, where losses play an important role.

P. 109 1st para of conclusion: "Given the relevance of these domains in the field, the universal focus of theoretical work on ambiguity aversion seems misplaced."

P. 109 1st para of conclusion: "Are the psychological mechanisms leading to ambiguity aversion in one domain and ambiguity seeking in another domain the same?" My answer: Yes! The fourfold pattern of ambiguity all results from insensitivity.

P. 110 endnote 4: "It is noteworthy that the comparative-ignorance effect does not typically lead to decreased valuations for the ambiguous act, but to increased valuations of the risky act. Loosely speaking, the presence of ambiguity seems to make known-probability risk look nicer. This can have implications for the elicited risk attitudes when measured jointly with ambiguity attitudes (see the section, Correlation between risk and ambiguity attitudes)." %}

Trautmann, Stefan T. & Gijs van de Kuilen (2015) "Ambiguity Attitudes." *In* Gideon Keren & George Wu (eds.), *The Wiley Blackwell Handbook of Judgment and Decision Making* (Ch. 3), 89–116, Blackwell, Oxford, UK.

{% **dynamic consistency**: Test whether subjects who beforehand subscribe to the a priori oriented process fairness, continue to accept it ex post. Most do. Do it also under ambiguity. This is a test of time consistency. %}

Trautmann, Stefan T. & Gijs van de Kuilen (2016) "Process Fairness, Outcome Fairness, and Dynamic Consistency: Experimental Evidence for Risk and Ambiguity," *Journal of Risk and Uncertainty* 53, 75–88.

{% %}

Trautmann, Stefan T. & Gijs van de Kuilen (2018) "Higher Order Risk Attitudes: A Review of Experimental Evidence," *European Economic Review* 103, 108–124.

{% %}

Trautmann, Stefan T. & Ferdinand M. Vieider (2012) "Social Influences on Risk Attitudes: Applications in Economics." *In* Sabine Roeser, Rafaela Hillerbrand, Per Sand, & Martin Peterson (eds.) *Handbook of Risk Theory: Epistemology, Decision Theory, Ethics, and Social Implications of Risk*, Ch. 22 (pp. 575–600). Springer, Amsterdam.

{% **suspicion under ambiguity**: This paper offers an original manner to control for suspicion (idea of Vieider): The prizes are videos where only the subjects themselves know which one they like better. So, the expermenter has no possibility and no interest in manipulating. %}

Trautmann, Stefan T., Ferdinand M. Vieider, & Peter P. Wakker (2008) "Causes of Ambiguity Aversion: Known versus Unknown Preferences," *Journal of Risk and Uncertainty* 36, 225–243.
https://doi.org/10.1007/s11166-008-9038-9
Direct link to paper

{% %}
Trautmann, Stefan T., Ferdinand M. Vieider, & Peter P. Wakker (2011) "Preference Reversals for Ambiguity Aversion," *Management Science* 57, 1320–1333.
https://doi.org/10.1287/mnsc.1110.1343
Direct link to paper

{% **dynamic consistency** %}
Trautmann, Stefan T. & Peter P. Wakker (2010) "Process Fairness and Dynamic Consistency," *Economics Letters* 109, 187–189.
https://doi.org/10.1016/j.econlet.2010.08.031
Direct link to paper

{% %}
Trautmann, Stefan & Peter P. Wakker (2018) "Making the Anscombe-Aumann Approach to Ambiguity Suitable for Descriptive Applications," *Journal of Risk and Uncertainty* 56, 83–116.
https://doi.org/10.1007/s11166-018-9273-7
Direct link to paper

{% Other things equal, I would prefer the unknown Ellsberg urn to the known urn, because with the known the certainty you have is the certainty that you will never know anything relevant, whereas for the unknown you may hope for some relevant info to come. In repeated choice it is clear that the unknown urn is preferable because one can learn. In experiments, subjects irrationally forgo this possibility under repeated choice and because of ambiguity aversion still choose the known urn. This paper shows this experimentally. %}
Trautmann, Stefan T. & Richard J. Zeckhauser (2013) "Shunning Uncertainty: The Neglect of Learning Opportunities," *Games and Economic Behavior* 44–55.

{% Considered health profiles for which there was no special reason to expect that joint independence would be violated. In the pairs of choices that tested independence, more than half were in agreement with independence. This is, of course, a very conservative test of independence. Discusses, at the end, other empirical studies, pointing out that sequencing effects can be due to (negative) discounting. %}

Treadwell, Jon R. (1998) "Test of Preferential Independence in the QALY Model," *Medical Decision Making* 18, 418–428.

{% Discuss implications of PT for CEAs (cost-effectiveness analyses), in particular whether quality of life assessment of general public should be used. %}

Treadwell, Jon R., & Leslie A. Lenert (1999) "Health Values and Prospect Theory," *Medical Decision Making* 19, 344–352.

{% %}

Treisman, Anne, Daniel Kahneman, & Jacquelyn Burkell (1983) "Perceptual Objects and the Cost of Filtering," *Perception and Psychophysics* 33, 527–532.

{% (**cognitive ability related to likelihood insensitivity (= inverse S)?**) %}

Trepel, Christopher, Craig R. Fox, & Russell A. Poldrack (2005) "Prospect Theory on the Brain? Toward a Cognitive Neuroscience of Decision under Risk," *Cognitive Brain Research* 23, 34–50.

https://doi.org/10.1016/j.cogbrainres.2005.01.016

{% **Dutch book** %}

Trockel, Walter (1992) "An Alternative Proof for the Linear Utility Representation Theorem," *Economic Theory* 2, 298–302.

{% %}

Trope, Yaacov & Nira Liberman (2010) "Construal-Level Theory of Psychological Distance," *Psychological Review* 117, 440–463.

{% Seems to be review of empirical evidence supporting construal level theory. %}

Trope, Yaakov, Nara Liberman, & Cheryl Wakslak (2007) "Construal Levels and Psychological Distance: Effects on Representation, Prediction, Evaluation, and Behavior," *Journal of Consumer Psychology* 17, 83–95.

{% A strategy f is dominant if, conditional on every event, it gives a best outcome. That is, for each state of nature s and each strategy g, $f(s) \succcurlyeq g(s)$. f is *obviously dominant* if for each pair of states s,t, and each strategy g, $f(s) \succcurlyeq g(t)$ (Li 2017, American Economic Review). So, the inf. under f should be preferred to the sup under g. Assume that E is to be assessed, and $A_1 \succ \cdots \succ A_n$ are used for calibration. That is, we want to find the k such that $A_k \succcurlyeq E \succ A_{k+1}$. In the ascending mechanism, first randomly a stopping time $1 \leq s \leq n$ is chosen, unknown to the subject. If in a round j, the subject can choose to stop (then getting A_j and the process finishes) or continue. If continue, then, if it turns out to be the stopping time s, the process stops and the subject receives E. Otherwise, the subject proceeds to the next round (j+1). A dominant strategy is to continue until k, and then stop. Thus, this process reveals the subject's value. It is not obviously dominant because the subject may follow some silly strategy but just be lucky that the process stops very soon. There is also a descending mechanism that seems to be obviously dominant, but I did not understand it.

The author describes his result for the special case where the choice objects are events to gamble on for a fixed prize, so that this can serve for eliciting beliefs. The author names the mechanisms after Karni (2009 Econometrica). %}
Tsakas, Elias (2019) "Obvious Belief Elicitation," *Games and Economic Behavior* 118, 374–381.

{% **proper scoring rules**: if the belief of a subject is elicited, this can give an incentive to the subject to acquire extra info. This paper assumes that getting such info costs something. One way to avoid it happening, is making the stakes of the elicitation sufficiently small. %}
Tsakas, Elias (2020) "Robust Scoring Rules," *Theoretical Economics* 15, 955–987. https://doi.org/10.3982/TE3557

{% A new way to identify probabilities under statedependt utility, a topic on which Karni worked much. Let E_2 be the complementary event to event E_1, and let SEU hold for them with state-dependent utility. Assume we have another event S_2 that is the complement to event S_1, which I all signals (the author calls them proxies). Assume, as an example, that $P(S_1) = P(S_2) = 0.5$, and these signal events do not affect utility. Then we can, in standard ways, elicit $P(S_i|E_j)$ for all i,j. For example, assume $P(S_1|E_1) = 0.4$, $P(S_2|E_1) = 0.6$, $P(S_1|E_2) = 0.2$, $P(S_2|E_2) = 0.8$. Then, because $\big(P(S_2|E_1) - P(S_1|E_1)\big) : \big(P(S_1|E_2) - P(S_2|E_2)\big) = 1 : 3$, $P(E_1) : P(E_2) = 3 : 1$. So, $P(E_1) = 3/4$. Thus, we can always elicit $P(E_1)$ and $P(E_2)$ unless the degenerate case of $P(S_i|E_j) = 0.5$ for all i,j. That is, unless the case where the signals are stochastically independent of the underlying events. %}

Tsakas, Elias (2023) "Belief Identification by Proxy," working paper.

{% Applications of rank dependence to finance. Proposes a new distortion risk measure. %}

Tsanakas, Andreas (2008) "Risk Measurement in the Presence of Background Risk," *Insurance: Mathematics and Economics* 42, 520–528.

{% %}

Tserenjigmid, Gerelt (2019) "Choosing with the Worst in Mind: A Reference-Dependent Model," *Journal of Economic Behavior and Organization* 157, 631–652.
https://doi.org/10.1016/j.jebo.2018.11.001

{% %}

Tsetlin, Ilia & Robert L. Winkler (2005) "Risky Choices and Correlated Background Risk," *Management Science* 51, 1336–1345.

{% **utility families parametric**: Study particular combinations of lotteries over multiattribute utility, and preferences for bad being combined with good (Richard's 1975 multivariate risk aversion). It leads to multiattribute utility functions that are mixtures of exponential functions (mixex), relating it to alternating signs of derivatives. %}

Tsetlin, Ilia & Robert L. Winkler (2009) "Multiattribute Utility Satisfying a Preference for Combining Good with Bad," *Management Science* 55, 1942–1952. https://doi.org/10.1287/mnsc.1090.1082

{% %}

Tsetlin, Ilia & Robert F. Winkler (2012) "Multiattribute One-Switch Utility," *Management Science* 58, 602–605.

{% About the history of decision theory, relating it to related fields such as fuzzy set theory, operations research (and its crisis in the 1970s), and other fields, with 324 references. %}

Tsoukiàs, Alexis (2008) "From Decision Theory to Decision Aiding Methodology," *European Journal of Operational Research* 187, 138–161.

{% **intertemporal separability criticized**: Confirm it, and good reference for it. Surveys 38 empirical and theoretical studies of the conditions of QALY such as independence of quality of life from time duration and preceding health states, etc. %}

Tsuchiya, Aki & Paul Dolan (2005) "The QALY Model and Individual Preferences for Health States and Health Profiles over Time: A Systematic Review of the Literature," *Medical Decision Making* 25, 460–467.

{% Considers probability transformations for the RDU model (couched in terms of risk measures). What the author calls one-parameter family is

$$w(p) = \psi\big(\psi^{-1}(p) + \ln(\theta)\big)$$

where ψ can be any strictly increasing and continuous transformation, considered to be "one parameter," and $\theta \in \mathbb{R}$ is another parameter. %}

Tsukahara, Hideatsu (2009) "One-Parameter Families of Distortion Risk Measures," *Mathematical Finance* 19, 691–705.

{% **probability communication**: Seems to write that statisticians recommend never reporting data using pie charts (as area of probability wheel). Seems that people can't judge angles well. %}

Tufte, Edward (2001) “*The Visual Display of Quantitative Information*.” Graphics Press.

{% Seems to be an early mentioner of utility. According to Rothbard (1990), he seems to have said, in the context of **time preference** for money: “The focus should not be on the amount of metal repaid but on the usefulness of the money to the lender and borrower” %}

Turgot, Robert Jacques (1977) “*The Economics of R.J. Turgot.*” Edited by Peter D. Groenewegen, Martinus Nijhof, The Hague.

{% %}

Turner, Brandon M., Dan R. Schley, Carly Muller, & Konstantinos Tsetsos (2018) “Competing Theories of Multialternative, Multiattribute Preferential Choice,” *Psychological Review* 125, 329–362. https://doi.org/doi:10.1037/rev0000089

{% To justify a nontrivial statement, one needs another one. To justify that other one, … and so on. This is the regress argument for infinitism, taken by some to prove that one needs infinitely many statements. It is like the childrens’ game of asking, after each answer, again, “Why?”, to quickly generate despair at the other end. Oh well … %}

Turri, John (2009) “On the Regress Argument for Infinitism,” *Synthese* 166, 157–163.

{% **value of information** %}

Tuteja, R.K. & U.S. Bhaker (1994) “On Characterization of Some Nonadditive Measures of “Useful” Information,” *Information Sciences* 78, 119–128.

{% People are not good at generating random sequences. %}

Tune, George S. (1964) “Response Preferences: A Review of Some Relevant Literature,” *Psychological Bulletin* 4, 286–302.

{% The game of my youth!!! %}

Tversky, Amos (1964) “On the Optimal Number of Alternatives at a Choice Point,” *Journal of Mathematical Psychology* 1, 386–391.

{% %}

Tversky, Amos (1964) "Finite Additive Structures," Michigan Mathematical Psychology Program, MMPP 64-6, University of Michigan.

{% **SEU = SEU**

real incentives: the **random incentive system**

P. 177 ℓ. 9–10 suggests that measuring utility when nonlinear probability may be difficult. **tradeoff method** of Wakker & Deneffe (1996) show it's not so difficult! Tversky writes: "To bypass the serious difficulty involved in simultaneous measurement of utility and subjective probability for each participant, researchers have derived and tested some empirical consequences of the SEU model."

… **risky utility u = transform of strength of preference v**: Utility for money is measured in a riskless context and found to be linear, as follows. For pairs (c_i,c_a) of cigarettes and candies, $W(c_i,c_a)$ is buy- or selling price for (c_i,c_a), $W(c_i,c_a) = f(c_i) + g(c_a)$ works well in data, so, it is concluded that $W(c_i,c_a)$ can be interpreted as riskless utility for money and further that therefore riskless utility of money is linear. Then also risky utility for money is measured, unfortunately in a somewhat confused manner. It is not always clear if the model is SEU à la Savage or SEU à la Edwards (separable prospect theory) (and **utility of gambling** is involved), and whether or not probability weighting at 1 is defined and is or is not 1. All these cases are discussed. It also seems that the !logarithm of! von Neumann Morgenstern utility is taken as risky utility. It is concluded from data that risky utility is different from riskless.

I like the general conclusion:

"The usefulness of utility theory for the psychology of choice, however, depends not only on the accuracy of its predictions but also on its potential value as a general framework for the study of individual choice behavior." %}

Tversky, Amos (1967) "Additivity, Utility, and Subjective Probability," *Journal of Mathematical Psychology* 4, 175–201.

{% %}

Tversky, Amos (1967) "A General Theory of Polynomial Conjoint Measurement," *Journal of Mathematical Psychology* 4, 1–20.

{% N = 11. Real incentives: the **random incentive system**.

P. 35 points out that the overestimation of small probabilities can explain both gambling and insurance.

decreasing ARA/increasing RRA: Uses power utility for gains and losses separately. It fits well. Utility is linear for gains and concave for losses.

inverse S: Probability transformation is inverse S, though not very pronounced. It should be kept in mind though that, because this paper considers one-nonzero-outcome prospects, the powers of utility and probability weighting are in fact unidentifiable. %}

Tversky, Amos (1967) "Utility Theory and Additivity Analysis of Risky Choices," *Journal of Experimental Psychology* 75, 27–36.

{% P. 41 Eq. 6, the additive difference model, can be taken as a state-dependent generalization of regret theory. It cites a preceding paper.

p. 42 points out that choice between two multiattribute objects can be done both by "horizontal" and by "vertical" (first making intradimensional) comparisons. Scholten et al. (2024 Psychological Review) use the term alternative-based for horizontal and attribute-based for vertical.

P. 45 writes that transitivity is one of the most basic and most compelling principles of rationality and bases it on the money pump argument. Justifies intransitivities on the basis of computation costs. %}

Tversky, Amos (1969) "Intransitivity of Preferences," *Psychological Review* 76, 31–48.
https://doi.org/10.1037/h0026750

{% Says, according to Birnbaum, that people tend to cancel common aspects in decision situations. %}

Tversky, Amos (1972) "Elimination by Aspects: A Theory of Choice," *Psychological Review* 79, 281–299.

{% T 74.1

coherentism: & **paternalism/Humean-view-of-preference;**

Presents some biases and heuristics. P. 158, last two paragraphs, discusses

whether internal consistency is the only requirement for rationality. It first mentions that many believe so. Amos then reacts: "I do not believe that the coherence, or the internal consistency, of a given set of probability judgments is the only criterion for their adequacy." Later: "In particular, he will attempt to make his probability judgments compatible with his knowledge about (i) the subject matter; (ii) the laws of probability; (iii) his own judgmental heuristics and biases. [PW of around 1990: I must say that I see no role for (iii), at most biases are something to !avoid! and correct for. PW of 2016: After digesting behavioral literature for a quarter century, including collaboration with Amos, I conjecture that here he already had in mind the behavioral approach to use biases to correct for them.] A deeper theoretical analysis of subjective probability will hopefully lead to the development of practical procedures whereby judged probabilities are modified or corrected to achieve a higher degree of compatibility with all these types of knowledge."

PE doesn't do well: seems to already argue for that. %}

Tversky, Amos (1974) "Assessing Uncertainty," *Journal of the Royal Statistical Society, Ser. B*, 36, 148–159.

{% T 75.,

Nicely explains that in Allais paradox the central issue can be how to define outcomes; what Broome (1991) calls "individuation"

P. 163: "The axioms of utility theory (e.g., transitivity, substitutability) are accepted by most students of the field as adequate principles of rational behavior under uncertainty."

P. 164 has a marvelous text on U in EU versus risk aversion: "In utility theory [EU], risk aversion is explained by the concavity of the utility function for money. Once the monetary scale is properly transformed — no risk aversion remains. (In this respect it is somewhat misleading to refer to the measurement of the utility for money as 'the measurement or attitudes towards risk'. One's utility function reflects one's attitude towards money, not towards risk. Risk aversion is an epiphenomenon in utility theory.)"

P. 172: "When Savage argues (*convincingly, I believe*) against Allais, he is arguing in effect for the monetary interpretation of the consequences as much as he argues for the independence axiom. Savage advises us, in effect, to disregard the element of regret and behave as if the effective consequences are limited to monetary payoffs. In so doing, he is telling us how to feel and not how to choose. *Personally, I find the argument compelling*, but it is completely independent of utility theory [EU]." [Italics added] I 100% agree with Tversky. Tversky here unambiguously writes that EU is normative. %}

Tversky, Amos (1975) "A Critique of Expected Utility Theory: Descriptive and Normative Considerations," *Erkenntnis* 9, 163–173.

http://www.jstor.org/stable/20010465

{% T 77.1;

measure of similarity;

tradeoff method: the relation ≃ defined in the appendix, p. 351, is similar to my derived tradeoff relation ~* (denoted $\sim^t$ in my 2010 book) and the invariance axiom 5 there is similar to tradeoff consistency. %}

Tversky, Amos (1977) "Features of Similarity," *Psychological Review* 84, 327–352.

{% %}

Tversky, Amos (1977) "On the Elicitation of Preferences: Descriptive and Prescriptive Considerations." *In* David E. Bell, Ralph L. Keeney, & Howard Raiffa (eds.) *Conflicting Objectives in Decisions*, Wiley, New York.

{% %}

Tversky, Amos (1996) "Contrasting Rational and Psychological Principles in Choice." *In* Richard J. Zeckhauser, Ralph L. Keeney, & James K. Sebenius (eds.) *Wise Choices, Decisions, Games, and Negotiations*, Harvard Business School Press, Boston.

{% T 1996.1

P. 186: "if gambles are represented as random variables, then any two realizations of the same random variables must be mapped into the same object."

P. 188 bottom has a version of pseudocertainty effect that avoids any dynamic aspect. Very nice! Page restates that this sheds new light on the normative status of the Allais paradox. P. 189, end of §4, points out that this is additional defense for the irrationality of the Allais paradox: "It is noteworthy that generalized utility models can account for the violation of substitution in the comparison of problems 5 and 6, but not for the violations of desciption invariance in problems 6 and 7."

In many places Amos does not discuss his views of normative, but how most people perceive of normativeness. That is, he takes it as an empirical issue, as he did in Slovic & Tversky (1974). %}

Tversky, Amos (1996) "Rational Theory and Constructive Choice." *In* Kenneth J. Arrow, Enrico Colombatto, Mark Perlman, & Christian Schmidt (eds.) *The*

Rational Foundations of Economic Behavior: Proceedings of the IEA Conference Held in Turin, Italy, 185–197, St. Martins Press, New York.

{% Criticizes Lopes' (1981) error that expected utility apply only to long-run decisions and not to single decisions. %}

Tversky, Amos & Maya Bar-Hillel (1983) "Risk: The Long and the Short," *Journal of Experimental Psychology: Learning, Memory, and Cognition* 9, 713–717.

{% **PT: data on probability weighting**; **natural sources of ambiguity**

inverse S: found for both risk and uncertainty

real incentives: **random incentive system** only for second out of three studies.

Basketball fans rather bet on basketball events, even while ambiguous, than on chance with known probabilities.

decreasing ARA/increasing RRA: use power utility;

inverse S; **ambiguity seeking for unlikely**: is found here (stated in sentence on pp. 281-282); they have gain outcomes only.

P. 271: "risk can be viewed as a special case of uncertainty where probability is defined through a standard chance device so that the probabilities of outcomes are known." Important: This shows that risk (I add: Ambiguity neutrality) refers to a neutral emotionless implementation of risk. The same statement is in Fox, Rogers, & Tversky (1996).

Pp. 271-272, on subcertainty: "$W(A) \le W(S) - W(S{-}A)$. This property, called subcertainty (Kahneman & Tversky, 1979) can also be interpreted as evidence that upper SA has more impact than lower SA; in other words, the certainty effect is more pronounced than the possibility effect."

P. 273 middle of 2nd column emphasizes that their certainty equivalents were derived from choice lists (and not from direct matching).

P. 274 last para points out that with only single nonzero outcomes, utility and probability weighting are not identifiable, and that one has to use prospects with two or more nonzero outcomes.

P. 276, 2nd column, ℓ. –3/–2, does a little discussion of measuring power in power utility and uses 1/3 probability gamble for \$100 gain because w(1/3) is approximately 1/3 on average.

P. 276: insensitivity is larger for unknown probabilities than for known probabilities, also for basketball events and basketball fans who have source preference for basketball over risk.

P. 279 considers the two-stage model that transformed introspective judgments of probability and finds it (taking those judgments transformed by the risk-probability-weighting-function) confirmed.

P. 279: "our main finding that decision weights are more subadditive for uncertainty than for chance." (**uncertainty amplifies risk**)

P. 280: **source preference directly tested.** They do it via certainty equivalents and transitivity.

Remarkable is the final text of the paper (p. 282): "To the extent that the experience of hope and fear is treated as a consequence of an action, subadditivity may have some normative basis. If lottery tickets are purchased primarily for entertaining a fantasy, and and protective action is undertaken largely to achieve peace of mind, then it is not unreasonable to value the first lottery ticket more than the second, and to value the elimination of a hazard more than a comparable reduction in its likelihood." It suggests that Amos can consider deviations of expected utility to be rational, contrary to all his other writings that I am aware of and contrary to my personal communication with him. I "discovered" this text, the first of that kind, only on 6 Sept. 2024. %}

Tversky, Amos & Craig R. Fox (1995) "Weighing Risk and Uncertainty," *Psychological Review* 102, 269–283. https://doi.org/10.1037/0033-295X.102.2.269

{% **measure of similarity** %}

Tversky, Amos & Itamar Gati (1982) "Similarity, Separability and the Triangle Inequality," *Psychological Review* 89, 123–154.

{% %}

Tversky, Amos & Thomas Gilovich (1989) "The Cold Facts about the "Hot Hand" in Basketball," *Chance* 2, 16–21.

{% %}

Tversky, Amos & Thomas Gilovich (1989) "The "Hot Hand": Statistical Reality or Cognitive Illusion?," *Chance* 2, 31–34.

{% Last section is nice, on choice versus well-being; p. 113: judgment ≠ choice; **paternalism/Humean-view-of-preference**: p. 116: The choice-judgment discrepancy raises an intriguing question: which is the correct or more appropriate measure of well-being? .... we lack a gold standard for the measurement of happiness.

References that people dislike it if all salaries increase, but in unequal ways; whether rich people are more happy than poor people.

p. 117 (last page): "It seems that judgments of well-being are insufficiently sensitive to endowment, whereas choice is insufficiently sensitive to contrast."

Final sentence: "A few glorious moments could sustain a lifetime of happy memories for those who can cherish the past without discounting the present." %}

Tversky, Amos & Dale Griffin (1991) "Endowment and Contrast in Judgments of Well-Being." *In* Fritz Strack, Michael Argyle, & Norbert Schwarz (eds.) *Subjective Well-Being*, Ch. 6, 101–118, Pergamon Press, Elmsford, NY.

{% Emphasize that scientists should pay more attention to power of tests. %}

Tversky, Amos & Daniel Kahneman (1971) "Belief in the Law of Small Numbers," *Psychological Bulletin* 76, 105–110.
Reprinted as Ch. 2 in Daniel Kahneman, Paul Slovic, & Amos Tversky (1982, eds.) *Judgment under Uncertainty: Heuristics and Biases*, Cambridge University Press, Cambridge.

{% %}

Tversky, Amos & Daniel Kahneman (1973) "Availability: A Heuristic for Judging Frequency and Probability," *Cognitive Psychology* 4, 207–232.
Abbreviated as Ch. 11 in Daniel Kahneman, Paul Slovic, & Amos Tversky (1982, eds.) *Judgment under Uncertainty: Heuristics and Biases*, Cambridge University Press, Cambridge.

{% Anchoring and adjustment heuristic. Discussion, p. 1130: "For judged probabilities to be considered adequate, internal consistency is not enough." (**paternalism/Humean-view-of-preference**) %}

Tversky, Amos & Daniel Kahneman (1974) "Judgment under Uncertainty: Heuristics and Biases," *Science* 185, 1124–1131.
Reprinted as Ch. 1 in Daniel Kahneman, Paul Slovic, & Amos Tversky (1982, eds.) *Judgment under Uncertainty: Heuristics and Biases*, Cambridge University Press, Cambridge.
https://doi.org/10.1126/science.185.4157.1124

{% %}
Tversky, Amos, & Daniel Kahneman (1977) "Causal Thinking in Judgment under Uncertainty." *In* Robert E. Butts & K. Jaako J. Hintikka (eds.) *Basic Problems in Methodology and Linguistics*, 167–190, Reidel, Dordrecht.

{% %}
Tversky, Amos, & Daniel Kahneman (1980) "Causal Schemata in Judgments under Uncertainty." *In* Martin Fishbein (ed.) *Progress in Social Psychology*, 49–72, Hillsdale, NJ: Erlbaum.
Reprinted as Ch. 8 in Daniel Kahneman, Paul Slovic, & Amos Tversky (1982, eds.) *Judgment under Uncertainty: Heuristics and Biases*, Cambridge University Press, Cambridge.

{% I only came to read this paper for the first time in January 2001 (having thought before that it would just be a didactical restatement of their earlier work). What a marvelous paper! It is extremely well written, with every line reflecting deep thought. It is the most impressive paper I ever read. (The first half of the book Savage (1954) is the only work yet more impressive.) I regret that I was not aware of it when Tversky was alive and I would meet him and talk with him.

real incentives/hypothetical choice: all monetary experiments are done both with and without real incentives, these never giving different results.

paternalism/Humean-view-of-preference: The paper presents the various framing effects as deviations from rationality to be avoided if possible. Abstract ("Summary"):

"is a significant concern for the theory of rationality."

P. 453 opening para: "The definition of rationality has been much debated, but there is general agreement that rational choices should satisfy some elementary requirements of consistency and coherence. In this article we describe decision problems in which people systematically violate the requirements of consistency and coherence" This says that this paper considers many observed choices to be violations of rationality. It does not specify here whether rationality means EU.

P. 453 2nd column $\ell\ell$. 3-4: "Because of imperfections of human perception and decision,"

P. 453 last sentence: "When faced with a choice, a rational decision-maker will prefer the prospect that offers the highest expected utility." (This says 100% clearly that EU is rational.) Also p. 456, 1st para: "The certainty effect reveals attitudes toward risk that are inconsistent with the axioms of rational choice"

P. 454, on probability weighting: "but the function is not well behaved near the endpoints."

P. 456 first para: "The certainty effect reveals attitudes toward risk that are *inconsistent with* the axioms of *rational choice*" [italics added]

They clearly state that the certainty effect, one of the pillars of prospect theory, is irrational.

p. 456, first para of 2nd column: After having identified an inconsistency of choice they say that one choice must be wrong but that it is hard to determine which. P. 457, 3rd column, 2nd para: "Such a discovery will normally lead the decision-maker to reconsider the original preferences, even when there is no simple way to resolve the inconsistency." P. 458, 1st column., end of 3rd para, however writes, on consistency: "This approach enjoins the decision-maker to resolve inconsistencies but offers no guidance on how to do so. It implicitly assumes that the decision-maker who carefully answers the question "What do I really want?" will eventually achieve coherent preferences. However, the susceptibility of preferences to variations of framing raises doubt about the feasibility and adequacy of the coherence criterion."

P. 453 introduces the famous Asian disease problem. (now in 2024 I find this term politically incorrect) I never liked it much. The message "200 people will be saved" does not make clear what will happen to the other 400 people, whether they will die or not.

P. 453 3rd column penultimate para: "a framing effect with contradictory attitudes towards risks involving gains and losses." This is a common theme throughout the paper. The gain- and loss framing give different results. So, which is wrong, the gain or the loss framing? Answer: neither. The real problem is that preferences deviate from EV too much. (Under EV, a gain- or loss frame would give the same result.) Note that the authors call the attitudes for gains and losses not "different," but "contradictory." This word conveys the message, reflecting the deep writing of the authors. P. 454 2nd column last para states that for linear utility and probability weighting, framing would not matter. P. 457 top of 3rd para states that it is always framing together with nonlinearity.

P. 454: The major qualitative properties of decision weights can be extended to cases in which the probabilities of outcomes are subjectively assessed rather than explicitly given. In these situations, however, decision weights may also be affected by other characteristics of an event, such as ambiguity or vagueness (9)." Here endnote 9 refers to Ellsberg (1961) and Fellner (1961). This sentence describes part of the source method, although it probably is the two-stage model where the probabilities to be transformed are subjective nonadditive, whereas in the source method they are additive.

risk averse for gains, risk seeking for losses: p. 453 3rd columns describes the fourfold pattern.

P. 454 1st column 3rd para: "The displeasure associated with losing a sum of money is generally greater than the pleasure associated with winning the same amount". The authors here ascribe loss aversion to experienced utility and do not mention weighting. P. 456 last para of middle column also ascribes it to the value function.

P. 454 1st column 2nd para and endnote (5): note that the authors point out that for pure-gain or pure-loss prospects a different formula *should* be applied, so that they really do not take the separate-weighting formula of separable prospect theory.

P. 454, 2nd column, $\ell\ell$. 4-5 (on probability weighting function): "but the function is not well behaved near the endpoints."

P. 454 2nd column end of 1st para: "The major qualitative properties of decision weights can be extended to cases in which the probabilities of outcomes are subjectively assessed rather than explicitly given. In these situations, however, decision weights may also be affected by other characteristics of an event, such as ambiguity or vagueness." This describes the source method if subjective probabilities are assumed additive-which is not clear here.

P. 454 2nd column middle para: "The simultaneous measurement of values and decision weights involves serious experimental and statistical difficulties." Well, the **tradeoff method** gives utilities fairly easily!

reference dependence test: p. 454, 3rd column (Problem 3): The "Framing of acts" example is particularly interesting. For one thing, it demonstrates isolation beyond any doubt. I consider it to be the most impressive paradox of all of decision theory. Note that they replicated the phenomenon with real incentives (p. 458 Footnote 11): **real incentives/hypothetical choice & losses from prior endowment mechanism.**

. **real incentives/hypothetical choice**: **random incentive system between-subjects** (paying only some subjects): paid one of every 10 subjects in incentivized version of Problems 3 and 4, finding similar results as with hypothetical choices, given on p. 458 footnote 11.

Problems 5-6 test forgone-event independence (consequentialism) and find it well satisfied (22% and 26% choices for the risky option, respectively). The other dynamic decision principles together are strongly violated (58% R choice in Problem 7). P. 455 2nd column first para gives in fact the condition that Hammond (1988) called consequentialism; i.e., same assignments of outcomes to states of the world should be judged equivalently, no matter what the particular dynamic structure is that generates the assignment.

real incentives/hypothetical choice: **random incentive system between-subjects P.** 458 footnote 15 (paying only some subjects): paid one of every 10 subjects for Problems 5-7. They found similar results, and conclude that the elimination of real payment reduces risk aversion but does not change the pattern.

There is also a discussion of probabilistic insurance.

RCLA: p. 456 1st para of 1st column treats RCLA as a framing phenomenon.

P. 456 3rd column 2nd para ff. discusses lability of reference outcomes. This text continuing on the next page, probably Kahneman wrote this. The sentence "Rather, the transaction as a whole is evaluated as positive, negative, or neutral, depending on .." (p. 456 penultimate para) suggests that reference points are not chosen attribute-wise but overall, referring to the indifference class of the prospect.

P. 457 2nd para: People can take minimal accounts (1st para on that page) but also more comprehensive accounts (2nd para on that page). This is like narrow or broad bracketing.

P. 457 Problem 10: **ratio bias** plays a role here.

P. 458 1st column 2nd para recognizes that the inconsistencies can be considered rational in view of bounded rationality. It then suggests that prospect theory and framing give better models than "ad hoc" appeals to the notion of cost of thinking. (**calculation costs incorporated**)

coherentism: p. 458, 1st column, third para, describes the strict representational view of preference well: "In order to avoid the difficult problem of justifying values, the modern theory of rational choice has adopted the coherence of specific preferences as the sole criterion of rationality." I enjoyed how first T&K present, in a factual manner, the, I think overly restrictive, coherence-interpretation of rationality. Then, without being negative, typical of the marvelous Kahneman style ("In order to avoid the difficult problem of justifying values") they push it aside for better interpretations. In a few sentences four or five philosophical issues, taking others pages to formulate, are taken care of.

P. 458, 1st column, last para, describes the "predictive criterion of rationality".

utility = representational: somewhat before, referring to March (1978): "the common conception of rationality also requires that preferences or utilities for particular outcomes should be predictive of the experiences of satisfaction or displeasure associated with their occurrence."

P. 458, 2nd column, 1st para: "A predictive orientation encourages the decision-maker to focus on future experience and to ask "What will I feel then?" rather than "What do I want now?" [This is opposite to p. 1256 of Weinstein et al.1996 JAMA, claiming that community prefs, not patient prefs., should be used.] The former question, when answered with care, can be the more useful guide in difficult decisions."

They mention the hedonic experience of outcomes.

Then they go on to argue that experiences really following from a frame can be part of a normative analysis. For example, this can be applied to regret. I only partly agree, and am more paternalistic. Perception of goodness is not the criterion, but real goodness of the outcomes is. Perception of goodness only serves as a signal for real goodness of the outcomes. So, framing dependence is normatively acceptable only if it affects the goodness of outcomes, not if it only affects perception of goodness.

ratio-difference principle: people are more willing to drive 20 minutes to save $5 on a cheap calculator than on an expensive one. %}

Tversky, Amos & Daniel Kahneman (1981) "The Framing of Decisions and the Psychology of Choice," *Science* 211, 453–458.
https://doi.org/10.1126/science.7455683

{% %}

Tversky, Amos, & Daniel Kahneman (1982) "Judgments of and by Representativeness." *In* Daniel Kahneman, Paul Slovic, & Amos Tversky (eds.) *Judgment under Uncertainty: Heuristics and Biases*, Ch. 6, Cambridge University Press, Cambridge.

{% **updating: testing Bayes' formula** %}

Tversky, Amos, & Daniel Kahneman (1982) "Evidential Impact of Base rates." *In* Daniel Kahneman, Paul Slovic, & Amos Tversky (eds.) *Judgment under Uncertainty: Heuristics and Biases*. Cambridge University Press, Cambridge.

{% %}

Tversky, Amos & Daniel Kahneman (1983) "Extensional versus Intuitive Reasoning: The Conjunction Fallacy in Probability Judgment," *Psychological Review* 90, 293–315.

{% Central theme of paper: normative and descriptive models must be different, because normative requirements simply are not descriptive.

P. S252 "A descriptive model of choice is presented, which accounts for preferences that are anomalous in the normative theory."

P. S253 (= 168 in Bell et al.), under the subheading transitivity: "Thus transitivity is satisfied if it is possible to assign to each option a value that does not depend on the other available options."

P. S260: "A basic principle of economic thinking is that opportunity costs and out-of-pocket costs should be treated alike."

P. S262 2nd para: I do not like this experiment. Fairness concerns relative, not absolute, level.

Interesting is Footnote 3 on p. S 263, especially if compared to the corresponding Endnote 3 in the Bell et al. Chapter (p. 189 there). They discuss the extension to multiple outcomes: "The extension of the present analysis to prospects with many (nonzero) outcomes involves two additional steps. First, we assume that continuous (or multivalued) distributions are approximated, in the framing phase, by discrete distributions with a relatively small number of outcomes. For example, a uniform distribution on the interval (0,90) may be represented by the discrete prospect (0, .1; 10, .1; …, 90, .1). Second, in the multiple-outcome case the weighting function, $\pi_p(p_i)$, must depend on the probability vector p, not only on the component p_i, $i = 1, \ldots, n$. *For example, Quiggin (1982) uses the function* $\pi_p(p_i) = \pi(p_i)/[\pi(p_1) + \cdots + \pi(p_n)]$. As in the two-outcome case, the weighting function is assumed to satisfy subcertainty, $\pi_p(p_1) + \cdots + \pi_p(p_n) \leq 1$, and subproportionality." [italics added] The text shows that Tversky had understood part of Quiggin's analysis, such as Quiggin's intermediate step that the weight of outcome-probability p_i depends on the ranked probability vector $(p_1,\ldots,p_n)$, but had not understood Quiggin's rank dependence. Tversky (personal communication) told me that he had seen Quiggin's paper even before it was published, but had not understood it well then, in part because it was not well-written. Remarkable is that in Bell et al. the italicized text above was corrected and changed into: "For eample, Karmarkar (1978) used the function $\pi_p(p_i) = \pi(p_i)/[\pi(p_1) + \cdots + \pi(p_n)]$. A more elaborate extension that ensures stochastic dominance was proposed by Quiggin (1982)." (See endnote 3 on p. 189 there.) Which is correct. But in the 1992 publication Tversky will still make the mistake of thinking that the normalized $\pi(p_i)/[\pi(p_1) + \cdots + \pi(p_n)]$ can satisfy stochastic dominance (1992 p. 299, ℓ. –6), whereas Quiggin had already shown that it does not and that only his rank dependence does.

In the preceding footnotes, the claim on subcertainty, $\pi_p(p_1) + \cdots + \pi_p(p_n) \leq 1$, is strange for large n, if small probabilities are overweighted.

coalescing: P. S263 (p. 178 in Bell et al.), problem 7, is their famous example where by a clever splitting of outcomes (**coalescing**) stochastic dominance is violated. The general procedure for generating violations of this kind is in Birnbaum (1997).

P. S268 argues that Allais' paradox is driven more by probability weighting (the certainty effect) than by regret.

P. S272: "But since the viola- tions of dominance predicted by the theory have actually been ob- served (see problems 2 and 8), Machina's objection appears invalid." I disagree. Kahneman and Tversky did empirically show particular violations of stochastic dominance, but not most of the anomalous ones predicted by their formulas.

P. 279 discusses that cancellation and satisfaction of the sure-thing principle are followed more if common outcomes are transparent than if not.

real incentives/hypothetical choice: p. S274 (P. 187 in Bell et al.) suggests that real incentives are not important.

P. S251 abstract (not in Bell et al. it seems, where they, apparently, dropped the abstract), on invariance and dominance: "Because these rules are normatively essential but descriptively invalid, no theory of choice can be both normatively adequate and descriptively accurate."

P. S252: "The main argument for cancellation [Savage's sure-thing principle and von Neumann-Morgenstern independence] is that *only one state will actually be realized*, which makes it reasonable to evaluate the outcomes of options separately for each state. The choice between options should therefore depend only on states in which they yield different outcomes." [italics added] (**independence/sure-thing principle due to mutually exclusive events**)

P. S259 makes clear that reference dependence concerns changing the reference point without changing final wealth.

P. S266 ℓ. -4/-1: "Allais' problem has attracted the attention of numerous theorists, who *attempted* to provide a *normative rationale* for the certainty effect by relaxing the cancellation rule (see, e.g., Allais 1979; Fishnurn 1982, 1983; Machina 1982; Quiggin 1982; Chew 1983)." [italics added] P.s.: Fishburn did not relax cancellation, but transitivity.

P. S267: "called the *pseudocertainty effect*, that cannot be accommodated by relaxing cancellation because it also involves a violation of invariance." [italics from original] What they call violation of invariance amounts to dynamic decision principles incuding RCLA.

P. S268 gives evidence that nonlinearity of decision weights and framing, rather than regret, play empirical roles in their tests of the Allais paradox.

P. 270: "Attempts to rationalize the preferences in Allais' example by discarding the cancellation axiom face a major difficulty: they do not distinguish transparent formulations in which cancellation is obeyed from nontransparent ones in which it is violated." I disagree with this text for two reasons. (1) obeying cancellation in transparent formulations is a descriptive fact, not necessarily normative. (2) it has been pointed out before that obeying in transparent situations can be due to a heuristic rather than true preference. (Although after much searching I haven't been able to find a concrete reference, but I have surely seen it.)

P. S272 (p. 185 in Bell et al.), about prospect theory: "Prospect theory differs from the other models n being unabashedly descriptive and in making no normative claims." The para somewehat later on could use more nuances. They write that stochastic dominance has sometimes been violated and that, therefore, Machina's criticism of prospect theory as a descriptive theory for violating stochastic dominance is not valid. More nuances are desirable. That violations of stochastic dominance have been found does not justify every way to give it up. It must be given up in a way as found. Both Machina's criticism and T&K's defense should look into it.

The paper nowhere states that violations of expected utility can be normative. To the contrary, on p. S267 ff. they put, under term pseudocertainty effect, the dynamic principles forward that imply independence/sure-thing principle, preceding Hammond (1988; T&K had it already in their Science 1981 paper), and argue that these principles have a normative status similar to invariance, which is beyond dispute. P. S268 has nice discussion of regret. P. S270 credits Savage (1954, p. 101-104) and Raiffa (1968, pp. 80-86) for inspiration.

P. S272: "… as shown in the discussion of pseudocertainty. It appears that both cancellation [= s.th.pr. = independence] and dominance have normative appeal, although neither one is descriptively valid."

They agree with experimental economists that nonEU will be reduced by learning and proper incentives:

"Indeed, incentives sometimes improve the quality of decisions, experienced decision makers often do better than novices, and the forces of arbitrage and competition can nullify some effects of error and illusion. Whether these factors ensure rational choices in any particular situation is an empirical issue, to be settled by observation, not by supposition (p. S273)."

P. S274: "Incentives do not operate by magic: they work by focusing attention and by prolonging deliberation. Consequently, they are more likely to prevent *errors that arise from insufficient attention and effort than errors that arise from misperception or faulty intuition*. The example of visual illusion is instructive. There is no obvious mechanism by which the mere introduction of incentives (without the added opportunity to make measurements) would reduce the illusion observed in figure 3, and the illusion vanishes-even in the absence of incentives-when the display is altered in figure 4. The corrective power of incentives depends on the nature of the particular error and cannot be taken for granted." [italics added]

P. S275: "The main theme of this article has been that the normative and the descriptive analyses of choice should be viewed as separate enterprises."

%}

Tversky, Amos & Daniel Kahneman (1986) "Rational Choice and the Framing of Decisions," *Journal of Business* 59, S251–S278.

https://doi.org/10.7208/9780226742410-005
Reprinted in David E. Bell, Howard Raiffa, & Amos Tversky (1988, eds.) *Decision Making: Descriptive, Normative and Prescriptive Interactions*, 167–192, Cambridge University Press, Cambridge.
Reprinted in Robin M. Hogarth & Melvin W. Reder (eds.) "*Rational Choice: The Contrast between Economics and Psychology,*" 67–94, University of Chicago Press.

{% Does loss aversion for multiattribute, with no risk. Every attribute has a reference point, and loss aversion can be different for different attributes. An especially nice feature is that the paper really considers reference dependence; i.e., how preferences change if reference points change.

Pp. 1046-1047: that prospect theory does not specify what the reference point is, so that in this respect the theory is left unspecified: "A treatment of referent-dependent choice raises two questions: what is the reference state, and how does it affect preferences? The present analysis focuses on the second question."

standard-sequence invariance?; proof on p. 1059 goes wrong but main theorem is still correct. %}

Tversky, Amos & Daniel Kahneman (1991) "Loss Aversion in Riskless Choice: A Reference Dependent Model," *Quarterly Journal of Economics* 106, 1039–1061. https://doi.org/10.2307/2937956

{% **biseparable utility**

event/outcome driven ambiguity model: event driven

The purported plots of $W_i(p)$ versus p (Fig. 3) are actually of CE(x,p;0). The correct plot is shown in Tversky & Fox (1995).

PT: data on probability weighting; **tradeoff method** used theoretically.

P. 299, ℓ. –6, writes, unfortunately, that the violation of stochastic dominance of PT can be handled by normalizing the decision weights so that they add to unity. This is incorrect. There is no easy way to make this work. People again and again come up with the idea to consider $(\text{SUM } w(p_j)v(x_j))/\text{SUM}w(p_j)$, but this formula does not give sensible results and continues to violate stochastic dominance (Wakker 2010 Exercise 6.7.1). For two-outcome prospects it reduces to RDU with a symmetric weighting function, which itself is OK.

Many people erroneously think that diminishing sensitivity only refers to the value/utility of outcomes, but it is a general principle of numerical perception that applies to the weighting function as well. P. 303 2nd para: "The principle of diminishing sensitivity applies to the weighting functions as well." (**cognitive ability related to likelihood insensitivity (= inverse S))**

P. 303, beginning of 2nd para, on diminishing sensitivity for the weighting function: "The principle of diminishing sensitivity applies to the weighting functions as well. In the evaluation of outcomes, the reference point serves as a boundary that distinguishes gains from losses. In the evaluation of uncertainty, there are two natural boundaries-- certainty and impossibility--that correspond to the endpoints of the certainty scale. Diminishing sensitivity entails that the impact of a given change in probability diminishes with its distance from the boundary. For example, an increase of .1 in the probability of winning a given prize has more impact when it changes the probability of winning from .9 to 1.0 or from 0 to .1, than when it changes the probability of winning from .3 to .4 or from .6 to .7. Diminishing sensitivity, therefore, gives rise to a weighting function that is concave near 0 and convex near 1. For uncertain prospects, this principle yields subadditivity for very unlikely events and superadditivity near certainty."

P. 303 end of 2nd para: "However, the function [probability weighting function] is not well-behaved near the endpoints, and very small probabilities can be either greatly overweighted or neglected altogether."

Although experimental economists today (2010) usually credit Holt & Laury (2002) for introducing the *choice list mechanism for measuring indifferences*, this mechanism has been used long before. This T&K paper also uses it. Here is how the authors describe it: p. 305, ℓ. −4 till p. 306, ℓ.8: "The display also included a descending series of seven sure outcomes (gains or losses) logarithmically spaced between the extreme outcomes of the prospect. The subject indicated a preference between each of the seven sure outcomes and the risky prospect. To obtain a more refined estimate of the certainty equivalent, a new set of seven sure outcomes was then shown, linearly spaced between a value 25% higher than the lowest amount accepted in the first set and a value 25% lower than the highest amount rejected. The certainty equivalent of a prospect was estimated by the midpoint between the lowest accepted value and the highest rejected value in the second set of choices. We wish to emphasize that although the analysis is based on certainty equivalents, the data consisted of a series of choices between a given prospect and several sure outcomes. Thus, the cash equivalent of a prospect was derived from observed choices rather than assessed by the subject. The computer monitored the internal consistency"

P. 306, ℓ. −16, §2.2: "The most distinctive implication of prospect theory is the fourfold pattern of risk attitudes."

P. 306 ℓ. −11, on 4-fold pattern: "provided the outcomes are not extreme."

P. 306 ℓ. −11/−9, on partial reflection: "prospect theory does not imply perfect reflection in the sense that the preference between any two positive prospects is reversed when gains are replaced by losses."

§2.3, p. 311 2nd para gives argument for parameter-free estimation: "The estimation of a complex choice model, such as cumulative prospect theory, is problematic. If the functions associated with the theory are not constrained, the number of estimated parameters for each subject is too large. [**nonadditive measures are too general**] To reduce this number, it is common to assume a parametric form (e.g., a power utility function), but this approach confounds the general test of the theory with that of the specific parametric form. For this reason, we focused here on the qualitative properties of the data rather than on parameter estimates and measures of fit."

A suggestion similar to the penultimate sentence is in Edwards (1954, p. 396, next-to-last para), which writes, on parametric fitting: "confounds the general test of the theory with that of the specific parametric form."

P. 313: Figure 3 is an error. It gives CE(x,p,0), i.e., the weighting functions if utility were linear.

P. 316, §3: that coexistence of gambling and insurance is explained by overweighting of small probabilities.

P. 317: "The presence of systematic preferences for some sources of uncertainty calls for different weighting functions for different domains, and suggests that some of these functions lie entirely above others. The investigation of decision weights for uncertain events emerges as a promising domain for future research." Tversky probably has his two-stage model in mind, where the weighting functions transform nonadditive subjective probabilities. The source method is different. The weighting functions there transform additive a-neutral probabilities.

P. 317: "Despite its greater generality, the cumulative functional is unlikely to be accurate in detail. We suspect that decision weights may be sensitive to the formulation of the prospects, as well as to the number, the spacing and the level of outcomes. In particular, there is some evidence to suggest that the curvature of the weighting function is more pronounced when the outcomes are widely spaced (Camerer 1992). The present theory can be generalized to accommodate such effects but it is questionable whether the gain in descriptive validity, achieved by giving up the separability of values and weights, would justify the loss of predictive power and the cost of increased complexity. … The heuristics of choice do not readily lend themselves to formal analysis because their application depends on the formulation of the problem, the method of elicitation, and the context of choice."

P. 317 last para of main text nicely explains that PT is a departure from rationality, and that this need not be chaotic. "Prospect theory departs from the tradition that assumes the rationality of economic agents; it is proposed as a descriptive, not a normative, theory."

P. 318: "We chose Wakker's (1989a, 1989b) [axiomatization] because of its generality and compactness." ☺

decreasing ARA/increasing RRA: do not reject constant RRA and, hence, assume power utility **utility families parametric**: power family; **concave utility for gains, convex utility for losses**;

real incentives/hypothetical choice: §2.4 argues that hypothetical choice gives same results as real choices **inverse S**; **standard-sequence invariance**

biseparable utility if restricted to gains or to losses.

The paper uses an unfortunate notation with negative subscripts for states of nature with negative outcomes. I visited Tversky when he received the proofs for proof corrections of the paper. I convinced him that this notation is unfortunate and better be changed. Next day Amos told me that he could not change anymore. Such a change at the stage of proof corrections is too risky. It was too late. Anyway, this notation is better not followed. %}

Tversky, Amos & Daniel Kahneman (1992) "Advances in Prospect Theory: Cumulative Representation of Uncertainty," *Journal of Risk and Uncertainty* 5, 297–323.
https://doi.org/10.1007/BF00122574

{% **coalescing**: explicit versus implicit unpacking is related.

P. 563: "If people have a hard time assessing a single definite value for the probability of an event, they are likely to have an even harder time assessing two definite values for its upper and lower probabilities or generating a second-order probability distribution." The same argument against multiple priors was put forward by Lindley (1996) and others.

Last sentence of paper: "The question of how to improve their quality through the design of effective elicitation methods and corrective procedures poses a major challenge to theorists and practitioners alike." (Here "their" refers to intuitive judgments of uncertainty) **paternalism/Humean-view-of-preference**: nice citation for that debate. %}

Tversky, Amos & Derek J. Koehler (1994) "Support Theory: A Nonextensional Representation of Subjective Probability," *Psychological Review* 101, 547–567. https://doi.org/10.1037/0033-295X.101.4.547

{% **measure of similarity** %}

Tversky, Amos & David H. Krantz (1969) "Similarity of Schematic Faces: A Test of Interdimensional Additivity," *Perception and Psychophysics* 5, 124–128.

{% **standard-sequence invariance**; references on preference reversal;

P. 372: they test prominence effect but the instructions, e.g., writing "technical knowledge is more important" of course just bring it in.

P. 373 1st column: Besides scale compatibility, also bargaining attitude plays a role. In the table, the entry of 26% surprises me.

Choice enhances noncompensatory heuristics: p. 375 last para nicely distinguishes ordinal (qualitative) and cardinal (quantitative) procedures, where choice enhances the former and matching the latter.

P. 376: I did not like the 2nd column top half.

P. 381: in the classical preference reversal, the main cause is the overpricing of the outcome gamble.

p. 382 writes: "Evidently, preference reversals are induced primarily by scale compatibility, not by the differential prominence of attributes that underlies the choice-matching discrepancy." Then the next sentence says, to my pleasure: "Indeed, there is no obvious reason to suppose that probability is more prominent than money or vice versa." This is contrary to Slovic (1985). Slovic, Griffin, & Tversky (1990), p. 22–23, however, write that they have changed their mind and believe that probability is indeed the prominent dimension.

P. 383 writes:

"But if different elicitation procedures produce different orderings of options, how can preferences and values be defined? And in what sense do they exist?" %}

Tversky, Amos, Shmuel Sattath, & Paul Slovic (1988) "Contingent Weighting in Judgment and Choice," *Psychological Review* 95, 371–384. https://doi.org/10.1037/0033-295X.95.3.371

{% About Samuelson's game, a fifty-fifty lottery for $200 or −$100 is done twice. Both if the first gives a win, and if it gives a loss, do people want to take the second. But if they don't yet know what the first will give they don't want the second.

The disjunction effect: Both if event E happens, and if it doesn't, you prefer f to g. But still a priori you prefer g to f. This is a particular violation of the sure-thing principle. Example: You did an exam. Don't know if you passed. Have to decide on taking vacation next week. If you get informed that you passed, you prefer to take the vacation, to celebrate. If you get informed that you failed, you prefer to take the vacation, for consolation. But you have to decide now, before getting informed. Important: You will be informed before vacation. Still, now you prefer not to take vacation. Subjects systematically violate the s.th.pr. this way if they are not aware of the structure of this. If, however, the structure is transparent, then they do not violate the s.th.pr.

P. 309 1st column middle writes: "This result shows that, like other axioms of choice such as substitution and stochastic dominance, STP tends to hold when its application is transparent, even though it is sometimes violated when its application is not obvious" This does not explicitly say whether satisfaction in the transparent case reflects true preference or heuristic. %}

Tversky, Amos & Eldar Shafir (1992) "The Disjunction Effect in Choice under Uncertainty," *Psychological Science* 3, 305–309.

{% Imagine that subjects choose between A and B, multidimensional objects. Some percentage chooses A. We now add an object C that is clearly inferior to A, and has no clear relation to B. Then people choose A more often than before. (The decoy effect or asymmetric dominance effect or attraction effect) This effect cannot be reconciled with rational economic revealed-preference principles under the usual ceteris paribus assumptions (such as no change in info about the intrinsic value of A).

The authors cite Huber, Payne, & Puto (1982) for having discovered this. %}

Tversky, Amos & Itamar Simonson (1993) "Context-Dependent Preferences," *Management Science* 39, 1179–1189.

{% %}

Tversky, Amos, Paul Slovic, & Daniel Kahneman (1990) "The Causes of Preference Reversal," *American Economic Review* 80, 204–217.

{% A.o., review of preference reversals. %}

Tversky, Amos & Richard H. Thaler (1990) "Anomalies: Preference Reversals," *Journal of Economic Perspectives* 4 no. 2, 201–211. https://doi.org/10.1257/jep.4.2.201

{% **inverse S**; **relative curvature**;

P. 1263 ℓ. –7/–6: "If expected utility is accepted as a standard for rational choice, then s could be interpreted as an index of rationality."

P. 1266: "from expected utility theory. If this theory is taken as the standard of rational behavior, then the more-SA-than relation can be interpreted as an ordering by departure from rationality." %}

Tversky, Amos & Peter P. Wakker (1995) "Risk Attitudes and Decision Weights," *Econometrica* 63, 1255–1280.
https://doi.org/10.2307/2171769
Direct link to paper
A correction

{% %}

Tversky, Barbara (2000), letter of September 27.

{% P. 944 seems to assign the following quote to Mark Twain: "Lack of money is the root of all evil," as a variation of the quote from the bible's new testament: "Love of money is the root of all evil." Other people asigned the quote to George Bernard Shaw. %}

Twain, Mark "Collected Tales, Sketches, Speeches, & Essays, 1891–1910," Louis J. Budd (ed. 1992) *Des Moines, IA*: Library of America.

{% **conservation of influence**: tv series; photographer has to choose between lover an career, and chooses for career. She … well, let me avoid spoilers. %}

Twilight zone, Season 1, Episode 9, Little boy lost 18 Oct. 1985;

{% 33 adolecents are compared to 32 adults. Risk and ambiguity attitudes are measured by choices between (E:$X, E^c:x) and $5, with X > 5 > x. Used random incentive system. Ambiguity is by giving a probability interval. The exact details in the 3rd para of the 2nd column of p. 17136 were incomprehensible to me ("half of the trials"; do subjects know this?) and as far as I can tell, there could be suspicion (**suspicion under ambiguity**).

Adolescents are not more risk seeking, but more ambiguity seeking. The end of the abstract does what many papers in our domain do: speculate on policy implications. The second half of the abstract also goes into evolutionary speculations.

It is remarkable that this very thin and routine study could appear in PNAS. %}

Tymula, Agnieszka, Lior A. Rosenberg Belmaker, Amy K. Roy, Lital Ruderman, Kirk Manson, Paul W. Glimcher, & Ifat Levy (2012) "Adolescents' Risk-Taking Behavior is Driven by Tolerance to Ambiguity," *Proceedings of the National Academy of Sciences* 109, 17135–17140. https://doi.org/10.1073/pnas.1207144109

{% They measured risk and ambiguity attitudes for gains and losses from N = 135 healthy subjects, selected using flyers at universities, clinics, and senior communities. Note that also for the elderly only healthy subjects are sampled. They implemented RIS. Their main purpose is to investigate how these things depend on age. (**relation age-risk attitude**) They do a good and clean job (although ambiguity attitude is not modeled very well, being unaware of empirically found likelihood insensitivity; see below), but it is also purely routine.

Subjects chose between a sure $5 and either a risky or ambiguous prospect with one nonzero outcome. The risky/ambiguous payments ranged between $125 and –$125. Each subject was endowed with $125 at the beginning! (**Losses from prior endowment mechanism**). Probability levels ranged from 0.13 to 0.75. So, unfortunately for me, the paper gives no very direct insights into insensitivity and small probabilities. Ambiguity was generated by indicating an interval of probabilities (Figure 1).

suspicion under ambiguity: there was one fixed ambiguous urn (I guess: for each ambiguity level), and half the times one of the two colors was winning, and half the times the other color.

Utility for both gains and losses was power utility. No loss aversion parameter because no mixed prospects. P. 17143: They assumed EU for risk with power utility (CRRA) and then the power as index of risk aversion. For ambiguity they used biseparable utility (although they only refer to maxmin EU of Gilboa & Schmeidler 1989) with $w(p) = p - \beta A/2$, where A is a measure of ambiguity (the length of the probability interval) and β an index of ambiguity aversion for gains, and of ambiguity seeking for losses. Given β and A, this treats all probabilities p by substracting the same constant, which will not work well empirically given the common finding of insensitivity.

Note that their method amounts to using matching probabilities as recommended by Dimmock, Kouwenberg, & Wakker (2015), given that they use EU for risk. Then logistic function and maximum likelihood. Every choice is repeated 4 times, giving good estimates of consistency. Elderly are way more inconsistent, and violate stochastic dominance more often. Old and young are more risk averse than midlife. (**relation age-risk attitude**)

risk averse for gains, risk seeking for losses: p.17146: they find this clearly.

ambiguity seeking for losses: they find ambiguity neutrality for losses, and aversion for gains (P. 17145 & 17146).

correlation risk & ambiguity attitude: they find positive for gains ($\rho = 0.30$) and absent for losses (P. 17146).

reflection at individual level for risk: slightly positive correlation between risk aversion for gains and losses (P.17146).

reflection at individual level for ambiguity: slightly positive correlation between ambiguitiy aversion for gains and losses (P.17146)..

Cognitive measures: Numeracy did not correlate with risk or ambiguity aversion. It did correlate negatively with consistency and satisfying stochastic dominance (P. 17146). (**cognitive ability related to risk/ambiguity aversion**)

P. 17144: more violations of dominance under ambiguity than under risk.

ambiguity seeking for losses: the following is not directly related to it, but indirectly somewhat. P. 17147:

"Our results also make an important point: findings obtained studying preference in the domain of gains should not be immediately generalized to the domain of losses." P. 17146 2nd column ℓ. 5 wrote: "The most commonly used theoretical models of ambiguity assume that the individual ambiguity attitude is the same in the domain of gains and losses." The authors do not cite prospect theory for ambiguity, whereas all their findings confirm this theory.

(**Prospect theory not cited**)

gender differences in risk attitude: I should check it out. %}

Tymula, Agnieszka, Lior A. Rosenberg Belmaker, Lital Ruderman, Paul W. Glimcher, & Ifat Levy (2013) "Like Cognitive Function, Decision-Making Across the Life Span Shows Profound Age-Related Changes," *Proceedings of the National Academy of Sciences* 110, 17143–17148. https://doi.org/10.1073/pnas.1309909110

{% Present hypothetical scenarios to students and inspect what the interest of students is in receiving extra probabilistic info, and how much the latter affects decisions. The interest in and effect of probabilistic info is smaller if ethical considerations play a role, and if decisions are one-shot. It is also smaller than usual in naturalistic settings. One explanation may be that people take their own probability estimations and will not pay much attention to the experimenter's estimates anyhow. %}

Tyszka, Tadeusz & Tomasz Zaleskiewicz (2006) "When Does Information about Probability Count in Choices under Risk?," *Risk Analysis* 26, 1623–1636.

{% Seem to find that people overestimate equity if one of allocations is constant. %}

Ubel, Peter A., Jonathan Baron, & David A. Asch (2001) "Preference for Equity as a Framing Effect," *Medical Decision Making* 21, 180–189.

{% **equity-versus-efficiency**: nice experimental demonstration of equity. Specialists in medical decision making (N = 73), prospective jurors (N = 568), and medical ethicists (N = 74), were asked: Suppose you must choose between a cheap and an expensive method of testing for colon cancer. Suppose the cheap test can be applied to everyone and saves 1000 lives. The expensive test can be given to half of the population only, but saves 1100 lives in total. What do you prefer? The majority preferred the cheap test for equity reasons. %}

Ubel, Peter A., Michael L. DeKay, Jonathan Baron, & David A. Asch (1996) “Cost-Effectiveness Analysis in a Setting of Budget Constraints, Is It Equitable?,” *New England Journal of Medicine* 334, 1174–1177.

{% **equity-versus-efficiency**: find preference for equity even if at the cost of efficiency. %}

Ubel, Peter A. & George F. Loewenstein (1996) “Distributing Scarce Livers: The Moral Reasoning of the General Public,” *Social Science and Medicin* 42, 1049–1055.

{% Seems that they take issue with the silly viewpoint of Gold, Siegel, Russell, & Weinstein (1996) that utilities for medical treatments should always be inferred from the general public rather than from patients, and properly argue that there can be no general rule. %}

Ubel, Peter A., George F. Loewenstein, & Christopher Jepson (2003) “Whose Quality of Life? A Commentary Exploring Discrepancies between Health State Evaluations of Patients and the General Public,” *Quality of Life Research* 12, 599–607.

{% Paper about the failed Oregon implementation of C/E (cost-effectiveness). Gold et al. (1996) stated a consensus, unjustified I think, that quality of life estimations should be derived from the general public. Thus, for the Oregon project lay people were interviewed by telephone with questions such as “What chance of death would you be willing to take in order to try the treatment?” I would find about every judgment more valuable than the telephonic judgments of lay people. The TTO question “How much time would you be willing to give up in order to eliminate the meninggiorna pain and remain in perfect health?” will be even harder to interpret. Subjects cannot imagine how they can assume to have 75 years to live in total.

This paper presents these questions to economic students. Problem is that we as experimenters may understand what the question is about, but lay people and also the econ students cannot imagine any scenario where this question could be relevant. Their best guess may be that, hypothetically, they are getting the treatment, and then are asked to voluntarily take some risk of dying, where they

will of course choose risk 0. The authors find negative results for utility measurement and draw negative general conclusions. P. 114 last para of 1st column: "But our study raises questions about whether utility-elicitation methods accurately assign relative values on health outcomes." But these negative conclusions may only concern the measurements used here. %}

Ubel, Peter A., George F. Loewenstein, Dennis Scanlon, & Mark Kamlet (1996) "Individual Utilities Are Inconsistent with Rationing Choices: A Partial Explanation of why Oregon's Cost-Effectiveness List Failed," *Medical Decision Making* 16, 108–116.

{% r**eal incentives/hypothetical choice, for time preferences**: seems to be on it %}

Ubfal, Diego (2016) "How General Are Time Preferences? Eliciting Good-Specific Discount Rates," *Journal of Development Economics* 118, 150–170. https://doi.org/10.1016/j.jdeveco.2015.07.007

{% Strategy choices of opponents are taken as ambiguous. Players do maxmin EU. What the author calls ambiguous-quality information enhances preference for constant payoff. What the author calls low-quality information enhances uniform belief. Low-quality info is never defined but is, apparently, a common term, and apparently leads to large sets of priors. It looks entirely like what I call insensitivity. Ambiguous quality triggers a debt rollover crisis. Low quality triggers a currency crisis. %}

Ui, Takashi (2025) "Strategic Ambiguity in Global Games," *Games and Economic Behavior* 149. 65–81. https://doi.org/10.1016/j.geb.2024.11.004

{% %}

Ulam, Stanislaw (1930) "Zur Masstheorie in der Allgemeinen Mengenlehre," *Fundamentà Mathematicae* 16, 140–150.

{% Seems to have said: "Using a term like nonlinear science is like referring to the bulk of zoology as the study of non-elephant animals." It seems that the quote can be found in

James Gleick (1987) "*Chaos: Making a New Science*." Viking Penguin, 1987 and on page 374 in

Campbell et al. (1985) “Experimental Mathematics: The Role of Computation in Nonlinear Science,” Commun. Assoc. Comput. Mach. 28, 374–384.

Another formulation of this quote sometimes found is:

“The study of non-linear physics is like the study of non-elephant biology.” %}

Ulam, Stanislaw

{% For the meaning of epistemic vs. aleatory, see my annotations at Walters et al. (2023, Management Science) who discuss it themselves on pp. 2762-2763. This paper examines the differences and interpretations in natural language. %}

Ülkümen, Gülden, Craig R. Fox, & Bertram F. Malle (2016) “Two Dimensions of Subjective Uncertainty: Clues from Natural Language,” *Journal of Experimental Psychology: General* 145, 1280–1297.
http://dx.doi.org/10.1037/xge0000202

{% %}

Ullrich, James R. & Ronald E. Wilson (1993) “A Note on the Exact Number of Two- and Three-Way Tables Satisfying Conjoint Measurement and Additivity Axioms,” *Journal of Mathematical Psychology* 37, 624–628.

{% Find evidence against some explanations of the underweighting of rare events found in the decision-from-experience approach. (**DFE-DFD gap but no reversal**)

Seems that, when presenting supposedly random samples to subjects, they in reality gave exactly representative samples (matching samples paradigm), which would comprise some deception (**deception**). %}

Ungemach, Christoph, Nick Chater, & Neil Stewart (2009) “Are Probabilities Overweighted or Underweighted when Rare Outcomes Are Experienced (Rarely)?,” *Psychological Science* 20, 473–479.

{% Fuzzy Wuzy was a bear.
But Fuzzy Wuzzy had no hair,
So Fuzzy Wuzzy wasn’t fuzzy,
Was he? %}

Unknown source (1999).

{% **homebias** %}

Uppal, Raman & Tan Wang (2003) “Model Misspecification and Under-Diversification,” *Journal of Finance* 58, 2465–2486. https://doi.org/10.1046/j.1540-6261.2003.00612.x

{% **crowding-out**: seems to have empirically verified the claim on blood donation by Titmuss (1970. %}

Upton, William E. (1973) “Altruism, Attribution, and Intrinsic Motivation in the Recruitment of Blood Donors.” Doctoral Dissertation, Cornell University.

{% Discuss a Roe, Busemeyer, & Townsend (2001) model with a model explaining loss aversion by other factors and, thus, in a way, assuming loss aversion away. This paper argues that there is a role for loss aversion still. %}

Usher, Marius & James L. McClelland (2004) “Loss Aversion and Inhibition in Dynamical Models of Multialternative Choice,” *Psychological Review* 111, 759–769.

{% Shows that trust (e.g. in safety of neighborhood where you live) reduces risk perception also if controlling for objective risks and own experiences. %}

Uslaner, Eric M. (2013) “Trust as an Alternative to Risk,” *Public Choice* 157, 629–639. http://dx.doi.org/10.1007/s11127-013-0082-x

{% r**eal incentives/hypothetical choice, for time preferences**: seems to be on it %}

Utsumi, Daniel A., Monica C. Miranda, & Mauro Muszkat (2016) “Temporal Discounting and Emotional Self-Regulation in Children with Attention-Deficit/Hyperactivity Disorder,” *Psychiatry Research* 246, 730–737. https://doi.org/10.1016/j.psychres.2016.10.056

{% Phrenology is old field of study that thought to localize many things in our brains, such as moral values being located on top of the brains, intellectual properties in front, and so on. The author compares neuro science to phrenology. %}

Uttal, William R. (2003) "*The New Phrenology. The Limits of Localizing Cognitive Processes in the Brain*." MIT Press, Cambridge MA.

{% Interview by Maarten Evenblij: "De concensus over cholesterol gaat uit van achtienduizend euro per voor kwaliteit gecorrigeerd levensjaar, bij taxol kom je op dertigduizend euro en bij een longtransplantatie op tachtigduizend euro. Zulke getallen worden impliciet gebruikt, maar niemand durft hardop criteria te noemen. Er wordt erg ad hoc beslist." (Translation: The consensus about cholesterol assumes €18,000 per quality-adjusted life year, for taxol you end up with €30,000, and for lung-transplantation at €80,000. Such numbers are used implicitly, and no one dares to mention criteria alound. The decisions are very ad hoc.) %}

Uyl-de Groot, Carin (2003) "Rekenen aan Zinnige Zorg," Volkskrant of approximately May 2003.

{% %}

Vallentyne, Peter (1993) "Utilitarianism and Infinite Utility," *Australasian Journal of Philosophy* 71, 212–217. https://doi.org/10.1080/00048409312345222

{% The constant ratio strategy for the **tradeoff method** is described following Table 10: a/b = x/y, without consideration of probabilities. %}

van Assen, Marcel A.L.M. (1996) "Eliciting Utilities when Probabilities Are Distorted and Eliciting Decision Weights Independently from Outcome Evaluations," master's thesis, Department of Mathematical Psychology, University of Nijmegen, the Netherlands.

{% %}

van Assen, Marcel A.L.M. (1998) "Effects of Individual Decision Theory Assumptions on Predictions of Cooperation in Social Dilemmas," *Journal of Mathematical Sociology* 23, 143–153.

{% **tradeoff method**: first measures utilities of players by means of the tradeoff method. Then uses these to make predictions in game theory. %}

van Assen, Marcel A.L.M. & Chris Snijders (2004) "Effects of Risk Preferences in Social Dilemmas: A Game-Theoretic Analysis and Evidence from Two Experiments." *In* Ramzi Suleiman, David V. Budescu, & David Messick (eds.) *Contemporary Psychological Research on Social Dilemmas*, 38–65, Kluwer, Dordrecht.

{% **tradeoff method**: First measures utilities of players by means of the tradeoff method. Then uses these to make predictions in game theory, in particular, how much people are willing to play cooperatively in the repeated prisoner's dilemma. %}

van Assen, Marcel A.L.M. & Chris Snijders (2001) "The Effect of Nonlinear Utility on Behavior in Repeated Prisoner's Dilemmas."

{% **free will/determinism**: The author was a masters' student in neuroscience & cognition. This text, published in a regular (!) general-public newspaper, is among my favorites on free-will/dterminism. (The author's expertise explains why the deterministic factors for him are signals in the brain, rather than forces and molecules as a physicist would have it, sets of equations as mathematicians would have it, emotions as psychologists would have it, and so on. (**ubiquity fallacy**) I give a translation of his text into English:

Daan Evers and Niels van Milten-Burg worry about the existence of a free will (this newspaper, 15 September), but for no reason. My thesis is that a free will obviously does not exists, but that this does not matter.

The idea of a free will results from our consciousness. We are aware that we are driven by certain motives, and we realize that we are acting organisms. But this does not mean that our consciousness (only an object and not a subject) can really influence the things we do and consciously experience. An order for action in our brains arises as a logical consequence of impulses that are already present there, and a coincidental observation of those impulses will not change this system. Even if we see our consciousness as a controlling system that can intervene if something is not going the way we want, then also this reaction is predictable beforehand on the basis of signals in our brains and, thus, our free will can be completely set aside.

What this amounts to, is that we will never be able to achieve this setting aside - not without powerful technologies and knowledge of really all variables influencing behavior. This means that there is a hole in what we understand of our own actions, and that hole we fill up with the illusion of a free will. The idea of a free will arises therefore if we do not fully understand why we do something [in causal terms] and then ascribe it to some sort of autonomous inspiration, an order

for action coming into existence in our brains in a magical manner.

Such an alchemy of brains has often been contested by Dick Swaab, but he too misses something important. That in theory a free will does not exist, does not matter. We will never be able to predict human behavior more precisely on the basis of currents in our brain and knowledge of external factors than we have been able to do for many years using a model for action called "free will." It is therefore extremely useful to be able to continue to assume a free will, purely because this works better in practice than a cold neurological determinism.

One of the many advantages of the belief in a free will is the fact that it gives happiness [utility]. Evers and Van Miltenburg can get themselves an icecream with no reason to worry and can have the pleasurable feeling that they decided entirely by themselves to do so. And this is how it is in fact: certain factors in their body - and more "self" than your own body you will never find - quite like to get that ice cream! However, philosophers desire a concept transpiring more autonomy, and the free will is that concept for them. Excellent, of course, because it makes them happy to have the feeling that in a moment of ultimate freedom (just do something crazy for a change) they could take three scoops of icre cream instead of two.

For me it is rather simple: I have no free will. Everything I do, is determined by an interaction of factors within and outside my body. But I do feel that I have a free will: it makes it very easy for me to accept what I do. And it makes me happy to think that I am free "to do what I want." Look, I know that falling in love consists of currents in the brain and materials in my blood, but this does not make the feeling generate less happinesss.

Thus Evers and van Miltenburg can rest assured and continue to order ice creams, and Dick Swaab can continue to scan brains. They should discriminate between research and daily life: belief in free will has no place in neuroscience, but setting it aside does not make life better. We need not pay much attention to the nonexistence of a free will: that only makes us less happy. Therefore consider the lack of a free will not to be a lack of freedom, but consider setting this nonexistence aside as a source of happiness. %}

van Baar, Jeroen (2011) "Geloof in Vrije Wil Maakt Gelukkiger" (in Dutch), De Volkskrant, p. 33, 24 September 2011.

http://personal.eur.nl/Wakker/pdf/vanbaar(2011).pdf

{% **probability communication**: Seems to write that statisticians recommend never reporting data using pie charts (as area of probability wheel). Seems that people can't judge angles well. %}

van Belle, Gerald (2002) "*Statistical Rules of Thumb*." Wiley, New York.

{% %}

van Benthem, Johan F.A.K. (1981) "Fundering of Ondermijning?," *Nieuw Archief voor Wiskunde* 29, 254–284.

{% %}

van Bilsen, Servaas & Roger J. Laeven (2020) "Dynamic Consumption and Portfolio Choice under Prospect Theory," *Insurance: Mathematics and Economics* 91, 224–237.

{% %}

van Boven, Leaf, George F. Loewenstein, & David Dunning (2005) "The Illusion of Courage in Social Predictions: Underestimating the Impact of Fear of Embarrassment on Other People," *Organizational Behavior and Human Decision Processes* 96, 130–141.

{% **revealed preference**: Varian showed that revealed preference cannot be falsified if we only observe some and not all goods. It has often been used against lab tests of revealed preference. This paper shows that Varian's result does not invalidate lab tests because then assumptions of fixed prices and expenditures there. %}

van Bruggen, Paul & Jan Heufer (2017) "Afriat in the Lab," *Journal of Economic Theory* 169, 546–550.

{% %}

van Daal, Jan & Arnold H.Q.M. Merkies (1984) "*Aggregation in Economic Research.*" Kluwer, Dordrecht.

{% **restricting representations to subsets**: P. 608 discusses global consistency (a kind of separability) that holds over the whole domain, and then local/conditional consistency, which considers the preference conditions only on subdomains. They do not provide results, but mention its interest.

Around p. 625: Maximization over twofold product set, so, choice options are, say, m by n matrices. Then weak separability w.r.t. both products already implies additive representability and, hence, strong separability. That is an, appealing, consequence of Gorman's (1968) theorem. The paper gives nice history on it. It was central in economics, where columns indicate commodities, rows indicate individuals at the micro level, and the whole matrix the macro level. Can macro be considered to be an aggregation of micro? Nataf (1948) is an early classic, showing the above result using differentiability. %}

van Daal, Jan & Arnold H.Q.M. Merkies (1988) “The Problem of Aggregation of Individual Economic Relations; Consistency and Representativity in a Historical Perspective.” *In* Wolfgang Eichhorn (ed.) *Measurement in Economics* (Theory and Applications of Economic Indices), 607–637, Physica-Verlag, Heidelberg.

{% didactical %}

van Daele, Alfons (1990) “The Lebesgue Integral without Measure Theory,” *American Mathematical Monthly* 97, 912–915.

{% Brouwer’s idea that every function is continuous. %}

van Dalen, Dirk (1988) “Infinitesimals and the Continuity of all Functions,” *Nieuw Archief voor Wiskunde* 6, 191–202.

{% Informele naam Harry wordt ook wel gebruikt. %}

van Dalen, Hendrik P. (1999) “The Golden Age of Nobel Economists,” *American Economist* 43, 19–35.

{% %}

van Damme, Eric (1983) “*Refinements of the Nash Equilibrium Concept*.” Springer, Berlin.

{% **normal/extensive form** %}

van Damme, Eric (1987) “Equilibria in Noncooperative Games.” *In* Hans J.M. Peters & Koos J. Vrieze (eds.) *Surveys of Game Theory and Related Topics*, 1–37, CWI Tract 39, Centre for Mathematics and Computer Science, Amsterdam.

{% **normal/extensive form** %}

van Damme, Eric (1987) “*Stability and Perfection of Nash Equilibrium*.” Springer, Berlin.

{% Introduced the burning-money idea in the battle of the sexes. Argues for forward induction. %}

van Damme, Eric (1989) “Stable Equilibria and Forward Induction,” *Journal of Economic Theory* 48, 476–496.

{% **dynamic consistency**

P. 34 nicely suggests that Aumann’s correlated equilibrium is only violation of the rules of the game.

Discusses, a.o., forward induction. %}

van Damme, Eric (1992) “Refinements of Nash Equilibrium.” *In* Jean-Jacques Laffont (ed.) *Advances in Economic Theory* I, 32–75, Cambridge University Press, Cambridge.

{% %}

van Damme, Eric (1993) “Evolutionary Game Theory,” Center for Economic Research, University of Tilburg.

{% Shows that probability weighting becomes more linear under repeated decisions where subjects can learn and get good incentives. %}

van de Kuilen, Gijs (2009) “Subjective Probability Weighting and the Discovered Preference Hypothesis,” *Theory and Decision* 67, 1–22.

{% %}

van de Kuilen, Gijs & Peter P. Wakker (2006) “Learning in the Allais Paradox,” *Journal of Risk and Uncertainty* 33, 155–164.

https://doi.org/10.1007/s11166-006-0390-3

Direct link to paper

{% **tradeoff method’s error propagation**: p. 595: effects are small; **inverse S**; **ambiguity seeking for unlikely**; **uncertainty amplifies risk**: m**ore inverse S for ambiguity** (for risk even more convexity); **Best core theory depends on error theory**: Web appendix D; **endogenous midpoints** %}

van de Kuilen, Gijs & Peter P. Wakker (2011) “The Midweight Method to Measure Attitudes toward Risk and Ambiguity,” *Management Science* 57, 582–598.

https://doi.org/10.1287/mnsc.1100.1282

Direct link to paper

{% **risky utility u = strength of preference v (or other riskless cardinal utility, often called value)**: Ask 300 subjects to mention six levels of income that are, respectively, very bad, bad, insufficient, sufficient, good, and very good. Assign "riskless" utility values 1/12, 3/12, …11/12 to these incomes. Then they fit a logarithmic and a lognormal-distribution à la Van Praag to these numbers. Next 50-50 lottery equivalence questions are asked. The authors assume that risky utility is the same as riskless and use this utility function to estimate the decision weight of .5. It is .45 for logarithmic utility and .47 for lognormal.

Remarkably, Fig. 1 proposes the **inverse S** probability weighting exactly as in Tversky & Kahneman (1992). %}

van de Stadt, Huib, Gerrit Antonides, & Bernard M.S. van Praag (1984) "Empirical Testing of the Expected Utility Model," *Journal of Economic Psychology* 5, 17–29.

{% Nice and clean application of decision analysis. "Clean" does not mean that one can do any useful applications without getting dirty hands. It is expected utility in full glory, with probability estimates, utility measurements, decision trees, and sophisticated software to analyze.

No probabilities are exactly known, of course, so we can call it ambiguity. The authors handle uncertainties about probabilities, like uncertainties about all other variables (probability is not special in this regard!), by using sensitivity analyses, univariate that is. I think that they are lucky in not knowing modern ambiguity theories …

They consider undescended testis (UDT) with baby-boys, mean that a testis is present but did not descend enough and did not make it to the scrotum; prevalence ±1%. Question is whether to operate, and if so, when (because often there is spontaneous cure, being in about 80% after a year). They find that operation is good, but best done only after 9 months. Pro of operation is cosmetic (keeping scrotum symmetric) and bigger fertility, but con is operation-complication risks (p. 912 end of 1st column). The result is highly sensitive to the subjective quality of life of asymmetric scrotum (p. 912 ℓ. −5) and, hence, the authors argue in several places that the patient, or probably his parents, should assess that. P. 917 last para explains that the medical profession did not want this, and one can read between the lines that the authors do not agree ("clinically counterintuitive"). They state their alternative view on p. 916 4th para and in the conclusion (p. 918) 1st para.

They measure probabilities from the literature and from expert judgments, and utility through introspective VAS scores transformed into decision-utilities based on Stiggelbout et al. (1996) (p. 911 & 916). Consider 0% and 3% discounting.

P. 911 Table 3 gives quality-of-life estimates for no paternity, having scar, dying, and so on. These were measured from the general public (so, not from patients or through doctors), with 41 complete questionnaires used (p. 911).

P. 916 para –3: that costs are too low to be very relevant here, suggesting a price of €20,000 to €40,000 for a QALY. %}

van den Akker–van Marle, M. Elske, Mascha Kamphuis, Helma B. M. van Gameren–Oosterom, Frank H. Pierik, Job Kievit, & NST Expert Group (2013) "Management of Undescended Testis: A Decision Analysis," *Medical Decision Making* 33, 906–919. http://dx.doi.org/10.1177/0272989X13493145

{% %}

van den Berg, Bernard, Han Bleichrodt, & Louis Eeckhoudt (2005) "The Economic Value of Informal Care: A Study of Informal Caregivers' and Patients' Willingness to Pay and Willingness to Accept for Informal Care," *Health Economics* 14, 363–376.

{% %}

van den Berg, Bernard & Ada Ferrer-i-Carbonell (2007) "Monetary Valuation of Informal Care: The Well-Being Valuation Method," *Health Economics* 16, 1227–1244.

{% **foundations of probability**; **foundations of quantum mechanics**: they criticize Accardi. %}

van den Berg, Hans, Dick Hoekzema, & Hans Radder (1990) "Accardi on Quantum Theory and the "Fifth Axiom" of Probability," *Philosophy of Science* 57, 149–157.

{% %}
Van den Bos, Kees, Riël Vermunt, & Henk A.M. Wilke (1997) "Procedural and Distributive Justice: What is Fair Depends More on What Comes First than on What Comes Next," *Journal of Personality and Social Psychology* 72, 95–104.

{% **total utility theory**: Used EQ-5D questionnaire to measure well-being under two treatments. Used the time-integrated results in C/E (cost-effectiveness) analysis. %}
van den Hout, Wilbert B., Yvette M. van der Linden, Elsbeth Steenland, Ruud G.J. Wiggenraad, Job Kievit, Hanneke de Haes, & Jan Willem H. Leer (2003) "Single- versus Multiple-Fraction Radiotherapy in Patients with Painful Bone Metastases: Cost-Utility Analysis Based on a Randomized Trial," *Journal of the National Cancer Institute* 95, 222–229.

{% Paper considers the case where agents do not know the probabilities but must estimate them. It implies that an agent choosing the action with perceived best chance to bring success, is likely to choose an action where he overestimates the chance of success, similar to the winner's curse. This provides an alternative explanation of overoptimism, attributing success to own actions but failure to external factors, and Langer's illusion of control. Nice! It gives many references to the literature on the mentioned biases. Benoît & Dubra (2011 Econometrica) also describe situations where probability distortion can be rational. %}
van den Steen, Eric (2004) "Rational Overoptimism (and Other Biases)," *American Economic Review* 94, 1141–1151.

{% **time preference**; many refs. %}
van der Pol, Marjon & John Cairns (2002) "A Ccomparison of the Discounted Utility Model and Hyperbolic Discounting Models in the Case of Social and Private Intertemporal Preferences for Health," *Journal of Economic Behavior and Organization* 49, 79–96.

{% **time preference**; Compare open and closed questions to measure discounting. Closed questions give much lower rates of time preference. %}

van der Pol, Marjon & John Cairns (2008) "Comparison of Two Methods of Eliciting Time Preference for Future Health States," *Social Science and Medicine* 67, 883–889.

{% N = 203; test stationarity by asking matching questions.

Details of stimuli: They describe illness to subjects, and then ask: How many days ill in X+2 years is equivalent to you to being ill for 30 days starting in X years? So, a matching question. Do this for X = 0 and some bigger Xs.

They find decreasing impatience throughout, not only at present. This falsifies not only constant discounting but also quasi-hyperbolic discounting. This need not violate generalized hyperbolic discounting of Loewenstein & Prelec (1992) although they, somewhat deviating from their title, do not test axioms of that theory and do only what I described above.

Similar tests of stationarity have often been done before, and they cite several, to which I would like to add Bleichrodt, Rohde, & Wakker (2009 GEB). They do cite the close Bleichrodt & Johannesson (2001).

They claim novelty in the combination of doing it for health rather than money and not being biased by subadditivity and similarity biases. The former claim is based on nothing but the fact that the delay between outcomes is kept constant and that the matching concerns the outcomes (p. 775 2nd last sentence above §4.1 & p. 779 ℓ. 2-5). The latter claim (fewer "similarity" biases) is based on nothing but the fact that they use matching questions, which they claim have fewer biases and then also fewer biases based on similarity (p. 775 last sentence above §4.1 & p. 779 ℓ. 2-5). Most people think that matching questions have more, and not fewer, biases than binary choices today (Bostic et al., 1990; Fischer et al. 1999; Noussair, Robbin, & Ruffieux 2004).

DC = stationarity: p. 771 ℓℓ. 6-7, & ℓ. –11/–9, and most clearly following Eq. 1.

Nice English: delay of nearest outcome versus delay between outcomes. %}

van der Pol, Marjon & John Cairns (2011) “Descriptive Validity of Alternative Intertemporal Models for Health Outcomes: An Axiomatic Test,” *Health Economics* 20, 770–782.

{% %}

van der Pol, Marjon & Larissa Roux (2005) “Time Preference Bias in Time Trade-Off,” *European Journal of Health Economics* 6, 107–111.

{% Investigate utility of life duration of mothers with children, and show that years needed to raise children receive considerably bigger utility than the years after, in deviation from people without children. %}

van der Pol, Marjon & Alan Shiell (2007) “Extrinsic Goals and Time Tradeoff,” *Medical Decision Making* 27, 406–413.

{% Get info on individuals from data of whole sample, maybe à la Conte, Hey, & Moffat. %}

van Dijk, Bram & Richard Paap (2008) “Explaining Individual Response Using Aggregated Data,” *Journal of Econometrics* 146, 1–9.

{% %}

van Doorslaer, Eddy K.A., Adam Wagstaff, Han Bleichrodt et al. (1997) “Income-Related Inequalities in Health: Some International Comparisons,” *Journal of Health Economics* 16, 93–112.

{% nonlinearity in probabilities %}

van der Meer, Hendrika C. (1963) “Decision-Making: The Influence of Probability Preference, Variance Preference and Expected Value on Strategy in Gambling,” *Acta Psychologica* 21, 231–259.

{% %}

van der Sar, Nico L., Bernard M.S. van Praag, & Steven Dubnoff (1988) “Evaluation Questions and Income Utility.” *In* Bertrand R. Munier (ed.) *Risk, Decision and Rationality*, 77–96, Reidel, Dordrecht.

{% ISBN: 9789023254485 %}
van der Veen, Gerrita, Arne Maas, Anne-Marie Delfgaauw, & Han Gerrits (2015) "*Social Media? Social Business! De Groei naar Sociale Volwassenheid*." Koninklijke van Gorcum, Assen, the Netherlands.

{% Could serve as simple decision-theoretic example for teaching. %}
van Dijk, Merel & Ewoud Steyerberg (2005) "A Decision-Analytic Approach for Defining Prognosis Groups in Oncology: A Case Study for Patients with Testicular Cancer,"

{% %}
van Dolder, Dennie & Martijn J. van den Assem (2018) "The Wisdom of the Inner Crowd in Three Large Natural Experiments," *Nature Human Behaviour* 2, 21–26.

{% **conservation of influence;** on conscious will being merely "an illusion created by the brain." Criticizes the controversial "Libet-experiments." %}
van Duijn, Marc & Sacha Bem (2005) "On the Alleged Illusion of Conscious Will," *Philosophical Psychology* 18, 699–714.

{% %}
van Everdingen, Yvonne M. & W. Fred van Raaij (1998) "The Dutch People and the Euro: A Structural Equations Analysis Relating National Identity and Economic Expectations to Attitude towards the Euro," *Journal of Economic Psychology* 19, 721–740.

{% **principle of complete ignorance**: seems to discuss this view that events that happen or not, cannot be assigned probabilities. %}
van Fraassen, Bas C. (1980) "A Temporal Framework for Conditionals and Chance," *Philosophical Review* 89, 91–108.
Reprinted *in* William L. Harper, Robert Stalnaker, & Glen Pearce (1981, eds.) *Ifs, Conditionals, Beliefs, Decision, Chance, and Time*, 323–340, Reidel, Dordrecht.

{% **Dutch book**: **dynamic consistency**:; philosophers and economists discuss these issues, involving dynamic decision principles, more or less independently. %}

van Fraassen, Bas C. (2023) “Reflection and Conditionalization: Comments on Michael Rescorla, *Nous* 57, 539–552. https://doi.org/10.1111/nous.12416

{% **cognitive ability related to risk/ambiguity aversion**: maybe. %}

van Gelder, Jean-Louis, Reinout E. de Vries, & Joop van der Pligt (2009) “Evaluating A Dual-Process Model of Risk: Affect and Cognition as Determinants of Risky Choice,” *Journal of Behavioral Decision Making* 22, 45–61.

{% Discussing the axioms of Cox (1946), and many follow-up references. Also discusses Halpern’s argument that Cox’s theorem need not hold on finite domains. %}

van Horn, Kevin S. (2003) “Structing a Logic of Plausible Inference: A Guide to Cox’s Theorem,” *International Journal of Approximate Reasoning* 34, 3–24.

{% Use RDU. %}

Van Houtven George, Reed F. Johnson, Vikram Kilambi, A. Bret Hauber (2011) “Eliciting Benefit-Risk Preferences and Probability-Weighted Utility Using Choice-Format Conjoint Analysis,” *Medical Decision Making* 31, 469–480.

{% **game theory can/cannot be viewed as decision under uncertainty** %}

van Huyck, John B., Raymond C. Battalio, & Richard O. Beil (1991) “Strategic Uncertainty, Equilibrium Selection, and Coordination Failure in Average Opinion Games,” *Quarterly Journal of Economics* 106, 885–910.

{% **free will/determinism**: Many people have argued that in a deterministic world there can be no free will. Seems that this author funnily reverses the argument and produces what is called the follback argument: if there is chance, probability, in the world, then this is what it is: Chance and probability. That cannot be free will. For example, if God repeats history 10 times and 7 times you lie but three times you tell the truth, then it is probability and not your free will. Others, including Buchak (2013), have criticized this view arguing that free will can be a form of indeterminism different than chance/probability. %}

van Inwagen, Peter (2000) "Free Will Remains a Mystery," *Philosophical Perspectives* 14, 1–20.

{% %}
van Lambalgen, Michiel (1990) "The Axiomatization of Randomness," *Journal of Symbolic Logic* 55, 1143–1167.

{% **probability elicitation**; a thorough study of this elicitation technique with a thorough discussion of the literature. Hence, it can serve as a: **survey on belief measurement.** %}
van Lenthe, Jelle (1993) "ELI: An Interactive Elicitation Technique for Subjective Probability Distributions," *Organizational Behavior and Human Decision Processes* 55, 379–413.

{% **ordering of subsets** %}
van Lier, Luc (1989) "A Simple Sufficient Condition for the Unique Representability of a Finite Qualitative Probability by a Probability Measure," *Journal of Mathematical Psychology* 33, 91–98.

{% Have subjects (mostly students) answer certainty equivalent questions and speak aloud. Record and analyze these data to find the location of the reference point. Find that planned goals influence the reference point.

The authors argue that certainty equivalents (CE's) are perceived differently than found and/or claimed before, for instance by Bleichrodt, Pinto, & Wakker (2001). P. 344: "Our findings argue that the CE life-year gamble is very likely not perceived as an all gains gamble, as has been suggested by Bleichrodt and others."

However, Bleichrodt (& Pinto & Wakker, 2001) argued so for CE's measured through matching. When matching, then no sure outcome is available to serve as an easy reference point and this is crucial in the argument. Van Osch et al. did not use matching, but derived CE's from observed choices through bisection (p. 340 2nd para). Thus, subjects could focus on a sure outcome in every choice and take that as reference point. This was indeed found (p. 344: "most attention was paid to the offered CE. … Through the use of the chioce-bracketing procedure, we may have induced a changing reference point in the way one introduces a change in the reference point by offering

respondents a money amount to start with in money gambles."

They write on the difference between matching and choice bracketing on p 345: "A further important point is that the findings are applicable only to the choice-bracketing method. If utilities had been derived using the matching method, these findings might have been different." Thus, their finding does not contradict Bleichrodt et al., contrary to what they write, but it agrees with Bleichrodt et al..

In the equivalence y ~ $x_{0.5}z$, take (y-x)/(z-x) (PM, the proportional match) as index of risk aversion.

utility families parametric: Use a logistic family $U(t) = a/(1+(b/t)^c)$, which is convex below the inflection point $t^* = b\big((c-1)/(c+1)\big)^{1/c}$, and concave above. Use this family to fit the data. Where the inflection point of this fitted curve ends up, that is where they also assume a reference point to be. %}

van Osch, Sylvie M.C., Wilbert B. van den Hout, & Anne M. Stiggelbout (2006) "Exploring the Reference Point in Prospect Theory: Gambles for Length of Life," *Medical Decision Making* 26, 338–346.

{% Used speak-aloud interviews in standard gamble choices to determine what reference points subjects take. The certain outcome was mostly taken as reference point, and the standard gamble was thus taken as a mixed prospect. Subjects mostly focus on the lowest outcome of the prospect. They also find scale compatibility confirmed although its effect on PE (they call it SG) measurements is not clear. %}

van Osch, Sylvie M.C. & Anne M. Stiggelbout (2008) "The Construction of Standard Gamble Utilities," *Health Economics* 17, 31–40.

{% Use correction procedures as recommended by Bleichrodt, Pinto, & Wakker (2002). The results agree with common intuitions on PE (if I remember well, they call it SG) scores. They are also related to TTO (Time TradeOff) measurements, and suggest that the latter, though less high than PE, may still be too high on average. %}

van Osch, Sylvie M.C., Peter P. Wakker, Wilbert B. van den Hout, & Anne M. Stiggelbout (2004) "Correcting Biases in Standard Gamble and Time Tradeoff Utilities," *Medical Decision Making* 24, 511–517.

https://doi.org/10.1177/0272989X04268955
Direct link to paper

{% **preferring streams of increasing income**: They consider loyalty points that people get from airline where for 3 already fixed flights they can get 300 then 200 then 100 or, say three times 200. Because it is very clear that only the total at the end matters, people should not care. Yet they prefer decreasing sequences (opposite to income where they often, even if irrationally, prefer increasing sequences. %}
van Osselaer, Stijn M.J., Joseph W. Alba, & Puneet Manchanda (2004) "Irrelevant Information and Mediated Intertemporal Choice," *Journal of Consumer Psychology* 14, 257–270.

{% Individual welfare function = utility function of income;
risky utility u = strength of preference v (or other riskless cardinal utility, often called value): van Praag argues that risky utility u = strength of preference v (or other riskless cardinal utility, often called value) in §5.4.
concave utility for gains, convex utility for losses: through lognormal utility function: U(y) = F(ln(y)) where F is the distribution function of the normal distribution; **utility families parametric**. %}
van Praag, Bernard M.S. (1968) "*Individual Welfare Functions and Consumer Behavior*." North-Holland, Amsterdam, 1968.

{% %}
van Praag, Bernard M.S. (1975) "Utility, Welfare and Probability: An Unorthodox Economist's View." *In* Dirk Wendt & Charles A.J. Vlek (eds.) *Utility, Probability, and Human Decision Making*, 279–295, Reidel, Dordrecht.

van Praag, Bernard M.S. (1976) "The Individual Welfare Function of Income and Its Offspring." *In* Jan S. Cramer, Arnold Heertje, & Paul E. Venekamp (eds.) *Relevance and Precision. From Quantitative Analysis to Economic Policy. Essays in Honour of Pieter de Wolff*, 279–295, Reidel, Dordrecht.

{% %}

van Praag, Bernard M.S. (1991) "Ordinal and Cardinal Utility: An Integration of the Two Dimensions of the Welfare Concept," *Journal of Econometrics* 50, 69–89.

{% %}

van Praag, Bernard M.S. & Ada Ferrer-i-Carbonell (2004) "*Happiness Quantified: A Satisfaction Calculus Approach*." Oxford University Press, Oxford, UK.

{% %}

van Praag, Bernard M.S., Paul Frijters, & Ada Ferrer-i-Carbonell (2003) "The Anatomy of Subjective Well-Being," *Journal of Economic Behavior and Organization* 51, 29–49.

{% %}

van Praag, Bernard M.S. & Arie Kapteyn (1994) "How Sensible Is the Leyden Individual Welfare Function of Income? A Reply," *European Economic Review* 38, 1817–1825.

{% %}

van Rooij, Maarten, Annamaria Lusardi, & Rob Alessie (2011) "Financial Literacy and Stock Market Participation," *Journal of Financial Economics* 101, 449–472.

{% For everything about continuity, differentiability, and the like about real functions that you ever believed to be true, you can find a counterexample here.

Statement 4.5 α: every monotonic function is almost everywhere differentiable.

%}

Van Rooij, Arnoud C.M. & Wilhelmus H. Schikhof (1982) "*A Second Course on Real Functions*." Cambridge University Press, Cambridge, UK.

{% %}

Van Roosmalen, Mariëlle S. (2005) "Shared Decision Making in Women Testing for a BRCA1/2 Mutation," Ph.D. dissertation, Medical Department, University of Nijmegen, the Netherlands.

{% **simple decision analysis cases using EU**: bit complex. %}
Van Roosmalen, Mariëlle S., Lia C.G. Verhoef, Peep F.M. Stalmeier, Nicole Hoogerbrugge, & Willem A.J. van Daal (2002) "Decision Analysis of Prophylactic Surgery or Screening for *BRCA*1 Mutation Carriers: A More Prominent Role for Oophorectomy," *Journal of Clinical Oncology* 20, 2092–2100.

{% %}
van Soest, Arthur, Marcel Das, & Xiaodong Gong (2005) "A Structural Labour Supply Model with Flexible Preferences," *Journal of Econometrics* 107, 345–374.

{% %}
van Stigt, Walter P. (1990) "*Brouwer's Intuitionism.*" Studies in the History and Philosophy of Mathematics, vol. 2. North-Holland, Amsterdam.

{% Philosophical discussions on whether nature should be taken as discrete or continuum. %}
van Strien, Marij (2015) "Continuity in Nature and in Mathematics: Boltzmann and Poincaré," *Synthese* 192, 3275–3295.

{% %}
van Veelen, Matthijs & Roy van der Weide (2008) "A Note on Different Approaches to Index Theory," *American Economic Review* 98, 1722–1730.

{% Subjects can get exposed to unpleasant electric shocks. Their risk aversion is measured from choices between a safe and risky option. After relief about just having escaped from an unpleasant shock, subjects take more risk. Prospect theory better captures this than expected value or mean-variance. %}
van Well, Sonja, John P. O'Doherty, & Frans van Winden (2019) "Relief from Incidental Fear Evokes Exuberant Risk Taking," *PLoS ONE* 14, e0211018. https://doi.org/10.17605/OSF.IO/PWUS7

{% %}
van Wijck, Esther E.E., Johanna L. Bosch, & Maria G.M. Hunink (1998) "The Reliability of Time Trade-off Values and Standard-Gamble Utilities Assessed in Telephone Interviews versus Face-to-Face Interviews," *Medical Decision Making* 18, 400–405.

{% %}
van Winden, Frans (2001) "Emotional Hazard Exemplified by Taxation-Induced Anger," *Kyklos* 54, 491–506.

{% Subjects had to make investment decisions with their own money, so, they could really lose (it was real incentives). They study the effect of the timing of the resolution of uncertainty, and of emotions on it. Timing has an effect in one treatment, entailing violations of EU and PT. The paper compares with the impressive Wu (1999, Theory and Decision). %}
van Winden, Frans, Michal W. Krawczyk, & Astrid Hopfensitz (2011) "Investment, Resolution of Risk, and the Role of Affect," *Journal of Economic Psychology* 32, 918–939.

{% **small worlds**; Nice sentence:
"It also illustrates the importance of modeling the source of violations of consistency conditions, rather than simply weakening axioms on preferences." %}
van Zandt, Timothy (1996) "Hidden Information Acquisition and Static Choice," *Theory and Decision* 40, 235–247.

{% Seems to show that subjects like to answer truthfully, and not lie, also if no incentive. %}
Vanberg, Christophe (2008) "Why Do People Keep Their Promises? An Experimental Test of Two Explanations," *Econometrica* 76, 1467–1480.

{% The VC (Vapnik-Chervonenkis) dimension of a theory is calculated as follows, where the theory has some free parameters. Imagine a game between a falsifier F, who likes to see a particular theory violated, and a Theorist, who does not want the theory violated. First, a theorist chooses a natural number k. Second, the theorist moves again, choosing k binary choice situations. Third, the falsifier can choose, at will, what the observations in these choice situations are. Then, if the theory is not violated, T wins, and receives k from F. If the theory is violated, F wins, and nothing happens. The largest k that T can win is called the VC dimension. For example, if the theory only imposes weak ordering, and the preference domain is infinite, then the VC dimension is infinite. If the theory is single-peak preference and the preference domainie ℝ, then the VC dimension is 1. %}

Vapnik, Vladimir N. & Alexei Y. Chervonenkis (1971) "On the Uniform Convergence of Relative Frequencies of Events to Their Probabilities." *Theory of Probability and Its Applications* 16, 264–280.

{% %}

Varey, Carol A. & Daniel Kahneman (1992) "Experiences Extended across Time: Evaluation of Moments and Episodes," *Journal of Behavioral Decision Making* 5, 169–186.

{% %}

Varey, Carol A., Barbara A. Mellers, & Michael H. Birnbaum (1990) "Judgments of Proportions," *Journal of Experimental Psychology: Human Perception and Performance* 16, 613–625.

{% This paper does not properly credit that most priority should go to Richter (1966).

Popularizes Afriat's revealed preference theorem and in fact uses Theorem 1 by Richter (1966). Main difference is that Richter considers completely general choice sets, for completely general objects, and not just choices from demand sets as in consumer theory. Another difference is that Richter wants all best elements to be in the choice set (where the idea is that then one is selected randomly) whereas Varian assumes that only one of the best is in the choice set; so, he gives the result from the final selection of selecting one element from the choice set.

Gives necessary and sufficient conditions for revealed preference to maximize a weak order and utility function. First, p. 946 gives Afriat's result in a more accessible form than Afriat did. Next it gives some variations, where the generalized axiom of revealed preference (GARP; Richter, 1966, calls it

congruency) in Fact 1 (p. 948) is most appealing. P. 947 announces: "there is an equivalent formulation of condition (2) which is quite easy to test. In addition this equivalent formulation is much more closely related to the traditional literature on the revealed preference approach to demand theory or Samuelson [24], Houthakker [12], Richter [21], and others."

This paper does not properly credit that most priority should go to Richter (1966). It does not explain what I explained above. Footnote 4 cites a Richer (1979) follow-up paper but is misleading and vague. Richer (1966) allows for any data set, finite or infinite. Richter (1966 Theorem 1) showed in full generality that GARP ("congruency") is equivalent to maximizing a weak order. Only difference, as explained before, is that Richter assumes a multi-element choice set.

Varian considers consumer theory and one-point demand functions, but allowing for other commodity bundles to be equivalent to the one demanded. And he assumes non-satiation. P. 946 gives Afriat's theorem with condition (2) "cyclical consistency" a version of GARP adapted to the context here. Given that the essential domain of chosen x^j's is assumed finite, any ordinal representing function can be turned into a concave function: Take the transitive extension of revealed preference over the x^i's, and make it complete over the x^i's. Give a utility value to the best indifference class, and somewhat lower to the 2nd best. Then give the 3rd best an extremely much lower value. Next, give the 4th best a yet way more extremely lower value. And so on, with each new utility difference way bigger than the ones before. This way Condition (3) can always get satisfied, with the lambda's all equal to 1 if one wants. Given that utility is ordinal, the interpretation of the lambda's as marginal utility (p. 946 ℓ. −10) is not meaningful. %}

Varian, Hal R. (1982) "The Nonparametric Approach to Demand Analysis," *Econometrica* 50, 945–973.

{% For consumer theory model, with budget sets and prices, gives a necessary and sufficient condition in terms of "there exist constants such that the inequality … holds" for additive separability with concave additive value functions. Wakker (1986; in Daboni, Montesano, & Lines) gives a necessary and sufficient condition for binary preference. I learned about Varian's paper only in January 2008. %}

Varian, Hal R. (1983) "Nonparametric Tests of Consumer Behavior," *Review of Economic Studies* 50, 99–110.

{% %}
Varian, Hal R. (1987) "The Arbitrage Principle in Financial Economics," *Journal of Economic Perspectives* 1 no. 2, 55–72.

{% Pratt-Arrow risk aversion %}
Varian, Hal R. (1988) "Estimating Risk Aversion from Arrow-Debreu Portfolio Choice," *Econometrica* 56, 973–979.

{% **risky utility u = transform of strength of preference v, latter doesn't exist**: p. 57–58: argues against cardinal utility through stength of preference 7th edn. of 2006 seems to discuss the assumption of total wealth on p. 555. %}
Varian, Hal R. (1993) "*Intermediate Microeconomics.*" Norton, New York.

{% **common knowledge** %}
Vassilakis, Spyros & Shmuel Zamir (1993) "Common Belief and Common Knowledge," *Journal of Mathematical Economics* 22, 495–505.

{% Study the BDM (Becker-DeGroot-Marschak) mechanism. and its difficulties. Consider various theories of reference dependence and test them in an experiment. They find significant deviations from incentive compatibility agreeing and see which reference dependent theories do and do not fit with them. %}
Vassilopoulos, Achilleas, Andreas C. Drichoutis, & Rodolfo M. Nayga (2024) "Reference Dependence, Expectations and Anchoring in the Becker-DeGroot-Marschak Mechanism," *Theory and Decision* 97, 637–683. https://doi.org/10.1007/s11238-024-09989-5

{% %}
Veblen, Thorstein (1898) "Why Is Economics not an Evolutionary Science?," in *The Place of Science in Modern Civilization, and Other Essays*.
Reprinted in Max Lerner (ed. 1948) *The Portable Veblen*, Viking Press, New

York. Seems to also have been Reprinted as Veblen (1909) *Journal of Political Economy* 17.

{% Most of this paper I found not so interesting, being negative on the researcher Mr. Clark, cardinal utility saying nothing about the movements of markets or institutions. But there are some nice citations on economics being on living beings and teleology. Here are citations (italics added). The italicized parts reflect essentials of living beings that can exert influence by, for instance, interested discrimination (=observation), to make decision theory and economics different than natural sciences.

conservation of influence: The theory is confined to the ground of sufficient reason instead of proceeding on the ground of efficient cause ...

“ The immediate consequence is that the resulting economic theory is of a teleological character ... instead of being drawn in terms of cause and effect. The relation sought by this theory among the facts with which it is occupied is the control exercised by future (apprehended) events over present conduct. Current phenomena are dealt with as conditioned by their future consequences; and in strict marginal-utility theory they can be dealt with only in respect of their control of the present by consideration of the future. Such a (logical) relation of control or guidance between the future and the present of course involves an exercise of intelligence, a taking thought, and hence an intelligent agent through whose *discriminating* forethought the apprehended future may affect the current course of events; unless, indeed, one were to admit something in the way of a providential elements, the relation of sufficient reason runs by way of the *interested discrimination*, the forethought, of an agent who takes thought of the future and guides his present activity by regard for this future. The relation of sufficient reason runs only from the (apprehended) future into the present, and it is solely of an intellectual, subjective, personal, teleological character and force; while the relation of cause and effect runs only in the contrary direction, and it is solely of an objective, impersonal materialistic character and force. The modern scheme of knowledge, on the whole, rests for its definitive ground, on the relation of cause and effect; the relation of sufficient reason being admitted only provisionally and as a proximate factor in the analysis, always with the unambiguous reservation that the analysis must ultimately come to rest in terms of cause and effect. The merits of this scientific animus, of course, do not concern the present argument.

Now, it happens that the relation of sufficient reason enters very substantially into human conduct. It is this element of discriminating forethought that distinguishes human conduct from brute behavior. And since the economist’s subject of inquiry is this human conduct, that relation necessarily comes in for a large share of his attention in any theoretical formulation of economic phenomena, whether hedonistic or otherwise. B*ut while modern science at large has made the causal relation the sole ultimate ground of theoretical formulation; and while the other sciences*

that deal with human life admit the relation of sufficient reason as a proximate, supplementary, or intermediate ground, subsidiary, and subservient to the argument from cause and effect; [after a marvelous beginning of the sentence, aggression takes over and nonsense follows] economics has had the misfortune -- as seen from the scientific point of view -- to let the former supplant the latter. It is, of course, true that human conduct is distinguished from other natural phenomena by the human faculty for taking thought, and any science that has to do with human conduct must face the patent fact that the details of such conduct consequently fall into the teleological form; but it is the peculiarity of the hedonistic economics that by force of its postulated its attention is confined to this teleological bearing of conduct alone. It deals with this conduct only in so far as it may be construed in rationalistic, teleological terms of calculation and choice. But it is at the same time no less true that human conduct, economic or otherwise, is subject to the sequence of cause and effect, by force of such elements as habituation and conventional requirements. But facts of this order, which are to modern science of graver interest than the teleological details of conduct, necessarily fall outside the attention of the hedonistic economist, because they cannot be construed in terms of sufficient reason, such as his postulates demand, or be fitted into a scheme of teleological doctrines." %}

Veblen, Thorstein (1909) "The Limitations of Marginal Utility," *Journal of Political Economy* 17, 620–636.

{% %}

Veenhoven, Ruut (1995) "Is Happiness Relative?," *Social Indicators Research* 24, 1–34.

{% %}

Veenhoven, Ruut (1995) "The Cross-National Pattern of Happiness: Test of Predictions Implied in Three Theories of Happiness," *Social Indicators Research* 34, 33–68.

{% Discusses, for instance, Brouwer's theorem that every function is continuous. %}

Veldman, Wim (2001) "Bijna de Waaier," *NAW* 5, 330–339.

{% Use introspective satisfaction measurements for German socio-economic panel of 16,000 individuals. Take income of reference group as reference point. Find concavity for gains and, surprisingly, even more concavity for losses. Also find loss aversion.

§4.3 uses a nice version of power utility. %}

Vendrik, Maarten & Geert Woltjer (2007) “Happiness and Loss Aversion: Is Utility Concave or Convex in Relative Income?,” *Journal of Public Economics* 91, 1423–1448.

{% **foundations of probability**: According to Zabell (1989), the first work in English that presented the frequentist interpretation of probability in detail. Seems to describe the rule of succession: when you observe m successes in n trials of a further unknown event, (m+1)/(n+2) is a good estimate of probability. %}
Venn, John (1866) “*The Logic of Chance*.” MacMillan, New York.

{% **crowding-out**: government subsidies seem to crowd-out private donations and charitable contributions. %}
Venti, Steven F. & David A. Wise (1990) “Have IRAs Increased U.S. Saving? Evidence from Consumer Expenditure Surveys,” *Quarterly Journal of Economics* 105, 661–698.

{% **foundations of statistics**: misunderstandings in health economics. %}
Verdam, Mathilde G. E., Frans J. Oort, & Mirjam A. G. Sprangers (2014) “Significance, Truth and Proof of p Values: Reminders about Common Misconceptions Regarding Null Hypothesis Significance Testing,” *Quality of Life Research* 3, 257–265.

{% %}
Verhoef, Lia C.G. (1994) “The Measurement of Individual Preferences for Treatment Outcomes in Breast Cancer,” Ph.D. dissertation, Medical Department, University of Nijmegen, the Netherlands.

{% **utility elicitation** %}
Verhoef, Lia C.G., Anton F.J. de Haan, & Willem A.J. van Daal (1994) “Risk Attitude in Gambles with Years of Life: Empirical Support for Prospect Theory,” *Medical Decision Making* 14, 194–200.

{% %}

Verhoef, Lia C.G., Anton F.J. de Haan, Arne Maas, André L.M. Verbeek, & Willem A.J. van Daal (1994) "Utility Assessment for Breast Cancer Treatment Selection: Reliability and Internal Consistency of the Time Tradeoff Test and the Certainty Equivalent Method," Institute of Radiotherapy, University of Nijmegen, Nijmegen, the Netherlands.

{% **utility elicitation** %}

Verhoef, Lia C.G., Arne Maas, Lucas J.A. Stalpers, André L.M. Verbeek, & Willem A.J. van Daal (1993) "Utility Assessment in Decision Support for Individual Patients: A Tradeoff between Feasibility and Validity," *Health Policy* 17, 39–50.

{% **utility elicitation** %}

Verhoef, Lia C.G., Arne Maas, Lucas J.A. Stalpers, André L.M. Verbeek, Theo Wobbes, & Willem A.J. van Daal (1991) "The Feasibility of Additive Conjoint Measurement in Measuring Utilities in Breast Cancer Patients," *Health Policy* 17, 39–50.

{% **utility elicitation**; %}

Verhoef, Lia C.G., Lucas J.A. Stalpers, André L.M. Verbeek, Theo Wobbes, & Willem A.J. van Daal (1991) "Breast-Conserving Treatment or Mastectomy in Early Breast Cancer: A Clinical Decision Analysis with Special Reference to the Risk of Local Recurrence," *Eur. J. Cancer* 27, 1132–1137.

{% **utility elicitation** %}

Verhoef, Lia C.G., André L.M. Verbeek, Lucas J.A. Stalpers, & Willem A.J. van Daal (1990) "Utiliteitsmeting bij the Klinische Besluitvorming," *Nederlands Tijdschrift voor de Geneeskunde* 134, 2195–2200.

{% A convention in the health domain is that QALY assessments of impaired health states have to be done by the general public because they are the ones who pay, through their taxes. Gold et al. (1996) argued for it, based on what I consider a misunderstanding of the veil of ignorance. I have always disagreed with it. This paper also expresses disagreement. It, for instance, puts up the (obvious!) counterargument that patients are better informed. %}

Versteegh, Matthijs M. & Werner B.F. Brouwer (2016) “Patient and General Public Preferences for Health States: A Call to Reconsider Current Guidelines,” *Social Science and Medicine* 165, 66–74.
http://dx.doi.org/10.1016/j.socscimed.2016.07.043

{% **real incentives/hypothetical choice**: for social preferences, it does not matter for a Krupka-Weber coordination game. %}
Veselý, Štěpán (2015) “Elicitation of Normative and Fairness Judgments: Do Incentives Matter?,” *Judgement and Decision Making* 10, 191–197.

{% %}
Vesely, William E. & Dale M. Rasmuson (1984) “Uncertainties in Nuclear Probabilistic Risk Analyses,” *Risk Analysis* 4, 313–322.

{% **foundations of probability**; reviewed by James Cussens (1990), in *History and Philosophy of Logic* 11, 116–117. %}
Vickers, John M. (1988) “*Chance and Structure: An Essay on the Logical Foundations of Probability*.” Clarendon Press, Oxford.

{% **risky utility u = strength of preference v (or other riskless cardinal utility, often called value)**: P. 327/328 seem to write: “Furthermore, there is abundant evidence that individual decisions in situations involving risk are not always made in ways that are compatible with the assumption that the decisions are made rationally with a view to maximizing the mathematical expectation of a utility function. The purchase of tickets in lotteries, sweepstakes, and ‘numbers’ pools would imply, on such a basis, that the marginal utility of money is an increasing rather than a decreasing function of income. Such a conclusion is obviously unacceptable as a guide to social policy.”

P. 328, “utilities derived in the process rather than from the end result;”

P. 325 top cites von Neumann & Morgenstern (1944) and Zeuthen (1937) as preceding him in suggesting that utility can be derived from risky chocies.

P. 329 states the veil of ignorance, preceding Harsanyi and Rawls. %}
Vickrey, William (1945) “Measuring Marginal Utility by Reactions to Risk,” *Econometrica* 13, 319–333.

{% %}

Vieider, Ferdinand M. (2009) “The Effect of Accountability on Loss Aversion,” *Acta Psychologica* 132, 96–101.

{% **real incentives/hypothetical choice** %}

Vieider, Ferdinand M. (2011) “Separating Real Incentives and Accountability,” *Experimental Economics* 14, 507–518.

{% %}

Vieider, Ferdinand M. (2012) “Moderate Stake Variations for Risk and Uncertainty, Gains and Losses: Methodological Implications for Comparative Studies,” *Economics Letters* 117, 718–721.

{% **real incentives/hypothetical choice**

This paper re-analyzes Callen, Isaqzadeh, Long, & Sprenger (2014 AER), criticizing it. Callen et al. claimed to find preferences for certainty that violate prospect theory. This paper shows, both analytically and experimentally, that prospect theory with plausible error theories can explain things. %}

Vieider, Ferdinand M. (2018) “Violence and Risk Preference: Experimental Evidence from Afghanistan: Comment,” *American Economic Review* 108, 2366–2382. https://doi.org/10.1257/aer.20160789

Vieider, Ferdinand M. (2021) “Noisy Coding of Time Delays and Reward Discounting,” Working Paper21/1036 FEB, Ghent University, Belgium.

{% Most empirical papers test what is the best-fitting core theory (deterministic) in combination with an error theory, where an implicit assumption often is that these are two independent components with independent answers. However, there obviously will be dependencies and interactions. What is the best error theory may depend on the core theory. More problematic, the best core theory may depend on the error theory chosen, as with the keyword in this annotated bibliography: **Best core theory depends on error theory**. The latter is more problematic because the core theory is of primary interest. The model of this paper, Bayesian inference model (BIM) does not try to separate but has parameters that at the same time affect core theory and

error theory, and those are not separated.

The BIM model takes inputs such as probabilities and money amounts as noisy signals and uses psychologically oriented theories with mental coding and decoding noisy inputs. This makes it harder to separate out the core theory, which is of primary interest. It supports: **cognitive ability related to likelihood insensitivity (= inverse S)**. There is most insensitivity for probability, but, as emphasized by the author, also for outcomes. The author emphasizes that there is no independence between the processing of outcomes and of (ambiguous!?) probabilities, giving up yet another property of prospect theory.

The paper agrees with my 2010 book and Abdellaoui, Baillon, Placido, & Wakker (2011) that there is no categorical difference between risk and ambiguity but that risk is an extreme of a continuum. The paper uses the term complexity, vague but fashionable in 2023. I did not study the paper enough to know how the theory is exactly defined. Probability transformations seem to be central, as in source theory of Baillon, Bleichrodt, Li, & Wakker (2025).

The paper compares risky choices with Oprea's mirror simplicity equivalents and again finds similar phenomena. The paper, unfortunately, is similar to Oprea's by the incorrect claim that risk theories would predict that mirror simplicity equivalents would be very different than risk attitudes. To the contrary, Kahneman and Tversky more than anyone else emphasized that many aspects of risk attitudes are based on *general* properties of cognition and perception.

The paper has in common with TAX and RAM models by Birnbaum, BEAST model by Erev, and others that it can better fit and predict than prospect theory, but that it is more complex with harder-to-interpret parameters. All common economics and decision analysis models use a deterministic ccore model satisfying basic properties such as transitivity. The author's BIM model cannot be used there. Neither can the models by Birnbaum or Erev, and this is a drawback of these models.

The intro ends with an enthusiastic para opening with: "The insights I present have potentially far-reaching policy implications." %}

Vieider, Ferdinand (2024) "Decisions under Uncertainty as Bayesian Inference on Choice Options," *Management Science* 70, 9014–9030.
https://doi.org/10.1287/mnsc.2023.00265

{% Use choice lists to determine CEs (certainty equivalents) of two-outcome prospects. Use RIS for real payment. Study within- and between-country differences, by doing two cities in China (Shanghai & Bejing) and two in Egypt. Find no within-country difference, but clear between-country difference. They point out that this suggests that randomization within a country, often difficult to do in intercultural studies, may not be a big problem. %}

Vieider, Ferdinand M., Thorsten Chmura, Tyler Fisher, Takao Kusakawa, Peter Martinsson, Frauke M. Thompson, & Adewara Sunday (2015) "Within- versus between-Country Differences in Risk Attitudes: Implications for Cultural Comparisons," *Theory and Decision* 78, 209–218.

{% **losses from prior endowment mechanism**: Did this. The prior endowment, conditional on a loss question implemented for real, was equal to the maximum loss, being €20c (p. 426). Used RIS.

Collected data of 2,939 subjects from 30 countries from all continents except Antarctica. They always take students. This makes the sample less representative for the world population as a whole, but makes between-country comparisons more reliable because for this purpose it is good to have little within-country heterogeneity.

Various teams and the main organizer, Vieider, wrote a number of papers on it. This paper verifies construct and convergence validity (my terms) of the measurements, by studying correlations between different ways to measure things. For each subject, 44 CEs of lotteries with gains, losses, mixed, and risk and uncertainty. (I did not find if/how they control for suspicion.) They analyze the CEs of the uncertain options, capturing general uncertainty attitude. To capture ambiguity attitude, which is the difference between uncertainty and risk, they could inspect differences of CEs under uncertainty and risk. Further intospective questions about general risk attitude and other things. They find that corresponding measures, both behaviorally and introspectively, are always positively related, though sometimes not strongly. This also holds between countries (taking each country as an individual).

Section 3.1, p. 428: They take unnormalized risk premium as index of risk aversion, and mention that normalizing by dividing by expected value (I: what if that is 0?; better divide by standard deviation) would not affect the results. As they will explain later (p. 446 last para of paper), this is not suited to test likelihood insensitivity (which they, unfortunately, call likelihood dependence), because to get that right you need different parameters.

inverse S: is found (p. 430 top);

Section 3.3, p. 439, end of 1st para: the uncertainty attitudes are more related to introspective questions than the risk attitudes.

Section 3.4, Table 3, gives correlations between the preference-based indexes, taking all countries together. It also considers many introspection-based indexes. Risk and uncertainty aversion for gains are strongly related (0.68), which is no surprise because uncertainty aversion comprises risk aversion (**correlation risk & ambiguity attitude**).

reflection at individual level for risk: They find a positive relation between risk aversion for gains and for losses. They also find that, stronger, for uncertainty aversion (p. 440; **uncertainty amplifies risk**).

gender differences in risk attitude: p. 443 reports more risk aversion for women and gains, but no significant result for losses.

P. 443 reports more uncertainty aversion (note that this comprises risk + ambiguity) for RICH countries. P. 445 last para will state the same for risk aversion.

P. 444 2nd para has nice discussion of context dependence being popular among psychologists. The finding of correlations of this paper shows that not everything is completely context dependent, but still to some degree.

P. 444 3rd para has nice discussion of constructive view of preference and writes: "We thus conclude that preferences are indeed discovered and derived from an underlying preference, rather than constructed *ex nihilo*."

P. 445 2nd para has an, again nice, discussion of the drawback of introspective measures that they are not clearly related to decision-theory components.

P. 445 last para: Risk aversion is decreasing in wealth between individuals, but increasing in wealth between countries. This is a risk-income paradox. They cite preceding papers on it. %}

Vieider, Ferdinand M., Mathieu Lefebvre, Ranoua Bouchouicha, Thorsten Chmura, Rustamdjan Hakimov, Michal W. Krawczyk, & Peter Martinsson (2015) "Common Components of Risk and Uncertainty Attitudes across Contexts and

Domains: Evidence from 30 Countries," *Journal of the European Economic Association* 13, 421–452.

{% Measure risk attitudes of Vietnamese farmers. They are on average risk neutral. Risk aversion is negatively related with income, but not related with wealth. %}

Vieider, Ferdinand M., Peter Martinsson, Pham Khanh Nam, & Nghi Truong (2019) "Risk Preferences and Development Revisited," *Theory and Decision* 86, 1–21. https://doi.org/10.1007/s11238-018-9674-8

{% Use Anscombe-Aumann framework, but to each state of nature not one lottery is assigned, but a set of lotteries. This set is evaluated by a convex combination of its best and worst element. The mixture weight is an index of pessimism. It reminded me much of Jaffray (1989), although it does not refer to this. The axioms used are as usual to characterize α-maxmin, dominance and independence of adding-removing intermediate ones. Considers both where α is set-dependent and where it is constant. %}

Vierø, Marie-Louise (2009) "Exactly what Happens after the Anscombe–Aumann Race?; Representing Preferences in Vague Environments," *Economic Theory* 41, 175–212.

{% %}

Vierø, Marie-Louise (2012) "Contracting in Vague Environments," *American Economic Journal: Microeconomics* 4, 104–130.

{% %}

Vijn, Pieter & Ivo W. Molenaar (1981) "Robustness Regions for Dichotomous Decisions," *Journal of Educational Statistics* 6, 205–235.

{% Seems to criticize/correct ideas of von Mises. %}

Ville, Jean A. (1939) "*Etude Critique de la Notion de Collectif.*" Gauthiers-Villars, Paris.

{% **revealed preference** %}

Ville, Jean A. (1946) “Sur les Conditions d’Existence d’une Ophélimité Totale et d’un Indice du Niveau des Prix,” *Annales de l’Université de Lyon*, 9, Sec. A(3) 32–39. Translated into English by Peter K. Newman (1952) “The Existence-Conditions of a Total Utility Function,” *Review of Economic Studies* 19, 123–128.

{% **ordering of subsets**; P. 1787 3rd para makes the misleading claim that, given that fine and tight qualitative probabilities are embeddable (requiring only compatibility w.r.t. finite unions!) in monotonely continuous (countably additive) qualitative probability structures, it is no loss of generality to consider only the latter. Example: Space is ℕ. Algebra contains all finite and co-finite subsets. P(A) = 0 if A is finite, and P(A) = 1 if A is cofinite. This structure can only be embedded in a countably additive probability structure if we merely respect finite unions and not infinite ones; i.e., merely if we take isomorphism as an algebra, and not as a σ-algebra. The author’s ensuring mathematical claims on such embeddability are incorrect (which fortunately does not affect his main Theorem 4.3):

(1) Counterexample to Remark on bottom of p. 1793: let $\mathcal{A}_0$ contain all measurable subsets of [0,1] for which there exists ε > 0 such that [0,1/4+ε) is entirely in or entirely out of the set. Take A = [0,1/4]. P(A}) = ¼, but the sup there is 0.

(2) Counterexample to claim directly preceding Theorem 4.5 on p. 1795: Let $\mathcal{U}$ be an ultra-filter on ℕ, containing all finite subsets. Let, for A ⊂ ℕ, P(A) = 0 if A ∈ $\mathcal{U}$, P(A) = 1 if A ∉ $\mathcal{U}$. Let ≽ be represented by P. ℕ itself is an atom, provides the finite (one-element!) partition into atoms, but ≽ is not monotonely continuous and we have no qualitative probability σ-algebra.

Theorem 4.2 shows that a finitely additive probability measure is countably additive if and only if the generated qualitative probability relation satisfies what I often call set continuity, and what Villegas calls monotonce continuity. Theorem 4.3 p. 1794 is the main representation theorem. %}

Villegas, Cesáreo (1964) “On Quantitative Probability σ-Algebras,” *Annals of Mathematical Statistics* 35, 1787–1796. https://doi.org/10.1214/aoms/1177700400

{% **ordering of subsets** %}
Villegas, Cesáreo (1967) "On Qualitative Probability," *American Mathematical Monthly* 74, 661–669.

{% Shows that Gorman's (1968) famous theorem only needs connectedness and not arc-connectedness. %}
Vind, Karl (1971) "Note on "The Structure of Utility Functions" " and "Comment," *Review of Economic Studies* 38, 113 and 115.
https://doi.org/10.2307/2296626

{% %}
Vind, Karl (1974) "A Note on a Four-Flagged Lemma," *Review of Economic Studies* 41, 571.
https://doi.org/10.2307/2296707

{% %}
Vind, Karl (1990) "Additive Utility Functions and Other Special Functions in Economic Theory," (with contributions by Birgit Grodal), Discussion paper 90–21, Institute of Economics, University of Copenhagen, Denmark.

{% **endogenous midpoints**
P. 120 figure: this is triple cancellation
P. 120 last para: sort of unrestricted solvability is involved
P. 122 penultimate para seems to need the conditions globally, rather than locally as they are assumed. The conclusion section, p. 134 beginning of 2nd para, claims that the conditons are only needed locally but I doubt it.
P. 125: the Reidemeister condition involves indifferences rather than preferences as the case here. %}
Vind, Karl (1991) "Independent Preferences," *Journal of Mathematical Economics* 20, 119–135.

{% %}
Vind, Karl (1992) "Uncertainty," Institute of Economics, University of Copenhagen, Copenhagen.

{% A very abstract and general, so, not-very-specific, extension of vNM EU, dropping transitivity and completeness. Theorems give sufficient, but apparently not necessary, conditions. %}

Vind, Karl (2000) "von Neumann Morgenstern Preferences," *Journal of Mathematical Economics* 33, 109–122.

{% So here then is, at long last, the book containing Vind's result on mean groupoids. A first version appeared as a working paper in 1969! Now, shortly before the anticipated passing away of Karl's co-author and life-long friend Birgit Grodal, the book went public.

endogenous midpoints: Mean groupoid means an endogenous subjective utility-midpoint operation, giving a grip on cardinal utility. Here is how it works under subjective expected utility, with E denoting an event, and $x_{1_E}x_2$ the act yielding outcome x_1 under event E and outcome x_2 otherwise. Then y is the utility midpoint between x and z if the following indifferences hold:

$$x \sim x_{1_E}x_2,\ z \sim z_{1_E}z_2, \text{ and } x_{1_E}z_2 \sim z_{1_E}x_2 \sim y.$$

The method holds under prospect theory if we add the requirement that $x_1 > x_2$, $x_1 > z_2$, $z_1 > z_2$, and $z_1 > x_2$, assuming only gains.

It provides an appealing and powerful tool to axiomatize many decision models. Basically, it is an alternative, and close relative, to the tradeoff technique that I often used and that is close to the standard sequence approach of Krantz et al. (1971). Current (2019) generations do not use such knowledge, because of which they work with the Anscombe-Aumann framework which amounts to assuming linear utility. Vind is more general than others in relaxing completeness and transitivity. In this respect he is close to Fishburn, who used similar techniques for relaxing transitivity in his papers on skew-symmetric bilinear utility.

One thing I never understood in the maths of mean groupoids. When the mean groupoid operation is transferred from elements to indifference classes, how is continuity maintained? Shouldn't this require some uniform continuity at the level of elements? %}

Vind, Karl (2003) "*Independence, Additivity, Uncertainty.*" With contributions by Birgit Grodal. Springer, Berlin.

{% In personal communication I (Peter Wakker) told Ghirardato, Maccheroni, Marinacci, Siniscalchi, and Vind, shortly after appearance of the Econometrica paper of the former 4 authors in 2003, that Karl Vind had found an alternative endogenous midpoint operation before. Karl then put this into writing, shortly before he died. %}

Vind, Karl (2004) "Midpoints and Biseparable Preferences," working paper.

{% **Dutch book**; P. 186: "The consequence of suffering a sure loss at the hands of a clever bookie is sometimes the best alernative in the long run" %}

Vineberg, Susan (1997) "Dutch Books, Dutch Strategies and What They Show About Rationality," *Philosophical Studies: An International Journal for Philosophy in the Analytical Tradition* 86, 185–202.

{% **real incentives/hypothetical choice**: Argue that instead of real incentives, other motives such as altruism and curiosity can be just as effective. Support it by a web experiment with no real incentives. Subjects who drop out before the end are taken to be badly motivated, and those who finish are taken to be well motivated. Then there is a usual control group of students with real incentives. They find that the well-motivated hypothetical students are not different from the incentivized, but the poorly-motivated are. To implement this idea, problem is how to get intrinsically motivated subjects.

they write p. 307 2nd column 2nd para: "Our main hypothesis is that non-monetary factors like curiosity and altruism provide adequate and non-distortionary incentives."

The particular test where they show the above things is the standard Ellsberg urn, where they find things as usual. A weak point is that the study is thin, basically having a one-point observation. %}

Vinogradov, Dmitri & Elena Shadrina (2013) "Non-Monetary Incentives in Online Experiments," *Economics Letters* 119, 306–310.

{% %}

Viscusi, W. Kip (1979) "*Employment Hazards: An Investigation of Market Performance.*" Harvard University Press, Cambridge, MA.

{% **inverse S**; we perceive probability distributions as a convex mix of what the probabilities really are, and the uniform distribution. Reminiscent of Parducci's range-frequency theory.

biseparable utility %}

Viscusi, W. Kip (1989) "Prospective Reference Theory: Toward an Explanation of the Paradoxes," *Journal of Risk and Uncertainty* 2, 235–264.

{% **paternalism/Humean-view-of-preference**: Last paragraph of paper (p. 108) is relevant, not only to insurance but to the whole decision theory. It points out that not only the existence of biases and deviations from rationality should be signaled but a better sense of the magnitudes of these is needed so as to mitigate these inadequacies:

"These results suggest that examination of theoretical characteristics of biases in decisions resulting from irrational choices of various kinds should not be restricted to the theoretical explorations alone. We need to obtain a better sense of the magnitudes of the biases that result from flaws in decision making and to identify which biases appear to have the greatest effect in distorting individual decisions. Assessing the incidence of the market failures resulting from irrational choices under uncertainty will also identify the locus of the market failure and assist in targeting government interventions intended to alleviate these inadequacies."

Also argues (p. 107, conclusion, first phrase) that most aspects of insurance are based on probability perception: "Most aspects of risk taking and insurance-related decisions hinge on the relationship between the perceived probability by the individual and the actual risk." %}

Viscusi, W. Kip (1995) "Government Action, Biases in Risk Perception, and Insurance Decisions," *Geneva Papers in Risk and Insurance Theory* 20, 93–110.

{% **Z&Z** Finds that in aggregating different sources of info about risk, subjects overweight the worst case prediction. P. 1667 calls subjects "informationally risk-averse" and writes "This phenomenon is, however, independent of the shape of individual preferences and the presence of risk aversion for changes of wealth." %}

Viscusi, W. Kip (1997) "Alarmist Decisions with Divergent Risk Information," *Economic Journal* 107, 1657–1670.

{% For moderate impaired health states, monetary equivalents can be formulated. Not so for seriously impaired health states, because they impact the utility of money. %}

Viscusi, W. Kip (2019) "Utility Functions for Mild and Severe Health Risks," *Journal of Risk and Uncertainty* 58, 143–166.

{% **inverse S**; **ambiguity seeking for losses**: Finds ambiguity seeking for "likely" ambiguous losses, ambiguity aversion for unlikely ambiguous losses. The crossover point is at approximately .5. Complication is here that it is risk per time unit, risks per 10 years were given.

Coastal North Carolina 266 business owners and managers, for risks of storm damages (risk per 10 years was given). Ambiguous probabilities were generated by conflicting expert estimates of a risk. For example, one expert estimates p = .5 and the other p = .1, etc. P. 158 points out that this way of generating ambiguity is more "real-world" than urn games etc. (**natural sources of ambiguity**).

P. 175 states explicitly that ambiguity aversion/seeking is irrational: "The findings presented in this paper suggest that the presentation of the risk as a mean will lead to more *rational* risk perceptions …more closely accord with a *rational* Bayesian learning process." [my italics]

reflection at individual level for ambiguity: only losses, so, they do not consider it. %}

Viscusi, W. Kip & Harrell W. Chesson (1999) "Hopes and Fears: The Conflicting Effects of Risk Ambiguity," *Theory and Decision* 47, 153–178. https://doi.org/10.1023/A:1005173013606

{% **updating under ambiguity with sampling**; Two-armed bandit. Only, after first loss, game immediately stops (≈ dead). Subjects reactions to changes of parameters in the decision problems give a mix of rationality and irrationality. The most remarkable irrationality is that subjects do not improve their performance in repeated games, but continue to be as irrational as at the beginning. In this game, somewhat seemingly paradoxical, the more ambiguity the better, because with more ambiguity there is more to learn. The authors write: "Despite the asymmetric nature of the learning process, ambiguity and learning are consequential. In particular, for any given mean probability of success, greater ambiguity is desirable. Increases in ambiguity with respect to the probability of success offer greater opportunities for long-term gains because of the greater chance that the underlying probability of success for that option offers a high chance of success on each trial (Viscusi 1979; Berry and Viscusi 1981)." (p. 226) %}

Viscusi, W. Kip & Scott DeAngelis (2018) "Decision Irrationalities Involving Deadly Risks," *Journal of Risk and Uncertainty* 57, 225–252.

{% %}

Viscusi, W. Kip & William N. Evans (1990) "Utility Functions that Depend on Health Status: Estimates and Economic Implications," *American Economic Review* 80, 353–374.

{% **natural sources of ambiguity**:
inverse S: Reanalyze data of their 1990 paper on chemical workers' risk perceptions and decisions. Analyzed judged probabilities but also decision weights derived from decisions (so, the two-stage model), finding that the decision weights depended on the stated probabilities through the usual inverse S relationship. Their curve fit found decision weights never below 0.10 and never above 0.49, so that the inverse S is very strong. They jointly fit decision weights and utility, with utility results being plausible. They seem to find that neo-additive weighting function fits well. %}

Viscusi, W. Kip & William N. Evans (2006) "Behavioral Probabilities," *Journal of Risk and Uncertainty* 32, 5–15.

{% Study WTP-WTA discrepancy. Consider not only the case where an outcome changes and one pays/is paid for that change, but also the case where a probability (of health risk) changes and one pays/is paid for that change. Propose a model where loss aversion as well applies to probability level, with an increase in probability (which is unfavorable and is a loss) weighted more than the corresponding decrease. Standard reference dependence as in prospect theory cannot model the latter because they only concern changes in outcome. I think that standard reference dependence can handle it if we take a two-stage probability model with backward induction (certainty equivalent substitution), where first-stage probabilities may be 1.

They find that reference dependence for outcomes is stronger than for probabilities. For adversarial probabilities it is only if they decrease, not it they increase. That is, there is an interaction. The authors can nicely rule out income effects in their large 2008-2009 national sample. %}

Viscusi, W. Kip & Joel Huber (2012) “Reference-Dependent Valuations of Risk: Why Willingness-to-Accept Exceeds Willingness-to-Pay,” *Journal of Risk and Uncertainty* 44, 19–44.
https://doi.org/10.1007/s10797-006-6663-6

{% Subjects are ambiguity averse to low probability losses. People are asked, hypothetically, if they rather move to area A or B. The areas are the same as where they live now, only because of a particular pollution one kind of disease has different likelihood. About area A they receive two conflicting pieces of evidence, next the objective probability in area B that gives equivalence is established; i.e., the matching probability. There is between-subject income dependence, in that it is different for rich than for poor people. The authors consider both event-based and outcome-based (unfortunately, the authors often call the latter preference-based) ambiguity models (**ambiguous outcomes vs. ambiguous probabilities**), but, as they indicate in several places (e.g. p. 385 top) their data cannot distinguish between the two.

P. 376 Eq. 7: Take difference between a-neutral probability (my term) and matching probability as index of ambiguity aversion. Was also done by Kahn & Sarin (1988).

P. 383 4th para indicates cognitive limitations underlying deviation from ambiguity neutrality, something about people paying more attention to investigation presented first without rational reason. (**cognitive ability related to risk/ambiguity aversion**)

suspicion under ambiguity: p. 380 indicates that Ellsberg urn may reflect that subjects think that the unknown urn is manipulated against them, rather than ambiguity attitude.

reflection at individual level for ambiguity: only losses, so, they do not consider it.

natural sources of ambiguity: Several places, e.g. p. 385 last para of main

text, points out that they deal with natural events, although they do not strongly plea for the importance of doing this. %}

Viscusi, W. Kip & Wesley A. Magat (1992) "Bayesian Decisions with Ambiguous Belief Aversion," *Journal of Risk and Uncertainty* 5, 371–387. https://doi.org/10.1007/BF00122576

{% If probabilistic information coming from Environmental Protection Agency is stated more vaguely then subjects get more suspicious and estimate risks higher. %}

Viscusi, W. Kip, Wess A. Magat & Joel Huber (1991) "Pricing Environmental Health Risks: Survey Assessments of Risk-Risk and Risk-Dollar Trade-Offs for Chronic Bronchitis," *Journal of Environmental Economics and Management* 21, 32–51.

{% %}

Viscusi, W. Kip, Wesley A. Magat, Alan Carlin, & Mark K. Dreyfus (1994) "Environmentally Responsible Energy Pricing," *Energy Journal* 15, 23–42.

{% Estimates biases in estimates of statistical values of lifes in big international data sets and then corrects for those. The authors write: "In much the same way that anchoring influences and reference point effects affect economic behavior generally (Tversky and Kahneman 1974; Kahneman and Tversky 1979), the U.S. evidence establishes a reference point for subsequent international studies." %}

Viscusi, W. Kip & Clayton Masterman (2017) "Anchoring Biases in International Estimates of the Value of a Statistical Life," *Journal of Risk and Uncertainty* 54, 103–128.

{% %}

Viscusi, W. Kip & Mike J. Moore (1989) "Rates of Time Preference and Valuations of the Duration of Life," *Journal of Public Economics* 38, 297–317.

{% **updating under ambiguity with sampling**; Seem to indicate a situation where ambiguous risks are preferable, however, in a complex situation with learning etc. involved. %}

Viscusi, W. Kip & Charles O'Connor (1984) "Adaptive Responses to Chemical Labeling: Are Workers Bayesian Decision Makers?," *American Economic Review* 74, 942–956.

{% If individuals take individual risky decisions but they are in a group, then the decisions taken by the others greatly influence those decisions.
gender differences in risk attitudes: no differences %}

Viscusi, W. Kip, Owen R. Phillips, & Stephan Kroll (2011) "Risky Investment Decisions: How Are Individuals Influenced by Their Groups?," *Journal of Risk and Uncertainty* 43, 81–106.

{% Ask a sample from the general public how they think about uncertainties regarding climate change, described as: (1) imprecision and uncertainty in theories and measurement instruments; (2) disagreement between experts; (3) unknown consequences due to complexity of climate models (p. 46 2nd column 2nd para). In several places, e.g. p. 44 §1.1, the authors seem to equate ambiguity with low level of info, reflecting a common misunderstanding. Ambiguity is the distance of state of information to a probabilized state of information, and not a general index of quality of information. A state of known probability can, by increase of information, turn into a state of ambiguity (dilation). %}

Visschers, Vivianne H.M. (2018) "Public Perception of Uncertainties within Climate Change Science," *Risk Analysis* 38, 43–55.

{% **probability communication**: This is exactly the survey that I searched for for many years. Although the paper focuses on communicating risk to the general public, rather than on how to explain probabilities in experiments (my main interest), it nevertheless covers studies on the latter also. The paper focuses on risks on health or technological accidents that could harm health. %}

Visschers, Vivianne H.M., Ree M. Meertens, Wim W.F. Passchier, & Nanne N.K. de Vries (2009) "Probability Information in Risk Communication: A Review of the Research Literature," *Risk Analysis* 29, 267–287.

{% November 2020: "Geen enkel geloof of levensbeschouwing als geheel mag worden aangesproken op de acties van een kleine groep." %}

Visser 't Hooft Lyceum (2020)

{% **Z&Z**; report data summarized from the 1987 National Medical Expenditure Survey that reveal that 26% of Medicare beneficiaries bought supplementary insurance to obtain complete coverage

P. 316: "beneficiaries in good or fair health are seven percentage points more likely to purchase insurance than those in poor health." ??? Isn't this the opposite of adverse selection??? %}

Vistnes, Jessica P. & Jessica S. Banthin (1997/98) "The Demand for Medicare Supplemental Insurance Benefits: The Role of Attitudes toward Medical Care and Risk," *Inquiry* 34, 311–324.

{% Marinacci wrote to me: "about the article that in the 1920s dealt with nonadditive integration, the author is the famous analyst (the same who came up with the first nonmeasurable set, the Vitali lemma, the Vitali-Hahn-Saks theorem, etc.). He considered the special case of inner and outer measure on the real line, and defined a notion of integral relative to them that looked to me close to that of Choquet for general nonadditive measures." This was later written in Marinacci (1997). %}

Vitali, Giuseppe (1925) "Sulla Definizione di Integrale delle Funzioni di una Variabile," *Annali di Matematica Pura ed Applicata* 4, 111–121.

{%

P. 7, nicely, mentions that people's recent experience with risk "leaks" into their current perception of objective risks. P. 7 2nd column also points out that same objective probabilities in different contexts generate different behavior, which violates the fundamental assumption of decision under risk and suggests a source preference idea, be it that the literature on source preference usually assumes that risk is one source. (**violation of risk/objective probability = one source**)

P. 8 ℓ. 1, on possible applications of their work: "These issues are likely to be of central importance in the development of the *next generation* of financial services." [italics added]

Conclusion writes that the goal of our cognitive system is to flexibly adapt to dynamic environments, with many positive adjectives added, and then suddenly targets on classical approaches with context-independence and transitivity

(apparently transitivity is also a target of their criticisms). To end with psychologists' favorite conclusion: context-dependence (i.e., everything depends on everything).

gender differences in risk: no difference %}

Vlaev, Ivo, Petko Kusev, Neil Stewart, Silvio Aldrovandi, & Nick Chater (2010) "Domain Effects and Financial Risk Attitudes," *Risk Analysis* 30, no. http://dx.doi.org/10.1111/j.1539-6924.2010.01433.x

{% %}

Vlek, Charles A.J. (1987) "Towards a Dynamic Structural Theory of Decision Behavior?," *Acta Psychologica* 66, 225–230.

{% Seems to be: d**ecision under stress**: chapter about risk management and acceptance, with sections about "protection motivation theory" and "emotional significance of risk". %}

Vlek, Charles A.J. (2004) "Environmental versus Individual Risk Taking: Perception, Decision, Behavior." *In* Charles D. Spielberger (ed.) *Encyclopedia of Applied Psychology*, Volume 1, 825–840, Elsevier, Amsterdam.

{% Many countries, the Netherlands and the UK primarily, have national risk assessment programs, for assessing risks of natural and other catastrophes. %}

Vlek, Charles (2013) "How Solid Is the Dutch (and the British) National Risk Assessment? Overview and Decision-Theoretic Evaluation," *Risk Analysis* 33, 948–971.

{% %}

Vlek, Charles A.J. & Lauri Hendrickx (1988) "Statistical Risk versus Personal Control as Conceptual Bases for Evaluating (Traffic) Safety." *In* Talib Rothengatter & Rudie A. de Bruin (eds.) *Road user Behavior: Theory and Research*. Van Gorcum, Assen.

{% Do priming experiments such as letting subjects wait with screen saver either displaying money or other things. Then let supposedly unrelated person (but in fact experimenter; there is deception everywhere in these experiments)

supposedly by accident drop pencils, and measure to what extent the primed subjects help pick up the pencils; or donate supposedly to some good purpose. People primed with money less help other people and more like to stay on their own. %}

Vohs, Kathleen D., Nicole L. Mead, & Miranda R. Goode (2006) "The Psychological Consequences of Money," *Science* 314, 17 Nov, 1154–156.

{% It is dangerous to be right in matters about which the established authorities are wrong. %}

Voltaire (1751) "*The Age of Louis XIV*."

{% %}

Völckner, Franziska (2006) "An Empirical Comparison of Methods for Measuring Consumers' Willingness to Pay," *Marketing Letters* 17, 137–149.

{% **dynamic consistency**: shows that, given dynamic consistency and one of consequentialism and RCLA, the other is equivalent to independence. %}

Volij, Oscar (1994) "Dynamic Consistency, Consequentialism and Reduction of Compound Lotteries," *Economics Letters* 46, 121–129.

{% **dynamic consistency**, distinguishes preference from choice and considers what happens if there are indifferences. %}

von Auer, Ludwig (1999) "Dynamic Choice Mechanisms," *Theory and Decision* 46, 291–308.

{% **bisection > matching**: this later Nobel-prize winner in fact used a bisection method to study hearing perception %}

von Békésy, Georg (1947) "A New Audiometer," *Acta Otolaryngology* 35, 411–422.

{% **discounting normative**: Strotz refers to p. 253–255 for zero discounting.

tradeoff method: When discussing Cuhel's work, Böhm-Bawerk seems to observe that multiplication is only a special case of summation, namely summation of equal quantities. Nice point to link my Hölder lemma techniques to mixture-space techniques. %}

von Böhm-Bawerk, Eugen (1889) "*Positive Theorie des Kapitals*, Vol. II.;" 4th edn.; translated by George D. Huncke & Hans F. Sennholz (1959) "Capital and Interest, Vol. II, Positive Theory of Capital, Book IV, §I, pp. 257–289, Libertarian Press, South Holland, IL.

{% **foundations of probability** %}
von Furstenberg, George M. (1990, ed.) "*Acting under Uncertainty: Multidisciplinary Conceptions*." Kluwer Academic Publishers, Dordrecht.

{% It uses the choice list to find indifferences between two-outcome gain prospects.

1. MAIN FINDING

Uses the representative Dutch LISS panel with N = 1422 subjects. It nicely tests Kreps & Porteus (1978), by having payment in three months, but resolving the uncertainty immediately or in three months. Will not find serious differences here (**source-dependent utility**: not found). The further main findings presented are that there are no clear predictions from demographics or otherwise because of unobserved heterogeneity of risk attitude.

2. SOME KEYWORDS

real incentives/hypothetical choice & random incentive system between-subjects: One group did hypothetical choice, and one group had real incentives, with one of every 10 subjects paid. (There was also a group with small real incentives.) No differences are found, also not in choice errors (p. 681).

losses from prior endowment mechanism: this they do.

P. 677: they use the good econometric technique of Conte, Hey, & Moffatt (2011).

concave utility for gains, convex utility for losses: this paper does not provide evidence on this topic (see below).

3. THEORETICAL ANALYSIS AND ITS LIMITATIONS

The authors consider risky choices with payments in 3 months, and two treatments (within-subject): either the uncertainty is resolved immediately (treatment 1) or in 3 months (treatment 2). They assume PT without probability weighting and with a fixed reference point 0. That is, they assume expected utility with a kink of utility at 0 (loss aversion). Then they test whether utility in one treatment is more or less conave than in the other, to test Kreps & Porteus

(1978). For treatment 2, late resolution, they assume exponential utility $-e^{-\gamma z}$, with the same γ for gains and losses (discussed below), and loss aversion added by multiplying loss utility by λ (adding the appropriate constant to have continuity at 0); see their Eq. 2. (Their function h in the second line of Eq. 3 can be dropped.) For treatment 1, early resolution, they also assume, in my notation, exponential utility $-e^{-\gamma' z}$. Then $\gamma' > \gamma$ gives more concave utility, and thus less preference, for early resolution. The authors use γ'/γ as an index. Because of this division by γ, effects depend on the sign of γ. Thus for $\gamma > 0$, a large ratio means preference for late resolution, and for $\gamma < 0$ it is the other way around. The authors therefore impose the following restrictions:

(1) They do not allow a sign-change between γ and γ'. In particular, for $\gamma = 0$ (linear utility) they allow no difference between early and late resolution.

(2) They assume the same loss aversion in both treatments. (Loss aversion is a substantial part of utility curvature and in general Kreps-Porteus comparisons would have to be incorporated in the comparison.)

(3) For positive γ and γ' they take the ratio $\gamma'/\gamma = \rho$ as index of preference for late resolution (Eq. 8, p. 691).

(4) For negative γ and γ' they take the ratio $\gamma/\gamma' = \rho$ (so, here γ is different than, reciproke to, the one for positive γ, γ') as index of preference for late resolution (Eq. 8, p. 691).

The particular way of comparing concavity of utility chosen by the authors imposes a further restriction, the most serious one, being

(5) Utility must have the same γ for gains as for losses (mentioned above), and also the same γ' for gains and for losses. Hence, it must either be concave for both gains and losses, or convex for both, and the majority pattern of utility, concave for gains and convex for losses, cannot be considered. Especially this last restriction imposes a limitation on the empirical relevance of the findings of this paper, and they should be taken only within this modeling assumption.

P. 665 end of 1st para: for further studies measuring loss aversion by measuring utility and then a kink at 0, see Abdellaoui, Bleichrodt, & Paraschiv (2007) and their references.

4. THE FINDINGS GIVEN THE THEORETICAL MODEL

P. 666 end of penultimate para & p. 683: demographic variables do not explain much variance in risk attitudes; pp. 684-685 discusses relations found. P. 684: "The individual choices thus contain much more information than what is captured by sociodemographic goups."

gender differences in risk attitudes: pp. 684-685: women are more loss averse.

It finds utility -exp(−0.032α) where the unit if money α is, I guess, euro (given the Dutch population). It means that the risk tolerance is €30. Risk tolerance α means, for instance, that a gamble (0.5:2α, 0.5: −α) is neutral (equivalent to not gambling), giving a nice and well-known interpretation to the utility parameters. The authors do not use this interpretation (p. 680 beginning of 3rd para; p. 682 ℓ. 3), but instead use risk premiums that, of course, depend on the prospects chosen.

Loss aversion is $\lambda = 2.38$. They find 8% inconsistency (p. 680), which is less than usual (**inconsistency in repeated risky choice**). The choice list method may have enhanced consistent choice.

It, nicely, finds that loss aversion is most volatile (p. 681), and utility is less volatile (p. 686 middle).

5. TOPIC FOR FUTURE RESEARCH

An obvious topic for future research is modifications of the above utility restrictions, for example by comparing differences rather than ratios of the Pratt-Arrow indexes γ and γ´, or even better, differences of their reciprokes, being risk tolerances, or by using other concave transformations such as exponential (leading to expexp utility for early resolution) to relate the utilities of the two treatments to more easily handle sign-dependence, or by separate comparisons for gains and for losses, preferably by also allowing for different loss aversion and then comparisons between those.

6. ALTERNATIVE UTILITY SPECIFICATIONS ANALYZED IN THE WEB APPENDIX

The web appendix pp. 4 ff. discusses alternative utilities. Unlike what was suggested in the main text, they do not really consider the utility function common in PT (see their Eqs. 11 & 12). Common in PT, if taking only one parameter for basic utility (= utility without the loss aversion parameter), is to take reflected utility, with:

for x < 0, u(x) = –u(–x) (*)

The authors use this formula only if utility is concave for gains. If utility for gains is convex then they add a flip, and let utility for losses be convex rather than concave by multiplying the exponential parameter by –1 for losses. (Their claim that prospect theory is silent on convex functions for gains, on p. 4 ℓ. –5 of the web appendix, I did not understand.) Thus, for losses, gamma and -gamma give the same utility function, and for losses no concave utility is possible. This is an unconventional model of utility that I haven't seen before. This paper finds that it does not perform well.

P. 669 seems to point out that their adaptive measurement is not incentive compatible.

P. 681: more noise for LISS panel than for students. %}

von Gaudecker, Hans-Martin, Arthur van Soest, & Erik Wengström (2011) "Heterogeneity in Risky Choice Behavior in a Broad Population," *American Economic Review* 101, 664–694.

{% **losses from prior endowment mechanism; random incentive system between-subjects** (paid 1 of every 10 subjects in the real incentive treatment)

Measure risk attitudes in usual ways, using choice lists and a variation of Binswanger (1981), with a student sample and a CentER panel data set representative of the general population. There are considerable differences between the students and the population, showing that the external validity of student experiments is questionable. Self-selection is less of a problem. Risk aversion and loss aversion is much larger in the general population than with students. They use usual PT parameter estimations as in their 2011 American Economic Review paper, but do not report their results here; for that see American Economic Review. %}

von Gaudecker, Hans-Martin, Arthur van Soest, & Erik Wengström (2012) "Experts in Experiments: How Selection Matters for Estimated Distributions of Risk Preferences," *Journal of Risk and Uncertainty* 45, 159–190.

{% **natural sources of ambiguity**: finance and climate change.

They use the method of Baillon, Huang, Selim, & Wakker (2018 Econometrica) to measure ambiguity attitudes. That is, they measure matching probabilities to measure ambiguity attitudes, both regarding ambguity aversion and ambiguity attitudes. The experimental implementation is impressive, using the marvelous LISS panel. They use high real incentives (€51 per hour), a very big sample N = 2200), good stimuli measuring ambiguity attitudes both for finance uncertainty and for temperature change, measuring risk aversion, many demographic variables, info about potfolio decisions, and they use solid statistical analysis techniques.

They find roughly four types, each about 20%, being subjective expected utility maximizers, likelihood insensitive subjects with considerable ambiguity aversion, likelihood insensitive subjects with moderate ambiguity seeking (**ambiguity seeking**:), and highly noisy subjects.

The paper finds similar ambiguity aversion and choice errors for finance and temperature change, suggesting person-dependence but source independence of these. Insensitivity depends on both.

Intelligence is negatively related with ambiguity attitudes and risk aversion (**cognitive ability related to risk/ambiguity aversion**).

It is encouraging that the parameters measured are stable over time. Also that the ambiguity indexes better predict portfolio decisions than risk attitude indexes, although this may also be because risk aversion measurements involved fewer observations.

correlation risk & ambiguity attitude: ambiguity neutrality (called near-SEU by the authors in the Nov’22 version of the paper but it should be near-ambiguity neutral) brings low risk aversion, and both ambiguity aversion and seeking bring more risk aversion. S, insensitivity brings risk aversion, and not so much ambiguity aversion or seeking.

It would have been very interesting if the authors had measured insensitivity not only w.r.t. ambiguity, but also for risk attitudes where it similarly is central. %}

von Gaudecker, Hans-Martin, Axel Wogrolly, & Christian Zimpelmann (2022) “The Distribution of Ambiguity Attitudes,” working paper.

{% Had a first version of Hölder's (1931) theorem. May be credited as a (the?) first to do representation, measurement theory, and axiomatization. %}

von Helmholtz, Hermann (1887) "Zäthlen und Messen Erkenntnis-Theoretisch Betrachet," *Philosophische Aufsatz Eduard Zeller gewidmet*, Leipzig. Reprinted 1895 in *Wissenschaftliche Abhandlungen* 3, 356–391. Translated into English by Charlotte Lowe Bryan (1895), *Counting and Measuring*, Van Nostrand, Princeton, NJ:, 1930.

{% **probability elicitation** %}

Staël von Holstein, Carl-Axel S. (1972) "Probabilistic Forecasting: An Experiment Related to the Stock Market," *Organizational Behaviour and Human Performance* 8, 139–158.

{% P. 18 seems to write: "Human action is necessarily always rational. The term "rational action" is therefore pleonastic and must be rejected as such. When applied to the ultimate ends of action, the terms rational and irrational are inappropriate and meaningless. The ultimate end of action is always the satisfaction of some desires of the acting man." %}

von Mises, Ludwig (1949) "*Human Action.*" Ludwig von Mises Institute, Auburn, Alabama.

{% Seems to write on p. 11, translated: "We can say nothing about the probability of death of an individual even if we know his condition of life and death in detail. The phrase 'probability of death,' when it refers to a single person, has no meaning at all for us." The claim is true for a strict frequentist interpretation, but is very false for every interpretation that I like. %}

von Mises, Richard (1928) "*Wahrscheinlichkeit, Statistik, und Wahrheit.*" Springer, Berlin. (Translated into English in 1939 as "Probability, Statistics and Truth," Hodge, London. Republished in 1957 by Allen & Unwin.)

{% %}

von Mises, Richard (1957) "*Probability, Statistics, and Truth.*" Allen & Unwin, London.

{% Seems to have shown that mixed Nash-equilibrium already exists in noncooperative game theory if preferences are quasi-concave w.r.t. probabilistic mixing. See also Debreu (1952 §4). %}

von Neumann, John (1928) "Zur Theorie der Gesellschaftsspiele," *Mathematische Annalen* 100, 295–320.

{% P. 8 (on unit of exchange between players): "substitutable, freely transferable and identical, even in the quantitative sense, with whatever 'satisfaction' or 'utility' is desired by each participant."

Pp. 8-9 write, about utility being a theoretical construct but then becoming as real as energy: "It is sometimes claimed in the economic literature that discussions of the notions of utility and preference are altogether unnecessary, since these are purely verbal definitions with no empirically observable consequences, i.e., entirely tautological. It does not seem to us that these notions are qualitatively inferior to certain well established and indispensable notions in physics, like force, mass, charge, etc. That is, while they are in their immediate form merely definitions, they become subject to empirical control through the theories which are built upon them—and in no other way."

game theory can/cannot be viewed as decision under uncertainty: p. 11 (that no probabilities should be assigned to strategy choices of others): "One would be mistaken to believe that it can be obviated, like the difficulty in the Crusoe case ... by a mere recourse to the devices of the theory of probability. Every participant can determine the variables which describe his own actions but not those of the others. Nevertheless those "alien" variables cannot, from his point of view, be described by statistical assumptions. This is because the others are guided, just as he himself, by rational principles-whatever that may mean-and no *modus procedendi* can be correct which does not attempt to understand those principles and the interactions of the conflicting interests of all participants." [italics from original]

risky utility u = strength of preference v: Ch. 3 writes in the spirit of utility being one concept, and not that there are various concepts of utility, but it is not explicit.

independence/sure-thing principle due to mutually exclusive events: §3.3.2, p. 18, mutual exclusiveness of events to avoid complementarity is emphasized (see also p. 628). They write, on the 50-50 probabilistic mix of B and C: "We stress that the two alternatives are mutually exclusive, so that no possibility of complementarity and the like exists."

risky utility u = strength of preference v: §3.3 writes that with probabilities available, we can give meaning to utility difference comparisons. Their term utility difference does not mean that they commit to the interpretations of riskless strength of preference.

§3.3.2, p. 18, footnote 3 describes the probability equivalent method to elicit U.

P. 19 (on incompleteness of preference): "It is conceivable—and may even in a way be more realistic—to allow for cases where the individual is neither able to state which of two alternatives he prefers nor that they are equally desirable"

P. 19 footnote 3 announces the Savage (1954) work: "If one objects to the frequency interpretation of probability then the two concepts (probability and preference) can be axiomatized together."

P. 20 footnote 1: "Points on the same indifference curve *must be identified* and" [italics added] This is part of how independence slips in into their analysis implicitly.

Pp. 23-24: they seem to write that their utility differences have no primitive meaning.

PP. 24-25, §3.5.1: utility is treated as an abstract concept, yet to be quantified. P. 29 will make it numerical; see below.

P. 26, §3.6: antisymmetry is assumed on preferences over utility, which is part of how independence slips in into their analysis implicitly.

P. 29 "we feel free to make use of a numerical concept of utility."

P. 32: Here is a text of vNM (already in the 44 version) that captures some of Nash's equilibrium. It still is different because it does not consider individual deviations but, apparently, also joint deviations by subgroups, which makes the concept less interesting, and more like the CORE:

"Second, and this is even more fundamental, the rules of rational behavior must provide definitely for the possibility of irrational conduct on the part of others. In other words: Imagine that we have discovered a set of rules for all participants to be termed as "optimal" or "rational" each of which is indeed optimal provided that the other participants conform. Then the question remains as to what will happen if some of the participants do not conform. If that should turn out to be advantageous for them and, quite particularly, disadvantageous to the conformists then the above "solution" would seem very questionable. We are in no position to give a positive discussion of these things as yet but we want to make it clear that under such conditions the "solution," or at least its motivation, must be considered as imperfect and incomplete. In whatever way we formulate the guiding principles and the objective justification of "rational behavior," provisos will have to be made for every possible conduct of "the others." Only in this way can a satisfactory and exhaustive theory be developed. But if the superiority of "rational behavior" over any other kind is to be established, then its description must include rules of conduct for all conceivable situations including those where “the others” behaved irrationally, in the sense of the standards which the theory will set for them. [underlining added].”

P. 66-84: description of decision trees

game theory can/cannot be viewed as decision under uncertainty: P. 99 seems to write: “from the point of view of player I who chooses a variable … the other variable can certainly not be considered as a chance event. The other variable … is dependent upon the will of the other player, which must be regarded in the same light of “rationality” as his own.”

P. 604 writes: “We have ... assumed that it [utility] is numerical ... but also that it is substitutable and unrestrictedly transferable between the various players.”

P. 617, §A.1.2: We do not axiomatize the relation =, but interpret it as *true identity*. [italics from original] This is part of how independence slips in into their analysis implicitly.

independence/sure-thing principle due to mutually exclusive events: P. 628, Remark A3.2 mutual exclusiveness of events to avoid complementarity is emphasized (see also p. 18). They write: “A.3.2. The first one [remark] deals with the relationship between our procedure and the concept of complementarity. Simply additive formulae, like (3:1:b) [$V(\alpha u + (1-\alpha)v) = \alpha V(u) + (1-\alpha)U(v)$], would seem to indicate that we are assuming absence of any form of complementarity between the things the utilities of which we are combining. It is important to realize, that we are doing this solely in a situation where there can indeed be no complementarity. As pointed out in the first part of 3.3.2, our u, v are the utilities not of definite—and possibly coexisiting—goods or services, but of imagined events. The u,v of (3:1:b) in particular refer to alternatively conceived events u,v, of which only one can and will become real. I.e. (3:1:b) deals with either having u (with the probability α) or v (with the remaining probability $1 - \alpha$)—but since the two are in no case conceived as taking place together, they can never complement each other in the ordinary sense.”

P. 631 (**risky utility u = strength of preference v**): “The reader will also note that we are talkinhg of entities like “the excess of v over u” or … merely to facilitate the verbal discussion—they are not part of our rigorous, axiomatic system.

P. 632 “how one should treat situations that involve probabilities, which are inevitably associated with expected utility.” Suggests a bit, just a bit, that they take EU for risk as normative.

biseparable utility: for their EU

Moscati (2019) writes that the EU axiomatization was done on 14 April 1942, and that Morgenstern noted in his diary: “Today at Johnny’s: axiomatization of

measurable utility . . . . It developed slowly, more and more quickly, and at the end, after two hours (!) it was nearly completely finished.” %}

von Neumann, John & Oskar Morgenstern (1944, 1947, 1953) “*Theory of Games and Economic Behavior.*” Princeton University Press, Princeton NJ.

{% %}

von Nitzsch, Rüdiger (1996) “*Entscheidungslehre - Der Weg zur Besseren Entscheidung*; 3rd edn.” Verlag der Augustinus-Buchhandlung, Aachen.

{% %}

von Nitzsch, Rüdiger (1998) “Prospect Theory und Käuferverhalten,” *Die Betriebswirtschaft* 5, 622–634.

{% %}

von Nitzsch, Rüdiger & Christian Friedrich (1999) “*Entscheidungen in Finanzmärkten, Psychologische Grundlagen.*” Mainz Verlag, Aachen.

{% %}

von Nitzsch, Rüdiger & Martin Weber (1988) “Utility Function Assessment on a Micro-Computer: A Reliable, Interactive Procedure,” *Annals of Operations Research* 16, 149–160.

{% %}

von Nitzsch, Rüdiger & Martin Weber (1993) “The Effect of Attribute Ranges on Weights in Multiattribute Utility Measurements,” *Management Science* 39, 937–943.

{% **updating: mistakes in using Bayes’ formula**: Treats human mistakes in Bayes formula and many other funny problems. %}

von Randow, Gero (1990/2?) “*Das Ziegenproblem.*” Rowohlt (pocket-book).

{% Maksa (2005) argues that the proof of this paper lacks too many details. %}

von Stengel, Bernhard (1993) “Closure Properties of Independence Concepts for Continuous Utilities,” *Mathematics of Operations Research* 18, 346–389.

{% Introduced overtaking criterion, simultaneously with Atsumi (1965), to generalize Ramsey (1928). Shows existence of policy optimal w.r.t. overtaking policy in a certain context. Brock (1970) axiomatized the overtaking criterion. %}
von Weizsäcker, Carl C. (1965) "Existence of Optimal Programs of Accumulation for an Infinite Time Horizon," *Review of Economic Studies* 32, 85–104.

{% P. 501: D**utch book** as if money pump, used only for violations of transitivity/dominanc in lotteries with one nonzero outcome. %}
von Winterfeldt, Detlof (1989) "A Re-Examination of the Normative- Descriptive Distinction in Decision Analysis," *Annals of Operations Research* 19, 499–502.

{% Decision analysis, presented in plenary lecture in SPUDM end of 1990s. On p. 537 the author states that at some stage it seemed that the author had only been hired to support a decision already taken, and that the author considered resigning for this reason. He also states, frankly, at the end that, although the final decision was consistent with the decision analysis, it was not clear if the decision analysis had been an input for it. %}
von Winterfeldt, Detlof (2007) "Choosing a Tritium Supply for Nuclear Weapons: A Decision Analysis Caught in Controversy." *In* Ward Edwards, Ralph F. Miles, & Detlof von Winterfeldt (eds.) "*Advances in Decision Analysis: From Foundations to Applications*," 514–538, Cambridge University Press, Cambridge.

{% **restrictiveness of monotonicity/weak separability**: seem to test it. %}
von Winterfeldt, Detlof, Ngar-Kok Chung, R. Duncan Luce, & Younghee Cho (1997) "Tests of Consequence Monotonicity in Decision Making under Uncertainty," *Journal of Experimental Psychology: Learning, Memory, and Cognition*. 23, 406–426.

{% Call attention to the flat maxima phenomenon, that near the optimum in a decision task deviations do not cost much. %}
von Winterfeldt, Detlof & Ward Edwards (1982) "Costs and Payoffs in Perceptual Research," *Psychological Bulletin* 91, 609–622.

{% The text is often verbose and not much structured, and not very formal/accurate. It is often not clear if a model is static or dynamic. The nice and special thing of this book is the many practical asides based on experiences of primarily von Winterfeldt. To get a sense of decision analysis in practice, this book is very good. To get a sense of concepts and models, less so.

P. xiii 3rd para: The authors do not seem to understand reference dependence. Maybe they automatically take outcomes as changes w.r.t. the reference point, in which case to get total wealth one has to add this "outcome" to the reference point of course. But then the dependence is very particular and not general, and their opening sentence distinguishing from total wealth is not right. Best I can think of is that they are confused. The elaborated discussion on pp. 373 ff. does not help, although bounded rationality plays some role.

Pp. 3-4: DUU as if the universal model of all life.

simple decision analysis cases using EU: pp. 8-15: Nice practical example of decision making. Ch. 12 (p. 448 ff.) gives 11 applications of decision analysis, not very simple. §3.6 (p. 86 ff.) has an example on a law suite.

utility elicitation

Ch. 2 is on structuring in general, with Ch. 3 focusing on decision trees.

Second sentence of §2.1: in the experience of most decision analysts, structuring problems and identifying options and objectives are the most difficult parts of most problems.

Ch. 4 is on measurement of uncertainty.

Ch. 5: Bayesian statistics.

P. 65/66: that money is a complex outcome.

P. 82: **value of information**

P. 112: **probability elicitation**; UAI p. 122, calibration (see Yates)

questionnaire versus choice utility: p. 216 ff.

P. 133 (in context of probability measurement): use interaction with client and exploit inconsistencies.

P. 144 is on the likelihood principle, on which Edwards has written more.

Ch. 6 is on general inference when not statistical and, as the authors say, is "frustrating" (p. 163) with little of general conclusions. They draw upon work in the legal literature, using scenarios.

Ch. 7: value and utility measurement. Pp. 312-313 give a useful summary of doing MAUT with recommendations such as having no more than 10 attributes per level. P. 313 point 6 discusses how to handle and benefit from inconsistencies.

risky utility u = strength of preference v (or other riskless cardinal utility, often called value): §7.1, p. 215:

"The conclusion of our four assertions is that for theoretical, psychological, and practical reasons the distinctions between utility and value are spurious."

Pp. 222/223: suggests use of psychophysical scales in utility assessment

P. 236: "However, in general three carefully assessed points of the value function should provide sufficient information to smooth a value curve."

P. 238 (in context of direct rating): "Different techniques almost inevitably produce different responses. Rather than finding such differences distressing, we consider them useful for gaining insights into the nature of the value scale and the reasons for technique, stimulus, and response mode effects. Such discrepancies should be carefully examined and resolved through direct interrogation of the respondent or decision maker."

P. 254: "If a natural scale exists, three or five points between the corner points are usually sufficient for smoothing a utility function."

Ch. 8 MAUT.

P. 256/257: "We speculate that formally justified **utility elicitation** methods deviate at least as much from one another as the utility methods do from the value scaling methods."

P. 267 uses the term dual standard sequence for the MAUT version of the standard sequences that Wakker & Deneffe (1996) use in their **tradeoff method**.

P. 296 illustrates method for eliciting standard sequences, à la tradeoff method of Wakker & Deneffe (1996) for MAUT

Ch. 9 does theory on utility measurement.

Ch. 10: biases.

conservation of influence: p. 545 refers to Piaget's work on conservation laws of quantity, length, number, and so on, how it is recognized by children at certain ages.

Use the, nice, term "joint independence" for separability.

Ch. 11, on sensitivity analysis: Glenn Harrison (2007, personal communication) pointed out to me that they (§11.4 and 11.5) preceded his influential 1989-paper on the flat optimal payoff problem.

Ch. 12 many applications.

Ch. 13 cognitive illusions.
Ch. 14 history. %}

von Winterfeldt, Detlof & Ward Edwards (1986) "*Decision Analysis and Behavioral Research.*" Cambridge University Press, Cambridge.

{% Practical lessons regarding the structuring of a decision problem learned from an application 10 years ago. Paper is short and accessible and, hence, especially suited for students. %}

von Winterfeldt, Detlof & Barbara Fasolo (2009) "Structuring Decision Problems: A Case Study and Reflections for Practitioners," *European Journal of Operational Research* 199, 857–866.

{% **utility elicitation** %}

von Winterfeldt, Detlof & Gregory W. Fischer (1975) "Multiattribute Utility Theory: Models and Assessment Procedures." *In* Dirk Wendt & Charles A.J. Vlek (eds.) *Utility, Probability, and Human Decision Making*, 47–66, Reidel, Dordrecht.

{% %}

von Wright, Georg Henrik (1963) "*The Logic of Preference: An Essay.*" Edinburgh.

{% P. 52 of this book cites a variation of the serenity prayer by Reinhold Niebuhr, being framed on the office of a man called Billy Pilgrim, a doctor, without source given. There the prayer goes like this:
God grant me
the serenity to accept
the things I cannot change,
courage
to change the things I can,
and wisdom always
to tell the
difference. %}

Vonnegut, Kurt (Jr.) (1969) "*Slaughterhouse-five, or the Children's Crusade: A Duty-Dance with Death.*" Delacorte Press, New York. (Apparently 3rd edn.)

{% **losses from prior endowment mechanism**
Use matching probabilities for Ellsberg urns.
Ambiguity seeking is more frequent among inconsistent agents, ambiguity neutrality among consistent ones, and ambiguity aversion is the same.
ambiguity seeking for losses: Not found. There is more ambiguity seeking for losses than for gains (a–d = 0.12 in the aggregate for gains and 0.10 for losses) but the difference is not significant, and aversion is stronger than seeking for losses. %}
Voorhoeve, Alex, Ken Binmore, Arnaldur Stefansson, & Lisa Stewart (2016) "Ambiguity Attitudes, Framing, and Consistency," *Theory and Decision* 81, 313–337.

{% Nice illustration of use of Choquet integral in physics. %}
Vourdas, Apostolos (2016) "Comonotonicity and Choquet Itegrals of Hermitian Operators and Their Applications," *Journal of Physics A: Mathematical and Theoretical* 49, 145002 (36pp)

{% **foundations of probability**, **foundations of statistics**; looks a bit like von Mises work. J.V. Howard on p. 343 updates von Mises mistakes and later solutions. %}
Vovk, Vladimir G. (1993) "A Logic of Probability, with Application to the Foundations of Statistics" with discussion, *Journal of the Royal Statistical Society* B 55, 317–351.

{% This paper analyzes e-values and helps much to popularize the concept in statistics, as does related work by Peter Grünwald. The concept had appeared before in works by Vovk. An e-value E is defined as a function defined on a statistic, so a transform thereof, that is nonnegative and under every parameter in H_0 has expected value ≤ 1. The idea is that the bigger E is, the stronger it is evidence against H_0. We have $P(E \geq 1/\alpha) \leq \alpha$ for every $0 \leq \alpha \leq 1$, i.e. $P(1/E \leq \alpha) \leq \alpha$. This way, rejecting H_0 if $E \geq 1/\alpha$ has significance probability $\leq \alpha$. But it is, of course, conservative. For simple H_0 and H_1, the liklihood ratio = Bayes factor is an e-value. For every simple H_0 and -value there exists a single H_1 such that the e-value is a likelihood rato, and in this existence sense every e-value then is a likelihood ratioo. A betting interpretation: a bet of E−1 has negative expected value under each parameter in H_0. A big pro of e-values is that they avoid the stopping rule paradox. One can decide to sample more or not depending on the observations made, and develop compounded e-values that remain e-values. But then, little wonder given their conservatism. For believers in the likelihood principle like me, Bayes factors usually are not e-values, and the ignoring of H_1 in the definition of e-values is not encouraging either.

This paper analyzes mathematical properties of e-values and p-values. It considers in particular combining several, as can be relevant for multiple hypothesis testing. %}

Vovk, Vladimir G. & Ruodu Wang (2021) "E-Values: Calibration, Combination and Applications," *Annals of Statistics* 49, 1736–1754.
https://doi.org/10.1214/20-AOS2020

{% **updating: mistakes in using Bayes' formula** %}

Vranas, Peter B.M. (2004) "Hempel's Raven Paradox: A Lacuna in the Standard Bayesian Solution," *British Journal for the Philosophy of Science* 55, 545–560.

{% %}

Vriens, Marco & Arne Maas (1990) "Conjoint Analysis of Trade-Off Preference Matrices: Some Possible Extensions." *In* Stephen E.G. Lea, Paul Webley, & Brian M. Young (eds.) "*Applied Economic Psychology in the 1990's*," 1075–1081, Springer, Berlin.

{% Elsevier is a weekly magazine with 100,000 subscriptions. %}

Vrieselaar, Nic, Ralph Koijen, & Peter P. Wakker (2014) "Sparen voor de Dood," *Elsevier* 70 (47) p. 73.
Direct link to paper

{% Models of total absence of information, with acts specified only by set of consequences, à la Barberà, Bossert, Pattanaik, Jaffray. Seems to show experimentally that the models depending only on min and max of set of consequence does not work well, and average utility model works better. %}

Vrijdags, Armélie (2013) "Min- and Max-Induced Rankings: An Experimental Study," *Theory and Decision 64/65*, 76–86.

{% Models of total absence of information, with acts specified only by set of consequences, à la Barberà, Bossert, Pattanaik, Jaffray. Tests average utility model. Finds that averaging axiom (A and B disjoint then $A \cup B$ is between them in preference, which, identifying sets with uniform lotteries, amounts to betweenness) is violated and that a considerable minority of subjects rather prefer what the authors call diversification, but what can also be taken as subjects considering sums rather than averages of utility. The paper also tests restricted independence (adding a disjoint set does not affect preference if the original sets have the same number of elements), but only comonotonic versions of it, and finds violations.

The paper then proposes a variation of RDU where for each n an n-dimensional weight vector is assigned. These weights can but need not be derived from an RDU functional (contrary to what is suggested on p. 83 2nd and 3rd para; there Yager's model in fact is a special case of RDU that does not comprise the nonRDU versions of the authors' model with linear utility). It is RDU if and only if, taking n-sets as uniform lotteries, stochastic dominance holds, as can be seen. It implies also that the first m elements of an n-tuple have the same weight as the first 2m elements from a 2n tuple. The dominance condition that the authors characterize in Proposition 1 is weaker than this stochastic dominance. %}

Vrijdags, Armélie & Thierry Marchant (2015) "From Uniform Expected Utility to Uniform Rank-Dependent Utility: An Experimental Study," *Journal of Mathematical Psychology* 64-65, 76–86.

{% %}

Vulkan, Nir (2000) "An Economist's Perspective on Probability Matching," *Journal of Economic Surveys* 14, 101–118.

{% **anonymity protection** %}

Waal, Ton (A.) G. de, & Leon C.R.J. Willenborg (1996) "A View on Statistical Disclosure Control for Microdata," *Survey Methodology* 22, 95–103.

{% **anonymity protection**; SDC means: Statistical Disclosue Control. %}

Waal, Ton (A.) G. de, & Leon C.R.J. Willenborg (1996) "SDC Measures and Information Loss for Microdata Sets," CBS.

{% **producing random numbers** %}

Wagenaar, Willem A. (1972) "Generation of Random Sequences by Human Subjects: A Critical Survey of Literature," *Psychological Bulletin* 77, 65–72.

{% %}

Wagenaar, Willem A. & Patrick T.W. Hudson (1990) "Cognitive Failures and Accidents," *Applied Cognitive Psychology* 4, 273–294.

{% %}

Wagenaar, Willem A. & Gideon B. Keren (1986) "Does the Expert Know? The Reliability of Predictions and Confidence Ratings of Experts." *In* Erik Hollnagel, Giuseppe Mancini & David D. Woods (eds.) *Intelligent Decision Support in Process Environments* 87–107, Springer, Berlin.

{% **foundations of statistics** %}

Wagenmakers, Eric-Jan & Peter D. Grünwald (2006) "A Bayesian Perspective on Hypothesis Testing: A Comment on Killeen (2005)," *Psychological Science* 17, 641–642.

{% **foundations of statistics**: extensive discussion. %}

Wagenmakers, Eric-Jan, Maarten Marsman, Tahira Jamil, Alexander Ly, Josine Verhagen, Jonathon Love, Ravi Selker, Quentin F. Gronau, Martin Smira, Sacha Epskamp, Dora Matzke, Jeffrey N. Rouder, & Richard D. Morey, "Bayesian Statistical Inference for Psychological Science. Part I: Theoretical Advantages and Practical Ramifications," *Psychonomic Bulletin and Review* 25, 35–57. https://doi.org/10.3758/s13423-017-1343-3

{% Provide software for doing Bayesian analyes. %}

Wagenmakers, Eric-Jan, Jonathon Love, Maarten Marsman, Tahira Jamil, Alexander Ly, Josine Verhagen, Ravi Selker, Quentin F. Gronau, Damian Dropmann., Bruno Boutin, Frans Meerhoff, Patrick Knight, Akash Raj, Erik-Jan van Kesteren, Johnny van Doorn, Martin Smira, Sacha Epskamp, Alexander Etz, Dora Matzke, Tim de Jong, Don van den Bergh, Alexandra Sarafoglou, Helen Steingroever, Koen Derks, Jeffrey N. Rouder, & Richard D. Morey (2018) "Bayesian Inference for Psychology. Part II: Example Applications with JASP," *Psychonomic Bulletin and Review* 25, 58–76. https://doi.org/10.3758/s13423-017-1323-7

{% **foundations of statistics**: Criticize a Bem (2011) paper in the same journal that claimed evidence for psi (that people can predict the future a little bit) and that gave statistically significant evidence. This paper criticizes the Bem paper, using Bayesian views (I sympathize with the latter):

Problem 1: Bem did exploratory (data mining; getting hypothesis from data and then testing using that same data), and not confirmatory (specifying statistical test before getting data).

Problem 2: it has the problem of all classical statistics, of dealing with probabilities over data given hypothesis, whereas one wants that reversed. The authors consider Bayesian updating with some extremely small prior probabilities for psi, in which case the posterior remains small. (**updating: discussing conditional probability and/or updating**)

Problem 3: P-values overstate for big samples. They put forward the Bayesian argument that one better consider Bayes factors, and I could not agree more. But difficult question for Bayesian factors is which H_1 to take. The authors take one called default that I do not understand (they cite papers I do not know) in which case the data more support H_0 (no psi) than H_1 (a specific degtee of psi, or a more subtle variation of this H_1). It is the known phenomenon of statistical significance but not economic significance (or a variation of this phenomenon for noneconomists).

Then the authors argue for more rigid statistics in psychology that more often should be confirmatory. In the last para the authors write that Bem played by the implicit rules of statistics in psychology and that they, therefore, aim to criticize those implicit tules rather than Bem.

The paper is too strict in imposing requirements on the Bem study that virtually no psychology study can satisfy. Note here that psychology, unlike medicine for instance, by nature is mostly exploratory.

It may be refreshing that authors are more explicit in criticizing others than is common in our overly diplomatic and nonexplicit field, but this paper goes too far. Many sentences add nothing to the content but only aim to ridiculize Bem, contrary to what the last para of the paper writes. Probably because many traditional researchers will like hostility towards psi anyhow, the authors could get away with it. Examples: P. 427 1st column 1st para ("anecdotal," also kown as "worth no more than a bare mention") P. 428 2nd column end of 1st para "a psychic's night out at the casino," p. 429 1st column 1st para ("infinite wealth"). %}

Wagenmakers, Eric–Jan, Ruud Wetzels, Denny Borsboom, & Han L.J. van der Maas (2011) "Why Psychologists Must Change the Way They Analyze Their Data: The Case of Psi: Comment on Bem (2011)," *Journal of Personality and Social Psychology* 100, 426–432.

{% %}

Wagner, Harvey M. (1975) "*Principles of Operations Research*;" 2nd edn. Prentice-Hall, Englewood Cliffs, NJ.

{% **measure of similarity** %}

Wagner, John & Robert Elliott (1999) "*The Simplified Personal Questionnaire*." Toledo: University of Toledo. Unpublished manuscript.

{% %}

Wagstaff, Adam & Anthony J. Culyer (2012) "Four Decades of Health Economics through a Bibliometric Lens," *Journal of Health Economics* 31, 406–439.

{% **Dutch book** %}

Waidacher, Christoph (1997) "Hidden Assumptions in the Dutch Book Argument," *Theory and Decision* 43, 293–312.

{% The paper points out an omission in the proof of Epstein & Schneider (2003) and corrects it. %}

Wakai, Katsutoshi (2007) “A Note on Recursive Multiple-Priors,” *Journal of Economic Theory* 135, 567–571.

{% In Eq. 2, used binary rank-dependent utility for intertemporal aggregation function, referring to multiple priors for it. For intertemporal choice this aggregation function leads to a preference for spreading good and bad outcomes. Very nice! I regret somewhat that the author uses the Anscombe-Aumann framework to characterize his form. %}

Wakai, Katsutoshi (2008) “A Model of Utility Smoothing,” *Econometrica* 76, 137–153.

{% **dominance violation by pref. for increasing income**: Generalizes his 2008 Econometrica model by allowing for violations of monotonicity, but only if due to loss aversion relative to habit up to that point, which may be so strong that one likes to give up present consumption just so as to avoid future loss aversion. Thus, the set of discount factors (like set of priors) may contain δs exceeding 1. The paper gives an axiomatization using, as in 2008, the Anscombe-Aumann framework. %}

Wakai, Katsutoshi (2011) “Modeling Nonmonotonic Preferences: The Case of Utility Smoothing,” *Journal of Mathematical Economics* 47, 213–226.

{% Considers a recursive expected utility that combines both ambiguity aversion as in the smooth model and intertemporal attitudes as Kreps & Porteus (1978), showing how to separate them, considering both conditionings on time and on states of nature. %}

Wakai, Katsutoshi (2013) “Intertemporal Utility Smoothing under Uncertainty,” *Theory and Decision* 74, 285–310.

{% **ordering of subsets** %}

Wakker, Peter P. (1981) “Agreeing Probability Measures for Comparative Probability Structures,” *Annals of Statistics* 9, 658–662.

https://www.jstor.org/stable/2240829

Direct link to paper

{% **standard-sequence invariance**; **tradeoff method** %}

Wakker, Peter P. (1984) "Cardinal Coordinate Independence for Expected Utility," *Journal of Mathematical Psychology* 28, 110–117.
https://doi.org/10.1016/0022-2496(84)90021-X
Direct link to paper

{% **tradeoff method** %}

Wakker, Peter P. (1985) "Continuous Expected Utility for Arbitrary State Spaces," *Methods of Operations Research* 50, 113–129.
https://hdl.handle.net/11245/1.426047
Direct link to paper

{% %}

Wakker, Peter P. (1985) "Extending Monotone and Non-Expansive Mappings by Optimization," *Cahiers du C.E.R.O.* 27, 141–149.
Direct link to paper

{% %}

Wakker, Peter P. (1986) "Representations of Choice Situations." Ph.D. Dissertation, University of Brabant, Department of Economics, Tilburg, the Netherlands.
https://personal.eur.nl/Wakker/pdfspubld/86.5Wakker1986ph.d.thesis.pdf

{% %}

Wakker, Peter P. (1986) "The Repetitions Approach to Characterize Cardinal Utility," *Theory and Decision* 20, 33–40.
https://doi.org/10.1007/BF00133634
Direct link to paper

{% **standard-sequence invariance**; **tradeoff method**; Harvey (1986) has similar results that I was not aware of when writing this paper. %}

Wakker, Peter P. (1986) "Concave Additively Decomposable Representing Functions and Risk Aversion." *In* Luciano Daboni, Aldo Montesano, & Marji Lines (eds.)

Recent Developments in the Foundations of Utility and Risk Theory, 249–262, Reidel, Dordrecht.
Direct link to paper

{% **coherentism**: §10.13, last line of third-to-last para of the book reviewed here expresses, unfortunately, the view that the only criterion for rationality is preference coherence. My review criticizes this view by comparing with a logician claiming that the only mistake an astronomer can make is violating the rules of logic. %}
Wakker, Peter P. (1986) Book Review of: Dennis V. Lindley (1985) "Making Decisions," Wiley, New York; *Kwantitatieve Methoden* 20, 144–145.
Direct link to paper

{% **state-dependent utility**; ordinal and cardinal state independence; **tradeoff method** %}
Wakker, Peter P. (1987) "Subjective Probabilities for State-Dependent Continuous Utility," *Mathematical Social Sciences* 14, 289–298.
https://doi.org/10.1016/0165-4896(87)90007-2
Direct link to paper

{% **Dutch book**.
The last para of this paper is as follows:
This paper is based on the observation that the same mathematical structure is underlying many problems in decision making under uncertainty and in game theory. By simple translations, mainly by interchanging "state of nature" and "player," many results derived for decision making under uncertainty and game theory can be interchanged. This paper gave some examples. Admittedly, sometimes, such as in Definition 3.3, a minimal amount of creativity was needed. Still, an author in lack of inspiration, but in need of publications, may succeed with the following algorithm:
Take any theorems from a journal dealing with the topic of game theory, or probability theory/decision making under uncertainty.
Carry out the translations as described in this paper.

Send the resulting theorems to a journal dealing with the other topic than the original journal.

Do not refer to the original journal.

Do not refer to this paper. %}

Wakker, Peter P. (1987) “From Decision Making under Uncertainty to Game Theory.” *In* Hans J.M. Peters & Koos J. Vrieze (eds.) *Surveys of Game Theory and Related Topics*, 163–180, CWI Tract 39, Centre for Mathematics and Computer Science, Amsterdam.

Direct link to paper

{% %}

Wakker, Peter P. (1987) “Nonadditive Probabilities and Derived Strengths of Preferences,” Internal report 87 MA 03, Nijmegen University, Department of Mathematical Psychology, Nijmegen, the Netherlands.

Direct link to paper

{% **dynamic consistency**; **information aversion**

P. 173 first objection in §4, puts forward that forgone-event independence (often called consequentialism nowadays, i.e., after 1990) is assumed. It is part of the ceteris paribus condition there. I admit that my text is not easy to interpret. That this text entails forgone-event independence appears from the requirement that information should be free of charge. If information were to cost money then dynamic consistency would not be affected because the costs would be foreseen, but forgone-event independence would be violated because the ex post situation would differ from the de novo situation by subtraction of the cost of information. As an excuse for my vague text, there was no clear terminology yet in those days and it is hard to formulate forgone-event independence without formal terminology. Other verbal discussions of these principles in the literature are also hard to interpret. %}

Wakker, Peter P. (1988) “Nonexpected Utility as Aversion of Information,” *Journal of Behavioral Decision Making* 1, 169–175. (Discussion in *Journal of Behavioral Decision Making* 2, 1989, 197–202.)

https://doi.org/10.1002/bdm.3960010305

Direct link to paper

{% **one-dimensional utility** %}

Wakker, Peter P. (1988) “Continuity of Preference Relations for Separable Topologies,” *International Economic Review* 29, 105–110.
https://doi.org/10.1002/bdm.3960010305
Direct link to paper

{% **standard-sequence invariance**; **strength-of-preference representation; criticizing the dangerous role of technical axioms such as continuity** %}

Wakker, Peter P. (1988) “The Algebraic versus the Topological Approach to Additive Representations,” *Journal of Mathematical Psychology* 32, 421–435.
https://doi.org/10.1016/0022-2496(88)90021-1
Direct link to paper

{% **standard-sequence invariance**; **strength-of-preference representation**; **tradeoff method** %}

Wakker, Peter P. (1988) “Derived Strength of Preference Relations on Coordinates,” *Economics Letters* 28, 301–306.
https://doi.org/10.1016/0165-1765(88)90002-X
Direct link to paper

{% **standard-sequence invariance** %}

Wakker, Peter P. (1988) “Characterizations of Quasilinear Representing Functions, and Specified Forms of These.” *In* Wolfgang Eichhorn (ed.) *Measurement in Economics* (Theory and Applications of Economic Indices), 311–326, Physica-Verlag, Heidelberg.
https://doi.org/10.2307/2526810
Direct link to paper

{% **standard-sequence invariance**; **tradeoff method** %}

Wakker, Peter P. (1989) “Continuous Subjective Expected Utility with Nonadditive Probabilities,” *Journal of Mathematical Economics* 18, 1–27.
https://doi.org/10.1016/0304-4068(89)90002-5
Direct link to paper

{% **revealed preference** %}
Wakker, Peter P. (1989) "A Graph-Theoretic Approach to Revealed Preference," *Methodology and Science* 22, 53–66.
hdl.handle.net/1765/23228
Direct link to paper

{% %}
Wakker, Peter P. (1989) "Subjective Expected Utility with Non-Increasing Risk Aversion," *Annals of Operations Research* 19, 219–228.
https://doi.org/10.1007/BF02283522
Direct link to paper

{% %}
Wakker, Peter P. (1989) "Transforming Probabilities without Violating Stochastic Dominance." *In* Edward E.Ch.I. Roskam (ed.) *Mathematical Psychology in Progress*, 29–47, Springer, Berlin.
Direct link to paper

{% ISBN-13: 9780792300502
cancellation axioms: Pp. 33-34 gives necessary and sufficient conditions for additive representation of a weak order on a finite product set. The result can be extended to any finite set of (incomplete) preferences on any (subset of) a product set, as shown by Fishburn (1970 Theorem 4.1B), Scott (1964), and other places indicated by the keyword cancellation axioms in this bibliography.

completeness criticisms: §III.1, p. 42.

revealed preference; **standard-sequence invariance**; **strength-of-preference representation**; **tradeoff method**; **Dutch book**: Theorem A2.1.

That for most preference conditions, versions with indifferences suffice, can be derived from Theorem III.6.6 (p. 70), Statement (ii), together with Remark III.7.3. The only nonindifference condition needed is weak separability, which for monetary outcomes is implied by monotonicity. Other than that, for two nonnull coordinates one needs the hexagon condition which only involves indifferences. For more than two nonnull coordinates Statement (ii) puts up CI (coordinate independence, which is sure-thing principle, or preference separability), a condition that involves more than indifference. Remark III.7.3 however shows that, given weak sparability, only the version of that condition with indifferences is used. This way conditions with only indifferences give additive representability. Usually, whatever more is needed is not very dififcult to do. %}

Wakker, Peter P. (1989) "*Additive Representations of Preferences, A New Foundation of Decision Analysis.*" Kluwer Academic Publishers, Dordrecht.

Link to comments & corrections

(Link does not work for some computers. Then can:

go to Papers and comments; go to paper 89.5 there; see comments there.)

Reviews:

French, Simon (1990) *British Journal of Mathematical & Statistical Psychology* 43, 335–336.

& Fishburn, Peter C. (1991) "Subjective Expected Utility with a Topological Twist," *Journal of Mathematical Psychology* 35, 403–409.

{% This paper generalizes Schmeidler (1989). It weakens comonotonicity to maxmin-relatedness: at every state of nature, either one act is maximal or the other is minimal. Anger (1977) and Chateauneuf (1991) used the same kind of condition. %}

Wakker, Peter P. (1990) "A Behavioral Foundation for Fuzzy Measures," *Fuzzy Sets and Systems* 37, 327–350.

https://doi.org/10.1016/0165-0114(90)90030-A

Direct link to paper

{% %}

Wakker, Peter P. (1990) "Characterizing Optimism and Pessimism Directly through Comonotonicity," *Journal of Economic Theory* 52, 453–463.

https://doi.org/10.1016/0022-0531(90)90043-J

Direct link to paper

{% P. 120 introduced the term Choquet expected utility. %}

Wakker, Peter P. (1990) "Under Stochastic Dominance Choquet-Expected Utility and Anticipated Utility are Identical," *Theory and Decision* 29, 119–132.

https://doi.org/10.1007/BF00126589

Direct link to paper

{% **cancellation axioms** %}

Wakker, Peter P. (1991) "Additive Representation for Equally Spaced Structures," *Journal of Mathematical Psychology* 35, 260–266.

https://doi.org/10.1016/0022-2496(91)90028-R

Direct link to paper

{% **one-dimensional utility** %}

Wakker, Peter P. (1991) "Continuity of Transformations," *Journal of Mathematical Analysis and Applications* 162, 1–6.

https://repub.eur.nl/pub/23214/Continuity_1991.pdf

Direct link to paper

{% **cancellation axioms**; **restricting representations to subsets** %}

Wakker, Peter P. (1991) "Additive Representations on Rank-Ordered Sets. I. The Algebraic Approach," *Journal of Mathematical Psychology* 35, 501–531.

https://doi.org/10.1016/0022-2496(91)90045-U

Direct link to paper

{% **standard-sequence invariance**; **strength-of-preference representation**; **tradeoff method** %}

Wakker, Peter P. (1991) "Additive Representations of Preferences, A New Foundation of Decision Analysis; The Algebraic Approach." *In* Jean-Paul Doignon & Jean-Claude Falmagne (eds.) *Mathematical Psychology: Current Developments*, 71–87, Springer, Berlin.

Direct link to paper

{% This paper proposes, on p. 566, a one-sentence proof of the theorems of Anscombe & Aumann (1963), Fishburn (1966), and Harsanyi (1955): "If a linear function is a function of linear functions, then the linear function is a linear function of the linear functions." %}

Wakker, Peter P. (1992) "Characterizing Stochastically Monotone Functions by Multi-Attribute Utility Theory," *Economic Theory* 2, 565–566.
https://repub.eur.nl/pub/23212/Characterizing_1992.pdf
Direct link to paper

{% **restricting representations to subsets** %}
Wakker, Peter P. (1993) "Additive Representations on Rank-Ordered Sets II. The Topological Approach," *Journal of Mathematical Economics* 22, 1–26.
https://doi.org/10.1016/0304-4068(93)90027-I
Direct link to paper

{% **restricting representations to subsets** %}
Wakker, Peter P. (1993) "Counterexamples to Segal's Measure Representation Theorem," *Journal of Risk and Uncertainty* 6, 91–98.
https://doi.org/10.1007/BF01065352
Direct link to paper

{% **finite additivity** %}
Wakker, Peter P. (1993) "Clarification of some Mathematical Misunderstandings about Savage's Foundations of Statistics, 1954," *Mathematical Social Sciences* 25, 199–202.
https://doi.org/10.1016/0165-4896(93)90053-L
Direct link to paper

{% **standard-sequence invariance**; **tradeoff method** %}
Wakker, Peter P. (1993) "Unbounded Utility for Savage's "Foundations of Statistics," and other Models," *Mathematics of Operations Research* 18, 446–485.
https://doi.org/10.1287/moor.18.2.446
Direct link to paper
Figure 2 in the journal is not clear if copied. Here is the pdf-file of it: Figure 2

{% **finite additivity**
Proposition 4.4 gives a necessary and sufficient condition for countable additivy, given finite additivity. %}

Wakker, Peter P. (1993) "Savage's Axioms Usually Imply Violation of Strict Stochastic Dominance," *Review of Economic Studies* 60, 487–493.
https://doi.org/10.2307/2298069
Direct link to paper
Link to comments
(Link does not work for some computers. Then can:
go to Papers and comments; go to paper 93.6 there; see comments there.)

{% **standard-sequence invariance**; **risky utility u = strength of preference v (or other riskless cardinal utility, often called value)**; RDU; **coherentism**; **tradeoff method** %}
Wakker, Peter P. (1994) "Separating Marginal Utility and Probabilistic Risk Aversion," *Theory and Decision* 36, 1–44.
https://doi.org/10.1007/BF01075296
Direct link to paper

{% **inverse S** %}
Wakker, Peter P. (1994) "Expected versus Nonexpected Utility: The State of the Art," Book Review of: Ward Edwards (ed. 1992) "Utility measurements and Applications," Kluwer Academic Publishers, Dordrecht; *Journal of Mathematical Psychology* 38, 521–524.
https://repub.eur.nl/pub/23189/ExpectedversusNonexpected_1994.pdf
Direct link to paper

{% %}
Wakker, Peter P. (1994) "Quiggin's Rank-Dependent Model," Book Review of: John Quiggin (1993) "Generalized Expected Utility Theory: The Rank-Dependent Model," Kluwer Academic Publishers; *Journal of Mathematical Psychology* 38, 525–526.
Direct link to paper

{% %}
Wakker, Peter P. (1995) "Keuze-theorie: Die Verdraaide Preferenties!" (in Dutch), *Economisch Statistische Berichten* 80/4000, 231.

Direct link to paper

{% **dynamic consistency**; **updating under ambiguity** %}

Wakker, Peter P. (1995) "Are Counterfactual Decisions Relevant for Dynamically Consistent Updating under Nonexpected Utility," Medical Decision Making Unit, Leiden University, the Netherlands.

Direct link to paper

{% %}

Wakker, Peter P. (1996) "A Criticism of Healthy-Years Equivalents," *Medical Decision Making* 16, 207–214.

https://doi.org/10.1177/0272989X9601600302

Direct link to paper

Rejoinder

{% %}

Wakker, Peter P. (1996) "The Sure-Thing Principle and the Comonotonic Sure-Thing Principle: An Axiomatic Analysis," *Journal of Mathematical Economics* 25, 213–227.

https://doi.org/10.1016/0304-4068(95)00721-0

Direct link to paper

{% **time preference** %}

Wakker, Peter P. (1996) "Time Preference," Book Review of: George F. Loewenstein & John Elster (1992) "Choice over Time," Russell Sage Foundation, New York; *Journal of Behavioral Decision Making* 9, 297–303.

Direct link to paper

{% %}

Wakker, Peter P. (1996) Book Review of: Patrick Rivett (1994) "The Craft of Decision Modelling," Wiley, New York; *Journal of Behavioral Decision Making* 9, 150–151.

Direct link to paper

{% %}

Wakker, Peter P. (1998) “Non-EU and Insurance,” Book Review of: Christian Gollier & Mark J. Machina (1995, eds.) “Non-Expected Utility and Risk Management,” Kluwer Academic Publishers, Dordrecht; *Journal of Behavioral Decision Making* 11, 151–160.

Direct link to paper

{% **dynamic consistency**; **foundations of statistics**; **sophisticated choice**; %}

Wakker, Peter P. (1999) “Justifying Bayesianism by Dynamic Decision Principles,” Medical Decision Making Unit, Leiden University Medical Center, the Netherlands.

Direct link to paper

{% **principle of complete ignorance**: is formalized here as the principle of complete ignorance (PCI) %}

Wakker, Peter P. (2000) “Dempster Belief Functions Are Based on the Principle of Complete Ignorance,” *International Journal of Uncertainty, Fuzziness and Knowledge-Based Systems* 8, 271–284.

https://doi.org/10.1142/S0218488500000198

Direct link to paper

{% %}

Wakker, Peter P. (2000) “Uncertainty Aversion: A Discussion of Critical Issues in Health Economics,” *Health Economics* 9, 261–263.

https://doi.org/10.1002/(SICI)1099-1050(200004)9:3<261::AID-HEC506>3.0.CO;2-L

Direct link to paper

{% %}

Wakker, Peter P. (2000) “Luce’s Paradigm for Decision under Uncertainty,” Book Review of: R. Duncan Luce (2000) “Utility of Gains and Losses: Measurement-Theoretical and Experimental Approaches,” Lawrence Erlbaum Publishers, London; *Journal of Mathematical Psychology* 44, 488–493.

Direct link to paper

{% %}
Wakker, Peter P. (2000) Book Review of: Salvador Barberà, Peter J. Hammond, & Christian Seidl (1998, eds.) "Handbook of Utility Theory, Vol. 1, Principles," Kluwer Academic Publishers, Dordrecht; *Journal of Economic Literature* 38, 638–639.
Direct link to paper

{% **standard-sequence invariance**; **inverse S**; First paper to characterize convex capacities under Choquet expected utility for continuous utility without restricting utility otherwise. This paper argues that convexity of the capacity is captured by the (common consequence version of) the Allais paradox, which suggests a general pessimistic attitude of overweighting low outcomes, and not by the Ellsberg paradox, which suggests that people are more pessimistic/convex for unknown probabilities than for known probabilities without committing to pessimism/convex in any absolute sense. §6 emphasizes that the novelty of Ellsberg is that it involves within-person, rather than between-person, comparisons. %}
Wakker, Peter P. (2001) "Testing and Characterizing Properties of Nonadditive Measures through Violations of the Sure-Thing Principle," *Econometrica* 69, 1039–1059.
https://doi.org/10.1111/1468-0262.00229
Direct link to paper

{% **updating: discussing conditional probability and/or updating** %}
Wakker, Peter P. (2002) "Decision-Principles to Justify Carnap's Updating Method and to Suggest Corrections of Probability Judgments." *In* Adnam Darwiche & Nir Friedman (eds.) *Uncertainty in Artificial Intelligence, Proceedings of the Eighteenth Conference*, 544–551, Morgan Kaufmann, San Francisco, CA.
Direct link to paper

{% %}

Wakker, Peter P. (2003) "The Data of Levy and Levy (2002) "Prospect Theory: Much Ado about Nothing?" Actually Support Prospect Theory," *Management Science* 49, 979–981.

https://doi.org/10.1287/mnsc.49.7.979.16383

Direct link to paper

Link to comments

(Link does not work for some computers. Then can:

go to Papers and comments; go to paper 03.1 there; see comments there.)

Reply by Levy & Levy

{% **inverse S;**

cognitive ability related to likelihood insensitivity (= inverse S) %}

Wakker, Peter P. (2004) "On the Composition of Risk Preference and Belief," *Psychological Review* 111, 236–241.

https://doi.org/10.1037/0033-295X.111.1.236

Direct link to paper

Link to comment on role of Amos Tversky

(Link does not work for some computers. Then can:

go to Papers and comments; go to paper 04.4 there; see comments there.)

{% A didactical text. %}

Wakker, Peter P. (2004) "Preference Axiomatizations for Decision under Uncertainty." *In* Itzhak Gilboa (ed.) *Uncertainty in Economic Theory: Essays in Honor of David Schmeidler's 65th Birthday*, 20–35, Routledge, London.

Direct link to paper

{% %}

Wakker, Peter P. (2005) "Decision-Foundations for Properties of Nonadditive Measures for General State Spaces or for General Outcome Spaces," *Games and Economic Behavior* 50, 107–125.

https://doi.org/10.1016/j.geb.2003.10.007

Direct link to paper

Link to comments

(Link does not work for some computers. Then can:
go to Papers and comments; go to paper 05.3 there; see comments there.)

{% The experiment briefly mentioned but never written down here is similar to Hershey & Schoemaker (1985), as I discovered May 2018. %}

Wakker, Peter P. (2008) "Lessons Learned by (from?) an Economists Working in Medical Decision Making," *Medical Decision Making* 28, 690–698.
https://doi.org/10.1177/0272989X08323916
Direct link to paper

{% Further useful comments are in Section 1.3 of Doyle (2013 judgment and Decision Making 8, 116-135). For example, the logpower family is known as the Box-Cox transformation in statistics. %}

Wakker, Peter P. (2008) "Explaining the Characteristics of the Power (CRRA) Utility Family," *Health Economics* 17, 1329–1344.
https://doi.org/10.1002/hec.1331
Direct link to paper

{% **source-dependent utility** is criticized here (p. 436 just above conclusion). %}

Wakker, Peter P. (2008) "Uncertainty." *In* Lawrence Blume & Steven N. Durlauf (eds.) *The New Palgrave: A Dictionary of Economics*, Vol. 8, 428–439, The MacMillan Press, London.
Direct link to paper

{% Publisher's website with further info: www.cambridge.org/9780521748681
paperback: ISBN-13:9780521748681; hardcover ISBN-13:9780521765015
P. 2, penultimate para: "At this moment of writing, 30 years after its invention, prospect theory is still the only theory that can deliver the full spectrum of what is required for decision under uncertainty, with a natural integration of risk and ambiguity."
Assumption 2.1.2: decision under risk assumption.
substitution-derivation of EU: Appendix 2.9.
source-dependent utility is criticized on p. 337 4th para.
questionnaire for measuring risk aversion; Exercise 3.6.3: Use choices between some lottery pairs with a big variation in outcomes and probabilities.

Then count the number of times the more risky lottery is chosen. Can relate to the well-known CRRA index by taking the index that would generate the same number of risky choices. This is better way to measure risk aversion index than the usual choice lists, which intensively and inefficiently probe in a small part of the domain. It was used by Wakker, Timmermans, & Machielse (2007).

inverse S: §7.1, p. 204, reviews empirical evidence for risk.

P. 208: for probability weighting for gains, the parameters $\gamma^+ = 0.69$ and $\delta^+ = 0.77$ best fit the current empirical findings.

P. 236: **linear utility for small stakes**: claims it normatively, with only two references and no extensive review.

§8.8 Problem 2 (p. 247) discusses the modeling of loss aversion through piece-wise linear utility with a kink at 0.

Somewhat hidden away, p. 272 Eqs. 9.7.1 - 9.7.3, are the general integral formulas for PT for risk.

criticism of monotonicity in Anscombe-Aumann (1963) for ambiguity: §10.7.3, pp. 301-304.

uncertainty amplifies risk: §10.4, p. 292, reviews empirical evidence, but only for insensitivity

ambiguity seeking for unlikely: Section 10.4.2 cites evidence on insensitivity, which comprises ambiguity seeking for unlikely.

biseparable utility for uncertainty: §10.6, pp. 298-299, presents it

criticism of monotonicity in Anscombe-Aumann (1963) for ambiguity: §10.7, p. 302, Figure 10.7.1.

nonadditive measures are too general:Section 11.2

Example 11.2.2 (p. 321) illustrates how matching probabilities easily capture ambiguity.

Pp. 338-342, §9.6, shows that power (CRRA) utility gives analytical problems when defining loss aversion.

P. 298, §10.6, Exercise 10.6.1: RDU for two outcome-prospects is identical to: $\gamma_E\beta \mapsto pU(\gamma) + (1-p)U(\beta) - \mu|U(\gamma)-U(\beta)|$ with $|\mu| < \min\{p,1-p\}$ an index of pessimism, $\mu < 0$ giving optimism.

P. 231, Observation 7.11.1 shows that many risk theories are special cases of binary RDU, as pointed out by Miyamoto (1988). §10.6 will extend this point to uncertainty, where the model is often called biseparable utility.

P. 354, §12.7, reviews the literature finding **ambiguity seeking for losses,** confirming reflection. %}

Wakker, Peter P. (2010) "*Prospect Theory: For Risk and Ambiguity*." Cambridge University Press, Cambridge, UK.

https://doi.org/10.1017/CBO9780511779329

Additional material

{% %}

Wakker, Peter P. (2011) "Jaffray's Ideas on Ambiguity," *Theory and Decision* 71, 11–22.

https://doi.org/10.1007/s11238-010-9209-4

Direct link to paper

{% NRC Handelsblad is a daily newspaper, with 200,000 copies per day, and is the 4th most sold newspaper in the Netherlands. %}

Wakker, Peter P. (2014) "Verliesangst," *NRC Handelsblads (Delta Lloyd Magazine)* 27 June, p. 9.

Direct link to paper

{% %}

Wakker, Peter P. (2019) "Rational vs. Irrational," *New in Chess* 2019.1, 10.

Direct link to paper

{% On **Prospect theory not cited**: Pp. 195-196 properly criticize the way experimental economists cite Holt & Laury (2002):

"As an historical and socio-academic digression, the authors follow the common convention in experimental economics of crediting authors recognized as experimental economists, Holt and Laury (2002), rather than "outsiders," for using choice lists, assuming expected utility, and then fitting parametrically (assuming, e.g., a Constant Relative Risk Aversion utility function) to measure risk aversion. Yet, this has been a common procedure for many decades, and drawbacks have also been known for many decades. The procedure was used for instance in the more comprehensive Cohen, Jaffray, and Said (1987). These authors, like Holt and Laury, used real incentives, but, unlike Holt and Laury, expressed awareness of the deficiencies of expected utility, writing:

"The reason why subjects' risk attitudes are not correctly conveyed by the conventional definitions may simply be that these definitions, despite their intrinsic character, take their origins in the EU [expected utility] model, and therefore share in its deficiencies." (Cohen, Jaffray, and Said, 10-11)

The survey by Farquhar (1984) gives further references. That socio-academic conventions of this kind occur in every field and every generation again can be inferred from Carver (1918) who, over a century ago, concluded his paper writing:

"But if they think that they have built up a complete system and can dispense with all that has gone before, they must be placed in the class with men in other fields, such as chemistry, physics, medicine, or zoölogy, who, because of some new observations, hasten to announce that all previous work is of no account." (Carver, 1918, 200)

Indeed, if ignoring previous work can be legitimized in any manner, then this saves much reading time and facilitates priority claims, providing irresistible benefits. The authors do cite Cohen et al. and Farquhar, but, understandably, do not enter the debate on priority as done in this digression."

%}

Wakker, Peter P. (2019) *Book Review of*: Nicolas Jacquement & Olivier l'Haridon (2019) "Experimental Economics: Method and Applications," Cambridge University Press, Cambridge; *Oeconomia - History | Methodology | Philosophy* 9, 193–197.

Direct link to paper

{% %}

Wakker, Peter P. (2020) "A Personal Tribute to David Schmeidler's Influence," *Revue Economique* 71, 387–390.

https://doi.org/10.3917/reco.712.0387

Direct link to paper

{% %}

Wakker, Peter P. (2020) "A One-Line Proof for Complementary Symmetry," *Journal of Mathematical Psychology* 98, 102406.

https://doi.org/10.1016/j.jmp.2020.102406

Direct link to paper

{% **risky utility u = strength of preference v (or other riskless cardinal utility, often called value)** %}

Wakker, Peter P. (2022) “Transforming Ordinal Riskless Utility into Cardinal Risky Utility: A Comment on Chung, Glimcher, & Tymula (2019),” *American Economic Journal: Microeconomics* 14, 561–565.
https://doi.org/10.1257/mic.20190338
Direct link to paper

{% %}
Wakker, Peter P. (2023) “The Correct Formula of 1979 Prospect Theory for Multiple Outcomes,” *Theory and Decision* 94, 183–187.
https://doi.org/10.1007/s11238-022-09885-w
Direct link to paper

{% %}
Wakker, Peter P. (2023) “A Criticism of Bernheim & Sprenger’s (2020) Tests of Rank Dependence,” *Journal of Behavioral and Experimental Economics* 107, 101950.
https://doi.org/10.1016/j.socec.2022.101950
Direct link to paper

{% Abstract: To avoid admitting mistakes in their preceding works pointed out by Wakker (2023), Bernheim & Sprenger (2023) use fallacies and miscitations, most of them easy to see through. %}
Wakker, Peter P. (2024) “A Criticism of Bernheim & Sprenger (2023),” working paper.
Direct link to paper

{% %}
Wakker, Peter P. (2024) “Notational and Terminological Conventions by Peter P. Wakker,” working paper.

{% PT: data on probability weighting;
tradeoff method; standard-sequence invariance; risky utility u = strength of preference v (or other riskless cardinal utility, often called value); utility elicitation; utility measurement: correct for probability distortion;

PE higher than CE; **CE bias towards EV**; **binary prospects identify U and W**: p. 1143 & pp. 1144-1145. %}

Wakker, Peter P. & Daniel Deneffe (1996) "Eliciting von Neumann-Morgenstern Utilities when Probabilities Are Distorted or Unknown," *Management Science* 42, 1131–1150.

https://doi.org/10.1287/mnsc.42.8.1131

Direct link to paper

{% **PT: data on probability weighting**; **PT falsified**; %}

Wakker, Peter P., Ido Erev, & Elke U. Weber (1994) "Comonotonic Independence: The Critical Test between Classical and Rank-Dependent Utility Theories," *Journal of Risk and Uncertainty* 9, 195–230.

https://doi.org/10.1007/BF01064200

Direct link to paper

Link to typo

(Link does not work for some computers. Then can:

go to Papers and comments; go to paper 94.2 there; see comments there.)

{% %}

Wakker, Peter P., Sylvia J.T. Jansen, & Anne M. Stiggelbout (2004) "Anchor Levels as a New Tool for the Theory and Measurement of Multiattribute Utility," *Decision Analysis* 1, 217–234.

https://doi.org/10.1287/deca.1040.0028

Direct link to paper

{% **statistics for C/E** %}

Wakker, Peter P. & Marc P. Klaassen (1995) "Confidence Intervals for Cost/Effectiveness Ratios," *Health Economics* 4, 373–381.

https://doi.org/10.1002/hec.4730040503

Direct link to paper

{% %}

Wakker, Peter P., Hans J.M. Peters, & Tom B.P.L. van Riel (1986) "Comparisons of Risk Aversion, with an Application to Bargaining," *Methods of Operations Research* 54, 307–320.
Direct link to paper

{% **utility elicitation**; **utility measurement**: c**orrect for probability distortion**; **paternalism/Humean-view-of-preference** %}
Wakker, Peter P. & Anne M. Stiggelbout (1995) "Explaining Distortions in Utility Elicitation through the Rank-Dependent Model for Risky Choices," *Medical Decision Making* 15, 180–186.
https://doi.org/10.1177/0272989X9501500212
Direct link to paper

{% **real incentives/hypothetical choice**: §1 argues that hypothetical high stakes are preferable to small actual stakes: "We believe that in this domain, thought experiments for large sums can be more instructive than real experiments for pennies."

PT: data on probability weighting; **backward induction/normal form, descriptive**, end of §4: first empirical finding in the literature against backward induction and in favor of normal-form analysis.

Conclusion suggests that authors consider nonEU irrational: the finding that people value the elimination of risk disproportionally more than the reduction of risk represents a major departure of human behavior from the canons of rational choice.

Tversky wanted the term prospect theory without any adjective to refer to the new 1992 version and not to the original 1979 version, as he told me and as appears from this paper. See for instance the beginning of §3.1, where the theory is applied to uncertainty which is only done with the 1992 version and not with the 1979 version. Further, the paper reckons with sign dependence of weighting, which holds for the 1992 version and not for the 1979 version.

Jan 2012: Just discovered that many people use the term self-protection or protective action for probabilistic insurance. Is pointed out by K&T79 p. 271. %}
Wakker, Peter P., Richard H. Thaler, & Amos Tversky (1997) "Probabilistic Insurance," *Journal of Risk and Uncertainty* 15, 7–28.
https://doi.org/10.1023/A:1007799303256

Direct link to paper

{% **risk averse for gains, risk seeking for losses**;

questionnaire for measuring risk aversion: choice questions to measure risk aversion.

natural sources of ambiguity; ambiguity seeking: find it for natural events. A similar point, that known probabilities is the unnatural situation, is put forward by Erev, Bornstein, & Wallsten (1993 p. 91 last para). %}

Wakker, Peter P., Daniëlle R.M. Timmermans, & Irma A. Machielse (2007) "The Effects of Statistical Information on Risk and Ambiguity Attitudes, and on Rational Insurance Decisions," *Management Science* 53, 1770–1784.

https://doi.org/10.1287/mnsc.1070.0735

Direct link to paper

{% **standard-sequence invariance**; **tradeoff method**; **risk averse for gains, risk seeking for losses**; loss aversion is defined on p. 164 as (something equivalent to) v´(−x) ≥ v´(x) for all x>0 %}

Wakker, Peter P. & Amos Tversky (1993) "An Axiomatization of Cumulative Prospect Theory," *Journal of Risk and Uncertainty* 7, 147–176.

https://doi.org/10.1007/BF01065812

Direct link to paper

Link to typos

(Link does not work for some computers. Then can:

go to Papers and comments; go to paper 93.7 there; see comments there.)

{% %}

Wakker, Peter P. & Jingni Yang (2019) "A Powerful Tool for Analyzing Concave/Convex Utility and Weighting Functions," *Journal of Economic Theory* 181, 143–159.

https://doi.org/10.1016/j.jet.2019.02.008

Direct link to paper

{% %}

Wakker, Peter P. & Jingni Yang (2021) "Concave/Convex Weighting and Utility Functions for Risk: A New Light on Classical Theorems," *Insurance: Mathematics and Economics* 100, 429–435.
https://doi.org/10.1016/j.insmatheco.2021.07.002
Direct link to paper

{% %}
Wakker, Peter P. & Horst Zank (1999) "State Dependent Expected Utility for Savage's State Space; Or: Bayesian Statistics without Prior Probabilities," *Mathematics of Operations Research* 24, 8–34.
https://doi.org/10.1287/moor.24.1.8
Direct link to paper

{% **standard-sequence invariance**; **tradeoff method** %}
Wakker, Peter P. & Horst Zank (1999) "A Unified Derivation of Classical Subjective Expected Utility Models through Cardinal Utility," *Journal of Mathematical Economics* 32, 1–19.
https://doi.org/10.1016/S0304-4068(98)00045-7
Direct link to paper

{% %}
Wakker, Peter P. & Horst Zank (2002) "A Simple Preference-Foundation of Cumulative Prospect Theory with Power Utility," *European Economic Review* 46, 1253–1271.
https://doi.org/10.1016/S0014-2921(01)00141-6
Direct link to paper

{% The authors that often choices involve incommensurable goods and then we should not try to commensure them. They write on p. 3012: "We also discuss what types of decision model could accommodate the lack of common currency of value. Such models include lexicographic (noncompensatory) heuristics, which do not require decision-makers to trade off attribute values to make a choice. Our conclusion is that although some heuristics may help decision-makers to choose, value incommensurability necessitates the use of rank-based processes for decision-making. Finally, we note that reliance on rank-based strategies leads

inevitably (by Arrow's impossibility theorem) to inconsistences in decisionmaking, such as preference reversals, of the type that are typically observed in experimental studies of choice."

Many psychologists may like the anarchistic nature of these ideas, and just accept preference reversals in what they still qualify as rational choice, as do these authors, but I couldn't be farther from it. When the first author presented this work online on 24 Oct. 2024 in the 3rd SJDM and EADM joint virtual symposium, I asked him the following question, which I qualified as critical: "I can't think of values more incommensurable than human lives versus money. I worked eight years in a hospital and there they are treated as commensurable on a daily basis. My first question to you is: "Do you agree that nothing is more incommensurable than money versus human lives, and, if so, do you think that my hospital and I have been doing bad things?" %}

Walasek, Lukasz & Gordon D. A. Brown (2024) "Incomparability and Incommensurability in Choice: No Common Currency of Value?" *Perspectives on Psychological Science* 19, 1011–1030. https://doi.org/10.1177/17456916231192828

{% Write that only few papers have useful data on it. Use 19 data sets from 17 papers. Find $\lambda = 1.31$, with a 95% confidence interval of 1.10, 1.53]. They assume logpower (CRRA) utility with same power for gains and losses, and also the same probability weighting for gains and losses.

Prospect theory/Rank-Dependent Utility most popular for risk: "prospect theory and, later, cumulative prospect theory (PT and CPT, Kahneman & Tversky, 1979; Tversky & Kahneman, 1992), the most influential descriptive model of choice under risk and uncertainty." (p. 1) %}

Walasek, Lukasz, Tim L Mullett, & Neil Stewart (2024) "A Meta-Analysis of Loss Aversion in Risky Contexts," *Journal of Economic Psychology* 103, 102740. https://doi.org/10.1016/j.joep.2024.102740

{% Subjects in hypothetical choice on internet should say for each of a set of lotteries whether they are acceptable or not. If gains range from 0 to 40, and losses from 0 to −20, then we find the usual loss aversion. If, however, gains range from 0 to 20, and losses from 0 to −40, then we find the opposite, gain seeking. These findings are in agreement with decision by sampling. My main problem is that, especially in view of the hypothetical nature of the experiment, it is not clear to

subjects what "accept" means. They are meant to take it as "preferring to a sure 0." But they may take it as "better than average among the lotteries presented to me." So, the decision situation is not made sufficiently clear. %}

Walasek, Lukasz & Neil Stewart (2015) "How to Make Loss Aversion Disappear and Reverse: Tests of the Decision by Sampling Origin of Loss Aversion," *Journal of Experimental Psychology: General* 144, 7–11.

{% P. 302 seems to have written, on loss function having to be determined by extraneous nonstatistical factors and using term weight for loss: "The question as to how the form of the weight function W(θ,ω) should be determined is not a mathematical or statistical one. The statistician who wants to test certain hypotheses must first determine the relative importance of all possible errors, which will entirely depend on the special purposes of his investigation." (**foundations of statistics**)

Seems to have proposed maxmin (minmax in terms of loss function). %}

Wald, Abraham (1939) "Contributions to the Theory of Statistical Estimation and Testing Hypotheses," *Annals of Mathematical Statistics* 10, 299–326. https://www.jstor.org/stable/2235609

{% It seems that here he proved his famous result, his "complete class theorem," that each undominated choice in decision under uncertainty can be taken as maximizing Bayesian subjective expected utility and even subjective expected value. %}

Wald, Abraham (1947) "An Essentially Complete Class of Admissible Decision Functions," *Annals of Mathematical Statistics* 18, 549–555.

{% %}

Wald, Abraham (1949) "Statistical Decision Functions," *Annals of Mathematical Statistics* 20, 165–205.

{% **event/outcome driven ambiguity model: event driven**: Proposed maxmin EU (minmax in terms of loss function) on pp. 18, 26-27. On p. 27, F denotes the prior, and Ω the set of priors. P. 1 explained that Ω need not be the set of all possible priors, but can be a subset of it.

Dutch book (end of Ch. II)

Seems to have shown that for finite state spaces, for a risk set that is bounded and closed from below, the set of Bayesian decision rules is complete. The idea is that we choose a Pareto-optimal option, take the tangential hyperplane (in view of the possibility to take mixes of options, the set is convex), then take the orthogonal probability vector, and then take the option chosen as minimizer of expected loss w.r.t. the probabilities generated. Mathematical generalizations are given. This result has often been used to justify the Bayesian use of subjective probabilities.

Seems to take as decision under uncertainty model a more general setup than Savage (1954): There is a state space S and an action space A. The "preconsequence space" (my term) is the product set A x S. Then there is a function f mapping A x S to a consequence space C. Savage's 1954 model can be considered to be the special case where acts with same consequences for each s are identified and, next, all maps from S to C are available. Conversely, one can interpret the Wald action space as a subset of the Savage act space. Oh well.

biseparable utility %}

Wald, Abraham (1950) "*Statistical Decision Functions.*" Wiley, New York.

{% %}

Wald, Abraham (1952?? Paris conference comments on independence).

{% Discusses empirical studies of which kind of lotteries sell best (e.g., many low prizes or not, etc. %}

Walker, Ian & Juliet Young (2001) "An Economist's Guide to Lottery Design," *Economic Journal* 111, F700–F722.

{% %}

Wall, Dan (2014) "Visualize Prospect Theory." https://decisionsciences.shinyapps.io/Shiny/pt_qtd_shiny.Rmd

{% %}

Wallace, Alfred Russell (1858) "On the Tendency of Species to form Varieties." Essay.

{% **probability communication**. Findings: title says it. Providing icon arrays or using vertical versus horizontal time formats mattered. %}

Wallace, Matthew J., E. Hope Weissler, [13 other authors], & Shelby D. Reed (2024) "Using Separate Single-Outcome Risk Presentations Instead of Integrated Multioutcome Formats Improves Comprehension in Discrete Choice Experiments," *Medical Decision Making* 44, 649–660. https://doi.org/10.1177/0272989X241258466

{% %}

Wallach, Michael A. & Cliff W. Wing (1968) "Is Risk a Value?" *Journal of Personality and Social Psychology* 9, 101–106.

{% Dempster's conditioning %}

Walley, Peter (1987) "Belief Function Representation of Statistical Evidence," *Annals of Statistics* 15, 1439–1465.

{% **completeness criticisms**; **updating: discussing conditional probability and/or updating**

three-doors problem: P. 279 argues, through three-prisoners problem, that Dempster-Shafer updating rule can lead to accept "sure loss." The argument does not result, contrary to what some have suggested, from dynamic inconsistency, but is primarily based on a de Finetti-like book making with adding up several accepted bets and requiring linear utility.

Seems that he wrote on dilation.

A summary is in Miranda (2008). %}

Walley, Peter (1991) "*Statistical Reasoning with Imprecise Probabilities*." Chapman and Hall, London.

{% **foundations of statistics**: argues for likelihood principle but against Bayesianism. P. 33:

"It seems to me that Carnap's programme was unsuccessful because he insisted on a Bayesian solution and therefore failed to satisfy the RIP."

Here RIP means "Representation Invariance Principle," i.e., independence of the sample space chosen. %}

Walley, Peter (1996) “Inferences from Multinomial Data: Learning about a Bag of Marbles,” *Journal of the Royal Statistical Society B* 58, 3–57.

{% %}

Walley, Peter & Terrence L. Fine (1982) “Toward a Frequentist Theory of Upper and Lower Probabilities,” *Annals of Statistics* 10, 741–761.

{% Propose procedures that satisfy the likelihood principle, even stronger than that, treat every two parameters with same likelihood the same (so, no role for differentiating priors). Procedures avoid subjective inputs and can also satisfy frequentist criteria. As a price to pay, the procedures are conservative. %}

Walley, Peter & Serafin Moral (1999) “Upper Probabilities Based only on the Likelihood Function,” *Journal of the Royal Statistical Society B* 61, 831–847.

{% **real incentives/hypothetical choice**: Seems that they criticized the use of hypothetical choice by Thurstone (1931). Seems they wrote, on pp. 179-180:

“For a satisfactory experiment it is essential that the subject give actual reactions to actual stimuli. . . . Questionnaires or other devices based on conjectural responses to hypothetical stimuli do not satisfy this requirement.”

They seem to discuss that when observing several choices and implementing them for real, income effects occur, and they seem to end pessimistically:

“These are more than technical or practical obstacles and indicate that it is probably not possible to design a satisfactory experiment for deriving indifference curves from economic stimuli.” %}

Wallis, W. Allen & Milton Friedman (1942) “The Empirical Derivation of Indifference Functions.” *In* Oskar Lange, Francis McIntyre, & Theodore O. Yntema (eds.) *Studies in Mathematical Economics and Econometrics in Memory of Henry Schultz*, 175–189, University of Chicago Press, Chicago.

{% Newcombs paradox is that player is physically second to play but mentally is first. %}

Walliser, Bernard (1988) “A Simplified Taxonomy of 2×2 Games,” *Theory and Decision* 25, 163–191.

{% **updating: discussing conditional probability and/or updating** %}

Walliser, Bernard & Denis Zwirn (2002) “Can Bayes’ Rule Be Justified by Cognitive Rationality Principles?,” *Theory and Decision* 53, 95–135.

{% %}

Wallsten, Thomas S. (1971) “Subjective Expected Utility Theory and Subjects’ Probability Estimates: Use of Measurement-Free Techniques,” *Journal of Experimental Psychology* 88, 31–40.

{% **probability elicitation**; Shows that physicans when giving probability judgment, do not provide objective guidelines for probability, but instead the probabilities that they think best support their recommended treatment. %}

Wallsten, Thomas S. (1981) “Physician and Medical Student Bias in Evaluating Diagnostic Information,” *Medical Decision Making* 1, 145–164.

{% P. 152: “In other words, most psychological variables are not directly observed, but rather are inferred though their manifestations. Although this is true for many physical variables as well, it is a much more serious problem in psychology.”

Seem to explain that subjective probabilities are theoretical constructs (**derived concepts in pref. axioms**). %}

Wallsten, Thomas S. & David V. Budescu (1983) “Encoding Subjective Probabilities: A Psychological and Psychometric Review,” *Management Science* 29, 151–173.

{% Review on how people use linguistic expressions of probabilities. %}

Wallsten, Thomas S. & David V . Budescu (1995) “A Review of Human Linguistic Probability Processing: General Principles and Empirical Evidence,” *The Knowledge Engineering Review* 10, 43-62.
https://doi.org/10.1017/S0269888900007256

{% Ague that averages (over different judges) of probability estimates are often way better than any individual judgments. %}

Wallsten, Thomas S., David V. Budescu, Ido Erev, & Adele Diederich (1997) “Evaluating and Combining Subjective Probability Estimates,” *Journal of Behavioral Decision Making* 10, 243–268.

{% %}

Wallsten, Thomas S., David V. Budescu, Amnon Rapoport, Rami Zwick, & Barbara H. Forsyth (1986) "Measuring the Vague Meanings of Probability Terms," *Journal of Experimental Psychology: General* 115, 348–365. https://doi.org/10.1037/0096-3445.115.4.348

{% **probability elicitation** %}

Wallsten, Thomas S., David V. Budescu, & Rami Zwick (1993) "Comparing the Calibration and Coherence of Numerical and Verbal Probability Judgments," *Management Science* 39, 176–190. https://doi.org/10.1287/mnsc.39.2.176

{% %}

Wallsten, Thomas S., Ido Erev & David V. Budescu (2000) "The Importance of Theory: Response to Brenner (2000)," *Psychological Review* 107, 947–949.

{% Imprecise probabilities: argue that upper and lower probabilities are more natural than precise probabilities, and give nice refs. %}

Wallsten, Thomas S., Barbara H. Forsyth, & David V. Budescu (1983) "Stability and Coherence of Health Experts' Upper and Lower Subjective Probabilities about Dose-Response Functions," *Organizational Behavior and Human Performance* 31, 277–302.

{% About equally many people prefer to work with verbal probabilities as with numerical probabilities. %}

Wallsten, Thomas S, David Budescu, Rami Zwick, & Steven M. Kemp (1993) "Preferences and Reasons for Communicating Probabilistic Information in Verbal or Numerical Terms," *Bulletin of the Psychonomic Society* 31, 135–138. https://doi.org/10.3758/BF03334162

{% Seems to be one of the inventors of marginal utility, together with Jevons and Menger. **marginal utility is diminishing**: according to Larrick (1993) one of the first to suggest diminishing marginal utility. %}

Walras, M.E. Léon (1874) “*Elements of Pure Economics.*” Translated by William Jaffé, Irwin, Homewood IL, 1954.

{% P. 98 (according to Georegescu-Roegen 1954 QJE p. 513):

“all these successive units have for their possessor an intensity of utility decreasing from the first unit which responds to the most urgent need to the last, after which satiety sets in.” %}

Walras, M.E. Léon (1896, 3rd edn.) “*Eléments d’Économie Politique Pure.*” F. Rouge, Lausanne.

{% **free will/determinism**: Epiphenomenalism means that mental is entirely caused by material things. Willusionism is the view that, because of this, free will is an illusion. %}

Walter, Sven (2014) “Willusionism, Epiphenomenalism, and the Feeling of Conscious Will,” *Synthese* 191 2215–2238.

{% On aleatory vs. epistemic uncertainty. P. 2762-2763 explains. Epistemic means that in principle it could have been known. Own lack of knowledge plays a role. And also, deviating from Savage (1954), own skills can play a role. Aleatory is fundamentally random and unknowable. Ambiguity is close to epistemic and risk is close to aleatory but they don’t seem to match perfectly.

This papers examines issues completely targeted towards investor behavior.

The paper uses introspective questions to measure degree of eleatory vs. epistemic and sees how it is related to behavior. %}

Walters, Daniel J., Gülden Ülkümen, David Tannenbaum, Carsten Erner, & Craig R. Fox (2023) “Investor Behavior under Epistemic vs. Aleatory Uncertainty,” *Management Science* 69, 2761–2777. https://doi.org/10.1287/mnsc.2022.4489

{% Proposes that after receipt of outcome, one feels regret or elation as the outcome is above or below the indifference class of the gamble. Those feeling are, however, only temporary and fade away and then the absolute level of the outcome determines the well-being. The speed of the fading away is determined by a time-preference parameter. The subject optimizes anticipating all that. %}

Walther, Herbert (2003) "Normal-Randomness Expected Utility, Time Preference and Emotional Distortions," *Journal of Economic Behavior and Organization* 52, 253–266.

{% Continues on his 2003 model. Theoretically shows how all kinds of properties in discounting and probability weighting can be captured by different functions, adding evolutionary considerations. %}

Walther, Herbert (2010) "Anomalies in Intertemporal Choice, Time-Dependent Uncertainty and Expected Utility—A Common Approach," *Journal of Economic Psychology* 31, 114–130.

{% Investigate statistical properties of the EQ-5D, using simulations. The term "model misspecification" is used in its common meaning. Nowadays (2020), people working on ambiguity often use the term as an alternative to ambiguity. %}

Waudby-Smith, Ian, A. Simon Pickard, Feng Xie, & Eleanor M. Pullenayegum (2020) "Using Both Time Tradeoff and Discrete Choice Experiments in Valuing the EQ-5D: Impact of Model Misspecification on Value Sets," *Medical Decision Making* 40, 483–497. https://doi.org/10.1177/0272989X20924019

{% Considers between-agent comparisons of ambiguity attitudes in the Anscombe-Aumann framework. Assumes EU maximization for risk. Then uses probability equivalents (matching probabilities) to compare ambiguity attitudes. The utility functions of the agents need not be the same here. %}

Wang, Fan (2019) "Comparative Ambiguity Attitudes," working paper.

{% **Prospect theory/Rank-Dependent Utility most popular for risk**: p. 8166 writes: "Tversky and Kahneman (1992) formulated cumulative prospect theory, which is nowadays the most widely accepted descriptive theory for decision making under risk." Note that T&K92 also handle ambiguity.

This paper considers an Anscombe-Aumann two-stage framework. It introduces the R-maxmin model, generalizing maxmin EU into maxmin RDU, giving the functional

$\min_{P \in \mathcal{P}} \int RDU(f(s))dP$

where $\mathcal{P}$ is a set of priors and only one RDU model, i.e., only one utility function U and one probability weighting function w are involved. Drawbacks are that the model is very general and has the problematic backward induction of the Anscombe-Aumann framework. Further, it treats ambiguity (through maxmin) differently than risk (rank-dependence), where I prefer the same, say rank-dependent, treatment of both.

Dean & Ortoleva (2017) also considered maxmin RDU but used a set of probability measures and a SET OF probability weighting functions. Further, D&O entirely focused on risk aversion, pessimism, and ambiguity aversion, which is too narrow empirically, and this paper to the contrary allows for the desirable insensitivity.

The paper uses the likelihood method, i.e., it uses the richness of probabilities, without needing richness of outcomes. This is desirable because the richness of probabilities is available anyhow. Abellaoui & Wakker (2005) pleaded for this approach. The author, therefore, does need continuous probability weighting. He, thus, applies the **tradeoff method** to probabilities. Section 2.6 shows how these techniques can be used to handle variational and multiplier preferences. Section 3 shows that we can now compare ambiguity attitudes without needing to assume the same risk attitudes, which is a highly desirable move. Section 4 accommodates Machina's counterexamples to rank dependence under ambiguity. %}

Wang, Fan (2022) "Rank-Dependent Utility under Multiple Priors," *Management Science* 68, 8166–8183.
https://doi.org/10.1287/mnsc.2021.4254

{% Many studies find a negative, rather than the usually assumed positive, relation between risk and returns of stocks. This paper puts reference dependence forward as a promising explanation. %}

Wang, Huijun, Jinghua Yan, & Jianfeng Yu (2017) "Reference-Dependent Preferences and the Risk–Return Trade-Off," Journal of Financial Economics 123, 395–414.

{% Analyze the famous RAND ("US") data set on heath insurance, and a similarly nice data set on health insurance from China.

real incentives/hypothetical choice: hypothetical choice

error theory for risky choice: The novelty of this study is what they call the "mixture model approach." That is, they do not assume a universal framing as gains or losses etc., but take as an extra parameter in their study whether the subjects perceive the outcomes as gains or losses, and in that manner derive from data who have a gains- and who a loss frame.

They estimate costs-probability distributions. For RAND data, their observable is preferred insurance by subjects, for Chinese data set it is WTP.

risk averse for gains, risk seeking for losses: US respondents: Risk averse for gains, and risk neutral or maybe some risk averse for losses. Chinese seemed to be risk neutral for gains and risk seeking for losses. This can be reconciled with the fourfold pattern if we assume that the framing in the context of insurance makes people more risk averse, which is well known (see keyword **insurance frame increases risk aversion**), and that in the Chinese group, who had to do WTP and not choice, WTP had the known biases downward. The authors instead resort to cultural differences. %}

Wang, Mei & Paul S. Fischbeck (2004) "Incorporating Framing into Prospect Theory Modeling: A Mixture-Model Approach," *Journal of Risk and Uncertainty* 29, 181–197.

{% Measure loss aversion in 53 countries around the world, using the data set also used by Rieger, Wang, & Hens (2015), and using Hofstede's indexes. They, properly, control for other components in loss aversion. They used hypothetical choice. I agree that for losses hypothetical is better than the common prior-endowment-and-then-paying-back procedure. Also, a study at this scale is hard to organize anyhow. Individualism, power distance, and masculinity increase loss aversion. Uncertainty avoidance and macroeconomic variables do not have effect.

Footnote 6 thanks anonymous referees for the addition of a comment, and, as usual, one can feel that it is a silly remark that was imposed on the authors because referees have too much power on writing subjective opinions today. %}

Wang, Mei, Marc Oliver Rieger, & Thorsten Hens (2017) "The Impact of Culture on Loss Aversion," *Journal of Behavioral Decision Making* 30, 270–281.

{% Distortion Riskmetrics are generalized Yaari (1987) type functionals, that need not be monotonic or translation invariant. %}
Wang, Qiuqi, Ruodu Wang, & Yunran Wei (2020) "Distortion Riskmetrics on General Spaces," *Astin Bulletin* 50, 827–851. https://doi.org/doi:10.1017/asb.2020.14

{% %}
Wang, Ruodu (2024) "Suggestions for Writing Mathematics in Scientific Papers." https://sas.uwaterloo.ca/~wang/files/writing.pdf

{% This paper analyzes the convex level sets (CxLS) property of risk functionals, which is necessary for elicitability, identifiability, and testability. The property is the analog of betweenness in decision theory: if F and G have the same functional value, then so does every convex combination of them.
Signed Choquet integrals play a special role. Identifiability means that a scoring rule can be devised such that the functional value of each distribution can be elicited in what economists call an incentive compatible manner. Identifiability means that a perfect accuracy score can be devised. %}
Wang, Ruodu & Yunran Wei (2020) "Risk Functionals with Convex Level Sets," *Mathematical Finance* 30, 1337–1367. https://doi.org/10.1111/mafi.12270

{% This paper is on nonmonotonic, signed, law-invariant Choquet integrals, denoted Ih, where h denotes a probability transformation function (I usually write w). Law-invariance means probabilistic sophistication. Here probabilities are assumed available, so that it is a Yaari (1987) type functional, generalized to be signed and nonmonotonic (so h need not be monotonic). The paper shows that many results assuming monotonicity go through unaltered if monotonicity is dropped, such as on convexity and on axiomatization through comonotonic additivity. Regarding monotonicity, this can often be gotten back by adding a strongly increasing linear functional, which does not affect many properties but brings back monotonicity. For instance, with λ the right derivative of h at q for q

≤ 1, we can add λp to h and have monotonicity on [0,q].

The paper cites much literature. It characterizes the functionals mainly by comonotonic additivity. Bounded variation, continuity, and convexity are studied.

Theorem 3 gives many properties that are equivalent to convexity of the probability transformation function h. Those are; (ii) convex order consistency (this is a version of aversion to mean-preserving spreads, or 2nd stochastic dominance), (iii) subadditivity, (iv) convexity of the functional w.r.t. outcome mixing, (v) quasi-convexity of the functional w.r.t. outcome mixing; (vi) concavity w.r.t. probabilistic mixtures. Wakker & Yang (2021) have related results but one difference concerns Statement (vi), where they have quasi-concavity rather than concavity w.r.t. probabilistic mixtures. This can be because W&Y only consider *strictly* increasing h. For nondecreasing h, W&Y's result would not hold (with quantile functions as counterexample, as pointed out by Wang 2021 personal communication), and this paper considers even more general h.

The paper also considers aggregations of risks where some marginal distributions are known but their joint distribution is unknown. %}

Wang, Ruodu, Yunran Wei, & Gordon E. Willmot (2020) "Characterization, Robustness, and Aggregation of Signed Choquet Integrals, *Mathematics of Operations Research* 45, 993–1015. https://doi.org/10.1287/moor.2019.1020

{% $(\Omega,\mathcal{F},P)$ is a probability space with P the "true" but maybe unknown probability measure. There is a set K of what are called scenarios. It is a partition of Ω. For $\theta \in K$, Q_θ denotes the conditional probability P conditioned on θ. If a functional ρ on the random variables on Ω assigns the same value to two random variables whenever those two have the same Q_θ distributions for all θ in a set $\mathcal{Q}$ of probability distributions over Ω, then ρ is called $\mathcal{Q}$-based. It is then like a multiple priors model with $\mathcal{Q}$ the set of priors. Thus, the paper provides a kind of general framework capturing multiple priors approaches. It then provides theorems characterizing ρ being a Choquet integral, convex, and other properties. %}

Wang, Ruodu & Johanna F. Ziegel (2021) "Scenario-Based Risk Evaluation," *Finance and Stochastics* 25, 725–756.
https://doi.org/10.1007/s00780-021-00460-9

{% Proposes Yaari's RDU with linear utility as risk measure and is much credited for this. People call it Wang's risk measure. %}
Wang, Shaun S. (1996) "Premium Calculation by Transforming the Layer Premium Density," *Astin Bulletin* 26, 71–92.

{% %}
Wang, Shaun W., Virginia R. Young, & Harry H. Panjer (1997) "Axiomatic Characterization of Insurance Prices," *Insurance: Mathematics and Economics* 21, 173–183.

{% Rewritten as Chapman, Jonathan, Erik Snowberg, Stephanie Wang, & Colin F. Camerer (2018) "Dynamically Optimized Sequential Experimentation (DOSE) for Estimating Economic Preference Parameters,"
Note that strategic answering, pointed out by Harrison (1986), is more of a theoretical problem than empirical. %}
Wang, Stephanie W., Michelle Filiba, & Colin F. Camerer (2010) "Dynamically Optimized Sequential Experimentation (DOSE) for Estimating Economic Preference Parameters," working paper, California Institute of Technology.

{% **updating under ambiguity**; **dynamic consistency** %}
Wang, Tan (2003) "Conditional Preferences and Updating," *Journal of Economic Theory* 108, 286–321.

{% %}
Wang, Tong V., Rogier J. D. Potter van Loon, Martijn J. van den Assem, & Dennie van Dolder (2016) "Number Preferences in Lotteries," *Judgment and Decision Making* 11, 243–259.

{% Many nice citations on uncertain preferences.
Use the modified BDM (Becker-DeGroot-Marschak) procedure of Schade &

Kunreuther. They assume that, for WTP, there is an interval in which there is a probability of buying. Below it buying is certain, and above it it is certainly not. The authors ask subjects to develop such an interval with a probability distribution, and then generate buying according to this probability distribution. The authors, however, assume, and I disagree, that it is in the subjects' interest to generate the probability distribution that agrees with their own distribution. If I face future uncertainties (even if regarding my own future tastes) then I integrate them out, come to one fixed current deterministic indifference price, and buy for all lower prices and do not buy for all higher. I have no interest in getting my future probability distribution reproduced at present. For instance, p. 204 2nd column end of 3rd para assumes that, if my future probability of buying is 10%, then at present my "ideal" probability of buying is 10%. %}

Wang, Tuo, Ramaswamy Venkatesh, & Rabikar Chatterjee (2007) "Reservation Price as a Range: An Incentive-Compatible Measurement Approach," *Journal of Marketing Research* 64, 200–213.

{% **SPT instead of OPT**: Eq. (5) in this paper.

P. 7 explains why 1979 prospect theory does not work: "A straightforward idea to solve the above problem is to discretize the continuous distribution into multiple outcomes and calculate the probability of each outcome, but this idea cannot work well because the discretized probabilities are usually very low, e.g., 0.001. In the classical PT method, these low probabilities will be transformed into subjective probabilities by the weighting function. Because the classical PT tends to overestimate the likelihood of small probability conditions, all these probabilities will likely be overestimated, and thus a distortion effect will be mistakenly imposed." They then propose a fractional modification, which involves separating a prospect into a deterministic and uncertain part. Is reminiscent of 1979 prospect theory for prospects with only positive or only negative outcomes, where also the sure (closest to 0) gain or loss is separated, but I did not check out carefully. %}

Wang, Ying, Jingxiao Jiang, Zhi Cai, & Kaifeng Zhang (2023) "Fractional Prospect Theory-Based Bidding Strategy of Power Retail Company in the Uniform Pricing Electricity Market under Price Uncertainty," *Fractal and Fractional* 7, 210. https://doi.org/10.3390/fractalfract7030210

{% **updating: nonadditive measures**; **updating** of Dempster-Shafer belief functions. %}

Wang, Ying-Ming, Jian-Bo Yang, Dong-Ling Xu & Kwai-Sang Chin (2007) "On the Combination and Normalization of Interval-Valued Belief Structures," *Information Sciences* 177, 1230–1247.

{% They further test the violation of internality that Gneezy, List, & Wu (2006) called the uncertainty effect, showing that it easily disappears. %}

Wang, Yitong, Tianjun Feng & L. Robin Keller (2013) "A Further Exploration of the Uncertainty Effect," *Journal of Risk and Uncertainty* 47, 291–310.

{% **value of information**: One ambiguous experiment is preferred to another by every decision maker in every decision problem if and only if for any first-order belief the decision maker entertains on the auxiliary state space (generating randomness of signals), the expected experiment resulting from this belief for the first experiment is Blackwell more informative than that of the second. The two parts of iff are very restrictive. Another informativeness order results if only maxmin EU. %}

Wang, Zichang (2024) "Informativeness Orders over Ambiguous Experiments," *Journal of Economic Theory* 222, 105937.
https://doi.org/10.1016/j.jet.2024.105937

{% Argues that for Bentham utility was multi-dimensional without aggregation to one-dimensional, so, without completeness of pref. P. 8 ℓ. 5/6 suggests that Bentham, at age 20, got concept of utility from writings of Hume, Helvétius, and Beccaria.

Cites Bentham for anonymity condition:
"Everybody to count for one, nobody for more than one." %}

Warke, Tom W. (2000) "Mathematical Fitness in the Evolution of the Utility Concept from Bentham to Jevons to Marshall," *Journal of the History of Economic Thought* 22, 3–23.

{% %}

Warke, Tom W. (2000) “Multi-Dimensional Utility and the Index Number Problem: Jeremy Bentham, J.S. Mill and Qualitative Hedonism,” *Utilitas* 12, 176–203.

{% **real incentives/hypothetical choice; time preference**: Military drawdown program of early 1990s, for 65,000 separatees had choice between annuity and lump-sum payment. So, real incentives, big stakes. They consider discounting of money; i.e., linear utility. Majority took lumpsum implying discount rates over 18%. %}

Warner, John T. & Saul Pleeters (2001) “The Personal Discount Rate: Evidence from Military Downsizing Programs,” *American Economic Review* 91, 33–53.

{% Uses CenTER panel. Some simple measures of risk aversion are correlated with financial decisions and other things. %}

Warneryd, Karl (1996) “Risk Attitude and Risky Behavior,” *Journal of Economic Psychology* 17, 749–770.

{% Legal controversy between Chichilnisky and Wooders %}

Warsh, David (1996) “Economic Principals: A Bitter Battle Illuminates an Esoteric World,” *Boston Globe Online Business*.

{% **(very) small probabilities**; **anonymity protection** %}

Washington, variety of species

{% **confirmatory bias**: (One of the?) first to find the confirmation bias, through the game where cards with a vowel on one side have an even number on the other. %}

Wason, Peter C. (1968) “Reasoning about a Rule,” *Quarterly Journal of Experimental Psychology* 20, 273–281.

{% %}

Wasserman, Larry A. (1990) “Prior envelopes Based on Belief Functions,” *Annals of Statistics* 18, 454–464.

{% **updating: nonadditive measures** %}

Wasserman, Larry A. & Joseph B. Kadane (1990) "Bayes' Theorem for Choquet Capacities," *Annals of Statistics* 18, 1328–1339.

{% %}
Wasserman, Larry A. & Joseph B. Kadane (1992) "Symmetric Upper Probabilities," *Annals of Statistics* 20, 1720–1736.

{% **foundations of statistics**: First part discusses procedures leading to the statement on p-values and is not interesting for me. Then comes the ASA statement. It is useful in general to warn against problems of p-values. Yet I found it a bit disappointing. It only writes standard generalities such as that one should not go by p-value alone but also by others things such as quality of design. And then always the usual point (their Point 4) that one should report all the tests and analyses ever considered, and the choice of the ones reported. This is indeed necessary by the rules of the game and the definition of p-value, but cannot and is never satisfied in any statistical analysis ever done before. For this discrepancy one cannot criticize the requirement to be incorrect given the def. of p-value, and neither mankind for violating it, but one should criticize p-value for being a partly nonsensical concept anyhow. %}
Wasserstein, Ronald L. & Nicole A. Lazar (2016) "The ASA's Statement on p-Values: Context, Process, and Purpose," *American Statistician* 70, 129–133. https://doi.org/10.1080/00031305.2016.1154108

{% **foundations of statistics**: this whole March issue of this journal is dedicated to it, taking papers from a 2017 conference on the topic. %}
Wasserstein, Ronald L., Allen L. Schirm, & Nicole A. Lazar (2019) "Moving to a World beyond "$p < 0.05$" (editorial)," *American Statistician* 73, 1–19.

{% Measure the ambiguity aversion and insensitivity indexes of Baillon et al. (2018) for a natural event (precipitation during rainy season) and an artificial event, being an Ellsberg urn. I am always happy if people consider the insensitivity component. They find:
People are more a-insensitive and more ambiguity averse for gains toward natural sources than artificial sources (surprising to me).

low cognitive more a-insensitive (**cognitive ability related to likelihood insensitivity (= inverse S)**); found significantly for artificial events but not for natural

cognitive ability related to risk/ambiguity aversion: not significant

Relation with real-world behavior (flood preparedness): for good cognitive: higher a-insensitivity then less mitigation for gains.

ambiguity seeking for losses: they find it

ambiguity seeking for unlikely: they find it

They confirm the whole fourfold pattern af ambiguity of Trautmann & van de Kuilen (2015) %}

Watanabe, Masahide & Toshio Fujimi (2024) "Ambiguity Attitudes toward Natural and Artificial Sources in Gain and Loss Domains," *Journal of Risk and Uncertainty* 68, 51–75.
https://doi.org/10.1007/s11166-023-09420-4

{% %}

Waters, Leonie K. & Michael Collins (1984) "Effect of Pricing Conditions on Preference Reversals by Business Students and Managers," *Journal of Applied Psychology* 69, 346–348.

{% **time preference**: seems to find sign dependence in intertemporal choice, with smaller discounting for losses than for gains ("gain-loss asymmetry").

intertemporal separability criticized: habit formation %}

Wathieu, Luc (1997) "Habits and the Anomalies in Intertemporal Choice," *Management Science* 43, 1552–1563.

{% %}

Wathieu, Luc (2004) "Consumer Habituation," *Management Science* 50, 587–596.

{% Seems to have introduced behaviorism. Schijnt te zeggen dat slechts uiterlijk waarneembaar gedrag onderwerp van een objectieve psychologie kan zijn. %}

Watson, John B. (1913) "Psychology as the Behaviorist Views It," *Psychological Review* 20, 158–177.

{% %}
Watson, John B. (1930) "*Behaviorism.*" Norton.

{% Criticizes Rabin & Thaler (2001) "Anomalies: Risk Aversion," *Journal of Economic Perspectives*. Argues that reasonable persons *should* not exhibit the risk aversion assumed by Rabin & Thaler. Rabin & Thaler, in their reply, correctly point out that this is irrelevant because their analysis is descriptive and not normative. Next the author argues that the phenomena assumed by Rabin & Thaler would require extremely high indexes of RRA (also argued by Palacios-Huerta & Serrano 2006) for some gambles and that this is not realistic. Rabin & Thaler, in their reply, correctly point out that they know this, agree with it, and always have done so, and that it is part of their reasoning (see, for example, Rabin (2000, Econometrica), p. 1287 2nd paragraph). The point is that this shows that the relative index of risk aversion is not suited for comparing small-stake gambles to high-stake gambles, or choices at different levels of wealth, the index being so very sensitive to where the origin of the scale is located. I expect that the latter deficiency of constant RRA has been known to many people in the present and past.

This paper is typical of many economists' thinking. Rabin & Thaler show that, for a plausible assumption denoted PA here ($11_{0.5}{-}10 \prec 0$ at various wealth levels), [EU & PA] $\Rightarrow$ implausible implications. They, correctly, conclude that EU is implausible. But many economists are just not able to make this step; they are not able to abandon EU. Instead, they enter their common way of thinking and come out with the conclusion that PA must be implausible. %}
Watt, Richard (2002) "Defending Expected Utility Theory," *Journal of Economic Perspectives* 16, 227–228.

{% Extends Nahs bargaining and other bargaining solutions from expected utility to biseparable utility. %}
Webb, Craig S. (2013) "Bargaining with Subjective Mixtures," *Economic Theory* 52, 15–39.

{% Uses the term ambivalence instead of (likelihood) insensitivity. The popular and useful neo-additive weighting functions of Chaeauneuf, Eichberger, & Grant (2007) are discontinuous at 0 and 1, which is crude and can sometimes bring theoretical complications. This paper proposes the simplest continuous extension that one can think of: The weighting function is linear on [0,1-k], [1-k, k], and [k,1]. 1-k is much like the best-rank boundary of Wakker (2010) and k is the worst-rank boundary. The nice thing is that the paper gives a preference foundation, where it is further nice that this is done in the Savage framework with richness of states and not of outcomes. %}

Webb, Craig S. (2015) "Piecewise Additivity for Non-Expected Utility," *Economic Theory* 60, 371–392.
https://doi.org/10.1007/s00199-015-0871-1

{% **tradeoff method**: Also used dually, to get probability weighting differences. Piecewise linearity means linearity on [0,p1], [p1,p2], and [p2,1]. It is a continuous variation of neo-additive. %}

Webb, Craig S. (2017) "Piecewise Linear Rank-Dependent Utility," *Theory and Decision* 82, 403–414.

{% Characterizes the variational model, using a two-stage setup with backward induction as do Anscombe-Aumann, but in the second stage using a subjective SEU model by imposing Savage's axioms there rather than Anscombe-Aumann's objective probabilities and EU for risk. It then enogenizes fifty-fifty mixing, and uses this endogenous operation to do Anscombe-Aumann type things. The fifty-fifty mixing is as follows: Assume for events A,C, we have A ≻ B (revealed preference). If we find a subset E of A, and an event E´ disjoint from B, with E ~ E´, such that A\E ~ CuE´, then these two events are midpoints between A and C, and so are all other events B ~ to them. They are called *second-stage averages*. They are a kind of 50-50 mixture, and can be used to get 50-50 utility mixtures. With these mixtures, subjective analogs of Anscombe-Aumann mixing, and theorems, can be obtained. Section 9 discusses pros and cons of different models with different kinds of richness.

Instead of Savage's P6, he uses solvability and an Archimedean axiom. I guess that the two-stage setup here rules out finite equally spaced cases. The set of events is assumed to be a sigma algebra. %}

Webb, Craig (2017) "Purely Subjective Variational Preferences," *Economic Theory* 64, 121–137.

{% This paper considers timed outcomes (α,t), and then probability distributions over those, $(p_1:(\alpha_1,t_1),\ldots, p_n:(\alpha_n,t_n))$. It gives characterizations of expected exponentially discounted utility, through dynamically interpretable conditions. It would be interesting to apply theorems of Keeney & Raiffa (1976) (not cited), on expected utility for multiattribute objects, two-attribute in this case. For instance, invariance under same delay is like constant absolute risk aversion. Theorem 1 on pp. 932-933 summarizes the five axiomatizations. %}

Webb, Craig S. (2024) "Dynamic Preference Foundations of Expected Exponentially-Discounted Utility," *Economic Theory* 77, 921–940. https://doi.org/10.1007/s00199-023-01523-y

{% **EU+a*sup+b*inf**: Novelty is that they do it using richness of probabilities and not of outcomes. Nice way to easily measure the jumps at 0 and 1. Propose to take these jumps, divided by 1 minus the jumps, as indexes of optimism and pessimism. That is, in the above a-b notation, a/(1–a–b) and b/(1–a–b). Thus, if a and b tend to 0.5, both optimism and pessimism tend to ∞, and optimism is for instance, for constant a, an increasing function of b and pessimism. They assume a finite outcome set and, hence, problems about null sets in the Chateauneuf, Eichberger, & Grant (2007) paper do not arise here.

They essentially impose vNM independence (≈ independence of common probability shifts, which in fact is the sure-thing principle for risk), and consistent optimism- and pessimism attitudes, which can be measured from limiting probability-shift properties and then be required to be consistent. %}

Webb, Craig S. & Horst Zank (2011) "Accounting for Optimism and Pessimism in Expected Utility," *Journal of Mathematical Economics* 47, 706–717.

{% Subjects can trade off time against outcome (wait longer for higher outcome with fixed probability) or against probability (wait longer for higher probability at fixed outcome). They want to wait longer for an increase in probability than for an increase in outcome if both entail the same expected value gain. However, stimuli are not just a money amount received with a probability at some timepoint, but the students are playing a computer game having to shoot many things and either the success-probability of every shot is increased or the damage of every shot. So, it is a complex situation that does not directly speak to usual decision theories. %}

Webb, Tara L. & Michael E. Young (2015) "Waiting when Both Certainty and Magnitude Are Increasing: Certainty Overshadows Magnitude," *Journal of Behavioral Decision Making* 28, 294–307.

{% **coalescing**: finds as much complexity aversion as seeking. %}

Weber, Bethany J. (2007) "The Effects of Losses and Event Splitting on the Allais Paradox. Judgment in Decision Making," *Judgment and Decision Making* 2, 115–125.

{% Consider the interaction of risk and time, in particular regarding the topic mentioned in the title. In direct binary choices, where subjects can by heuristic delete common components, they do not find reductions of the certainty effect if delay is added, or of the immediacy effect if risk is added. Here they do not replicate Keren & Roelofsma (1995). In CE or present value evaluation, they still find no reduction of the certainty effect if adding delay when the certainty effect concerns the common consequence version of the Allais paradox (the authors use the term Allais paradox only for the common consequence version). They do find it for the common ratio version of the Allais paradox. They also find reduction of the immediacy effect if adding risk. Hence, the effects are found a bit but not very clearly. %}

Weber, Bethany J. & Gretchen B. Chapman (2005) "The Combined Effects of Risk and Time on Choice: Does Uncertainty Eliminate the Immediacy Effect? Does Delay Eliminate the Certainty Effect?," *Organizational Behavior and Human Decision Processes* 96, 104–118.

{% Do 3-color Ellsberg paradox for monetary outcomes and for waiting time (for delivery of a good). Choices are hypothetical. In the waiting time setup subjects seem to choose between sure waiting times and ambiguous waiting times (only specified up to an interval), without very clear rationality/ambiguity-neutrality point, and the results are not easily comparable. %}

Weber, Bethany J. & Wah Pheow Tan (2012) "Ambiguity Aversion in a Delay Analogue of the Ellsberg Paradox," *Judgment and Decision Making* 7, 383–389.

{% %}

Weber, Elke U. (1984) "Combine and Conquer: A Joint Application of Conjoint and Functional Approaches to the Problem of Risk Measurement," *Journal of Experimental Psychology: Human Perception and Performance* 10, 179–194.

{% %}

Weber, Elke U. (1988) "Expectation and Variance of Item Resemblance Distributions in a Convolution-Correlation Model of Distributed Memory," *Journal of Mathematical Psychology* 32, 1–43.

{% The main point of this paper, stated immediately in the intro, is that an asymmetric loss function, also studied by Birnbaum, can give a motivational (deliberate, not due to misperceptions/biases) justification for nonlinear decision weights. The idea is that for some internal or external reason a person dislikes more underestimating some probability than overestimating it. It is analogous to statistical estimation theory where not the outcome of the gamble but the error of your estimation (whether too high or too low) matters for you. This internal/external reason may be psychologically plausible but it is not part of the decision model and its outcomes. It is something like "your colleague might blame you or you might feel silly the morning after you received the outcome of the gamble if it was way more than you estimated," and this approach is not decision-theoretic. Therefore, while psychologically plausible, this main point is not of direct interest to me. This notwithstanding, there are many comments and discussions about decision theory that are subtle and valuable, and the paper is very well written. I therefore read it several times and often cite it.

SPT instead of OPT: p. 231 last para

uncertainty amplifies risk: p. 237/238 suggests more deviation (**inverse S**) from EU under uncertainty than under risk.

P. 237 next-to-last paragraph, on pessimism, cites evidence from “impression formation” where cues receive more attention as they are ranked lower between the other cues.

P. 238 last paragraph expresses preference for decision weights depending on outcomes over utilities depending on probabilities/events and, thus, for rank-dependent utility over lottery-dependent utility of Becker & Sarin. Footnote 9 gives several refs on utility depending on probability.

P. 239 1st column: two-stage model of, first, estimation of probability and, second, configural weighting.

questionnaire versus choice utility: p. 239 2nd column end of first para: “Thus, decision analysts’ dogmatic refusal to consider introspective judgements of perceived probability as valid evidence may one day seem as unnecessary in its self-imposed limitations as a behaviorist approach to, say, language acquisition.”

risky utility u = strength of preference v (or other riskless cardinal utility, often called value): Many suggestions on p. 239/240, in particular p. 239 2nd column middle of page. Nice is p. 239 2nd column ℓ. –10/–3: “By separating the utility of the outcome itself from the weight given to the outcome as a function of its relative rank or the nature of the task …, changes in preference as a function of elicitation method can be attributed to changes in configural weighting, while allowing the utility of the outcome to remain invariant.”: This citation expresses what Birnbaum calls scale convergence and what I argued for in my ’94 Theory and Decision paper and used in Wakker & Deneffe (1996). See also discussion of Weber, Anderson, & Birnbaum some lines above.)

P. 240 discusses, twice, that people may want to change the internal constraints that they are imposing upon themselves, which I interpret as meaning that we shouldn’t take any utility function as normatively acceptable.

paternalism/Humean-view-of-preference: last sentence, on use of configural-weighting models (is approximately the same as rank-dependence): “and finally help to provide more accurate and consistent estimates of subjective probabilities and utilities in situations where all parties agree on the appropriateness of the expected-utility framework as the normative model of choice.” %}

Weber, Elke U. (1994) “From Subjective Probabilities to Decision Weights: The Effects of Asymmetric Loss Functions on the Evaluation of Uncertain Outcomes and Events,” *Psychological Bulletin* 115, 228–242.

{% Study direct judgments of riskiness versus attractiveness of lotteries. %}
Weber, Elke U., Carolyn J. Anderson, & Michael H. Birnbaum (1992) "A Theory of Perceived Risk and Attractiveness," *Organizational Behavior and Human Decision Processes* 52, 492–523.

{% Seem to have a **questionnaire for measuring risk aversion** %}
Weber, Elke U., Ann-Renée Blais, & Nancy E. Betz (2002) "A Domain-Specific Risk-Attitude Scale: Measuring Risk Perceptions and Risk Behaviors," *Journal of Behavioral Decision Making* 15, 263–290.

{% **risk averse for gains, risk seeking for losses**: Exhibit 8: seem to be risk neutral for losses, risk averse for gains. %}
Weber, Elke U. & William P. Bottom (1989) "Axiomatic Measures of Perceived risk: Some Tests and Extensions," *Journal of Behavioral Decision Making* 2, 113–131.

{% %}
Weber, Elke U., Ulf Böckenholt, Dennis J. Hilton, & Brian Wallace (1993) "Determinants of Diagnostic Hypothesis Generation: Effects of Information, Base rates, and Experience," *Journal of Experimental Psychology: Learning, Memory, and Cognition* 19, 1151–1164.

{% %}
Weber, Elke U. & Dennis J. Hilton (1990) "Contextual Effects in the Interpretations of Probability Words: Perceived Base rate and Severity of Events," *Journal of Experimental Psychology: Human Perception and Performance* 16, 781–789.

{% Redoes Wakker, Erev & Weber (1994), with several modifications. Shows that, if you deliberately bring in perceptional framing effects by highlighting, boldprinting, larger-font printing, etc. lowest or highest outcomes, then in that manner you can generate rank-dependence. Similarly, if you deliberately bring in motivational effects by letting lotteries be evaluated as buyer or seller etc., then this can also generate rank-dependence effects. This way they can distinguish

perceptual and motivational effects.

They often use an asymmetric loss model, also used by the psychologist Birnbaum. It is psychologically realistic and interesting, but has no clear role in revealed preference and, hence, will be of less interest to economists.

One of the findings of this paper is that the absence of rank dependence in Wakker, Erev, & Weber (1994) (WEW) may be due to the cancellation heuristic. That is, the common outcome was always so clear that subjects canceled it, not because it is their true preference, but only a heuristic to simplify choice. The paper suggests so because in direct choice they quite replicate the absence of rank dependence, but if they do pricing, where cancellation cannot be, then they get rank dependence.

WEW found no differences between four displays. Hence, this paper uses only the graphical display, which seems to be clearest and had the best consistency in WEW. This paper used many fillers to reduce heuristics.

P. 57 top (§5.1): "The current modification of their study was designed to test whether the cancellation of common outcomes in choice pairs may be partially responsible for their null results."

P. 57 (§5.12 1st para), writes a text that can be interpreted as saying that cancellation of common outcomes does not reflect true preference, but is only a heuristic. The last sentence strongly suggsts so, although it does not fully commit to the existence of "true preference": "The reversals between choice-based and price-inferred preference observed in this study were, at least partly, due to the fact that a significant portion of respondents seemed to cancel the COs of the lottery pairs in the choice task but incorporated them into their pricing judgments. If people were EU maximizers, such cancellation could not lead to a reversal in the rank order of preference between the two elicitation modes. When alternatives are evaluated in a rank-dependent fashion, on the other hand, CO cancellation can have this effect."

P. 59, §5.4, nicely discusses normative implications of rank dependence. %}

Weber, Elke U. & Britt Kirsner (1997) "Reasons for Rank-Dependent Utility Evaluation," *Journal of Risk and Uncertainty* 14, 41–61.
https://doi.org/10.1023/A:1007769703493

{% Propose a model of variance divided by expectation to determine if people/animals are risk averse or risk seeking and show that in 20 data sets from other studies with choices between sure and two-outcome prospects their formula performs well. A problem may occur if the expected value in the denominator is zero or negative.

real incentives/hypothetical choice: pp. 435-436: real incentives give more risk aversion both for gains and for losses. %}

Weber, Elke U., Sharoni Shafir, & Ann-Renee Blais (2004) "Predicting Risk-Sensitivity in Humans and Lower Animals: Risk as Variance or Coefficient of Variation," *Psychological Review* 111, 430–445.

{% %}

Weber, Martin (1983) "An Empirical Investigation on Multi-Attribute Decision Making." *In* Pierre Hansen, (ed.) *Essays and Surveys on Multiple Criteria Decision Making*, 379–388, Springer Verlag, Berlin.

{% %}

Weber, Martin (1985) "A Method for Multiattribute Decision Making with Incomplete Information," *Management Science* 31, 1365–1371.

{% %}

Weber, Martin (1987) "Decision Making with Incomplete Information," *European Journal of Operational Research* 28, 44–57.

{% %}

Weber, Martin (1998) "Remarks on the Paper "On the Measurement of Preferences in the Analytical Hierarchy Process" by Ahti A. Salo and Raimo P. Hämäläinen," *Journal of Multi-Criteria Analysis* 6, 320–321.

{% %}

Weber, Martin (1998) "Comment on Mayer, C., Financial Systems and Corporate Governance: A Review of the International Evidence," *Journal of Institutional and Theoretical Economics* 154, 166–169.

{% P. 10 gives nice interpretation on finding that decision weights are more problematic than thought: The finding is bad news for MAUT because they turn out to be more problematic. But it is good news for MAUT because henceforth we can better measure because we now know the errors better. %}

Weber, Martin & Katrin Borcherding (1993) "Behavioral Influences on Weight Judgments in Multiattribute Decision Making," *European Journal of Operational Research* 67, 1–12.

{% **survey on nonEU**

p. 134: "For instance, prospect theory (Kahneman and Tversky [49], Sect. 3.2 below) is clearly built from data and intuition." (**Prospect theory/Rank-Dependent Utility most popular for risk**:) %}

Weber, Martin & Colin F. Camerer (1987) "Recent Developments in Modelling Preferences under Risk," *OR Spektrum* 9, 129–151.

{% **risk averse for gains, risk seeking for losses**: they study Shefrin & Statman's (1985) disposition effect, which suggests risk seeking for losses and risk aversion for gains. %}

Weber, Martin & Colin F. Camerer (1998) "The Disposition Effect in Securities Trading: An Experimental Analysis," *Journal of Economic Behavior and Organization* 33, 167–184.

{% %}

Weber, Martin, Franz Eisenführ, & Detlof von Winterfeldt (1987) "Bias in Assessment of Attribute Weights." *In* Yoshikazu Sawaragi, Koichi Inoue & Hirotaka Nakayama (eds.) *Toward Interactive and Intelligent Decision Support Systems*, 309–318, Springer Verlag, Berlin.

{% **part-whole bias** (attribute-splitting effect): it can be related to the findings of Wolfe & Kaplon (1941), Capaldi, Miller, & Alptekin (1989), Showers (1992), and Pelhan & Swann (1989), that splitting up a quantity into several smaller parts makes it look like more. %}

Weber, Martin, Franz Eisenführ, & Detlof von Winterfeldt (1988) "The Effects of Splitting Attributes on Weights in Multiattribute Utility Measurement," *Management Science* 34, 431–445.
https://doi.org/10.1287/mnsc.34.4.431

{% %}

Weber, Martin & Steven O. Kimbrough (1999) "An Empirical Comparison of Utility Assessment Programs." *In* Peter Kleinschmidt et al. (eds.) *Proceedings of the 12. Symposium on Operations Research*, 389–390, Athenäum Verlag, Frankfurt/Main 1989.

{% Third paragraph (? says Stigler, 1950, may rather mean section?) on p. 361-368 says that Weber-Fechner law is not relevant for economics (Stigler, 1956, end of §IV). %}

Weber, Max (1908) "Die Grenznutzlehre und das 'Psychophysisches Grundgesetz'." Reprinted in Max Weber, (1922) "Gesammelte Aufsätze zur Wissenschaftslehre," Mohr, Tübingen.

{% Seems to be not the first, but the most influential, to argue for "verstehen" (similar to introspection) as a crucial tool in social sciences. %}

Weber, Max (1922) "The Nature of Social Action."*From Wirtschaft und Gesellschaft*," 1922.

Reprinted in W.G. Runciman (1978) "Max Weber: Selections in Translation," Cambridge University Press, Cambridge.

{% %}

Weber, Roberto A. & Colin F. Camerer (2006) " "Behavioral Experiments" in Economics," *Experimental Economics* 9, 187–192.

{% If in battle of sexes one player moves first but the other will not observe this move, then by rationality principles this should not matter. Yet players usually give the first-mover advantage to the first mover. %}

Weber, Roberto A., Colin F. Camerer, & Marc Knez (2004) "Timing and Virtual Observability in Ultimatum Bargaining and "Weak Link" Coordination Games," *Experimental Economics* 7, 25–48.

{% Seems to have proposed Choquet-integral as integral w.r.t. fuzzy measures. %}

Weber, Siegfried (1984) "⊥-Decomposable Measures and Integrals for Archimedean t-Conorms ⊥," *Journal of Mathematical Analysis and Applications* 101, 114–138.

{% %}
Weber, Siegfried (1986) "Two Integrals and some Modified Versions-Critical Remarks," *Fuzzy Sets and Systems* 20, 97–105.

{% **Newcomb's problem**: Takes it as a game. Has the person assign subjective probabilities to the demon's predictive power, and then SEU maximization decides. %}
Weber, Thomas A. (2016) "A Robust Resolution of Newcomb's Paradox," *Theory and Decision* 81, 339–356.

{% P. 429 2nd para of 2nd column erroneously writes that vNM EU would be based on long-run argument, with EU a long-run limit, and then cites the confused Lopes (1981) on this. %}
Wedell, Douglas H. & Ulf Böckenholt (1990) "Moderation of Preference Reversals in the Long Run," *Journal of Experimental Psychology: Human Perception and Performance* 16, 429–438.

{% %}
Weddepohl, Hubertus N. (1970) "*Axiomatic Choice Models (and Duality)*." Ph.D. Dissertation, Universitaire Pers Rotterdam, Wolters-Noordhoff, Rotterdam.

{% **conservation of influence**; He investigates in this book and elsewhere when we think to decide something but maybe don't. Seems that the philosopher Michael Bratman studies similar things but believes more in the freel will. %}
Wegner, Daniel M. (2002) "*The Illusion of Conscious Will.*" MIT Press, Cambridge MA.

{% **risk averse for gains, risk seeking for losses**? %}
Wehrung, Donald A. (1989) "Risk Taking over Gains and Losses: A Study of Oil Executives," *Annals of Operations Research* 19, 115–139.

{% Translates the vNM EU axioms from lotteries to relative frequencies in infinite series with a limiting relative frequency existing. %}

Wei Hu, Tai (2013) "Expected Utility Theory from the Frequentist Perspective," *Economic Theory* 53, 9–25.

{% **Dutch book**; **ordered vector space**

This paper essentially presents what I consider to be de Finetti's theorem (cited by the author), showing that for decision under uncertainty with known (linear) utility, additivity of preference n the outcome dimension implies subjective expected value maximization. The paper correctly points out that this is dual to the von Neumann-Morgenstern expected utility axiomatization.

Pp. 192-193 don't make very clear that Savage (1954) is not just similar and more or less dual to one and the other, but fundamentally more general. It also suggests that Savage provided only sufficient conditions whereas this paper provides necessary and sufficient conditions, which is also very misleading given that this paper assumes utility as known/input in axioms. %}

Weibull, Jörgen W. (1982) "A Dual to the von Neumann-Morgenstern Theorem," *Journal of Mathematical Psychology* 26, 191–203.

{% **Dutch book**; **ordered vector space** %}

Weibull, Jörgen W. (1984) "Continuous Linear Representations of Preference Orderings in Vector Spaces." *In* Hans Hauptmann, Wilhelm E. Krelle, & Karl C. Mosler (eds.) *Operations Research and Economic Theory*, 291–305, Springer, Berlin.

{% **Dutch book**; **Dutch book; ordered vector space dynamic consistency**; **present value**; characterizes some forms, well known nowadays (1990-2023), of discounting under linear utility; domain is a cone, so, can't be bounded. %}

Weibull, Jörgen W. (1985) "Discounted-Value Representations of Temporal Preferences," *Mathematics of Operations Research* 10, 244–250.

{% %}

Weibull, Jörgen, Lars-Göran Mattsson, & Mark Voorneveld (2007) "Better May be Worse: Some Monotonicity Results and Paradoxes in Discrete Choice under Uncertainty," *Theory and Decision* 63, 121–151.

{% %}

Weil, Philippe (1990) "Nonexpected Utility in Macroeconomics," *Quarterly Journal of Economics* 105, 29–42.

{% **deception**: seems that in public good game, subjects were given false information about contributions by others. %}

Weimann, Joachim (1994) "Individual Behaviour in a Free-Riding Experiment," *Journal of Public Economics* 54, 185–200.

{% This paper presents a model of inductive observation and updating, with expected value maximization based on subjective probabilities. There are some cases, with total probability assumed less than some α, where the agent does not do Bayesian updating (called a shift or a paradigmatic shift). It is not specified what happens after a shift. It is shown in two propositions that the *normalized* expected losses due to arbitrage (if normalized by dividing by (roughly) the absolute value of the largest outcome involved) then cannot exceed α.

The author relates his α to the significance level α in statistics, proposing his result as a foundation of classical statistics. But there remain differences and the two αs are not the same. In hypothesis testing, alpha is the supremum of probabilities, *conditioned* over parameters in the null, of observations at which the null is rejected. The alpha in the author's model is not close to that.

The author points out that you need not know the whole subjective probability distribution, but only the probability α, to apply his result, and relates this to bounded rationality.

Violation of Bayesian updating is equated with dynamic consistency, implicitly taking the other dynamic conditions required to derive Bayesianism from dynamic consistency as given.

Proposition 4 modifies Proposition 3 by, first, defining as shift-protected bets the bets that have constant payoffs after shifts, so that shifts do not affect their

value. Proposition 14 then adds that for Dutch books we should look at the non-shift-protected (shift-exposed) bets. %}
Weinstein, Jonathan (2015) "A Bayesian Foundation for Classical Hypothesis Testing," working paper.

{% Studies risk sensitivity in normal form games. That is, how the solution is affected by vNM utility becoming more concave or more convex. The set of rationalizable outcomes increases as utility becomes more concave. A generalization is in Battigalli, Cerreia-Vioglio, Maccheroni, & Marinacci (2016 Econometrica). %}
Weinstein, Jonathan (2016) "The Effect Changes in Risk Attitude on Strategic Behavior," *Econometrica* 84, 1881–1902.

{% %}
Weinstein, Milton C. (1986) "Risky Choices in Medical Decision Making: A Survey," *Geneva Papers on Risk and Insurance* 11, 197–216.

{% **discounting normative**: Bleichrodt, 1994: this paper argues that constant discounted utility can be placed normatively on the same footing as EU. %}
Weinstein, Milton C. (1993) "Time-preference Studies in the Health Care Context," *Medical Decision Making*, 218–219.

{% **simple decision analysis cases using EU**: §9.3 (p. 270 ff.) has a nice case, although somewhat complex. %}
Weinstein, Milton C., Harvey V. Fineberg, Arthur S. Elstein, Howard S. Frazier, Duncan Neuhauser, Raymond R. Neutra, & Barbara J. McNeil (1980) "*Clinical Decision Analysis.*" Saunders, Philadelphia.

{% P. 1256 repeats in several places that community prefs, not patient prefs., should be used, confusing prefs representing best interest with prefs elicited in surveys. Tversky & Kahneman (1981 p. 458 1st/2nd column will argue differently.

P. 1256, end: it remains an open question whether PE (if I remember well, they call it SG), TTO, VAS, produce the right weights for QALYs. P. 1257: sorting that out will be important to address in future research

P. 1257 recommends discounting (after correction for inflation) by 3%. %}

Weinstein, Milton C., Joanna E. Siegel, Marthe R. Gold, Mark S. Kamlet, & Louise B. Russell (1996, for the Panel on Cost-Effectiveness in Health and Medicine) "Recommendations of the Panel of Cost-Effectiveness in Health and Medicine," *JAMA* 276, 1253–1258.

{% Seem to have been one of the first to state QALYs;
Nice example of the conflicting effects of utilitarianism and egalitarianism.

Wanted to determine most cost-effective way to control hypertension. That way is: Target the patients already treated, don't search much for new cases. That rule is not egalitarian, it's bad for the poor etc. without regular access to medical care. Authors are well aware of that and acknowledge it, but conclude that here the utilitarian argument is too strong and decides here.

"a community with limited resources would probably do better to concentrate its efforts on improving adherence of known hypertensives, even at a sacrifice in terms of the numers screened." %}

Weinstein, Milton C. & William B. Stason (1976) "*Hypertension: A Policy Perspective.*" Harvard University Press, Cambridge, MA.

{% %}

Weinstein, Milton C. & William B. Stason (1977) "Foundations of Cost-Effective Analysis for Health and Medical Practices," *New England Journal of Medicine* 296, 716–721.

{% %}

Weinstein, Neil D. (1980) "Unrealistic Optimism about Future Life Events," *Journal of Personality and Social Psychology* 40, 822–832.

{% **correlation risk & ambiguity attitude**: Give evidence for positive a relation. Find usually positive relations between risk seeking and optimistic choices under uncertainty. To what extent the optimistic choices are due to optimism in the risk attitude, or to additional ambiguity-generated optimism, is not easy to identify. The authors discuss this point in §5. %}

Weinstock, Eyal & Doron Sonsino (2014) "Are Risk-Seekers more Optimistic? Non-parametric Approach," *Journal of Economic Behavior and Organization* 108, 236–251.

{% **Newcomb's problem**? %}
Weintraub, Ruth (1995) "Psychological Determinism and Rationality," *Erkenntnis* 43, 67–79.

{% **R.C. Jeffrey model;** discusses an earlier criticism of Lewis on Jeffrey's model joining decisions and beliefs. %}
Weintraub, Ruth (2007) "Desire as Belief, Lewis Notwithstanding," *Analysis* 67, 116–122.

{% **updating: discussing conditional probability and/or updating** %}
Weirich, Paul (1983) "Conditional Probabilities Given Knowledge of a Condition," *Philosophy of Science* 50, 82–95.

{% **foundations of probability** %}
Weirich, Paul (1986) "Expected Utility and Risk," *British Journal for the Philosophy of Science* 37, 419–442.

{% Seems to argue that Ellsberg's paradox can be explained by incorporating ambiguity as extra aspect of the outcomes. (**event/outcome driven ambiguity model: outcome driven**) %}
Weirich, Paul (2001) "Risk's Place in Decision Rules," *Synthese* 126, 427–441.

{% Seems to argue for process-dependent utility, although I did not read enough to really pin this down. %}
Weirich, Paul (2010) "Utility and Framing," *Synthese* 176, 83–103.

{% The journal has a whole issue on ambiguity in law. %}
Weisbach, David (2015) "Introduction: Legal Decision Making under Deep Uncertainty," *Journal of Legal Studies* 44, S319–S335.

{% Propose a variation of expected utility where an extra weight is added: How salient the outcome is. The model (p. 175) is not formalized, as philosophical models often are not, being less precise but more open to interpretations. Thus, it is not specified in the formula on p. 175 what the domain is and how the salience weight MS_j can be identified from utility or probability. The authors propose a definition of rationality amounting to sticking to your plans, i.e., similar to dynamic consistency (a term not used by the author). I wonder how it relates to other irrationalities such as violations of monotonicity. The text seems to assume that the von Neumann-Morgenstern axiomatization of EU was only for money, but it was for general outcomes. %}

Weiss, Jie W. & David J. Weiss (2012) "Irrational: At the Moment," *Synthese* 189, 173–183.

{% Nicely written; p. 18: "That few aspects of utility analysis have been satisfactorily subjected to empirical testing is unfortunate for economics because of this key role [link human preferences with economic behavior] in (but) the theory of demand."

Footnote 5: S**EU = SEU**

inverse S?: Explains ways in which people bet on horse races through utility of money. People overbet on longshot which suggests that utility is convex, indeed the optimal fit was from a slightly convex curve. This finding seems to be in agreement with Griffith (1949) who explained it in terms of probability transformation. %}

Weitzman, Martin L. (1965) "Utility Analysis and Group Behavior: An Empirical Study," *Journal of Political Economy* 73, 18–26.

{% Argues that a discount rate of .04 for the immediate future is appropriate, then should go down to zero. One reason is that if all individuals want constant discounting but don't agree on which rate, then in the aggregate the proposal made here comes out.

Emailed with over 2,000 economists over the world, also with 50 distinguished, on what they consider an appropriate discount rate. %}

Weitzman, Martin L. (2001) "Gamma Discounting," *American Economic Review* 91, 260–271.

{% **(very) small probabilities**: examines unlikely events with very extreme, –∞ or ∞, utility. Suggests a tail-fattening effect of what he calls structural uncertainty, which the ambiguity literature of 2024 may call model uncertainty. Seems to not properly emphasize that unbounded utility is what mostly drives his results. %}

Weitzman, Martin L. (2009) "On Modeling and Interpreting the Economics of Catastrophic Climate Change," *Review of Economics and Statistics* 91, 1–19. https://doi.org/10.1162/rest.91.1.1

{% %}

Weller, Joshua A., Irwin P. Levin, Baba Shiv, & Antoine Bechara (2007) "Neural Correlates of Adaptive Decision-Making in Risky Gains and Losses," *Psychological Science* 18, 958–964.

{% **dynamic consistency**; argues that (dyn.?) consistency can hold only under EU but, according to Johnsen and Donaldson (1985, Econometrica) implicitly assumes EU in the second stage. %}

Weller, Paul (1978) "Consistent Planning under Uncertainty," *Review of Economic Studies* 45, 263–266.

{% **value of information**: About the expected value gain. This paper is the editorial of a whole issue on this topic. %}

Welton, Nicky J. & Howard H. Z. Thom (2015) "Value of Information: We've Got Speed, What More Do We Need? (editorial)," *Medical Decision Making* 35, 564–566.

{% Seems to contain survey on unrealistic optimism. %}

Wenglert, Leif & Anne-Sofie Rosen (2000) "Measuring Optimism-Pessimism from Beliefs about Future Events," *Personality & Individual Differences* 28, 717–728.

{% Assume one fixed probability vector ($p_1,\ldots,p_n$), and prospects for those with real-valued outcomes. Assume an additively decomposable representation $V_1(x_1) + \ldots + V_n(x_n)$, so, kind of **state-dependent utility**. If risk aversion (preference of

expected value over prospect) holds on this limited domain, then already state independent EU holds, with respect to the given probabilities. %}

Werner, Jan (2005) "A Simple Axiomatization of Risk-Averse Expected Utility," *Economics Letters* 88, 73–77.

{% Introduces mean-independent risk aversion. ε is *mean-independent risk at* z if conditional expectation of ε given z is 0 (for readers who know the concept of conditioning on a random variable). So, in discrete case, the conditional expectation of ε given each value of z is 0. x *differs from* y by *mean-independent risk* if then x = z+ε and y = z+λε with 0≤λ≤1, where this is transitively extended. This condition is studied in DUU with states of nature with, obviously, probabilities given, but dropping the DUR assumption that only the probability distributions generated over outcomes matter. So, state-dependence could in principle be. Shows that under sure-thing principle (implying state-dependent EU) the condition will imply EU, so, state independence, after all. Under EU, aversion to mean-independent risk is equivalent to risk aversion (i.e., concave U). In general it is implied by Rotschild-Stiglitz aversion to mean-preserving spreads. NonEU, with violation of the sure-thing principle, can also be in this model. This paper denotes the general representing functional by U (I usually denote it by V), which is what I will do here. For every prospect x, the condition is, under differentiability, equivalent to the derivative of U w.r.t. x(s) (s state of nature) being anticomonotonic (the author says negatively comonotonic) with x(s): The worse an outcome is ranked within a prospect, the more impact it has on the preference value. §6 extends to nondifferentiability using superdifferentials.

A restriction of the analysis of this paper is that its playing ground, with probabilities needed to be available but DUR not holding, is not big. %}

Werner, Jan (2009) "Risk and Risk Aversion when States of Nature Matter," *Economic Theory* 41, 231–246.

{% This paper is on decision under risk. Several papers have shown how endogenous utility-midpoint outcomes can be derived for outcomes under EU, RDU, and PT. Then, under continuity of utility, preference foundations can be obtained of the models of interest by imposing consistency on such endogenous midpoints. This

paper uses a duality between outcomes and goodnews probabilities (for losses: badnews probabilities) to obtain an endogenous weighting-function-midpoint probability. It will thus provide a generalization of the appealing derivations of RDU by Nakamura (1995), Abdellaoui (2002), and Abdealloui & Wakker (2005) to PT, providing the most appealing axiomatization of PT presently available.

The paper imposes, first, a common elementary probability shift condition (= sure-thing principle/separability but taken dually, in the probability dimension) to get a general additive rank-dependent representation. Then it adds consistency of endogenous probability midpoints, separately for gains and losses, to axiomatize PT. Remarkable is that no richness of outcomes is used. Only richness in probability is used, which is available anyhow. %}

Werner, Katarzyna Maria & Horst Zank (2019) "A Revealed Reference Point for Prospect Theory," *Economic Theory* 67, 731–773.

{% Seems to introduce a "scale of competition" to compare within-group selection with between-group selection, a hot topic in debates on evolution. %}

West, Stuart A., Andy Gardner, David M. Shuker, Tracy Reynolds, Max Burton-Chellow, Edward M. Sykes, Meghan A. Guinnee, & Ashleigh S. Griffin (2006) "Cooperation and the Scale of Competition in Humans," *Current Biology* 16, 1103–1106.

{% %}

Wester, Jeroen & Peter P. Wakker (2012) "Heffen op Nationale Hobby: Verzekeren," Interview in *NRC* 04 Oct 2012. (National Dutch newspaper)

Direct link to paper

{% %}

Westerbaan, Kayleigh L. (2014) "Cognitieve Vaardigheden en Risico-Attituden: Is er een Verband?," bachelor's thesis, Erasmus School of Economics, Erasmus University Rotterdam.

{% Summarizes contributions to an international colloquium on the foundations and applications of the theory of risk, held from May 12 to May 17, 1952 at Paris under the sponsorship of the Centre National de la Recherche Scientifique.

P. 3, condition (2) describes in the summary of Savage's exposition the sure-thing principle in lotteries with one nonzero outcome. %}

Weyl, F. Joachim (1952) "Preference Patterns in the Face of Uncertainty;" Summary of contributions to the international "Colloquium on the Foundations and Appications of the Theory of Risk," held from May 12 to May 17 at Paris under the sponsorship of the Centre National de la Recherche Scientifique. Technical Report ONRL-115-52, November 5, Office of Naval Research, London.

{% Theorem 3 is Yaari's (1987) result (RDU with linear utility) for the finite case for equally-likely n-outcome lotteries, for fixed n. Is presented as generalization of Gini index. The text below Eq. 20 mentions what in fact is comonotonicity. Theorem 7 then shows that the weak Pigou-Dalton transfer principle (aversion to elementary mean-preserving spreads) is equivalent to pessimism, with bigger weights for worse ranks. Donaldson & Weymark (1980) considers this functional with n variable, but then does not do rank dependence and, hence, the result here is not very close.

P. 411, Eq. 1, representative income in welfare is certainty equivalent in risk.

P. 412: Weak Pigou-Dalton transfer principle in welfare is aversion to elementary mean-preserving spreads in risk. %}

Weymark, John A. (1981) "Generalized Gini Inequality Indices," *Mathematical Social Sciences* 1, 409–430.
https://doi.org/10.1016/0165-4896(81)90018-4

{% %}

Weymark, John A. (1991) "A Reconsideration of the Harsanyi-Sen Debate on Utilitarianism." *In* John Elster & John E. Roemer (eds.) *Interpersonal Comparisons of Well-Being*, 255–320, Cambridge University Press, Cambridge.

{% Considers weakenings of Harsanyi's Pareto. Also discusses the inaccuracy of domain in Harsanyi's proof. %}

Weymark, John A. (1993) "Harsanyi's Social Aggregation Theorem and the Weak Pareto Principle," *Social Choice and Welfare* 10, 209–221.

{% %}

Weymark, John A. (1995) “Further Remarks on Harsanyi’s Social Aggregation Theorem and the Weak Pareto Principle,” *Social Choice and Welfare* 12, 87–92.

{% **proper scoring rules**; They elicit only first-order probabilities; then they apply the famous de Finetti theorem for exchangeable variables and interpret the density resulting from that as second-order probability. %}

Whitcomb, Kathleen & P. George Benson (1994) “Evaluating Second-Order Probability Judgments with Strictly Proper Scoring Rules,” Draft copy.

{% %}

White, Douglas John (1982) “*Optimality and Efficiency.*” Wiley, New York.

{% %}

White, Douglas John (1985) “*Operational Research.*” Wiley, New York.

{% In the beginning of 2000, this was the most cited of all economics papers published between 1975 and 2000. The statistics is at

White, Halbert (1980) “A Heteroskedasticity-Consistent Covariance Matrix Estimator and a Direct Test for Heteroskedasticity,” *Econometrica* 48, 817–838.

{% Seems to be influential paper on dilation. %}

White, Roger (2010) “Evidential Symmetry and Mushy Credence.” *In* Tamar Szabo Gendler & John Hawthorne (eds.) *Oxford Studies in Epistemology*, 161–186, Oxford University Press.

{% %}

Whitmore, George A. & Merlin C. Findlay (1978, eds.) “*Stochastic Dominance.*” Heath, Lexington, MA.

{% In WTP people have particular preferences for round numbers such as 5, 10, 20, etc. %}

Whynes, David K., Zoe Philips, & Emma Frew (2005) “Think of a Number … Any Number?,” *Health Economics* 14, 1191–1195.

{% Ask managers hypothetical choices of wildfire risks. Want to fit prospect theory, but do the Edwards fixed-probability weighting, what is sometimes called separable PT. (Eq. 2; **SPT instead of OPT**) They only fit the Prelec (1998) one-parameter CI family, and then small risks at catastrophes are overweighted. %}

Wibbenmeyer, Matthew J., Michael S. Hand, David E. Calkin, Tyron J. Venn, & Matthew P. Thompson (2012) "Risk Preferences in Strategic Wildfire Decision Making: A Choice Experiment with U.S. Wildfire Managers," *Risk Analysis* 32, 1021–1037.

{% The topic of this paper is how emotions affect perception and cognition (**cognitive ability related to risk/ambiguity aversion**). In particular, subjects were shown high-arousal aversive slides, and then predecisional information search was tested. The results are in line with the attention-narrowing hypothesis. Emotional stress limits info search, leading to simpler decision strategies. (**decision under stress**) Not concretely, but vaguely, this fits with more inverse S. %}

Wichary, Szymon, Rui Mata, & Jörg Rieskamp (2016) "Probabilistic Inferences under Emotional Stress: How Arousal Affects Decision Processes," *Journal of Behavioral Decision Making* 29, 525–538.

{% Spits is a free daily newspaper, with 500,000 copies per day distributed over the Netherlands, estimated to have 2,000,000 readers per day. %}

Wijers, Suzanne, Guus de Jonge, & Peter P. Wakker (2013) "Effectieve Dekking zonder Oververzekering," *Spits* 11 June 2013, Personal Finance p. 6.
Direct link to paper

{% **random incentive system**: discusses that

Oct. 21, 1997: Uses decision cost model, and not nonEU model, to explain deviations from EU, in context of random incentive system. Finds that incentives do not matter much for simple choices but do for complex ones. This result is not surprising, but it is useful to have it demonstrated clearly. I think, actually, that the underlying decision-cost model is not very useful here.

Decision time is taken as index for decision complexity. For low incentives, increased complexity gives less EV maximization (so, less risk seeking I assume); then also more violations of **RCLA.** This shows that incentives do not just reduce noise, but can have systematic effects; a point emphasized much by the author. (**real incentives/hypothetical choice**)

For high incentives, no differences are found.

Pp. 1398-1399 has a good balanced discussion, that the RIS (the author writes RLM) does not really need all of vNM independence, and what is needed may not be violated that much.

P. 1402: Refs that find that EV explains much of decisions. For calculating decision costs, the paper takes EV as the correct model, as first approximation. The discussion on p. 1401-1402 is defensive. True that any other model assumed can be criticized, but so can EV be just as much.

The example on p. 1402 shows that satisfying preference axioms such as independence need not always be better than all else. This can be shown trivially by doing EU minimization (stoch. dom. then needs rediscussion). It is a trivial point rather than a good argument against the pragmatic principle of taking preference-condition optimization as index of goodness of decisions.

Concluding sentence: "The results of this experiment suggest that decision time is a potentially rich explanatory and dependent variable, and so should not be an omitted one." %}

Wilcox, Nathaniel T. (1993) "Lottery Choice: Incentives, Complexity and Decision Time," *Economic Journal* 103, 1397–1417.
https://doi.org/10.2307/2234473

{% **error theory for risky choice**; pp. 200-201 point out that results about the core theory may depend on the error theory assumed.

P. 211 has writing from the cold-war period, with Wilcox considering himself to be experimental economist, considering Camerer and Hogarth to be from another hostile clan ("behavioral economists"), and then time to shoot:

"Notwithstanding Camerer and Hogarth's (1999) claim to the contrary, there are findings based on purely hypothetical tasks, or tasks with very low incentive levels, that simply do not hold up with real performance-contingent incentives of sufficient size (see e.g., Wilcox (1993) on violations of "reduction of compound lotteries," or Cummings, Harrison, and Rutström (1995) on binary choice valuation methods)." %}

Wilcox, Nathaniel T. (2008) "Stochastic Models for Binary Discrete Choice under Risk: A Critical Primer and Econometric Comparison." *In* James C. Cox & Glenn

W. Harrison, (eds.) *Risk Aversion in Experiments*; Research in Experimental Economics 12, 197–292, Emerald Group Publishing Limited, Bingley, UK.

{% Usual probabilistic choice theories do not preserve the more risk averse than relation. This paper proposes a probabilistic choice theory that does, and shows that it fits data well in the Hey & Orme (1994) data set. %}
Wilcox Nathaniel T. (2011) " 'Stochastically More Risk Averse:' A Contextual Theory of Stochastic Discrete Choice under Risk," *Journal of Econometrics* 162, 89–104.

{% **probability communication**: Seems to write that pie charts (as area of probability wheel) are among the most criticized ways to display numerical results. Seems that people can't judge angles well. %}
Wilkinson, Leland (2005) "*The Grammar of Graphics*;" 2nd edn. Springer, Berlin.

{% Textbook on behavioral economics. %}
Wilkinson, Nick (2007) "*An Introduction to Behavioral Economics A Guide for Students*." Palgrave, The MacMillan Press, London.

{% Good reference on Dirichlet priors; i.e., the multinomial versions of beta priors. %}
Wilks, Samuel S. (1962) "*Mathematical Statistics*." Wiley, New York

{% %}
Willard, Stephen (1970) "*General Topology*." Addison Wesley, Reading MA.

{% Generalizes Scott's method for solving linear inequalities. Shows that a finite system of axioms cannot do in general. I think that Krantz et al. (1971) refer to Suppes for such a result but don't remember details now. %}
Wille, Uta (2000) "Linear Measurement Models—Axiomatizations and Axiomatizability," *Journal of Mathematical Psychology* 44, 617–650.

{% %}
Willems, Edwin P. (1969) "Risk is a Value," *Psychological Reports* 24, 81–82.

{% On compromise effect and other things. %}

Willemsen, Martijn C. (2002) “Explaining Asymmetries in Preference Elicitation: The Role of Negative Attributes in Judgment and Choice,” Ph.D. dissertation, Eindhoven University.

{% Upward and downward matching give different results. Give further references, for example, to Massaro (1975). %}

Willemsen, Martijn C. & Gideon Keren (2002) “The Meaning of Indifference in Choice Behavior: Asymmetries in Adjustments Embodied in Matching,” Eindhoven University.

{% P. 577 uses the term pure risk for loss prospects, and speculative risks for mixed prospects, citing earlier insurance literature on these terms.

P. 578 column 1-2 suggests inertia for what leads to loss aversion.

N = 51. Hypothetical choice. Paper chooses matching. P. 581 explains some that pilots had considered choice list (“multiple choices”) also. They were not systematically different, but, as the author points out, crude.

Did not do pure translation of prospects.

risk averse for gains, risk seeking for losses: p. 582 last para finds risk seeking for loss gambles, to the surprise of the authors.

P. 584 finds correlation −0.39 between risk attitude for losses and for mixed prospects. Suggests a bit that some reflection, although loss aversion intervenes.

P. 585: finds no correlation between risk attitude questions and insurance attitude questions.

P. 585: insurance is about losses. %}

Williams, C. Arthur Jr. (1966) “Attitudes toward Speculative Risks as an Indicator of Attitudes toward Pure-Risk,” *Journal of Risk and Insurance* 33, 577–586.

{% **present value**; **DC = stationarity**; p. 855 bottom discussion of Axiom IV.

Dutch book: Do it in intertemporal context, with Axiom III (marginal consistency; p. 853) the additivity axiom. Use term temporal consistency for

Koopman's stationarity. Thus, they axiomatize net present value, i.e., discounted value, with however the discount factor subjective. %}

Williams, C. Arthur Jr. & John I. Nassar (1966) "Financial Measurement of Capital Investments," *Management Science* 12, 851–864.

{% Does what its title says. %}

Williams, Lawrence E. & John A. Bargh (2008) "Experiencing Physical Warmth Promotes Interpersonal Warmth," *Science* 322, 24 Oct, 606–607.

{% **inverse S:** People overvalue longshots and undervalue favorites in horse-betting. Suggest it's a result of adverse selection faced by bookmakers, regarding bettors with superior information. %}

Williams, Leighton V. & David Paton (1997) "Why is there a Favourite-Longshot Bias in British Racetrack Betting Markets?," *Economic Journal* 107, 150–158.

{% Aangeraden door Voorbraken, leerling Jan Bergstra. %}

Williams, Peter M. (1976) "Indeterminate Probabilities." *In* Marian Przelecki, Klemens Szaniawski, & Ryszard Wojcicki (eds.) *Formal Methods in the Methodology of Empirical Sciences*, 229–246, Ossolineum and Reidel, Dordrecht.

{% a.o. Dempster's rule of combination %}

Williams, Peter M. (1978) "On a New Theory of Epistemic Probability;" Review of Shafer, Glenn (1976) "*A Mathematical Theory of Evidence.*" Princeton University Press, Princeton NJ, *British Journal for the Philosophy of Science* 29, 74–85.

{% **foundations of probability** %}

Williamson, Jon (2005) "*Bayesian Nets and Causality. Philosophical and Computational Foundations*." Oxford University Press, Oxford.

{% **foundations of statistics** %}

Williamson, Jon (2010) "*In Defence of Objective Bayesianism*." Oxford University Press, Oxford.

{% **foundations of statistics** %}
Williamson, Jon (2011) "Objective Bayesianism, Bayesian Conditionalisation and Voluntarism," *Synthese* 178, 67–85.

{% **value of information**, in the LaValle sense of increase in expected utility, is related to an index of concavity of utility. %}
Willinger, Marc (1989) "Risk Aversion and the Value of Information," *Journal of Risk and Insurance* 56, 320–328.

{% **time preference**: A poet's way of, first, defining time discounting, and then negating it, suggesting that time is not ordered linearly;
Tijd en ruimte
Het perspectief, gezichtsbedrog
voor mens en dier, of beter nog:
gezichtsverlies,
maakt alles kleiner wat verdwijnt,
zodat de ruimte kleiner schijnt
dan ze echt is.

Had ook de tijd maar perspectief:
steeds kleiner werden elke grief,
en elk verdriet,
tot stipjes aan de horizon
waar niemand meer om huilen kon,
maar 't gaat niet zo.

Tijd is een weg in een groot woud
dat iedereen gevangen houdt
in schemering,
tijd is een pad waar je verdwaalt
en door jezelf wordt ingehaald,
een heksenkring. %}
Wilmink, Willem (19??)

{% **foundations of quantum mechanics**: brings together objective probabilities in quantum mechanics and subjective, decision-based, probabilities. %}
Wilson, Alastair (2013) "Objective Probability in Everettian Quantum Mechanics," *British Journal for the Philosophy of Science* 64, 709–737.

{% **anonymity protection** %}
Wilson, Edward O. (1992) "*The Diversity of Life.*" Cambridge, MA. (Later edn. 1994, Penguin, London.)

{% Book on ants %}
Wilson, Edward O. (1979) "*On Human Nature.*" Bantam, New York.

{% Investigate loss aversion if it concerns payments for others. It exists if just evaluating gains and losses of others, but may disappear if social and environmental contexts are added. %}
Wilson, Robyn S., Joseph L. Arvai, & Hal R. Arkes (2008) "My Loss Is Your Loss … Sometimes: Loss Aversion and the Effect of Motivational Biases," *Risk Analysis* 28, 929–938.

{% Mental contamination is, roughly, making errors in judgments. It is a very broad domain. The authors explicitly exclude one special class, incorrect application of rules such as in mathematical mistakes. What remains is still very broad. Figure 1 mentions four requirements to avoid mental contamination if unwanted mental processing is triggered: 1. Awareness of unwanted processing 2. Motivation to correct 3. Awareness of the direction and magnitude of the bias 4. Ability to correct. They discuss the literature through these four steps. %}
Wilson, Timothy D. & Nancy Brekke (1994) "Mental Contamination and Mental Correction: Unwanted Influences on Judgments and Evaluations," *Psychological Bulletin* 116, 117–142.

{% **intuitive versus analytical decisions**; Students can choose between different jams and different courses to enrol. Some are encouraged to evaluate attributes, others are not. The latter take decisions more in agreement with recommendations of experts (taste specialists in the first case, and more experienced students or teachers in the second case). It suggests that the deliberate thinking only worsens the decision relative to intuitive deciding.

Pp. 182-183 gives nice list of explanations: Verbalizing can worsen nonverbal memories, and deliberate thinking can worsen natural adaptive systems (as for me when typing where the fingers find the letters without me being able to state their places verbally). This paper is alternative to Dijksterhuis et al. (2006), with the criterion for goodness not self-reported degree of satisfaction, but extraneous. %}

Wilson, Timothy D. & Jonathan W. Schooler (1991) "Thinking too Much: Introspection Can Reduce the Quality of Preferences and Decisions," *Journal of Personality and Social Psychology* 60, 181–192.

{% Find that verbal expressions of probability are more information-sensitive and do better predict betting than numerical probabilities, maybe because numerical probabilities may invoke ad hoc rules. %}

Windschitl, Paul D. & Gary L. Wells (1996) "Measuring Psychological Uncertainty: Verbal versus Numerical Methods," *Journal of Experimental Psychology: Applied* 2, 343–364.
https://doi.org/10.1037/1076-898X.2.4.343

{% This book seems to be a classic on statistics in psychology and biology.

Chapter 3 seems to discuss that t-test is still OK if the distribution does not deviate much from normality, citing Box (1954). %}

Winer, Ben J., Donald R. Brown, & Kenneth M. Michels (1962) "*Statistical Principles in Experimental Design.*" McGraw-Hill, inc., New York. (3rd edn. 1991.)

{% **probability elicitation**;

inverse S: P. 792 top finds it, with overestimation of low probabilities and underestimation of high. Seems that people improve with training.

P. 785: People had to assess both density function and distribution function. They found the former easier, and did not understand well how the two are related. %}

Winkler, Robert L. (1967) "The Assessment of Prior Distributions in Bayesian Analysis," *Journal of the American Statistical Association* 62, 776–800.

{% **probability elicitation** %}

Winkler, Robert L. (1967) "The Quantification of Judgment: Some Methodological Suggestions," *Journal of the American Statistical Association* 62, 1105–1120.

{% **probability elicitation** %}

Winkler, Robert L. (1969) "Scoring Rules and the Evaluation of Probability Assessors," *Journal of the American Statistical Association* 64, 1073–1078.

{% **probability elicitation** %}

Winkler, Robert L. (1971) "Probabilistic Prediction: Some Experimental Results," *Journal of the American Statistical Association* 86, 675–685.

{% **simple decision analysis cases using EU**: Example 5.10, gives a nice didactical illustration with all that is there being properly balanced (with collecting info analyzed in §6.4 and §6.5). It is a simplified version of an actual analysis done by Grayson (1960, 1979). %}

Winkler, Robert L. (1972) "*An Introduction to Bayesian Inference and Decision Theory*." Holt, Rinehart and Winston, New York.

{% **probability elicitation** %}

Winkler, Robert L. (1986) "On "Good Probability Appraisers" ." *In* Prem K. Goel & Arnold Zellner (eds.) *Bayesian Inference and Decision Techniques*. Elsevier, Amsterdam.

{% **event/outcome driven ambiguity model: outcome driven**: Argues that ambiguity should not be modeled through nonadditive probabilities, but rather should be incorporated in utility. P. 288 cites Smith (1969) for it. Is mostly prescriptively oriented (e.g., p. 288 3rd para).

P. 289: "Although ambiguity about probabilities is the ambiguity of concern in this article, I would argue that the influence of this ambiguity on decision-making behavior generally operates through preferences. Thus, attention should be focused on the preference side of modeling rather

than on probabilities. The preference side involves the consequences in the decision model and the value function or utility function over those consequences."

P. 295: "M.B.A. students studying decision analysis are often quite surprised at how risk averse their assessed utility functions are and at how much they must give up in expected value to accommodate their assessed risk attitudes. This realization often leads them to move towards less risk-averse positions, and the same might happen with respect to ambiguity." %}

Winkler, Robert L. (1991) "Ambiguity, Probability, Preference, and Decision Analysis," *Journal of Risk and Uncertainty* 4, 285–297.

{% **proper scoring rules**: Without aiming to be complete, this paper gives a survey of proper scoring rules and some of their properties in the first 26 pages. §5, for instance, explains that scores obtained for different events are not directly comparable. The rest is comments and discussions. %}

Winkler, Robert L. (1996) "Scoring Rules and the Evaluation of Probabilities," *Test* 5, 1–60.

{% **probability elicitation**;

Consider what happens with subjective probabilities when elicited through quadratic scoring rule if utility is nonlinear, but assuming expected utility. As Figure 1 shows, for the convex ("risk-seeking") U(x) = x^2, for subjective p = 0.33 and smaller, it is best to report r = 0.0. Symmetrically, for subjective p = 0.67 and higher, it is optimal to report r = 1. Between p = 0.33 and p = 0.67, the optimal reply is linear, being r = 0.5 at p = 0.5. For the concave ("risk-averse") U(x) = 1 − e^{-x}, the reported optimal probability r is an inverse S-curve of the "true" subjective probability p, illustated in Figure 3 p. 146, that propect-theory advocates will like. (**inverse S**) %}

Winkler, Robert L. & Allan H. Murphy (1970) "Nonlinear Utility and the Probability Score," *Journal of Applied Meteorology* 9, 143–148.

{% **proper scoring rules** %}

Winkler, Robert L. & Roy M. Poses (1994) "Evaluating and Combining Physicians' Probabilities of Survival in an Intensitive Care Unit," *Management Science* 39, 1526–1543.

{% %}

Winkler, Robert L. & James E. Smith (2004) "On Uncertainty in Medical Testing," *Medical Decision Making* 24, 654–658.

{% %}

Winston, Gordon C. (1980) "Addiction and Backsliding: A Theory of Compulsive Consumption," *Journal of Economic Behavior and Organization* 1, 295–324.

{% **Z&Z**; %}

Winter, Joachim, Rowilma Balza, Frank Caro, Florian Heiss, Byung-Hill Jun, Rosa L. Matzkin, & Daniel McFadden (2006) "Medicare Prescription Drug Coverage: Consumer Information and Preferences," *Proceedings of the National Academy of Sciences* 103, 7929–7934.

{% Shows that people in bad health find life-prolonging treatment more acceptable, and explain it through diminishing sensitivity of prospect theory. %}

Winter, Laraine & Barbara Parker (2007) "Current Health and Preferences for Life-Prolonging Treatments: An Application of Prospect Theory to End-of-Life Decision Making," *Social Science & Medicine* 65, 1696–1707.

{% r**eal incentives/hypothetical choice**: seems to be on it %}

Wiseman, David B., & Irwin P. Levin (1996) "Comparing Risky Decision Making under Conditions of Real and Hypothetical Consequences," *Organizational Behavior and Human Decision Processes* 66, 241–250. https://doi.org/10.1006/obhd.1996.0053

{% **probability communication**: Diverse sample of U.S. parents and guardians (n = 407), either standard information about influenza vaccines or risk communication using absolute and incremental risk formats. Subjects randomized to the risk communication condition combined with the values clarification interface were more likely to indicate intentions to vaccinate ($\beta = 2.10$, $t(399) = 2.63$, $p < 0.01$). %}

Witteman, Holly O., Selma Chipenda Dansokho, Nicole Exe, Audrey Dupuis, Thierry Provencher, & Brian J. Zikmund-Fisher (2015) "Risk Communication, Values Clarification, and Vaccination Decisions," *Risk Analysis* 35, 1801–1819.

{% Study loss aversion and utility curvature for qualitative health states, subsequently quantified in a nontrivial manner. They find loss aversion confirmed, but linear instead of S-shaped utility. %}

Wittenberg, Eve, Eric P. Winer, & Jane C. Weeks (2003) "Empirical Support for Prospect Theory among Health State Valuations of Advanced Cancer Patients," Massachussetts General Hospital, Harvard Medical School, Boston, MA.

{% Seems to say: "The procedure of induction consists in accepting as true the *simplest* law that can be reconciled with our experiences." 6.363 %}

Wittgenstein, Ludwig (1922) "*Tractatus Logico Philosophicus*." Routledge, London.

{% **conservation of influence**: through illusion of control. %}

Wohl, Michael J.A. & Michael E. Enzle (2002) "The Deployment of Personal Luck: Illusory Control in Games of Pure Chance," *Personality and Social Psychology Bulletin* 28, 1388–1397.

{% The Wold three parts were recommended to me as good surveys by Ward Edwards on September 15, 1997. %}

Wold, Herman O. (1943) "A Synthesis of Pure Demand Analysis. Part I," *Skandinavisk Aktuarietidskrift* 26, 85–118.

{% Cardinal utility is measured by "unit of measurement" method. That is, if x and y are two commodity bundles, then a "unit of measurement," i.e., another commodity bundle u, is chosen, and real numbers s,t, such that su~x, tu~y. Then s/t is a measure for the utility proportion of x and y. Under homotheticity this is independent of the choice of unit of measurement.

First to derive existence of utility function through certainty equivalents in Theorem I, based on a continuity-like axiom V. (Before existence of utility function was simply assumed.)

Ref aan me gegeven door Karl Vind op 10 maart 1994. %}

Wold, Herman O. (1943) "A Synthesis of Pure Demand Analysis. Part II," *Skandinavisk Aktuarietidskrift* 26, 220–263.

{% %}
Wold, Herman O. (1944) "A Synthesis of Pure Demand Analysis. Part III," *Skandinavisk Aktuarietidskrift* 27, 69–120.

{% Note itself does not do more than show that repeated choice is a different thing than one-shot. Wold's rejoinder is more interesting. It points out that if EU is to be applied only in single-shot then it is very hard to test empirically. %}
Wold, Herman O. (1952) "Ordinal Preference or Cardinal Utility?" (with discussion), *Econometrica* 20, 661–664.

{% This paper addresses the intriguing question of whether we can have utility over past events (even though we cannot influence them anymore) and, then, how much we discount those. Unfortunately, the model used is out of the blue and not well defined. An interest point is that, although we cannot influence the past, we can still have uncertainty about it. Under nonEU this can probably be used to derive past utility from revealed preference through choices of receiving info about the past or not. Most examples in this paper concern another phenomenon: past events influence current utility instrumentally. But that is a different point. %}
Wolf, Charles (1970) "The Present Value of the Past," *Journal of Political Economy* 78, 783–792.

{% **utility elicitation**: of vNM utility function for money;
decreasing ARA/increasing RRA: They studied one subject, a dealer in U.S. government securities. First they used hypothetical gamble questions, and also discussed preference axioms, with the dealer. The dealer said he wanted to satisfy constant RRA. (Maybe he did that only because it was easy for his way of thinking?) After these hypothetical choices, they studied his real bids. In his real bids he was more risk averse. There, however, seem to be many distorting factors. Evidence supported increasing RRA, but not significantly. %}

Wolf, Charles & Larry Pohlman (1983) “The Recovery of Risk Preferences from Actual Choices,” *Econometrica* 51, 843–850.

{% **ratio bias**. Describe denominator neglect in probability estimation of joint events, and ways to reduce it, done in an experiment. %}
Wolfe, Christopher R. & Valerie F. Reyna (2010) “Semantic Coherence and Fallacies in Estimating Joint Probabilities,” *Journal of Behavioral Decision Making* 23, 203–223.

{% Chickens like less one whole kernel of corn than when it is divided into four pieces. %}
Wolfe, John B. & Martin D. Kaplon (1941) “Effect of Amount of Reward and Consummative Activity on Learning in Chickens,” *Journal of Comparative Psychology* 31, 353–361.

{% %}
Wolfers, Justin & Eric Zitzewitz (2004) “Prediction Markets,” *Journal of Economic Perspective* 18, 107–126.

{% **PE higher than others**: PE (if I remember well, they call it SG) gives higher utility than TTO. %}
Wolfson, Allan D., John C. Sinclair, Claire Bombardier, & Allison McGreer (1982) “Preference Measurements for Functional Status in Stroke Patients: Inter-Rater and Inter-Technique Comparisons.” *In* Robert L. Kane & Rosalie A. Kane (eds.) *Values and Long-Term Care*, Lexicon Books, Lexicon, MA.

{% Treats topics such as Cournot competition while explaining the formal assumptions such as strict concavity of the profit function. %}
Wolfstetter, Elmar (1999) “*Topics in Microeconomics*.” Cambridge University Press, Cambridge.

{% **utility = representational**: Argues for importance of emotions and psychological inputs in economics, giving many citations. There are no concrete directions for predictions.

conservation of influence: several references to psychological/philosophical literature on will. %}
Wolozin, Harold (2002) “The Individual in Economic Analysis: Toward Psychology of Economic Behavior,” *Journal of Socio-Economics* 31, 45–57.

{% **Newcomb’s problem** %}
Wolpert, David H. & Gregory Benford (2013) “The Lesson of Newcomb’s Paradox,” *Synthese* 190, 1637–1646.

{% %}
Womack, Andrew J., Luis León-Novelo, & George Casella (2014) “Inference from Intrinsic Bayes’ Procedures under Model Selection and Uncertainty,” *Journal of the American Statistical Association* 109, 1040–1053.

{% At the and of a EQ-5D-5L questionnaire, there is feedback to subjects/patients/clients regarding inconsistent answers, such as apparent violations of dominance, and subjects get the change to correct. %}
Wong, Eliza L. Y., Juan Manuel Ramos-Goni, Annie W. L. Cheung, Amy Y. K. Wong, & Oliver Rivero-Arias (2018) “Assessing the Use of a Feedback Module to Model EQ-5D-5L; Health States Values in Hong Kong,” *Patient* 11: 235–247. https://doi.org/10.1007/s40271-017-0278-0

{% **ordering of subsets**: Characterization of qualitative orderings of finite algebras that can be represented by belief functions (complicated proof). Drawback is that the functions are mostly unique only up to an ordinal transformation, given the absence of additivity as probability measures. Roughly, any weak ordering of a finite algebra satisfying monotonicity w.r.t. set inclusion and one more kind of null invariance condition (with >´ denoting strict preference) (A >´ B and A∩C = ∅ then A∪C >´ B∪C) seems to be representable by a belief function if I understand right. Idea is to start with a quantitative representation whatsoever and then apply a sufficiently concave transformation to get all inequalities satisfied.

Main theorem briefly described by Mukerji (1997 *Economic Theory*). %}

Wong, S.K. Michael, Yi Yu Yao, Peter Bollmann, & H.C. Bürger (1991) "Axiomatization of Qualitative Belief Structure," *IEEE Transactions on Systems, Man, and Cybernetics* 21 (4) 726–734.

{% An original way to measure the interesting differences between **dynamic consistency**, naivity, and sophistication. Students are asked: (a) How much time spent on studying a course to be taken in the future would be optimal; (b) how much time they expect to actually study it; (c) afterwards how much they really studied. (a) = (c) is time consistent. If (a) ≠ (c), then (b) = (a): naïve; (b) = (c): sophisticated. (b) in between is partially sophisticated. My main problem: (a) ≠ (c) can be due to unforeseen circumstances, rather than time inconsistency. The author argues (p. 546 end of 2nd para) that such unforeseen circumstances, if random and exogenous, are only noise and generate no bias, but I disagree: Their average is not 0, but positive. This is typical of time planning, as considered here: They are usually underestimations because unforeseen things are usually bringing extra delays. Would have been interesting had the author asked a question at (c) if there had been unforeseen circumstances, and how big they were. P. 646 3rd para says that it is surprising that predicted delay in one sample has worse general performance than unpredicted delay, but this can be explained by the problem mentioned, that unpredicted delay can be clever students subject to unforeseen extraneous delays.

(b) – (c) is an index of lack of self-control.

Question is also to what extent the subjects have an interest in truthfully responding, but I cannot easily think of biases.

DC = stationarity: p. 646 3rd l of §2.1 writes that time consistency iff exponential discounting. %}

Wong, Wei-Kang (2008) "How Much Time-Inconsistency Is there and Does It Matter? Evidence on Self-Awareness, Size, and Effects," *Journal of Economic Behavior and Organization* 68, 645–656.

{% On bookmakers, bettors %}

Woodland, Bill M. (1991) "The Effects of Risk Aversion on Wagering: Point Spread versus Odds," *Journal of Political Economy* 99, 638–653.

{% %}
Woolfolk, Robert L. & Louis A. Sass (1988) "Behaviorism and Existentialism Revisited," *Journal of Humanistic Psychology* 28, 108–119.

{% Proposes a theory of subjective perception (elaborated in detail in a working paper) where perception depends on calculating capacity available and expectation of distribution of stimuli in environment, which reminds me of the range-frequency theory of Parducci and decision by sampling by Chater, Stewart, and others. It leads to reference dependence where the reference point is the expectation as in Köszegi & Rabin, and risk aversion for gains with risk seeking for losses (**risk averse for gains, risk seeking for losses**). %}
Woodford, Michael (2012) "Prospect Theory as Efficient Perceptual Distortion," *American Economic Review, Papers and Proceedings* 102, 41–46.

{% **foundations of statistics** %}
Worrall, John (2007) "Why There's No Cause to Randomize," *British Journal for the Philosophy of Science* 58, 451–488.

{% **coherentism**: is discussed. The author argues that preference consistencies can rule out particular behaviors as irrational, but do not fully determine rational behavior, and they give a way to think. This in itself has been known long time. The novelties of philosophical twists escape me non-philosopher. %}
Worsnip, Alex (2022) "Making Space for the Normativity of Coherence," *Nous* 56, 393–415.

{% %}
Wright, Patricia, & Daniel Kahneman (1971) "Evidence of Alternative Strategies of Sentence Retention," *Quarterly Journal of Experimental Psychology* 23, 197–213.

{% %}
Wright, Peter (1974) "The Harassed Decision Maker: Time Pressures, Distractions, and the Use of Evidence," *Journal of Applied Psychology* 59, 555–561.

{% **probability elicitation** %}

Wright, William F. (1988) “Empirical Comparison of Subjective Probability Elicitation Methods,” *Contemporary Accounting* 5, 47–57.

{% Find neural basis for skewness preference; i.e., preference for positive skew and against negative skew. This is equivalent to inverse S probability weighting. The authors, on p. 1 top of 2nd column, incorrectly claim that this is not so, citing incorrect claims by Levy & Levy (2002 Management Science). %}

Wu, Charlene C., Peter Bossaerts, & Brian Knutsen (2011) “The Affective Impact of Financial Skewness on Neural Activity and Choice,” *Plos ONE 6*, e16838.

{% %}

Wu, George (1993) “Temporal Risk and Probability Weights: Rank-, Sign-, and Timing-Dependent Utility,” Harvard Business School, Boston MA.

{% real incentives: not used; instead, flat payment

PT falsified through **coalescing**;

inverse S: taking PT violations as they are, probability weighting seems to be inverse S.

Finds violations of PT (= 1992 prospect theory; the author writes CPT) due to canceling of common outcomes, which original 1979 prospect theory (OPT) can account for. I did not find definitions of the theories in the paper, and am not sure which version of OPT the author uses. P. 57 writes “whether or not the editing stage is formalized”

Structure on p. 42, with r = q´-q, and s remaining probability.

R				S				
p	q	r	s	p	q	r	s	
$\underline{x}$	y	0	0	$\underline{x}$	y´	y´	0	A question
$\underline{y}$	y	0	0	$\underline{y}$	y´	y´	0	B question

The A question concerns choosing between

(p:x, q:y, r:0, s:0) and (p:x, q:y´, r:y´, s:0). In the B question, the underlined common outcome $\underline{x}$ has been replaced by a common outcome $\underline{y}$.

Cancellation here does not work to enhance the sure-thing principle, but differently: Consider, with majority preferences indicated in percentages

0.32	0.01	0.01	0.66		0.32	0.01	0.01	0.66		
3600	3500	0	0	[60%]	**3600**	2000	2000	0		Question A
3500	3500	0	0		**3500**	2000	2000	0	[78%]	Question A´

This violates the comonotonic sure-thing principle, and even Green & Jullien's ordinal independence. Explanation: in Question A, the common 3600 is ignored, and then the longshot effect gives overweighting of the best (of what remains) outcome 3500. In reality, the prospects are presented in collapsed form with outcome 0 not written. Then Question A´ becomes

(0.33: 3500) versus (0.32: 3500, 0.2: 2000) and there is no longshot perception for the best outcome 3500.

P. 42, ℓℓ. 7-8: "we believe that subjects are using this editing operation to simplify the gamble, thus reducing the complexity of the decision-making task."

P. 56, §3.2, discusses between versus within prospect heuristics.

P. 56 has nice balanced writing: "Although the results are not completely clean" %}

Wu, George (1994) "An Empirical Test of Ordinal Independence," *Journal of Risk and Uncertainty* 9, 39–60.
https://doi.org/10.1007/BF01073402

{% %}

Wu, George (1996) "The Strengths and Limitations of Expected Utility Theory," *Medical Decision Making* 16, 9–10.

{% NonEU can well be due to preference for the timing of uncertainty. Probability weighting functions get more inverse S-shaped as the time of resolution proceeds. %}

Wu, George (1999) "Anxiety and Decision Making with Delayed Resolution of Uncertainty," *Theory and Decision* 46, 159–198.

{% **PT: data on probability weighting**; **inverse S** of weighting function;

P. 1679: I rewrite their concavity condition, boldprinting the common outcome that changes, ordering outcomes from good (left) to bad (right), and writing z for the worst outcome (so, x > y > z), to show that it is the kind of test of the sure-thing that can be used to test for optimism/pessimism:

If

	p	q´	q–p	q´´–q´	r
R	x	y´	z	**z**	z
			~		
R	y	y	y	**z**	z

then R becomes preferred if we change the common outcome from z to y. So,

	p	q´	q´´–q´	q–p	r
R	x	y´	**y**	z	z
			$\succcurlyeq$		
R	y	y	**y**	y	z

Their convexity condition is similar.

§5 does estimations; use preference ladders, which means choices that differ only regarding their common outcome (common consequence), but in a very particular way, so that it fits into the probability triangle. Assume $\gamma \succ \beta \succ \alpha$:

$(\mathbf{p_1+\varepsilon:\gamma}, p_2:\gamma, p_3:\alpha, \mathbf{p_4-\varepsilon:\alpha})$ vs. $(\mathbf{p_1+\varepsilon:\gamma}, p_2:\beta, p_3:\beta, \mathbf{p_4-\varepsilon:\alpha})$.

The bold-printed parts reflect common consequences. By manipulating ε, we can compare degrees of convexity of probability weighting w throughout the unit interval.

real incentives: they used flat payments

decreasing ARA/increasing RRA: use power utility;

$x^{0.55}$ comes out as utility function for gains. %}

Wu, George & Richard Gonzalez (1996) "Curvature of the Probability Weighting Function," *Management Science* 42, 1676–1690.

{% **coalescing** %}

Wu, George & Richard Gonzalez (1996) "Dominance Violations and Event Splitting," School of Business, Harvard University, Boston, MA.

{% **PT: data on probability weighting**; **inverse S** of weighting function %}

Wu, George & Richard Gonzalez (1998) "Common Consequence Conditions in Decision Making under Risk," *Journal of Risk and Uncertainty* 16, 115–139.

{% **PT: data on probability weighting**; **inverse S** of weighting function
real incentives: they used flat payments. %}

Wu, George & Richard Gonzalez (1999) "Nonlinear Decision Weights in Choice under Uncertainty," *Management Science* 45, 74–85.

{% **PT falsified**: The authors claim that the weighting function for mixed prospects has more insensitivity than that for pure gains or pure losses (**probability weighting depends on outcomes**). However, they don't have enough data to separate curvature from elevation (they assume only one weighting parameter that captures both) and also cannot separate it from loss aversion.

P. 1332 nicely writes on sign dependence: "Losses are not merely the opposite of gains, but gains and losses appear to be processed in different parts of the brain … and seem to be distinct psychologically, and not just to ends of a continuum"

I think that much of the evidence in this paper can be explained by the counting heuristic (Birnbaum 2008 Psychological Review), explained in my annotations there, which underlies the famous violation of stochastic dominance by Tversky & Kahneman (1986) and all of Levy & Levy (2002 Management Science). %}

Wu, George & Alex B. Markle (2008) "An Empirical Test of Gain-Loss Separability in Prospect Theory," *Management Science* 54, 1322–1335.
https://doi.org/10.1287/mnsc.1070.0846

{% Test OPT ('79 version of prospect theory) versus PT (or CPT; '92 version of prospect theory). Overall, OPT does some better.

§1.12, pp. 109-110, define PT and OPT. Their Eq. 1.3 is OPT. They describe it as "OPT with an editing operation," but it is OPT and nothing but OPT. (Their Eq. 1.4 is an earlier version of OPT that was used in the working paper Kahneman & Tversky (1975).) Their Eq. 1.2 is not OPT, but what has sometimes been called separable prospect theory (Camerer & Ho 1994), and that has often erroneously been taken as OPT. The authors do not make clear which formula they use for OPT. It does not matter for what they do. For OPT tradeoff consistency (p. 116) they only consider prospects that assign a positive probability to 0. Then Eqs. 1.2 and 1.3 coincide. (EQ. 1.4 is somewhat different but also implies OPT tradeoff consistency.

They assume at most three outcomes, the domain where OPT is defined only, but which gives an advantage to OPT because its natural extension to more outcomes does not work at all.

no real incentives but flat payment.

They derive a tradeoff consistency condition for PT, based on Abdellaoui (2002), and one for OPT, and find data in the **probability triangle** where these two give contradictory predictions.

violation of certainty effect: p. 120 reports that Simplex IV gives, strangely enough, a violation of the certainty effect.

P. 126 writes that PT (their CPT) has several advantages so that

"Thus, our tests should not be seen as reason to abandon CPT." %}

Wu, George, Jiao Zhang, & Mohammed Abdellaoui (2005) "Testing Prospect Theories Using Tradeoff Consistency," *Journal of Risk and Uncertainty* 30, 107–131.

https://doi.org/10.1007/s11166-005-6561-9

{% A focused history of decision under risk and uncertainty. It puts many subtle nuances that many people don't know exactly right.

P. 401 middle writes: "Indeed, in its abstract form, the independence axiom [vNM independence characterizing EU] is intuitively compelling." This is exactly how it is. The problems of the axiom are only recognized in concrete examples such as the Allais and Ellsberg paradoxes, when plausible interactions between disjoint events become conceivable. Luce (2000) p. 55, opening sentence of §2.4.2 is similarly nice: "Although this line of rational argument seems fairly compelling in the abstract, it loses its force in some concrete situations."

P. 401 ℓ. -4 writes: "The critical axiom is Savage's "Sure Thing Principle." The sure thing principle shares the same basic intuition as the Independence Axiom." Again, I fully agree. The s.th.pr. is way more critical than his other intuitive axiom, his P4. Here the authors, as commonly accepted today, let the sure-thing principle only refer to Savage's P2. (Savage took the term s.th.pr. broader and less formal.)

P. 402, Section "The Pre-prospect Theory Area" gives a central role to Edwards (1954), and I again agree.

P. 403 first half explains how between 1954-1980, many "modern" empirical

findings were already known, (e.g., described by Edwards 1954), but that theory was lacking in that period: "Looking back, it is surprising how much was already known both empirically and theoretically by 1954. It is also surprising how far away researchers and theoreticians were from a comprehensive model of decision making under risk and uncertainty. Many of the major empirical results that characterized research in the 1980s were already known, but the lack of a proper theoretical framework kept researchers from fully understanding these results. ... Edwards [1954] identified the fundamental problem of decision making research, "[the] development of a satisfactory scale of utility of money and of subjective probability" (p. 403). Indeed, Edwards also anticipated the theoretical problem that would characterize much research in the last 15 years: the composition rule that combines utility with distorted probabilities. In Edwards' words, "it seems very difficult to design an experiment to discover that law of combination" (p. 400)." The point is reiterated more or less on p. 404: "Although the Allais Paradox was now 25 years old, very little data existed challenging expected utility, and there were no theoretical alternatives to the classic model.
" P. 404: "Kahneman and Tversky's (1979) ... The paper's success is probably due to its unique combination of simplicity and depth." This is, indeed, a big feature of Kahneman and Tversky's work in general: they have deep understandings but present them accessibly. They can put everything so right and have everything working so well because of their deep understandings. Luce had similar deep understandings, but could not make things tractable and accessible.

P. 407: "prospect theory ... The paper took ideas that had been around, some for as long as 30 years, scattered in different literatures and thought to be unrelated, and constructed a formal model in which all the elements worked together."

Prospect theory/Rank-Dependent Utility most popular for risk: P. 407: "the reputation of prospect theory as one of the most important papers in social science is nevertheless completely deserved.". P. 408: "At the end of these 25 years of research, prospect theory stands out as the best descriptive model.". P. 410: "Rank-dependent utility (RDU) was an ingenious way of allowing probability distortions"

P. 407, as a contribution of prospect theory: "Most importantly, the view that the Allais Paradox was an isolated problem for expected utility was no longer tenable."

P. 407: "In general, economists strove for a descriptive theory of decision under risk that was elegant, general, and mathematically tractable. P. 408: … In contrast, psychologists were generally more concerned with explaining the underlying psychological process. ... These models tended to have more free parameters than prospect theory, and therefore were more flexible but less tractable and parsimonious."

P. 413: "The new theory unified the basic shape of the value and weighting function according to one psychophysical principle ... diminishing sensitivity" … The authors properly let diminishing sensitivity apply as well to utility as to probability weighting. For utility the reference point, the outcome denoted 0, is salient, and for probability two points are, p = 0 and p = 1. Diminshing sensitivity, however, does not speak to loss aversion. %}

Wu, George, Jiao Zhang, & Richard Gonzalez (2004), "Decision under Risk." *In* Derek J. Koehler & Nigel Harvey (eds.), *Blackwell Handbook of Judgment and Decision Making*, 399–423, Blackwell Publishing, Oxford, UK.

{% Considers three-player sequential game, where players 1 and 3 only interact indirectly through player 2. Beliefs are taken the traditional way, as probabilities. %}

Wu, Jiabin (2018) "Indirect Higher Order Beliefs and Cooperation," *Experimental Economics* 21, 858–876.

{% **natural sources of ambiguity; second-order probabilities to model ambiguity**.

Many papers have discussed the relation between ambiguity aversion and violation of reduction of compound lotteries (RCLA), with aversion to compound lotteries (ACL), propagated by Halevy (2007) who argued that ambiguity aversion is mostly generated by ACL, assuming that people perceive of ambiguity as 2nd stage uncertainty, uncertainty about what probabilities are. I think that such 2nd stage perception may occur for Ellsberg urns, but not for natural ambiguity. This paper nicely reverses the direction, finding that ambiguity aversion generates ACL, not the other way around. It does so by having a control group just exhibiting the usual ACL and ambiguity aversion, with the usual strong correlation. However, in the experimental treatment subjects are taught how to reduce compound lotteries. The idea is that this directly reduces ACL, but doed not DIRECTLY impact ambiguity aversion. Then, if ACL generates ambiguity aversion, and this is the causal direction, then one should also find reduced ambiguity aversion. However, ambiguity aversion is not reduced if ambiguity aversion impacts ACL and this is the causal direction, or if there is another cause impacting both the same way. The latter is found: ambiguity aversion is not reduced at all. This finding suggests that ambiguity aversion impacts ACL and not the other way around (or they have a common cause).

They find much and much higher correlation between ambiguity aversion and compound risk aversion when the former is from Ellsberg urns (what I qualify as artificial ambiguity) than from natural ambiguity, cnfirming opinions that I have. %}

Wu, Keyu, Ernst Fehr, Sean Hofland, & Martin Schonger (2024) "On the Psychological Foundations of Ambiguity and Compound Risk Aversion," working paper.

{% The enthusiasm of the authors appears from their abstract, writing: "This paper makes a significant methodological contribution to developing a numerical method."

SPT instead of OPT: Their p. 209, Eq. 3. Propose a numerical method to fit data, using fitting with Prelec's family as intermediate step. An experiment confirms all common properties. %}

Wu, Sheng, Hong-Wei Huang, Yan-Lai Li, Haodong Chen, & Yong Pan (2021) "A Novel Probability Weighting Function Model with Empirical Studies," *International Journal of Computational Intelligence Systems* 14, 208–227. https://doi.org/10.2991/ijcis.d.201120.001

{% **inverse S:** in a motor task, subjects had to quickly hit a spot on a screen and then got prizes if they succeeded. After some learning, their hit probabilities stabilized (the subjects were not told what these were but could experience so). Then they were given choices between different games, which amounts to choices between different lotteries. They also answered traditional risky decision questions.

In motor decision tasks people are closer to EU than in usual decision tasks (several further references are given). The utility functions elicited were the same (**source-dependent utility**: not the case here), but the probability weighting functions were different, with motor tasks giving the opposite of inverse S. The motor task is very similar to the experienced decision tasks (DFE) studied by Erev, Hertwig, and others, involving some ambiguity, be it that now motoric skills come in. Note here that a crucial assumption in Savage's (1954) expected utility is that the agent has no influence at all on the states of nature (no moral hazard). This assumption is violated if agents vary their efforts, but is satisfied if agents are assumed to maximize their effort. An explanation may be that subjects dislike a task where they fail with high probability. Another difference with classical decisions under risk is that the motoric task has repeated payments, so, perceptions of laws of large numbers come in. %}

Wu, Shih-Wei., Mauricio R. Delgado, & Laurence T. Maloney (2009) "Economic Decision-Making under Risk Compared with an Equivalent Motor Task," *Proceedings of the National Academy of Sciences* 106, 6088–6093. https://doi.org/10.1073/pnas.0900102106

{% Rescale EQ-5D using VAS. %}

Wu, Xiuyun, Arto Ohinmaa, Jeffrey A. Johnson, & Paul J. Veugelers (2014) "Assessment of Children's Own Health Status Using Visual Analogue Scale and Descriptive System of the EQ-5D-Y: Linkage between Two Systems," *Quality of Life Research* 23, 393–402. https://doi.org/10.1073/pnas.0900102106

{% Review of decision from experience (DFE) using non-rewarded sampling. Typical of the overselling in DFE: "When people decide whether to start a business or contemplate the success of a first date, there are no written records of risks to consult. Instead, they need to rely on their experience— if existent—with these options, and make decisions from experience rather than decisions from description (Hertwig, Barron, Weber, & Erev, 2004)." They first claim that many everyday decisions are different than decision from description (DFD), but then, out of the blue, claim that it must be DFE. I think DFE is as rare to happen in practice as DFD, and that most practical decisions are neither. Some lines below it is more nuanced "which we understand as poles on a continuum." But I still disagree. Most everyday decisions are not somewhere between DFD and DFE, but are just different.

P. 157 reviews whether there is a reversal of the overweighting of rare events into actual underweighting and concludes that the evidence is completely mixed, unclear, and hard to assess. (**DFE-DFD gap but no reversal**) The main problem is that it is hard to say which probability is being underweighted. The evidence is clearly that in DFE there is less overweighting than in DFD (p. 159 2nd para). %}

Wulff, Dirk U., Max Mergenthaler-Canseco, & Ralph Hertwig (2018) "A Meta-Analytic Review of Two Modes of Learning and the Description-Experience Gap," *Psychological Bulletin* 144, 140–176.

{% **ordering of subsets** %}
Wynn, Henry P. (1983) "Optimum Subset Problems in Statistics and Operations Research." *In* Simon French (ed.), *Multi-Objective Decision Making*, Academic Press, New York, 49–58.

{% Do what title says, with intertemporal growth also considered. Get a CCAPM model for RDU. One restriction they need is that all agents have the same probability weighting. Section 7 shows that their RDU results can be translated into EU results with a modified utility function, and end of Section 7 derives rank-neutral probabilities. This sheds some role on risk aversion in combination with as-if risk-neutral, something in finance that has puzzled me. %}
Xia, Jianming & Xun Yu Zhou (2016) "Arrow–Debreu Equilibria for Rank-Dependent Utilities," *Mathematical Finance* 26, 558–588.

{% The value heuristic entails that people use extremity of value as a cue to expect low frequency. %}
Xianchi Dai, Klaus Wertenbroch, & C. Miguel Brendl (2008) "The Value Heuristic in Judgments of Relative Frequency," *Psychological Science* 19, 18–19.

{% **measure of similarity** %}
Xiao, Jitian & Yanchun Zhang (2001) "Clustering of Web Users Using Session-Based Similarity Measures," *Proceedings of International Conference on Computer Networks and Mobile Computing*, 223–228.

{% **utility families parametric**; Seems to propose his family as improvement of Merton's HARA. His family seems to be the same as Saha's expo-power family, with Xie's σ one minus a parameter of Saha and Xie's γ the product of the two parameters of Saha.
Xie's power risk aversion family seems to be

$$\frac{1 - \exp(-\gamma \frac{x^{1-\sigma} - 1}{1-\sigma})}{\gamma},$$

with $\gamma \geq 0$ and $\sigma \geq 0$. $-U''/U' = \sigma/x + \gamma x^{-\sigma}$. %}

Xie, Danyang (2000) “Power Risk Aversion Utility Function,” *Annals of Economics and Finance* 1, 265–282.

{% %}

Xiong, Wei, Xudong Luo, Wenjun Ma, & Minjie Zhang (2014) “Ambiguous Games Played by Players with Ambiguity Aversion and Minimax Regret,” *Knowledge-Based Systems* 70, 167–176.

{% **anonymity protection** %}

Xu, Heng & Nan Zhanga (2022) “Implications of Data Anonymization on the Statistical Evidence of Disparity,” *Management Science* 68, 2600–2618. https://doi.org/10.1287/mnsc.2021.4028

{% Studies how people evaluate experts beforehand. Good experts are evaluated properly, but quacks (bad experts) are overvalued. Finds failure of contingent reasoning: People do not correctly *anticipate* how new info will affect their decision. So, it is not insensitivity to new info, but wrong anticipation of such. %}

Xu, Yan (2021) “Revealed Preferences over Experts and Quacks and Failures of Contingent Reasoning,” working paper.

{% Implement Dempster-Shafer so as to avoid the problem of assigning prior probabilities. %}

Xu, Yejun, Kevin W. Li, & Huimin Wang (2013) “Dempster Shafer Neural Network Algorithm for Land Vehicle Navigation Application,” *Information Sciences* 253, 56–73.

{% Generalizes α maxmin, first, by letting α depend on the act, second, by involving an open neighborhood of the priors. Uses α to axiomatize increasing and decreasing relative and absolute ambiguity aversion, in utility units. %}

Xue, Jingyi (2020) “Preferences with Changing Ambiguity Aversion,” *Economic Theory* 69, 1–60. https://doi.org/10.1007/s00199-018-1156-2

{% A remarkable paper that contains many of the ideas basic to prospect theory! **utility elicitation**: one of the few empirical papers actually trying to find out whether gambles for money show risk aversion through an experiment.

Takes DUU with finite state space and monetary outcomes. Explains that in SEU the probabilities are not objectively given and therefore traditional risk aversion cannot be defined. Then tests convexity of prefs. Does not show formally that that is equivalent to risk aversion in DUU. The tests of convexity are such that they involve, by modern views, loss aversion, which may explain the extensive risk aversion = convexity found there.

inverse S: End of §IV finds longshot effect, and explains it by overestimation of small probability rather than by EU. P. 278 says that coexistence of gambling and insurance can both be explained by overestimation of small probabilities.

real incentives: it seems that he used that. He discusses an auction and the **random incentive system** to do so, and suggests that these were done, but is not 100% clear on it.

P. 278: "because utility and probability are two purely theoretical components of an integral decision process."

P. 281, 2/3, in criticism of Friedman & Savage (1948), Yaari confuses risky and cardinal riskless utility, or, at least, equates them without further ado. (**risky utility u = strength of preference v (or other riskless cardinal utility, often called value)**)

P. 282: "writing P ... for preference or indifference, and agreeing to call the wealth level to which the relation corresponds the zero wealth level. In other words, let us agree to measure wealth in terms of deviations from the level which corresponds to P."

P. 285 2nd para: Discusses that each choice should be in isolation, and in fact proposes RIS, where unfortunately he also suggests that maybe a few, so, more than one, choices will be implemented. The description of the experiment does not make clear how the incentives were actually implemented.

End of §IV finds that several subjects (seven out of seventeen) exhibited risk seeking for small probability

inverse S: Yaari posits this on p. 290: "one finds that some subjects tend to overstate low probabilities and to understate high probabilities" and refers to Preston & Baratta (1948) and Mosteller & Nogee (1951) for related findings.

Yaari argues that convexity of preference w.r.t. outcome mixing and the overestimation of small probabilities, and also coexistence of gambling and insurance, can be reconciled. However, under Quiggin's (1982) rank-dependent utility and modern 1992 prospect theory, convexity w.r.t. outcome mixing is equivalent to concave utility AND convex probability weighting=pessimism (Wakker & Yang 2021), so then small probabilities of good outcomes are UNDERweighted and gambling cannot be accommodated. But Yaari did not commit to any such theory here. %}

Yaari, Menahem E. (1965) "Convexity in the Theory of Choice under Risk," *Quarterly Journal of Economics* 79, 278–290.

{% Seems to have mentioned that discounting can be due to uncertainty. %}

Yaari, Menahem E. (1965) "Uncertain Lifetime, Life Insurance, and the Theory of Consumer," *Review of Economic Studies* 32, 137–150.

{% Introduced comonotonicity on p. 328 $\ell\ell$. 3-5 ("bets on the same event," also stated for n events) but did not foresee its role in nonadditive theories. When Yaari worked on his (1987, Econometrica) paper on rank-dependent theories, he first was not aware of the role of comonotonicity. He learned it from Schmeidler. Hence, I still think it is fair to say that Schmeidler invented comonotonicity for rank-dependent theories.

He introduced the MRA relation for subjective EU. It implies that agents must have the same subjective probabilities. One can, of course, take more flexible definitions of MRA that, under EU, allow for comparisons of concave utility also if decision makers have different beliefs, e.g., in Baillon, Driesen, & Wakker (2012).

P. 328 last para argues that the analysis requires state-independence of utility. %}

Yaari, Menahem E. (1969) "Some Remarks on Measures of Risk Aversion and on Their Uses," *Journal of Economic Theory* 1, 315–329.

{% %}

Yaari, Menahem E. (1977) "A Note on Separability and Quasi-Concavity," *Econometrica* 45, 1183–1186.

{% %}

Yaari, Menahem E. (1978) "Separable Concave Utilities or the Principle of Diminishing Eagerness to Trade," *Journal of Economic Theory* 18, 102–118.

{% %}

Yaari, Menahem E. (1984) "Risk Aversion without Diminishing Marginal Utility and the Dual Theory of Choice under Risk." Research memorandum 65, Hebrew University, Jerusalem.

{% **Dutch book**; Fifth page suggests a bit, but not entirely, that continuity has no empirical content. %}

Yaari, Menahem E. (1985) "On the Role of "Dutch Books" in the Theory of Choice under Risk," Nancy L. Schwartz memorial lecture. *In* Donald P. Jacobs, Ehud Kalai, and Morton I. Kamien (1998 eds.) *Frontiers of Research in Economic Theory: The Nancy L. Schwartz Memorial Lectures*, 1983–1997. Cambridge University Press, Cambridge UK.

{% **risky utility u = strength of preference v (or other riskless cardinal utility, often called value)**: Suggests so. Says that risk aversion is attitude towards risk, and marginal utility towards wealth. He nowhere commits to EU or nonEU in a normative sense.

He only assumes weak stochastic dominance, not strong.

P. 108 middle emphasizes that the probability weighting function w is not about misperceiving probabilities, but about nonlinear weighting of perceived probabilities whatever the latter are. I hope that this deviates less from my preferred interpretation (w is both misperception and nonlinear weighting) than first meets the eye ... Maybe Yaari is not precluding numerical insensitivity, where the subjects know that the probability is, say, 10^{-6}, will say so if asked, but still feel it as bigger than 10^{-6}. He may only be precluding cases like ambiguity.

P. 112 bottom Eq. 16: Quiggin handles a more general functional at that stage.

P. 113 middle is correct that Quiggin's (1982) maths is not fully correct, but things are a bit different than written there. Quiggin & Wakker (1994) give exact details. %}

Yaari, Menahem E. (1987) "The Dual Theory of Choice under Risk," *Econometrica* 55, 95–115.

{% P. 173 near bottom overstates irrelevance of Arrow-Pratt index outside of expected utility for risk. He is thinking too narrowly about his dual model where utility is linear.

P. 176, Definition 1, considers more convexity for probability weighting, but puts the transformation outside, as with Pratt-Arrow utility, and not inside, as in source theory of Wakker (2004) and other papers. %}

Yaari, Menahem E. (1987) "Univariate and Multivatiate Comparisons of Risk Aversion: A New Approach." *In* Walter P. Heller, Ross M. Starr, & David A. Starrett (eds.) *Uncertainty, Information and Communication, Essays in Honor of Kenneth J. Arrow*, Vol. III, 173–187, Cambridge University Press, Cambridge.

{% Reformulates his dual risk model of 1987 for welfare.

P. 385 top mispresents axiom as if only concerning physically-identical situations. %}

Yaari, Menahem E. (1988) "A Controversial Proposal Concerning Inequality Measurement," *Journal of Economic Theory* 44, 381–397.

{% Proposed $\sum_{j=1}^{n}(w_j \times v_j)$ where $v_1 \geq \cdots \geq v_n$ and the w_js are weights, summing to 1. That is, a symmetric case of the Choquet integal %}

Yager, Ronald R. (1988) "On Ordered Weighted Averaging Aggregation Operators in Multicriteria Decisionmaking," *IEEE Transactions on Systems, Man, and Cybernetics* 18, 183–190.

{% %}

Yager, Ronald R. (1991) "Connectives and Quantifiers in Fuzzy Sets," *Fuzzy Sets and Systems* 40, 39–75.

{% %}
Yager, Ronald R. & Liping Liu (2008) "*Classic Works of the Dempster-Shafer Theory of Belief Functions.*" Springer, Berlin.

{% People find a 1286 out of 10,000 risk of cancer as higher than a 24.14 out of 100 risk. %}
Yamagishi, Kimihiko (1977) "When a 12.86% Mortality is More Dangerous than 24.14%: Implications for Risk Communication," *Applied Cognitive Psychology* 11, 495–506.

{% On support theory. Binary complementarity can be violated if event has both many similarities and many dissimilarities with the conditioning event. %}
Yamagishi, Kimihiko (2002) "Proximity, Compatibility, and Noncomplementarity in Subjective Probability," *Organizational Behavior and Human Decision Processes* 87, 136–155.

{% %}
Yamagishi, Kimihiko & John M. Miyamoto (1996) "Asymmetries in Strength of Preference: A Focus Shift Model of Valence Effects in Difference Judgments," *Journal of Experimental Psychology: Learning, Memory, and Cognition* 22, 493–509.

{Formalizes uniqueness of utility and then analyzes which can escape from Arrow's impossibility. %}
Yamamura, Hirofumi (2017) "Interpersonal Comparison Necessary for Arrovian Aggregation," *Social Choice and Welfare* 49, 37–64.

{% Mainly discusses mass versus density/number of atoms and circularity in that. %}
Yan, Kangnian (1990) "A Re-Examination into Newton's Definition of Mass and Mach's Criticism," *Historia Scientiarum* 40, 29–39.

{% The authors compare ambiguity with two-stage risk, applying two-stage ambiguity theories such as maxmin EU (although they have no 2nd order distribution) and the smooth model to the latter. Then the predictions of the two-

stage ambiguity models are violated. This provides evidence supporting non-two-stage models, for which the authors cite source preference of Tversky and others.

P. 231, ("Failure of a basic monotonicity condition") (**criticism of monotonicity in Anscombe-Aumann (1963) for ambiguity**) %}

Yang, Chun-Lei & Lan Yao (2017) "Testing Ambiguity Theories with a Mean-Preserving Design," *Quantitative Economics* 8, 219–238. https://doi.org/10.3982/QE460

{% Multiattribute measurement of utility over time and money. The novelty of this paper is in a new optimization algorithm. %}

Yang, I-Tung (2008) "Utility-Based Decision Support System for Schedule Optimization," *Decision Support Systems* 44, 580–594.

{% %}

Yang, Jaeyeong, Mark A. Pitt, Woo-Young Ahn, & Jay I. Myung (2020) "A Python Package for Adaptive Design Optimization," *Behavior Research Methods* 53, 874–897. https://doi.org/10.3758/s13428-020-01386-4

{% Considers ambiguity in games, but the ambiguity is only about nature's moves ("external"). They show existence of equilibria, continuity in how they depend on ambiguity aversion. The paper does consider some ambiguity seeking, although no insensitivity. %}

Yang, Jian (2018) "Game-Theoretic Modeling of Players' Ambiguities on External Factors," *Journal of Mathematical Economics* 75, 31–56.

{% **proper scoring rules**

It is well known that the only strictly proper scoring rule that is local (payoff conditional on event depends only on probability assigned to that event) is the logarithmic family. However, virtually all proofs in the literature assume differentiability. For applications, one should also answer the question without assuming differentiability. This paper provides the answer, and some generalizations: it shows that, also without presupposed differentiability, the logarithmic family is the only one that satisfies weak properness and locality,

where it also generalizes the domain considered. Before, Savage (1972) had also provided a proof without differentiability assumed for properness and on full domain, but it was complex and contained some steps that I never understood. The present paper considerably simplifies Savage's proof. %}

Yang, Jingni (2020) "The Uniqueness of Local Proper Scoring Rules: The Logarithmic Family," *Theory and Decision* 88, 315–322. https://doi.org/10.1007/s11238-019-09727-2

{% r**eal incentives/hypothetical choice, for time preferences**: seems to be on it %}

Yang, Xing-Lan., Si-Tan Chen, & Hong-Zhi Liu (2022) "The Effect of Incentives on Intertemporal Choice: Choice, Confidence, and Eye Movements," *Frontiers in Psychology* 13, 989511 https://doi.org/10.3389/fpsyg.2022.989511

{% They analyze how particularities of prospect theory can and cannot explain particular henomena, such as negative-feedback trading patterns. They assume no probability weighting.

loss aversion: erroneously thinking it is reflection: I was glad to see that, unlike many authors in finance, these authors define loss aversion properly, and do not confuse it with reflection. %}

Yao, Jing & Duan Li (2013) "Prospect Theory and Trading Patterns," *Journal of Banking & Finance* 37, 2793–2805.

{% Survey many (83), though obviously not all (Harless & Camerer 1994; Hey & Orme 1994), empirical studies into violations of EU. They do not really do a meta analysis, but they only list references, but (too) many are missing. %}

Yaqub, Muhammad Z., Gökhan Saz, & Dildar Hussain (2009) "A Meta Analysis of the Empirical Evidence on Expected Utility Theory," *European Journal of Economics, Finance and Administrative Sciences* 15, 117–133.

{% %}

Yates, J. Frank (1982) "External Correspondence: Decompositions of Mean Probability Scores," *Organizational Behavior and Human Decision Processes* 43, 145–171.

{% **probability elicitation**; **substitution-derivation of EU**;

Pp. 25-27 are on matching probabilities.

P. 99: References to studies showing that overconfidence in lay judgment is not universal. For easy questions (extremely high probabilities) underconfidence

Marcel zegt that Yates voordelen van PT groter vindt dan nadelen.

Ch. 1, Ch. 2 up to p. 20, and Chs. 8-11 are on general decision, EV, EU, PT, etc. Rest of Ch. 2 and Chs. 3-7 are on probability elicitation. Chs. 12 etc. are on underlying psychological principles.

risky utility u = transform of strength of preference v: stated in Ch. 12 pp. 166-168. %}

Yates, J. Frank (1990) "*Judgment and Decision Making.*" Prentice Hall, London.

Yates, J. Frank, Paul C. Price, Ju-Whei Lee, & James Ramirez (1996) "Good Probabilistic Forecasters: The "Consumer's" Perspective," *International Journal of Forecasting* 12, 41–56.

{% Seems to find negative discounting for losses. %}

Yates J. Frank & Royce A. Watts (1975) "Preferences for Deferred Losses," *Organizational Behavior and Human Performance* 13, 294–306.

{% Real incentives are implemented.

suspicion under ambiguity: done by letting subjects choose the winning color ("designation of valuable chip")

second-order probabilities to model ambiguity: Two-color Ellsberg urns. (Actually bags with 10 chips.) Game G is risk. Game G' is second-order probability, very clearly generated by the subjects themselves. Game G" is just unknown probability. Find $G \sim G' \succ G''$. So, no aversion to 2^{nd} order probability, but aversion to pure ambiguity. So, there is more to ambiguity aversion than second-order probabilities. %}

Yates, J. Frank & Lisa G. Zukowski (1976) "Characterization of Ambiguity in Decision Making," *Behavioral Science* 21, 19–25.
https://doi.org/10.1002/bs.3830210104

{% %}
Yearsley, James M. (2017) “Advanced Tools and Concepts for Quantum Cognition: A Tutorial,” *Journal of Mathematical Psychology* 78, 24–39.

{% **PT falsified**: This paper re-analyzes classical evidence favoring loss aversion, such as Fishburn & Kochenberger (1979), showing many weak points in that evidence. It argues that loss aversion was found for high stakes, but not for small ones.

I imagine that for high stakes, concavity of utility for gains and fear of ruin for losses, rather than loss aversion, can be doing much. For small stakes, joy of gambling and peanut effect can distort. For intermediate outcomes, loss aversion is more manifest. The distinction between what is small and what is moderate in the author’s terminology and in mine plays a big role here. I am more positive about loss aversion than the author. I think that loss aversion is strong and frequent, but, it is very volatile and can double or entirely disappear just by small changes in the stimuli. As components of decision attitudes become more volatile as they are more irrational. Loss aversion in the strict sense as I take it (only what results from reframing effects on reference point, and not “genuine” utility) is very volatile.

In the penultimate para, p. 1337, the author seems to argue that increased attention for losses is not loss aversion, and is not cognitive. I do not understand this para, and disagree. It can still be cognitive, and is as much part of loss aversion as strengthened feelings. Peeters & Czapinski (1990) give a good discussion of these two together comprising loss aversion. %}
Yechiam, Eldad (2019) “Acceptable Losses: The Debatable Origins of Loss Aversion,” *Psychological Research* 83, 1327–1339. https://doi.org/10.1007/s00426-018-1013-8

{% **dynamic consistency**; Seem to find underweighting of rare events for DFE. (**DFE-DFD gap but no reversal**) %}
Yechiam, Eldad & Jerome R. Busemeyer (2006) “The Effect of Foregone Payoffs on Underweighting Small Probability Events,” *Journal of Behavioral Decision Making* 19, 1–16.

{% Seem to find underweighting of rare events for DFE. (**DFE-DFD gap but no reversal**:) %}

Yechiam, Eldad, Meir Druyan, & Eyal Ert (2008) "The Effect of Observing Others on Risk Taking in Decisions from Experience," *Judgment and Decision Making* 3, 493–500.

{% **reflection at individual level for risk**: correlation between risk aversion for gains and losses seem to be positive. %}

Yechiam, Eldad & Eyal Ert (2011) "Risk Attitude in Decision Making: In Search of Trait-Like Constructs," *Topics in Cognitive Science* 3, 166–186.

{% Present a model and evidence that loss aversion is driven more by overattention to losses than by extremer utility (for which the authors use the term weight) for losses. P. 213 first para cites preceding findings.

losses give more/less noise: Several studies have found that choices under losses are more difficult and, hence, noisier than choices under gains (de Lara Resende, Guilherme, & Wu 2010 p. 129; Gonzalez, Dana, Koshino, & Just 2005 JEΨ; Lopes 1987). Somewhat different in spirit but not contradictory is that rewarding in terms of imposing losses to punish mistakes can work more effectively than imposing gains for good acts in making people make right choices. The presence of losses can make people pay more attention, improving decision quality.

PT falsified: This paper has an interesting experiment: People can choose between safe 35 and risky $200_{0.5}1$, and also between safe 35 and risky $200_{0.5}(-1)$. (Unit of outcome is points converted into small money amounts at the end of the experiment, with repeated payments, so income effects.) They more often choose risky in the second case, amounting to a violation of transitivity or stochastic dominance! The explanation is that the loss makes people pay more attention and, thus, they more rationally choose the highest expected value. This goes against the spirit of loss aversion. Interesting finding. They show that it is increased attention rather than contrast effect, because if the risky option has lower expected value then the loss makes people more often choose against the, now inferior, risky prospect. (**cognitive ability related to risk/ambiguity aversion**)

Note that, in general, loss aversion can be generated by increased attention for losses (rather than losses having lower utility), but the above increased attention is of a different kind.

This indirect violation of montonicity is comparable to the zero-outcome effect paradox of Slovic-Birnbaum ((.95, $96; .05, $24) receives lower CE than (.95, $96; .05, $0); Birnbaum, Coffey, Mellers, & Weiss (1992)) but now without outcome 0 involved.

The conclusion writes: "losses may be treated as signals of attention and not only as signals of avoidance. … Our findings demonstrate that the attentional effect of losses is indeed distinct from loss aversion," %}

Yechiam, Eldad & Guy Hochman (2013) "Loss-Aversion or Loss-Attention: The Impact of Losses on Cognitive Performance," *Cognitive Psychology* 66, 212–231.

{% Seem to find underweighting of rare events for DFE. (**DFE-DFD gap but no reversal**:) %}

Yechiam, Eldad, Tim Rakow, & Ben R. Newell (2015) "Super-Underweighting of Rare Events with Repeated Descriptive Summaries," *Journal of Behavioral Decision Making* 28, 67–75.

{% They add results to Yechiam & Hochman (2013) on the Slovic-Birnbaum paradox but with no 0 outcome involved. Here, for instance, subjects can choose between 50 for sure or $200_{0.5}X$ where $X = 1$ or $X = -1$, with again, paradoxically, with $X = -1$ subjects more often chose risky than with $X = 1$.

losses give more/less noise: seem to find that less %}

Yechiam, Eldad, Matan Retzer, Ariel Telpaz, & Guy Hochman (2015) "Losses as Ecological Guides: Minor Losses Lead to Maximization and not to Avoidance," *Cognition* 139, 10–17.

{% **dynamic consistency**: nice empirical test of forgone-event independence %}

Yechiam, Eldad, Julie C. Stout, Jerome R. Busemeyer, Stephanie L. Rock, & Peter R. Finn (2005) "Individual Differences in the Response to Forgone Payoffs: An Examination of High Functioning Drug Abusers," *Journal of Behavioral Decision Making* 18, 97–110.

{% Re-analyze data of meta-analysis by Brown, Imai, Vieider, & Camerer (2024 JEL) on loss aversion and find that details in presentation can greatly affect loss aversion, showing its volatility. %}

Yechiam, Eldad & Dana Zeif (2025) "Loss Aversion Is not Robust: A Re-Meta-Analysis," *Journal of Economic Psychology* 107, 102801. https://doi.org/10.1016/j.joep.2025.102801

{% **decreasing ARA/increasing RRA**: they find it.

Present 50-50 risky choices, framed as good/bad harvest, to N = 262 farmer households in Ethiopia, 6 gain choices and 6 mixed choices, using the Binswanger (1981) method to measure in each of those 12 choices. Real incentive for each of the gain choices (with stakes some days of salary), so that income effects do arise. For losses only real incentives if first gained enough in gains (which is a mild form of deception regarding the gains) (**deception when implementing real incentives**) and only if they accept to participate, which only 76 of the 226 offered did. They only had to pay losses if not exceeding a threshold. This all gives huge biases as the authors properly point out on p. 1026 and defend given the limitations of the setting. More risk aversion they find for mixed than for pure-gain. %}

Yesuf, Mahmud & Randall A. Bluffstone (2009) "Poverty, Risk Aversion, and Path Dependence in Low-Income Countries: Experimental Evidence from Ethiopia," *American Journal of Agricultural Economics* 91, 1022–1037.

{% %}

Yi, Byeong-Uk (2013) "Conditionals and a Two-envelope Paradox," *Journal of Philosophy* 110, 5, 233–257.

{% Comparative statics for the smooth ambiguity model. %}

Yi-Chieh Huang, Larry Y. Tzeng, Lin Zhao (2015) "Comparative Ambiguity Aversion and Downside Ambiguity Aversion," *Insurance: Mathematics and Economics* 62 257–269.

{% Investigate in a simple setup with hypothetical data how time and risk interact when one fixed positive amount is involved. They do it for one small and one big amount. A central point in their writing is that probability and delay can be combined into a single metric. Find that hyperbolic discounting fits well. Because only one positive gain, utility of outcomes plays no role. %}

Yi, Richard, Xochitl de la Piedad, & Warren K. Bickel (2006) "The Combined Effects of Delay and Probability in Discounting," *Behavioural Processes* 73, 149–155.

{% When physicians communicate probabilities, they do so strategically, not just expressing their beliefs but distorting them in the direction of their preferred treatment. %}

Yin, Siyuan, Hal R. Arkes, John P. McCoy, Margot E. Cohen, & Barbara A. Mellers (2021) "Conflicting Goals Influence Physicians' Expressed Beliefs to Patients and Colleagues," *Medical Decision Making* 41, 505–514. https://doi.org/10.1177/0272989X211001841

{% **dynamic consistency** Seems to show that, under some natural dynamic conditions on multistage CEU (Choquet expected utility), it can only be SEU. %}

Yoo, Keuk-Ryoul (1991) "The Iterative Law of Expectation and Non-Additive Probability Measure," *Economics Letters* 37, 145–149.

{% %}

Yoo, Keuk-Ryoul (1991) "Steady-State Probabilities under Non-Additivity," Dept. of Business Administration, Dongduck Women's University, Seoul, Korea.

{% Studies the interaction between impatience and time inconsistency in various discounting models. Quasi-hyperbolic predicts a positive relation, hyperbolic predicts the opposite, and constant sensitivity predicts a peak of insensitivity at moderate impatience. Data confirm the latter. Bleichrodt, Kothiyal, Prelec, & Wakker (2013 p. 69) preferred the term unit invariance for constant sensitivity. %}

Yoon, Haewon (2020) "Impatience and Time Inconsistency in Discounting Models," *Management Science* 66, 5850–5860. https://doi.org/10.1287/mnsc.2019.3496

{% They seem to show that any finitely additive measure ν can be decomposed uniquely as $\nu = \nu_1 + \nu_2$ with ν_1 countable additive and ν_2 “pure,” that is any countable additive measure between zero and ν_2 must be zero. (There is a sequence of events, all with measure 1, but converging to the empty set.) Seem to show it for Borel sigma-algebras on Hausdoff topological spaces. Aliprantis & Border (1999) have more. %}

Yosida, Kosaka & Edwin Hewitt (1952) “Finitely Additive Measures,” *Transactions of the American Mathematical Society* 72, 46–66.

{% Consider decision under pure risk with decision where the uncertain events are partly influenced by the agent (cf. Drèze 1959). In the latter case, they ask the agent for probability estimates for the latter events. They then fit PT. That way they get probability weighting for the two kinds of events (source functions!?). There then is source preference for the events under own control. %}

Young, Diana L., Adam S. Goodie, & Daniel B. Hall (2011) “Modeling the Impact of Control on the Attractiveness of Risk in a Prospect Theory Framework,” *Journal of Behavioral Decision Making* 24, 47–70.

{% **risk averse for gains, risk seeking for losses**: they find this.

In two risky choice experiments with gains, and PT of Tversky & Kahneman (1992) data fitting, they find that time pressure increases risk seeking, but the effects on utility and probability weighting alone are not clear. In a similar experiment with losses, time pressure increases likelihood insensitivity, but does not affect risk aversion or risk seeking.

They asked almanac questions about sizes of states in the US, and asked to express $j \times 25\%$ confidence levels. How these were used for risky questions, and whether the expressed confidence levels were used as probabilities, was not clear to me. They asked for direct assessments of certainty equivalents, but how these were incentivized was not clear to me either. P. 181 2nd column 2nd para writes that they used RIS in the gains-choices of experiment 1. P. 182 1st column 3rd para suggests that it was incentive compatible. %}

Young, Diana L., Adam S. Goodie, Daniel B. Hall, & Eric Wu (2012) "Decision Making under Time Pressure, Modeled in a Prospect Theory Framework," *Organizational Behavior and Human Decision Processes* 118, 179–188.

{% %}

Young, H. Peyton (1975) "Social Choice Scoring Functions," *SIAM Journal of Applied Mathematics* 28, 824–838.

{% %}

Young, H. Peyton (1987) "Progressive Taxation and the Equal Sacrifice Principle," *Journal of Public Economics* 32, 203–214.

{% %}

Young, H. Peyton (1987) "On Dividing an Amount According to Individual Claims or Liabilities," *Mathematics of Operations Research* 12, 398–414.

{% **risky utility u = strength of preference v (or other riskless cardinal utility, often called value)**: Considers tax schedules in some countries, such as US. Assumes equal sacrifice principle of John Stuart Mill: All people paying tax should lose the same amount of utility (leading to flat tax rate under logarithmic utility). Then from the amounts that the authorities let be paid by the various levels of income, we can derive the marginal utility that the authorities assume there, and then the cardinal utility. For 1957 US tax data, CRRA 1.61 fits the data well. This could be interpreted as cardinal welfare utility and be left as that. The author, however, does not shy away from relating this to utility measured from risky choice. On p. 255 2nd column the author very explicitly relates the utility found to risky utility, writing for instance: "The equal sacrifice hypothesis will be plausible if: (i) the estimated utility function is reasonably consistent with utility theory; … In the modern theory of risk bearing, …" %}

Young, H. Peyton (1990) "Progressive Taxation and Equal Sacrifice," *American Economic Review* 80, 253–266.

{% %}

Younger, Daniel H. (1963) “Minimum Feedback Arc Sets for a Directed Graph,” *IEEE Transactions on Circuit Theory* 10, 238–245.

{% %}

Yu, Chi Waj., Y. Jane Zhang, & Sharon X. Zuo, “Multiple Switching and Data Quality in the Multiple Price List,” *Review of Economics and Statistics* 103, 136–150.
https://doi.org/10.1162/rest_a_00895

{% %}

Yu, Wencheng, Shaobo Liu, & Lili Ding (2021) “Efficiency Evaluation and Selection Strategies for Green Portfolios under Different Risk Appetites, *Sustainability* 13, 1933.
https://doi.org/10.3390/su13041933

{% %}

Zabell, Sandy L. (1982) “W.E. Johnson’s “Sufficientness” Postulate,” *Annals of Statistics* 10, 1091–1099.

{% **foundations of statistics**: history.
P 255: “But it is a common failing to read into the words of the past the thoughts of the present, and to view the evolution of history as the progressive triumph of one’s own viewpoint.” %}

Zabell, Sandy L. (1989) “R.A. Fisher on the History of Inverse Probability,” *Statistical Science* 4, 247–263.

{% **foundations of statistics**: history. Laplace’s rule of succession: if on n trials we see m successes, then then next trial has success probability (m+1)/(n+2). (The rule I use privately lifelong.) %}

Zabell, Sandy L. (1989) “The Rule of Succession,” *Erkenntnis* 31, 283–321.

{% **foundations of statistics**: history %}

Zabell, Sandy L. (1992) “R.A. Fisher and the Fiducial Argument,” *Statistical Science* 7, 369–387.

{% %}

Zabell, Sandy L. (2011) “Carnap and the Logic of Inductive Inference.” *In* Dov M. Gabbay, John Woods, & Stephan Hartmann (eds.), *Handbook of the History of Logic* Vol. 10., 265–309.

{% %}

Zachow, Ernst-Wilhelm (1979) “Expected Utility in Two-Person Games,” *Mathematics of Operations Research* 4, 186–195.

{% %}

Zadeh, Lofti A. (1965) “Fuzzy Sets,” *Information and Control* 8, 338–353.

{% %}

Zadeh, Lofti A. (1973) “Outline of a New Approach to the Analysis of Complex Systems and Decision Processes,” *IEEE Transactions on Systems, Man and Cybernetics* 3, 28–44.

{% %}

Zadeh, Lofti A. (1975) “Calculus of Fuzzy Restrictions.” *In* Lofti A. Zadeh, King-Sun Fu, Kazu Tanaka, & Masamichi Shimura (eds.) *Fuzzy Sets and their Applications to Cognitive and Decision Processes*, 1–39, Academic Press, New York.

{% %}

Zadeh, Lofti A. (1975) “Fuzzy Logic and Approximate Reasoning,” *Synthese* 30, 407–428.

{% %}

Zadeh, Lofti A. (1978) “Fuzzy Sets as a Basis for a Theory of Possibility,” *Fuzzy Sets and Systems* 1, 3–28.

{% %}

Zak, Paul J., Robert Kurzban, & William T. Matzner (2004) “The Neurobiology of Trust,” *Annals of the New York Academy of Sciences* 102, 224–227.

{% Seems to show that people are insensitive to the time dimension. %}
Zakay, Dan (1998) “Attention Allocation Policy Influences Prospective Timing,” *Psychonomic Bulletin and Review* 5, 114–118.

{% %}
Zakay, Dan (1985) “Post-Decisional Confidence and Conflict Experienced in a Choice Process,” *Acta Psychologica* 58, 75–80.

{% If you observe one CE (certainty equivalent) of a risk averse EU maximizer, you can derive inequalities for the subjective probabilities. %}
Zambrano, Eduardo (2008) “Expected Utility Inequalities: Theory and Applications,” *Economic Theory* 36, 147–158.

{% Argues for paternalism that just seeks efficiency. %}
Zamir, Eyal (1998) “The Efficiency of Paternalism,” *Vir1a Law Review* 84, 229–286.

{% **risk averse for gains, risk seeking for losses**
Much risk aversion for mixed. The authors find in an experiment that mostly loss aversion drives clients’ preferences for contingent-fee arrangements regarding attorney’s fees, rather than other components of risk aversion. Experiment 1 did hypothetical legal situations. Experiment 2 (N = 27) did real incentives, with the real payments a proportion of the amounts mentioned in the legal story. Four more experiments were done. Probabilities were always given. %}
Zamir, Eyal & Ilana Ritov (2010) “Revisiting the Debate over Attorneys’ Contingent Fees: A Behavioral Analysis,” *Journal of Legal Studies* 39, 245–288.

{% %}
Zang, Lian-Wen (1986) “Weights of Evidence and Internal Conflict for Support Functions,” *Information Sciences* 38, 205–212.

{% %}
Zank, Horst (1999) “Risk and Uncertainty: Classical and Modern Models for Individual Decision Making,” Ph.D. dissertation, Dept. of Economics, Maastricht University, Maastricht, the Netherlands.

{% Characterizes PT for parametric utility which simplifies the derivation of the underlying PT, essentially generalizing Wakker & Zank (2002) from RDU to PT. Does a similar thing but now with multiattribute outcomes, and utility independence type conditions similarly simplifying the underlying PT derivation. Nice thing here is that just tail independence (or, similarly, the stronger comonotonic independence) already gives a kind of state-dependent-utility generalization of RDU and PT, so that the axioms for parametric utility or utility independence need to be imposed only on gains and losses separately. %}

Zank, Horst (2001) "Cumulative Prospect Theory for Parametric and Multiattribute Utilities," *Mathematics of Operations Research* 26, 67–81. https://doi.org/10.1287/moor.26.1.67.10598

{% Characterizes PT in the context of welfare. Uses conditions to characterize particular forms of utility, to simplify the underlying derivation of PT, generalizing Wakker & Zank (2002) from RDU to PT. Shows that concavity at reference point is a kind of loss aversion. %}

Zank, Horst (2007) "Social Welfare Functions with a Reference Income," *Social Choice and Welfare* 28, 609–636. https://doi.org/10.1007/s00355-006-0184-1

{% An axiomatization of RDU for risk that is alternative to Abdellaoui (2002). The paper used the same notation with cumulative probabilities. It weakens Abdellaoui's main axiom in the same appealing manner as Chateauneuf (1999) weakened the tradeoff consistency for outcomes of Wakker (1989, 2010), using a midpoint version rather than a general tradeoff version. %}

Zank, Horst (2010) "Consistent Probability Attitudes," *Economic Theory* 44, 167–185.

{% Discusses definitions of loss aversion, and proposes a new one that also has implications for probability weighting. The new proposal is:
$0 \succ (p{:}x,\ 1-2p{:}0,\ p{:}-x)$ for all $x > 0$ and $p \leq ½$. Holds under PT iff $w^+(p)U(x) \leq -w^-(p)U(-x)$. %}

Zank, Horst (2010) "On Probabilities and Loss Aversion," *Theory and Decision* 68, 243–261.

{% Proposes, for a prospect x, a representation PT*(p: PT(x+), q:PT(x-)) where: PT* may be an entirely different PT functional than PT; p is the total probability of x yielding a gain (outcome > 0); q is the total probability of x yielding a loss (outcome < 0), 1-p-q is the probability of getting 0; x+ is the CONDITIONAL probability distribution of x given that it is a gain; x- is the CONDITIONAL probability distribution of x given that it is a loss. %}

Zank, Horst (2016) "A General Measure for Loss Attitude," working paper.

{% This paper, a follow up on the later-appeared Zappia (2021) (cited as Zapia 2020 in this paper), does what its title says. I disagree with its main point similarly as with Zappia (2021). I think that Savage would accept no violation of his sure-thing principle P2. Savage's doubts about his axioms and admissions to vagueness, as in his text cited on p. 170 (last display) only concern violations of completeness. Here is the text of Savage displayed there:

> One of the consequences of vagueness is that, in trying
> to apply any theory like mine, we sometimes find that we
> are able to elicit precise probabilities by self-interrogation
> in some situations but not in others. This is perhaps the very
> phenomenon that you are alluding to in section 4, and I admit
> that I know no satisfactory way of dealing with it. %}

Zappia, Carlo (2020) "Paradox? What Paradox? On a Brief Correspondence between Leonard Savage and Karl Popper," *Resaerch in the History of Economic Thought and Methodology* 38C, 161–177.
https://doi.org/10.1108/S0743-41542020000038C011

{%Was lecture at D-TEA conference 2019, Paris.

This paper reports on personal letter communication between Savage and others regarding the issue of unknown/imprecise probabilities and ambiguity. I want to distinguish between two different reasons for having imprecise probabilities:

(1) You are fully Bayesian, but for your decisions to be made you need not

specify your probabilities precisely. For example, you have to choose between 100_E0 and 40, and have linear utility. Then it suffices to know that P(E) < 0.4 to know that you choose the sure 40. In this sense your probability can be imprecise while being fully Bayesian. Your preference relation over some usual rich set of acts is incomplete only because it is irrelevant, not because it would be "intrinsically" incomplete.

(2) You are not ambiguity neutral and go by some multiple prior model such as maxmin EU.

In papers published and in public presentations Savage never stated that deviations from his axioms can be rational. I conjecture that in his letters Savage was open to imprecise probabilities only because of (1) and not because of (2), so that it was not really a deviation from Bayesianism, and I here deviate from the opinions expressed in this paper.

de Finetti writes to Savage: "Have you read D. Ellsberg's note (Quarterly J. of Econ., 75,4, Nov. 1961) that claims that you were 'inconsistent' in answering to one of his questions concerning issue such as Smith's?"

B. de Finetti to L. J. Savage, March 8, 1962, LJS Papers, 8, 194, (Zappia's translation from the original Italian)

Savage replies in a letter: "I have not only read Ellsberg's paper but had a very thorough visit with him here in Ann Arbor. He is intelligent, steeped in the material, but quite blind about certain aspects of it. I feel that there may be a grain of truth in what he is trying to say, but find it very difficult to clear my own head on the subject." (L. J. Savage to B. de Finetti, March 16, 1962, LJS Papers, Box 8, 194)

Here Savage may be close to accepting Ellsberg's violation of his model as rational, by not explicitly negating what de Finetti writes, but there can be many explanations for why Savage wrote this.

In later writings Savage says that there may be unsatisfactory aspects to his theory, and that alternative theories are welcome if they get laid down, but this may as well be ADDING axioms to his own as removing some.

Savage wrote to de Finetti: "If upper and lower probabilities are taken seriously, they at least double the vagueness that they intended to alleviate … Nevertheless, I agree that there is practical importance in exploring the implication of a set of probabilities that might be designed as "acceptable" … I would expect convexity to be an innocuous assumption about a set of acceptable probabilities, and a convex set of probabilities can be well described by inequalities on expectations" (L. J. Savage to B. de Finetti, (February 23, 1962, LJS Papers, 8, 194)

This can all fit with (1) above. It can also be that one precise probability is desired at the end, to be a convex combination of a set considered.

Zappia's paper ends with:

> It can then be concluded that Savage's reluctance to endorse the critical viewpoint underlying the Ellsberg Paradox was related to methodological caution rather than to rejection of its content. The new notion of mathematical rigor he had endorsed as part of the group of mathematical economists and statisticians he had worked with in the 1950s was crucial to him. His doubts were mostly based on the inability of his critics to provide an alternative theoretical set-up rather than on a clear-cut denial of the normative relevance of their argument. He may have been ready to endorse it had a consistent theoretical corpus and the appropriate axioms been made available by his critics. He died at the age of fifty-four, far too early to see such analytical progress come into reality.

In Zappia's interpretation, Savage would accept later-axiomatized multiple prior models of ambiguity and violations of his sure-thing principle P2. But I do not share this interpretation. My reading of Savage is that he only doubted completeness. That he would never abandon the sure-thing principle. With which I agree.%}

Zappia, Carlo (2021) "Leonard Savage, the Ellsberg Paradox and the Debate on Subjective Probabilities: Evidence from the Archives," *Journal of the History of Economic Thought* 43, 169–192.
https://doi.org/10.1017/S1053837220000152

{% **nonconstant discount = nonlinear time perception**: not fully that point, but nonlinear perception of time is central in their paper.

Decompose discounting into subjective time perception and then weighting of that, and cite many preceding works on the idea of subjective time perception. When reading the first pages of the paper, I never saw the mystery revealed of how will they measure subjective time perception? P. 546 shows how psychologists can do this: They asked subjects to indicate on a line "how long" various periods of time were. Oh well.

Seem to find that perception of time is more labile than perception of money.

Köbberling, Schwieren, & Wakker (2007, Theory and Decision) used the

introduction of the Euro to separate what they called numerical perception out of the utility of money based on revealed-preference. %}

Zauberman, Gal, B. Kyu kim, Selin A. Malkoc, & James R. Bettman (2009) "Discounting Time and Time Discounting: Subjective Time Perception and Intertemporal Preferences," *Journal of Marketing Research* 66, 543–556. http://dx.doi.org/10.1509/jmkr.46.4.543

{% Seems to have been the first to formally model moral hazard. %}

Zeckhauser, Richard J. (1970) "Medical Insurance: A Case Study of the Tradeoff between Risk Spreading and Appropriate Incentives," *Journal of Economic Theory* 2, 10–26.

{% **suspicion under ambiguity**: p. S445 points out that suspicion can drive Ellsberg paradox. %}

Zeckhauser, Richard J. (1986) "Comments: Behavioral versus Rational Economics: What You See Is What You Conquer," *Journal of Business* 59, S435–S449.

{% Many examples and lessons about good investments when probabilities could not be known. Ricardo gained a fortune buying English bonds 4 days before the battle of Waterloo.

P. 14: "Prospect theory, the most important single contribution to behavioral decision theory to date, …" (**Prospect theory/Rank-Dependent Utility most popular for risk**)

P. 15 has nice experiment. Ambiguous event is that 10,000-ton asteroid passed within 40,000 miles of earth during last decade. To get anchor probability, asked a random sample of people to guess probability until a distance was found where the median estimated probability was 0.03. Took that as anchor probability for measuring ambiguity attitude. Nice! However, seems to assume that for such small likelihood one will find ambiguity aversion still, contrary to many empirical findings.

P. 34, §V: Buffett made much money reinsuring earth quakes in California. His capital was so big that he could still be risk neutral (if we can say so for unknown probabilities) for such high amounts.

P. 36, about ambiguity aversion: "Maxim G: discounting for ambiguity is a natural

tendency that should be overcome, just as should be overeating." He, thus, like me, takes ambiguity aversion as irrational and, I presume expected utility as rational. %}

Zeckhauser, Richard J. (2006) "Investing in the Unknown and Unknowable," *Capitalism and Society* 1, Article 5, 1–39.

{% Seems that they introduced the term QALY. The earliest I know that used the concept is Fanshel & Bush (1970). %}

Zeckhauser, Richard.J. & Donald S. Shepard (1976) "Where Now for Saving Lives?," *Law and Contemporary Problems* 40, 5–45.

{% **inverse S:** the authors several times emphasize that small probabilities are overweighted. P. 559 2nd column ℓ. –15: individuals have great difficulties comprehending extremely low-probability events. (Suggests it's cognitive; **cognitive ability related to likelihood insensitivity (= inverse S)**) P. 560 ℓ. 3 suggests inverse S in probability estimation.

P. 5672 5th para nicely points out that in environments with learning possibilities we should prefer unknown probabilities (**ambiguity seeking**). %}

Zeckhauser, Richard J. & Kip W. Viscusi (1990) "Risk within Reason," *Science* 248 no. 4955, 559–564.

{% %}

Zeelenberg, Marcel (1999) "Anticipated Regret, Expected Feedback and Behavioral Decision Making," *Journal of Behavioral Decision Making* 12, 93–106.

{% Contains much of the ψ literature up to 2007. %}

Zeelenberg, Marcel & Rik Pieters (2007) "A Theory of Regret Regulation 1.0," *Journal of Consumer Psychology* 17, 3–18.

{% Mrkva et al. (2020) is replicated, but controling for some things, and then no loss aversion is found for moderate amounts. For losses of $100, loss aversion is about 1.54. %}

Zeif, Dana & Eldad Yechiam (2022) "Loss Aversion (simply) Does not Materialize for Smaller Losses," *Judgment and Decision Making* 17, 1015–1042.

{% DFE where subjects quickly receive much feedback from normal distributions. The authors present an RDU model for sequential sampling showing that in one task subjects weighted larger payoffs more. %}

Zeigenfuse, Matthew D., Timothy J. Pleskac, & Taosheng Liu (2014) “Rapid Decisions from Experience,” *Cognition* 131, 181–194.

{% A modification of a model of Diecidue & van de Ven (2008), where the evaluation of a lottery has extra terms being the probability of gaining and the probability of losing. It can be modeled by letting utility have jumps at outcome 0. This paper does it for prospect theory. If finds that people pay more attention to the probability of a loss than of a gain.

PT falsified: the paper qualifies its model and finding as a violation of prospect theory but it is no more than jumps of utility at 0, i.e., prospect theory with utility jumps at 0. %}

Zeisberger, Stefan (2022) “Do People Care about Loss Probabilities?,” *Journal of Risk and Uncertainty* 65, 185–213.
https://doi.org/10.1007/s11166-022-09391-y

{% Section 2 nicely reviews stability across domains, tasks, and time.

Fit the same parametric family as T&K’92 to CE (certainty equivalent) measurements. Do measurements month apart, to test time stability. If I remember right, Cohen, Jaffray, & Said (1987) did two measurements a week apart.

random incentive system between-subjects (paying only some subjects): paid 1 of every 10 subjects.

losses from prior endowment mechanism: did that.

risk averse for gains, risk seeking for losses: find it.

concave utility for gains, convex utility for losses: Find linear utility for gains (power 0.98), somewhat convex for losses (power 0.88). The probability weighting parameter is 0.865 for gains and 0.79 for losses, so, somewhat stronger for the latter. Loss aversion is 1.41.

Abstract and p. 360 point out that for CE measurements of PT parameters there can be considerable collinearities (they do not use this term). This is further

analyzed on p. 366-369. Figure 1 concerns gain prospects with only one nonzero outcome. Then the joint power of utility and probability weighting is unidentifiable. Because the parametric family chosen for w has no free power, it leads to implications for the w parameter.

They show nice figures of maximum likelihood tests, showing that for CE measurements the parameters of PT strongly interact, with much collinearity. Show that there is a wide set of parameter combinations that fits the data almost as well as the optimal parameters. Figure 3b shows it for the Tversky & Kahneman (1992) data.

They find PT parameters similar to other studies, confirming **inverse S** (although their one-parameter T&K'92 family enhances it).

P. 374: They test for stability at the individual level by using statistics that take within-subject choices as independent. It gives 1/3 of instable subjects (significant changes according to the statistic just mentionend. %}

Zeisberger, Stefan, Dennis Vrecko, & Thomas Langer (2012) "Measuring the Time Stability of Prospect Theory Preferences," *Theory and Decision* 72, 359–386. https://doi.org/10.1007/s11238-010-9234-3

{% %}

Zellner, Arnold (1971) "*An Introduction to Bayesian Inference in Econometrics*." Wiley, New York.

{% %}

Zellner, Arnold (1985) "Bayesian Econometrics," *Econometrica* 53, 253–269.

{% Nice but no new points %}

Zellner, Arnold (1995) "Bayesian and non-Bayesian Approaches to Statistical Inference and Decision-Making," *Journal of Computational and Applied Mathematics* 64, 3–10.

{% Use Liu's uncertainty theory. %}

Zeng, Zhiguo, Rui Kang, Meilin Wen, & Enrico Zio (2018) "Uncertainty Theory as a Basis for Belief Reliability," *Information Sciences* 429, 26–36.

{% That every position in chess has a unique value; also uses backward induction (but only in a deterministic sense). Or so it was cited for a long time. But it seems that he considered games that can last infinitely long and did not use backward induction. He seems to have proved that if a position is winning, then it is winning in a finite number of moves. Ismail Mehmet pointed out to me in 2017 that may be Euwe (1929) was the first to use backward induction to prove that chess is determined. %}

Zermelo, Ernst (1913) “Über eine Anwendung der Mengenlehre auf die Theorie des Schachspiels,” *Proceedings of the Fifth International Congress of Mathematics* 2, Cambridge, UK, 501–504.

{% **risky utility u = strength of preference v (or other riskless cardinal utility, often called value)**; seems to be the first to show how expected utility provides “measurable utility;” pp. 237-238 proposes both uncertainty and time aggregation as sources of cardinal utility, though not stated very clearly; explains that one should use hypothetical choices and abstraction. %}

Zeuthen, Frederik (1937) “On the Determinateness of the Utility Function,” *Review of Economic Studies* 4, 236–239.

{% %}

Zeynep, Kantur & Kerim Keskin (2019) “On (Mis-)Perception of Probabilities in First-Price Sealed-Bid Auctions,” *Economics Bulletin, AccessEcon* 39, 726–733.

{% An application of prospect theory in a remote field. %}

Zhang, Dianfeng, Yanlai Li, & Kwai-Sang Chin (2022) “Photovoltaic Technology Assessment Based on Cumulative Prospect Theory and Hybrid Information from Sustainable Perspective,” *Sustainable Energy Technologies and Assessments* 52 (2022) 102116.

{% Examine and discuss probability and frequency (mis)perception in many areas, including risk & uncertainty, signal detection, support theory. P. 10 3rd para points out that in experiment 1 the slope decreases with experience, which is counterintuitive. (**cognitive ability related to likelihood insensitivity (= inverse S)**) P. 11 around Eq. 6 nicely relates Stevens’ power law on probability, for odds,

to a one-parameter version of the LLO (linear in logodds = Goldstein-Einhorn family). The paper ends with humor: "we conjecture that there are factors in each of the domains we considered that are responsible for the particular choice of probability distortion observed. We need only find out what they are." %}

Zhang, Hang & Laurence T. Maloney (2012) "Ubiquitous Log Odds: A Common Representation of Probability and Frequency Distortion in Perception, Action, and Cognition," *Frontiers in Decision Neuroscience* 6, 1–14. https://doi.org/10.3389/fnins.2012.00001

{% **ordering of subsets** %}

Zhang, Jiankang (1999) "Qualitative Probabilities on Lambda-Systems," *Mathematical Social Sciences* 38, 11–20.

{% Axiomatizes CEU (Choquet expected utility) with belief functions that are inner measures; proposes lambda-system for collection of unambiguous events, which generalizes sigma-algebra by relaxing intersection-closedness.

The author points out that the collection of unambiguous events is not intersection-closed. This had been known before, and I knew it as widely understood in the 1980s. If one knows marginal distributions then one need not know joint distributions. It sometimes came up in my conversations with Rakesh Sarin in the 1990s. Once Rakesh proposed what he called the flip-flop example that had it, but we never used it in a paper.

Introduction claims that people prefer known to unknown probabilities; §§1.3 and 4.1 erroneously write that the unambiguous events in Sarin & Wakker (1992) are primitive rather than derived from preference; §4.1 sides with Nehring's (1992) criticism of cumulative dominance. %}

Zhang, Jiankang (2002) "Subjective Ambiguity, Expected Utility and Choquet Expected Utility," *Economic Theory* 20, 159–181.

{% They define and (trivially) axiomatize what they call obvious dominance, which is what I have known as internality: an act is preferred between its worst and best outcome. %}

Zhang, Luyao & Dan Levin (2017): “Bounded Rationality and Robust Mechanism Design: An Axiomatic Approach,” *American Economic Review, Papers and Proceedings* 538, 235–239.
https://doi.org/10.1257/aer.p20171030

{% When studying discounting one should correct for misperceived utility. She focuses on mispeception by subjects. Interesting point is that the misperception can also be on the part of the researcher. %}
Zhang, Sili (2022) “Times are Changing: Pojective Misperceptions and Misinferred Time Preferences,” working paper.

{% Correction to “Determinants of Economic Risk Preferences Across Adolescence”
Volume 38 Issue 2 Journal of Behavioral Decision Making First Published online: February 27, 2025.
N = 444, age 13–27. Test six demographic and psychological determinants (age, gender, positive/negative affect, state anxiety, and indecision) for loss aversion and skewness. Adolescents have higher positive affect and lower negative affect than adults. Anxiety and indecision were age-invariant. Women showed lower positive affect and higher negative affect, state anxiety, indecision, and loss aversion. All other factors unrelated to loss aversion. Adolescents demonstrated reduced bias toward negatively skewed risks compared to young adults. They had similar preferences for positively skewed and symmetric risks. Adolescents favored symmetrical risks more, while adults favored negatively skewed risks more. %}
Zhang, Yubing, Colin F. Camerer, & Sarah M. Tashjian (2025) “Determinants of Economic Risk Preferences Across Adolescence,” *Journal of Behavioral Decision Making* 38, e70007.
https://doi.org/10.1002/bdm.70007

{% Measure prospect theory for US farmers. %}
Zhao, Shuoli & Chengyan Yue (2020) “Risk Preferences of Commodity Crop Producers and Specialty Crop Producers: An Application of Prospect Theory,” *Agricultural Economics* 51, 359–372.

{% The paper is “typically psychological” in being happy about context dependence. They investigate how many manipulations, such as putting a choice option left or right, how one gives info, and many other things, impact decisions, and have parametric models to fit it. %}

Zhao, Wenjia Joyce, Aoife Coady, & Sudeep Bhatia (2022) “Computational Mechanisms for Context-Based Behavioral Interventions: A Large-Scale Analysis,” *Proceedings of the National Academy of Sciences* 119(15): e2114914119. https://doi.org/10.1073/pnas.2114914119

Zhao, Xin Jessica & Kee H. Chung (2006) “Decimal Pricing and Information-Based Trading: Tick Size and Informational Efficiency of Asset Price,” *Journal of Business Finance & Accounting* 33, 753–766.

{% Investigate how neuro-chemical factors are related to gains and losses in risky decisions, and find differences between gains and losses. %}

Zhong, Songfa, Robin Chark, Richard P. Ebstein, & Soo Hong Chew (2012) “Imaging Genetics for Utility of Risks over Gains and Losses,” *NeuroImage* 59, 540–546. https://doi.org/10.1016/j.neuroimage.2011.07.031

{% Studying twins, they find evidence for heritability of economic risk attitudes. %}

Zhong, Songfa, Chew Soo Hong, Eric Set, Junsen S. Zhang, Hong Xue, Pak C. Sham, Richard P. Ebstein, & Salomon Israel (2009) “The Heritability of Attitude toward Economic Risk,” *Twin Research and Human Genetics* 12, 103–107. https://doi.org/10.1375/twin.12.1.103

{% N = 350 students. Measure preference for longshot gains and losses, from one simple choice, with gains incentivized but losses not so. Find some relations with genes. I find it hard to believe that there could be easy direct relations with genes because preferences are too much a metaphenomenon, involving 1000s of combinations of 1000s of combinations of … of genes. %}

Zhong, Songfa, Salomon Israel, Hong Xue, Richard P. Ebstein, & Chew Soo Hong (2009) "Monoamine Oxidase A Gene (MAOA) Associated with Attitude towards Longshot Risks," *PLoS ONE* 4, e8516.
https://doi.org/10.1371/journal.pone.0008516

{% **losses from prior endowment mechanism**; Use choice list to determine CEs (certainty equivalents) of prospects for both gains and losses, for N = 350 Chinese students. From each take some blood for genotyping.

risk averse for gains, risk seeking for losses: 38% risk averse for losses, only 52% for gains. Although the introduction and so on present this paper as a study into utility, it is only a study into risk attitude and not into utility (remember that EU fails descriptively). Find that high DA tone implies high risk aversion and high 5HT tone gives less risk aversion for losses.

Use random incentive system but do it several times so that there are income effects still. %}

Zhong, Songfa, Salomon Israel, Hong Xue, Pak C. Sham, Richard P. Ebstein, & Soo Hong Chew (2009) "A Neurochemical Approach to Valuation Sensitivity over Gains and Losses, *Proceedings of the Royal Society B* 276, 4181–4188.
https://doi.org/10.1098/rspb.2009.1312

{% %}

Zhong, Songfa, Idan Shalev, David Koh, Richard P. Ebstein, & Chew Soo Hong (2018) "Competitiveness and Stress," *International Economic Review* 59, 1263–1281.
https://doi.org/10.1111/iere.12303

{% %}

Zhou, Lin (1994) "A New Bargaining Set of an N-Person Game and Endogenous Coalition Formation," *Games and Economic Behavior* 6, 512–526.

{% %}

Zhou, Lin (1994) "The Set of Nash Equilibria of a Supermodular Game Is a Complete Lattice," *Games and Economic Behavior* 7, 295–300.

{% %}

Zhou, Lin (1995) “A Characterization of Demand Functions that Satisfy the Weak Axiom of Revealed Preference,” *Economics Letters* 49, 403–406.

{% %}

Zhou, Lin (1995) “Integral Representation of Continuous Comonotonically Additive Functionals,” Cowles Foundation, Yale University, New Haven, CT.

{% %}

Zhou, Lin (1995) “A Simple Choice-Based Subjective Probability Theory,” Cowles Foundation, Yale University, New Haven, CT.

{% %}

Zhou, Lin (1996) “A Theorem on Bayesian Utilitarianism,” Cowles Foundation, Yale University, New Haven, CT.

{% **Harsanyi’s aggregation** %}

Zhou, Lin (1997) “Harsanyi’s Utilitarianism Theorems: General Societies,” *Journal of Economic Theory* 72, 198–207.

{% **Nash bargaining solution**; theorem shows that asymmetric NBS holds on closed, comprehensive, bounded from above, containing d in interior, BGs iff IIA, INV, and strict individual rationality (all more than d). %}

Zhou, Lin (1997) “The Nash Bargaining Theory with Non-convex Problems,” *Econometrica* 65, 681–685.

{% Considers DUU with a continuous state space and considers only continuous acts. Takes two-stage approach of Anscombe & Aumann (1963). Gives preference characterization for (upper-continuous capacity-) CEU (Choquet expected utility). %}

Zhou, Lin (1999) “Subjective Probability Theory with Continuous Act Spaces,” *Journal of Mathematical Economics* 32, 121–130.

{% Argue that one should not just take utility in game theory for granted but derive it from observed choice; refer to observability problem in my ’89 book! %}

Zhou, Lin & Indrajit Ray (2001) “Game Theory via Revealed Preferences,” *Games and Economic Behavior* 37, 415–424.

{% They measure risk attitudes by fitting preference functionals, EU and RDU with CRRA and CARA utility and, for RDU, the Tversky & Kahneman (1992) 1-parameter probability weighting family. They do so for four elicitation methods: Choice list (called Holt-Laury), pairwise choice, BDM (Becker-DeGroot-Marschak), and allocation. They equate risk aversion with utility curvature. (I criticized this on many occasions.) The main finding is that utility curvature depends more on elicitation method than on functional assumed. The paper presents a new visual implementation of BDM in Figure 4: The CE chosen leads to a lottery that is a mixture of a uniform distribution over [CE, max] and the original lottery. Reducing the CE a bit means adding a lower part to the uniform distribution while reducing the probability of getting the lottery. This works under EU but depends much on conditional thinking and may not be easy under nonEU theories. I suggest a different visual representation in Figure 4c: Put the uniform distribution all to the right, so that the subject clearly sees that reducing the CE means reducing the conditioning probability so as to add the lower part of the uniform distribution. Even nicer would be 100 little lines with each either containing the lottery or part of the uniform distribution, and the subject could choose how many of the 100 parts with lotteries to replace by the uniform distributions.

P. 737: “We choose the most popular [preference functionals] in the literature, namely Expected Utility (EU) and Rank Dependent expected utility (RD).” %}

Zhou, Wenting & John Hey (2018) “Context Matters,” *Experimental Economics* 21, 723–756.
https://doi.org/10.1007/s10683-017-9546-z

{% Investigates elicitability of risk measures. Elicitability is something like the possibility to elicit it using proper scoring rules. Quantile-based risk measures, such as VaR, are elicitable. Expected shortfall and, more general, all law-invariant (= probabilistically sophisticated) spectral risk measures are not

elicitable unless just minus expected value. This restriction does not hold for law-invariant "coherent" risk measures. %}

Ziegel, Johanna F. (2016) "Coherence and Elicitability," *Mathematical Finance* 26, 901–918.

{% **probability communication** & **ratio bias**: this editorial argues that 1 in X is bad way to communicate risk, following Pighin et al. (2011). Refers to the Sirota et al. meta-analysis that argues that the effect is smaller than thought, but existing. The issue of this journal has several other papers on probability communication. %}

Zikmund-Fisher, Brian J. (2014) "Continued Use of 1-in-X Risk Communications Is a Systemic Problem," *Medical Decision Making* 34, 412–413.

{% **relation age-risk attitude**: see title;

Several studies reported that risk aversion increases with age. This is usually done in experiments on choices between safe and risky options. This paper investigates whether complexity of the choice options is a confounding factor. To do so, it manipulates complexity by expressing outcomes through more or less complex mathematical formulas. This can, of course bring many confounds on its own, such as formulations not being more complex but rather more artificial. They also investigate/find that probability weighting becomes less pronounced when all options are complex. %}

Zilker, Veronika, Ralph Hertwig, & Thorsten Pachur (2020) "Age Differences in Risk Attitude Are Shaped by Option Complexity," *Journal of Experimental Psychology: General*, 149, 1644–1683. https://doi.org/10.1037/xge0000741

{% The paper argues that the probability weighting found in prospect theory (inverse S) may be explained by the attentional Drift Diffusion Model (aDDM). This model, widely used in psychology, uses attention paid to all kinds of aspects to explain many things. The authors argue that aDDM can replace, refute, the interpretations of inverse S probability weighting through insensitivity and liking/disliking. I did no read enough to know: to what extent aDDM may explain, rather than refute, prospect theory's concepts, to what extent it is "simply" assuming different stimuli, and to what extent it can accommodate just anything.

Prospect theory/Rank-Dependent Utility most popular for risk: p. 949: "cumulative prospect theory (CPT; Tversky & Kahneman, 1992), arguably the most influential theory of decision making under risk." %}

Zilker, Veronika & Thorsten Pachur (2022) "Nonlinear Probability Weighting Can Reflect Attentional Biases in Sequential Sampling," *Psychological Review* 129, 945–975.
https://doi.org/10.1037/rev0000304

{% Gives psychological background to verbal probabilities. %}

Zimmer Alf C. (1984) "A Model for the Interpretation of Verbal Predictions," *International Journal of Man-Machine Studies* 20, 121–134.

{% **restrictiveness of monotonicity/weak separability**: The author shows that independence/separability is, essentially, the same as monotonicity if we allow outcomes to be complex things such as conditional prospects and a subjective ordering of those. This was also demonstrated by Marschak (1987) and LaValle (1992). %}

Zimper, Alexander (2008) "Revisiting Independence and Stochastic Dominance for Compound Lotteries," *B.E. Journal of Theoretical Economics* (MS #1444).

{% %}

Zimper, Alexander (2009) "Half Empty, Half Full and why We Can Agree to Disagree forever," *Journal of Economic Behavior and Organization* 71, 283–299.

{% **updating: nonadditive measures**: Considers several ways of updating capacities. Applies it in economic equilibrium model. Heavy weighting of tails is accommodated by using neo-additive weighting functions. %}

Zimper, Alexander (2010) "Asset Pricing in a Lucas "Fruit-Tree" Economy with Non-Additive Beliefs,"

{% **updating: nonadditive measures**: (Shows that the law of iterated expectations can be satisfied under CEU (Choquet expected utility) if updating happens in a "rank-respecting" manner suggested by Sarin & Wakker 1998. Lapied & Toquebeuf (2013) provide a correction. %}

Zimper, Alexander (2011) "Re-Examining the Law of Iterated Expectations for Choquet Decision Makers," *Theory and Decision* 71, 669–677.

{% **updating under ambiguity**
Considers Bayesian updating for RDU maximizer under uncertainty. Assumes neo-additive weighting function. Shows that updated beliefs will mostly converge to fifty-fifty unless neo-additive is just additive and RDU is SEU. %}

Zimper, Alexander (2013) "The Emergence of "Fifty–Fifty" Probability Judgments through Bayesian Updating under Ambiguity: Re-Examining the Law of Iterated Expectations for Choquet Decision Makers," *Fuzzy Sets and Systems* 223, 72–88.

{% **updating: nonadditive measures**: (Use the neo-additive function of Chateauneuf et al. in a learning/updating model where new info leads to polarization. %}

Zimper, Alexander & Alexander Ludwig (2009) "On Attitude Polarization under Bayesian Learning with Non-Additive Beliefs," *Journal of Risk and Uncertainty* 39, 181–212.

{% **updating under ambiguity**: Nicholls, Romm, & Zimper (2015) did an experiment with Ellsberg urns where subjects could sample and learn. Strangely enough, that did not move towards EU but, if anything, made the violations worse. This paper proposes a theory on updating under ambiguity with multiple priors where there need not be convergence to EU, because of a "stubbornness" factor in the model, where priors are not removed very much after observations. %}

Zimper, Alexander & Wei Ma (2017) "Bayesian Learning with Multiple Priors and Nonvanishing Ambiguity," *Economic Theory* 64, 409–447. https://doi.org/10.1007/s00199-016-1007-y

{% **Christiane, Veronika & I** %}

Zorzi, Marco, Konstantinos Priftis, & Carlo Umiltà (2002) "Neglect Disrupts the Mental Number Line," *Nature* 417, May 2002, 138–139.

{% %}

Zou, Liang (1986) "On the Distribution of Economic Rights under State Ownership," *Guang Ming Daily*, 10 Jan. 1986 (in Chinese).

{% %}

Zou, Liang (1991) "The Target Incentive System vs. the Price Incentive System under Adverse Selection and the Ratchet Effect," *Journal of Public Economics* 46, 51–89.

{% %}

Zou, Liang (1992) "Threat-Based Incentive Mechanisms under Moral Hazard and Adverse Selection," *Journal of Comparative Economics* 16, 47–74.

{% %}

Zou, Liang (1992) "Threat-Based Implementation of Incentive Compatible Mechanisms," *Annales d'Economie et Statistique on Organization and Games* 25/26, 189–204.

{% %}

Zou, Liang (1992) "Ownership Structure and Efficiency: An Incentive Mechanism Approach," *Journal of Comparative Economics* 16, 399–431.

{% %}

Zou, Liang (1995) "Incentive Contracting with Hidden Choices of Effort and Risk," *Economics Letters* 47, 311–316.

{% %}

Zou, Liang (1996) "Interest Rate Policy and Incentives of State-Owned Enterprises in the Transitional China," *Journal of Comparative Economics* 23, 292–318.

{% %}

Zou, Liang (1997) "Investments with Downside Insurance and the Issue of Time Diversification," *Financial Analysts Journal* 53, 73–79.

{% %}

Zou, Liang (1997) "Incentive Roles of Fringe Benefits in Compensation Contracts," *Journal of Economics* 65, 181–199.

{% %}

Zou, Liang (2000) "Inherent Efficiency, Security Markets, and the Pricing of Investment Strategies," Tinbergen Institute Discussion Paper TI 2000–108/2.

{% %}

Zou, Liang (2001) "The Dichotomous Theory of Choice under Risk," Economic Dept., University of Amsterdam.

{% Considers a general Anscombe-Aumann framework, with usual EU (affine function) in 2nd stage, but horses interpreted as individuals. Theorem 1: Under some structural assumptions, monotonicity w.r.t. horses and strong Pareto iff SEU with same beliefs for all individuals but individual-dependent utility functions. The structural assumptions comprise some diversity: for each individual there exists an outcome that has all other individuals indifferent but this individual not. %}

Zuber, Stéphane (2016) "Harsanyi's Theorem without the Sure-Thing Principle: On the Consistent Aggregation of Monotonic Bernoullian and Archimedean Preferences," *Journal of Mathematical Economics* 63, 78–83.

{% Consider infinite sequences of outcomes (interpreted as intertemporal), and rank-dependent representation + exchangeability, so, temporal ordering plays no role (rank-discounted utilitarian approach). Provide preference foundation for it, mostly by a comonotonic stationarity. Mathematical problem is how to do for infinite sequences, where symmetry can generate impossibility results. Results on inequality aversion, dictatorship.

Here is a detailed explanation:

It is easiest to understand this model first for finitely many timepoints/generations. In fact, let us first do decision under uncertainty, where RDU (often called CEU (Choquet expected utility)) is better understood, and then extend it to the case of this paper. Assume that there are n states of nature in S =

$\{s_1,\ldots,s_n\}$, and

$x = (x_1, \ldots, x_n)$ is the prospect

yielding $\$x_j$ if state of nature s_j occurs.

We consider a rank-dependent evaluation, as in Wakker (2010). We will do reversed rank-ordering to stay close to the paper. Wakker (2010 §7.6) explains, for risk, that reversed or not reversed ranking does not matter, and the same holds for uncertainty. I strongly advise everyone to do nonreversed ranking, but for clarifying this paper consider reversed ranking still. We take a weighting function W with $W(\varnothing) = 0$ and $W(S) = 1$ (the latter relaxed soon). If $x_1 \leq \cdots \leq x_n$, then

$$\mathrm{RDU}(x_1,\ldots,x_n) = \sum_{j=1}^{n} \pi_j U(x_j)$$

where the weight π_j is

$W\{(s_j,\ldots,s_1\} - W\{s_{j-1},\ldots,s_1\}$. (My book does it for non-reversed ranking $x_1 \geq \ldots \geq x_n$, but this is an arbitrary convention as just explained.)

If not $x_1 \leq \cdots \leq x_n$, then we have to reorder the outcomes into

$x_{[1]}, \ldots, x_{[n]}$ with $x_{[1]} \leq \cdots \leq x_{[n]. \text{The}}$n

$$\mathrm{RDU}(x_1,\ldots,x_n) = \sum_{j=1}^{n} \pi_{[j]} U(x_{[j]})$$

where $\pi_{[j]} = W\{(s_{[j]},\ldots,s_{[1]}\} - W\{s_{[j-1]},\ldots,s_{[1]}\}$.

For example, if $n = 3$, $(x_1,x_2,x_3) = (5,7,1)$, then

$x_{[1]} = x_3 = 1$, $x_{[2]} = x_1 = 5$, and $x_{[3]} = x_2 = 7$.

The convention is that $W(S) = 1$, but this is not important and is just normalization. We can allow it to be any value > 0, and will do so. Only point to keep in mind is that a constant act $\alpha = (\alpha,\ldots,\alpha)$ is evaluated by $W(S)(U\alpha)$ rather than by $U(\alpha)$.

Now assume

$W(E) = 1 + \beta^1 + \ldots + \beta^{j-1}$ whenever E contains j states, such as

$E = \{s_1, \ldots, s_j\}$ or $E = \{s_{n-j+1}, \ldots, s_n\}$. Here $\beta \geq 0$.

If $x_1 \leq \cdots \leq x_n$, then $\mathrm{RDU}(x_1,\ldots,x_n) =$

$U(x_1) + \beta^1 U(x_2) + \cdots + \beta^{j-1} U(x_j)$.

Rank dependence allows dependence of the weights on the rank, with different weighting for the best outcome than for the worst outcome for instance. This happens here. For $\beta < 1$, outcomes are weighted more as they are ranked worse.

Such pessimism can be seen to be equivalent to W being concave for this reversed rank-ordering.

Now assume that s_j does not refer to a state of nature, but to a generation. Then we can use the same evaluation as above. Now overweighting the lowest outcome does not reflect pessimism, but preference for equity: The poorer a person is, the more weight is given to this person. It reflects a desire for fairness. That rank dependence can be used this way to capture fairness in welfare (if s_j is a person instead of a state of nature) has been long known, and has been used in several papers. Wakker (2010, Appendix D, Interpretation D.2) discusses it. This is what Zuber & Asheim do, for generations. A generation is not weighted more as it is nearer to the present, but as it is poorer, for fairness reasons. So, β has nothing to do with discounting, but reflects fairness. The smaller β, the more fairness concern. The authors extend the model to the case of infinite generations, which brings some mathematical complications but does not affect the concepts. %}

Zuber, Stéphane & Geir B. Asheim (2012) "Justifying Social Discounting: The Rank-Discounted Utilitarian Approach," *Journal of Economic Theory* 147, 1572–1601.

{% **questionnaire for measuring risk aversion**; %}

Zuckerman, Marvin & D. Michael Kuhlman (2000) "Personality and Risk-Taking: Common Biosocial Factors," *Journal of Personality* 68, 999–1029.

{% Seems to cite Markowitz on Markowitz himself, irrationally, investing his retirement savings fifty-fifty in bonds and equity. %}

Zweig, Jason (1988) "Five Investment Lessons from America's Top Pension Fund," 8*Money*, January, 115–118.

{% "Het gevoel is belangrijker dan het verstand: met passie, bevlogenheid en overgave kan het cynisme van alledag worden overleefd."

English translation by Wakker:

"Feelings are more important than the mind: with passion, enthusiasm, and devotion the cynicism of everyday can be survived." (Claim of Dutch Ph.D. dissertation at the University of Amsterdam.) %}

Zwiet, Channah Shanon (1998).

{% Find that more than half of the variance in risk aversion can be ascribed to genetic factors. An incredibly strong finding. %}

Zyphur, Michael J., Jayanth Narayanan, Richard D. Arvey, & Gordon J. Alexander (2009) "The Genetics of Economic Risk Preferences," *Journal of Behavioral Decision Making* 22, 367–377.