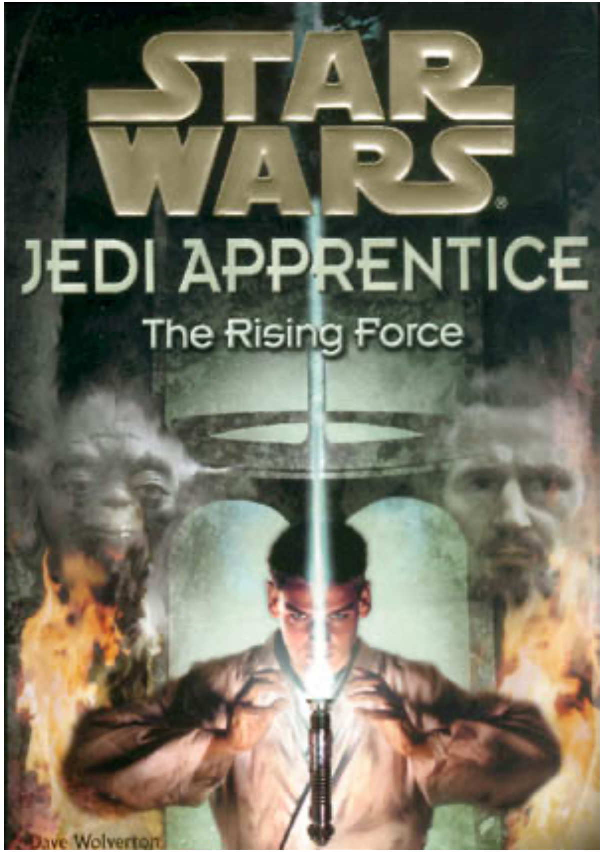
Bocconi

ELICITING BELIEFS UNDER UNCERTAINTY CHALLENGES AND OPPORTUNITIES.

Cédric Gutierrez

EOS MASTERCLASS – March 21th 2023

Università Bocconi
DEPARTMENT OF MANAGEMENT AND TECHNOLOGY



Not a master… yet!

Not an exhaustive review!

Possibly biased by my training!

Mix of theory, experience, and tips!

Temporal discounting of gains and losses of time: An experimental investigation

Mohammed Abdellaoui[1] · Cédric Gutierrez[2] · Emmanuel Kemel[1]

The Impact of Overconfidence and Ambiguity Attitude on Market Entry

Cédric Gutierrez,[a,*] Thomas Åstebro,[b] Tomasz Obloj[c]

Measuring natural source dependence

Cédric Gutierrez and Emmanuel Kemel*

Unpacking Overconfident Behavior When Betting on Oneself

Mohammed Abdellaoui,[a] Han Bleichrodt,[b] Cédric Gutierrez[c]

The Role of Economic Preferences in Venture Capital Decision-Making

Mario Daniele Amore (*Bocconi University, CEPR, ECGI*)
Orsola Garofalo (*Copenhagen Business School, CEPR*)
Cédric Gutierrez (*Bocconi University*)
Victor Martin-Sanchez (*University of Southern Denmark*)
Valerio Pelucco (*Bocconi University*)

A cognitive perspective on real options investment: CEO overconfidence

Joon Mahn Lee, Jung Chul Park, Guoli Chen

Biased interpretation of performance feedback: The role of CEO overconfidence

Christian Schumacher[1] | Steffen Keck[2] | Wenjie Tang[3]

Entrepreneurial learning and strategic foresight

Aticus Peterson | Andy Wu

Prior Experience of Managers and Maladaptive Responses to Performance Feedback: Evidence from Mutual Funds

Vibha Gaba, Sunkee Lee, Philipp Meyer-Doyle, Amy Zhao-Ding

Failing to Learn from Failure: How Optimism Impedes Entrepreneurial Innovation

Mario Daniele Amore , Orsola Garofalo , Victor Martin-Sanchez

The Ideator's Bias: How Identity-Induced Self-Efficacy Drives Overestimation in Employee-Driven Process Innovation

Christoph Fuchs, Fabian J. Sting, Maik Schlickel and Oliver Alexy

INTROSPECTION-BASED METHODS

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Method 1: Ask for a point estimate

How much do you think the average temperature in Milan will be in June 2023?

- Easy but less informative. Assuming extreme precision in beliefs.

Method 2: Ask for probabilities about events

What is the probability that the average temperature in Milan in June 2023:

- will be **greater than 16°C?**
- will be **greater than 20°C?**
- will be **greater than 24°C?**

Method 3: Ask for probability interval

"Please give us two numbers: a 'lower bound' and an 'upper bound'. The 'lower bound' is a number so low that there is only a 5% probability that the right answer is less than that. Similarly, an 'upper bound' is a number so high that there is only a 5% probability the right answer is more than that. In other words, you should be 90% sure that the answer falls between the lower and upper bounds." (Moore et al. 2015)

"individuals may have some difficulty expressing beliefs as numerical probabilities" (Manski 2004)

ATTENTION!

"One criticism of this approach is that it **requires familiarity with probability** and **confidence intervals**—statistical concepts with which even well-educated people routinely make large errors" (Mannes & Moore 2013)

"A second criticism is that this approach **bears little relationship to the way overprecision affects people's judgments in daily life.** It is rare for people to have to specify confidence intervals around some belief." (Mannes & Moore 2013)

Method 4: Attitudinal research

Think about the temperature in Milan in June 2023. How likely it is that it will be greater than 24°C?

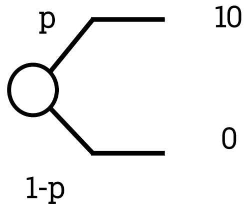
"persistent problem that researchers face in interpreting verbal expectations data—assessment of the interpersonal comparability of responses" (Manski 2004)

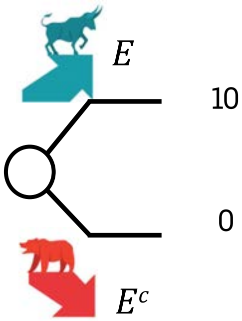
Limitation: Not based on revealed preferences

"economists have been deeply skeptical of subjective statements; they often assert that **one should believe only what people do, not what they say**" (Manski, 2004)

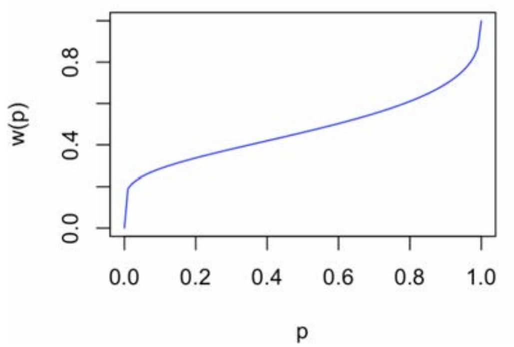
"This article examines differences between the attribute-importance weights consumers use during value elicitation and the attribute weights revealed to influence actual choice. The results of an empirical analysis of automobile stated preference and purchase decisions, and an experiment and subsequent qualitative analysis of wine choice, converge to suggest that consumers' attribute weightings differ in value elicitation versus choice in a reliable manner." (Horsky et al. 2004)

INCENTIVIZED MEASURES





Expected payoff maximization	x_p0	px
	x_E0	$P(E)x$
Expected utility maximization	x_p0	$pU(x)$
	x_E0	$P(E)U(x)$
Rank dependent utility	x_p0	$w(p)U(x)$
	x_E0	$f(P(E))U(x)$



Proper scoring rules

scoring rules: “are functions mapping the beliefs a subject reports about a random variable and the ex post realization of that random variable into a payoff for the subject” (Schotter and Trevino, 2014).

E = Stock market increases

E_c = Stock market drops

$$1-(1-r)^2$$

$$1-r^2$$

$$E[S(r)] = p(1-(1-r)^2) + (1-\mathrm{p})(1-r^2)$$

FOC: **An expected payoff maximizer chooses r=p**

Proper scoring rules

Can be challenging to explain to participants.

"Before taking each round of the quiz, participants were asked to predict the probability (p) that they would obtain each of the 11 possible scores, 0 through 10. Predictions were rewarded according the quadratic scoring rule, as follows. Participants earned 1 + r – w dollars, where r = 2p for the score they actually received and w equals the sum total of each p^2 for each of the 11 scores." (Moore and Healy 2008)

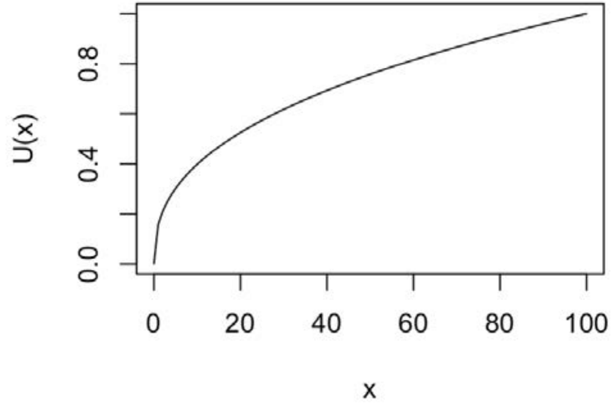
This formula may appear complicated, but what it means for you is very simple: You get paid the most when you honestly report your best guesses about the likelihood of each of the different possible outcomes. The range of your payoffs is from $0 to $2 for each set of guesses.

Proper scoring rules

r	It doesn't rain	It rains
0%	0	100
10%	19	99
20%	36	96
30%	51	91
40%	64	84
50%	75	75
60%	84	64
70%	91	51
80%	96	36
90%	99	19
100%	100	0

What would you choose?

"Risk-averse agents, for example, have an incentive to report probabilities closer to 0.5 to reduce the variance of their payoff."
(Charness et al. 2021)



Binary scoring rules

Idea: being paid in probability rather than monetary amounts (Hossain and Okui 2013)

E = Stock market increases

E^c = Stock market drops

Step 1:

$1 - (1 - r)^2$

Probability of winning X if E occurs

$1 - 1r^2$

Probability of winning X if E^c occurs

Step 2:

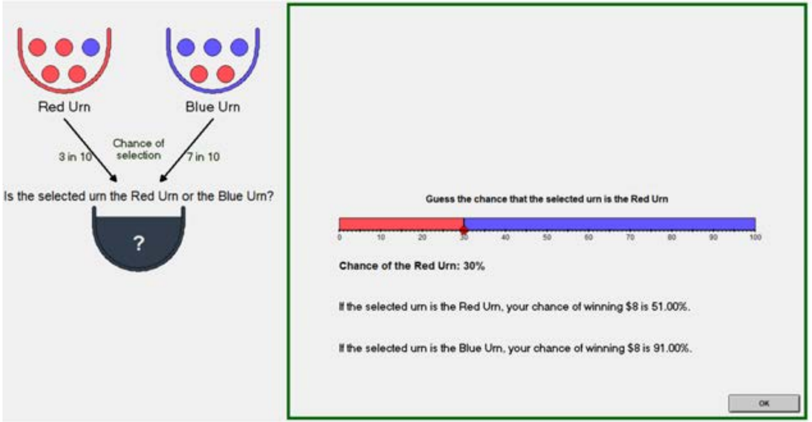
Lottery with the probability determined by realization of E or E^c and the corresponding probability

ATTENTION!

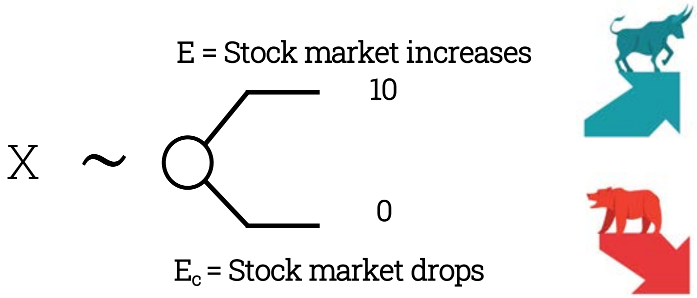
More challenging than the proper scoring rule

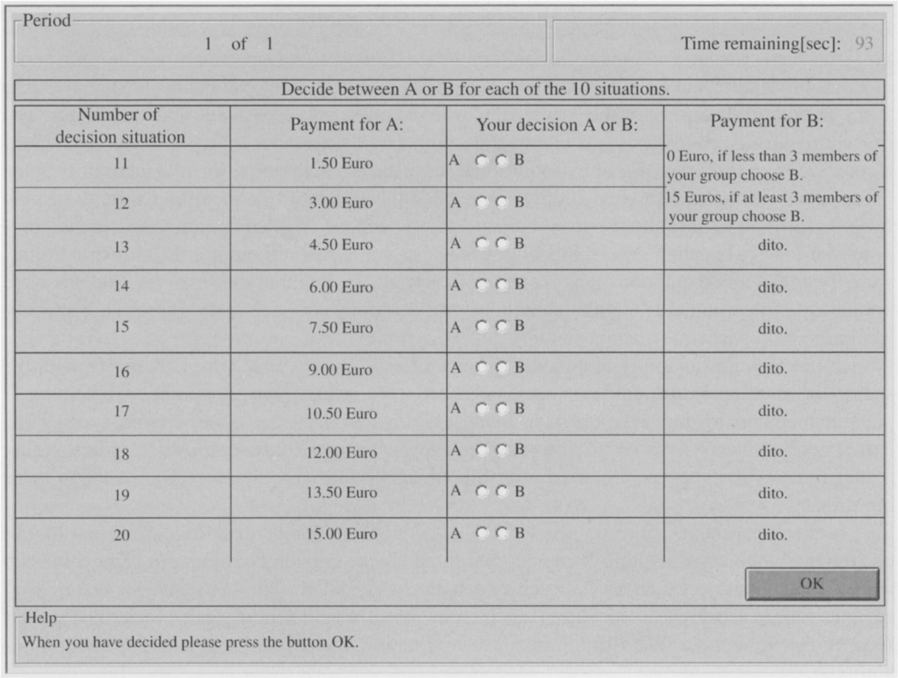
"the **theoretical robustness** of BSR comes with further complexity costs compared to proper scoring rules. Not only do participants have to intuit that reporting truthfully maximizes their expected number of lottery tickets by examining the list of available bets or the payoff formula, they also have to understand the additional layer of randomization this procedure involves" (Charness et al. 2021)

"we show that the binarized scoring rule, a state-of-the-art elicitation, violates two weak conditions for behavioral incentive compatibility: (i) within the elicitation, **information on the incentives increases deviations from truthful reporting**"(Danz et al. 2022)



Certainty equivalent





Period

1 of 1

Time remaining[sec]: 93

Decide between A or B for each of the 10 situations.

Number of decision situation	Payment for A:	Your decision A or B:	Payment for B:
11	1.50 Euro	A ◯ ◯ B	0 Euro, if less than 3 members of your group choose B.
12	3.00 Euro	A ◯ ◯ B	15 Euros, if at least 3 members of your group choose B.
13	4.50 Euro	A ◯ ◯ B	dito.
14	6.00 Euro	A ◯ ◯ B	dito.
15	7.50 Euro	A ◯ ◯ B	dito.
16	9.00 Euro	A ◯ ◯ B	dito.
17	10.50 Euro	A ◯ ◯ B	dito.
18	12.00 Euro	A ◯ ◯ B	dito.
19	13.50 Euro	A ◯ ◯ B	dito.
20	15.00 Euro	A ◯ ◯ B	dito.

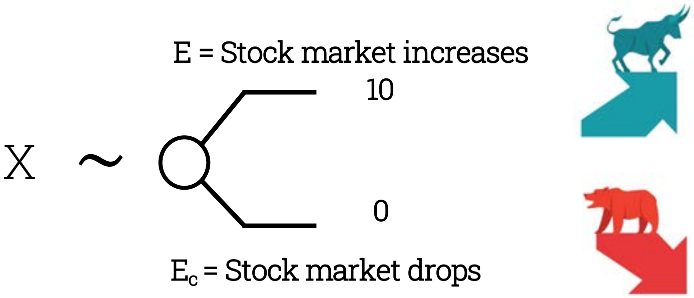
OK

Help

When you have decided please press the button OK.

Heinemann, F., Nagel, R., & Ockenfels, P. (2009). Measuring strategic uncertainty in coordination games. The review of economic studies, 76(1), 181-221.

Certainty equivalent



"The switching point, however, is not enough to pin down beliefs exactly, because the **participant's choices also depend on her risk preferences** (the measurement of which is subject to error). For instance, if we assume that the agent is risk-neutral, then the true belief corresponds to the value of p that equates the expected payoff of the lottery with the switching point C(rswitch). This is clearly a major issue, because there is a **great deal of evidence showing that people are not risk-neutral in experiments**" (Charness et al. 2021)

Under expected payoff maximization $X = P(E) * 10$

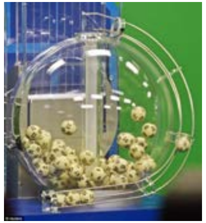
Under SEU maximization $\mathrm{U}(X) = P(E) * U(10)$ **Elicitation of utility function**

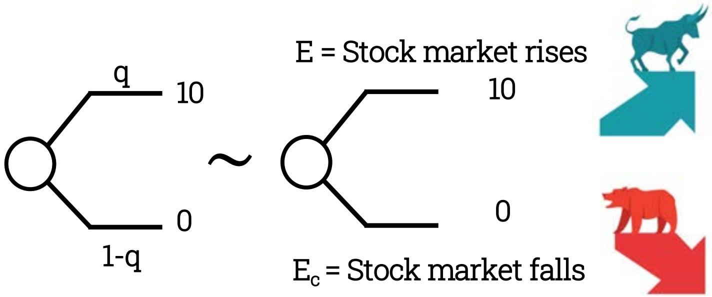
Matching probabilities

The matching probability q of event E is the probability that makes the subject indifferent between:

- A prospect that gives X with probability q, and nothing otherwise
- A prospect that gives X if E occurs, and nothing otherwise

P	**Option A** $10 with probability P	**Option B** $10 if stock market rises
0%		X
10%		X
20%		X
30%		X
40%	X	
50%	X	
60%	X	
70%	X	
80%	X	
90%	X	
100%	X	





Matching probabilities

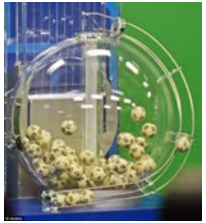
"The main advantage of probability-matching elicitation procedures is their theoretical robustness. As already mentioned, it is robust to deviations **from expected payoff maximization**, as well as some deviations from expected utility maximization…. For example, **non-linear weighting of subjective probabilities** still enables the identification of the subjective belief." (Charness et al. 2021)

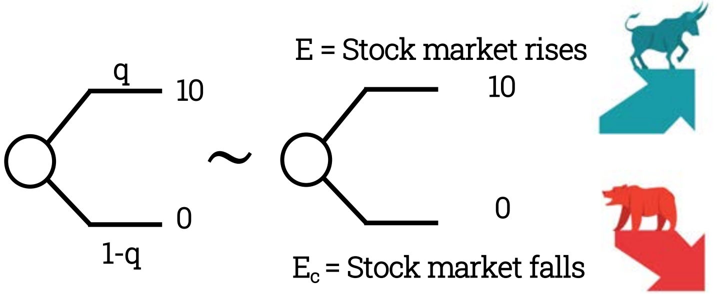
Under expected payoff maximization $q = P(E)$

Under SEU maximization $q = P(E)$

Under RDU maximization $w(q) = f(P(E))$

$$q = P(E)\ if\ w(a) = f(a)$$





Matching probabilities

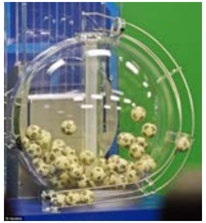
But **it is not robust to non neutral ambiguity attitudes**, "for example, that a participant is ambiguity-averse and prefers known unknowns to unknown unknowns " (Charness et al. 2021).

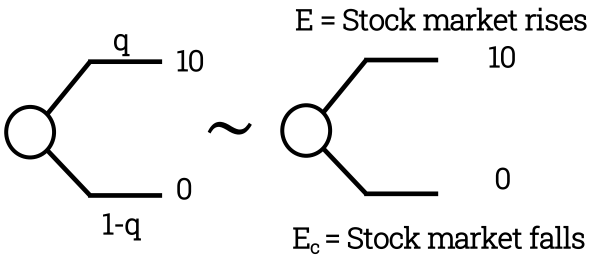
Under expected payoff maximization $q = P(E)$

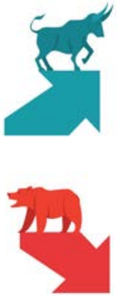
Under SEU maximization $q = P(E)$

Under RDU maximization $w(q) = f(P(E))$

$q = P(E)\ if\ w(a) = f(a)$



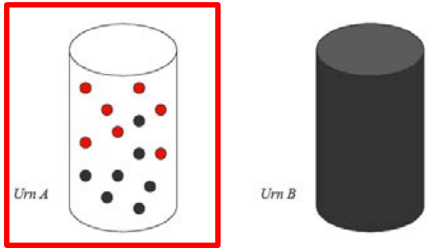


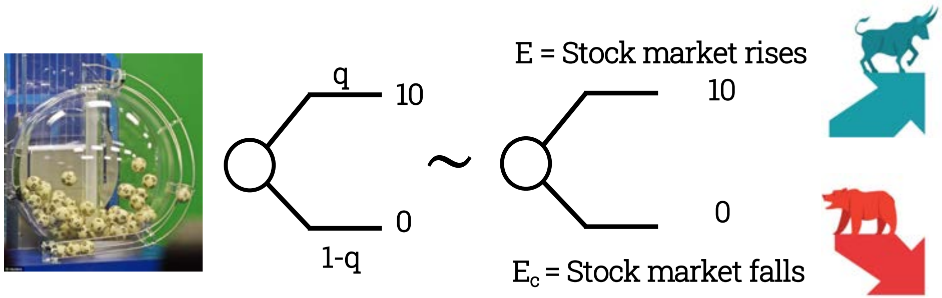


Matching probabilities

But **it is not robust to non neutral ambiguity attitudes**, "for example, that a participant is ambiguity-averse and prefers known unknowns to unknown unknowns " (Charness et al. 2021).

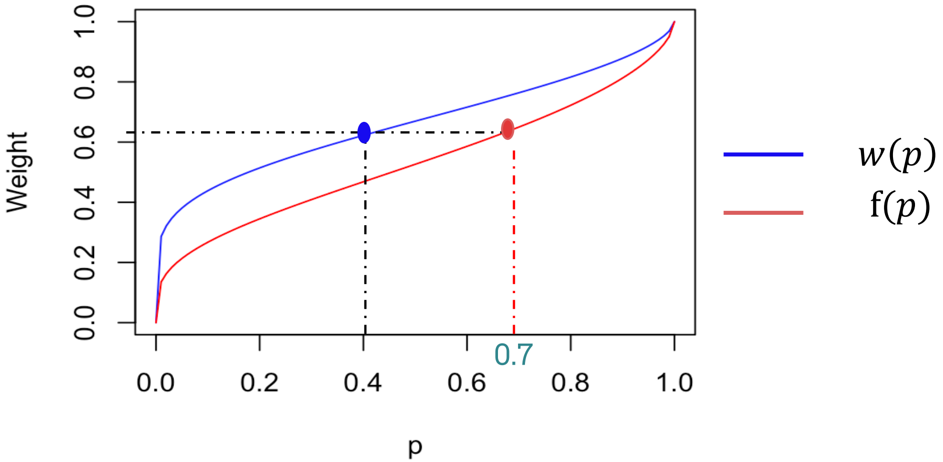
The Ellsberg paradox
(Ellsberg 1961)





$$w(q)\,U(10) \quad = \quad f(P(E))\,U(10)$$

Ambiguity averse $\quad w(q) = f(P(E)) \quad q < P(E)$



matching probability q=0.4

but P(E)=0.7

Events-exchangeability

Baillon (2008); Abdellaoui et al. (2011)

T	**Option A** $10 if temperature is lower than T	**Option B** $10 if temperature is at least T
32°C	X	
30°C	X	
28°C	X	
26°C	X	
24°C	X	
22°C		X
20°C		X
18°C		X
16°C		X
14°C		X

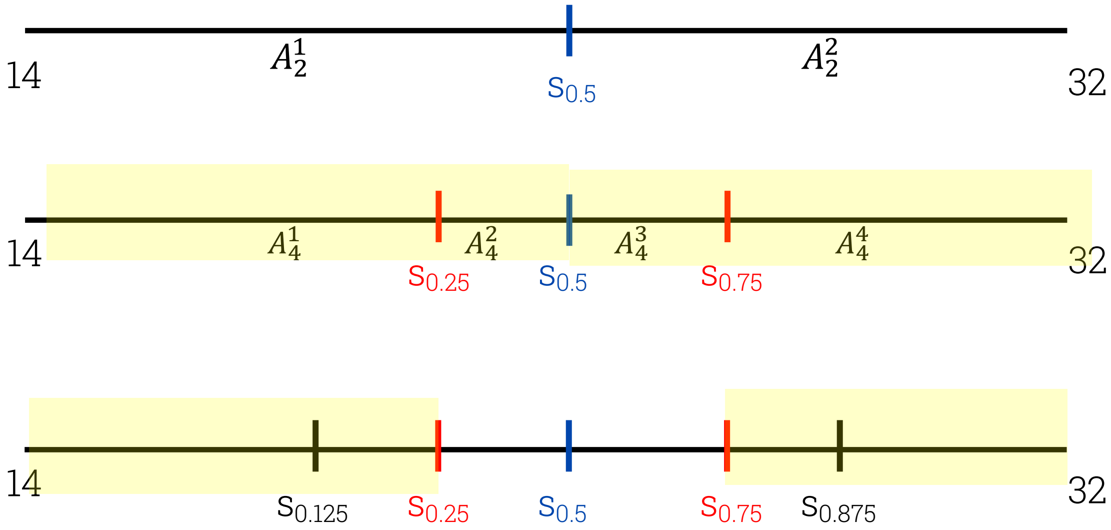
$\mathrm{E}: T \geq 23$ $\mathrm{E}^c: T < 23$

$$W(E)U(10) = W(\mathrm{E}^c)U(10)$$

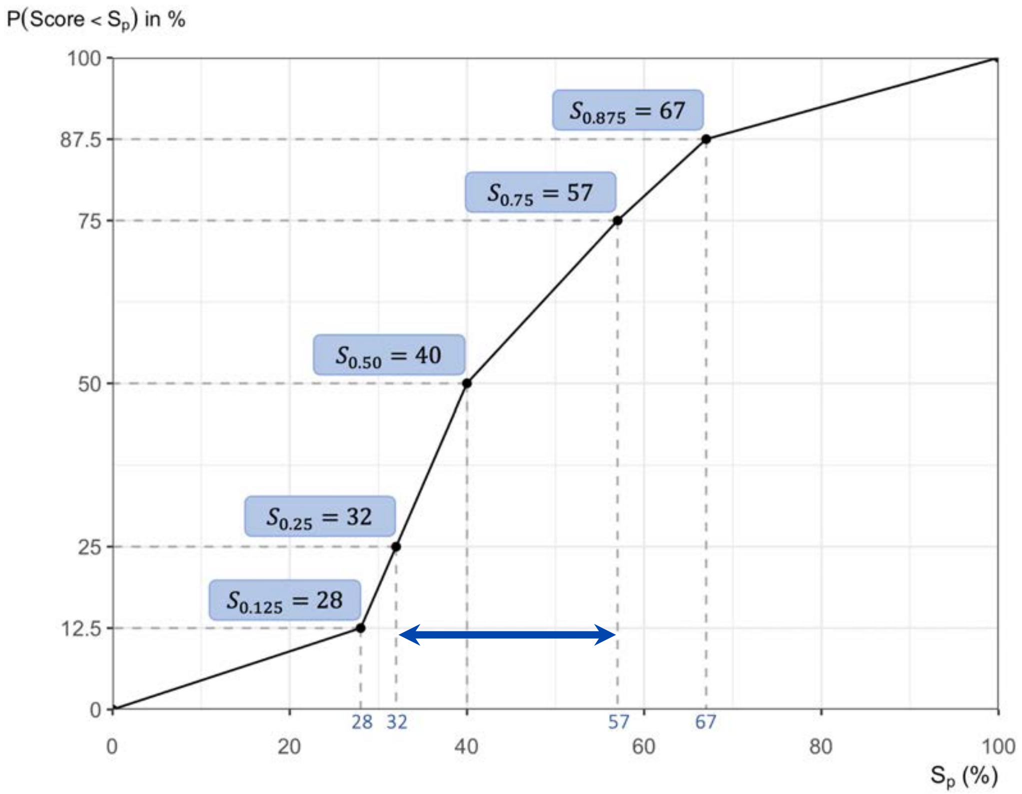
$$f\,(P(E)) = f(P(\mathrm{E}^c))$$

$$p(E) = p(E^c) = 0.5$$

Events-exchangeability



Events-exchangeability

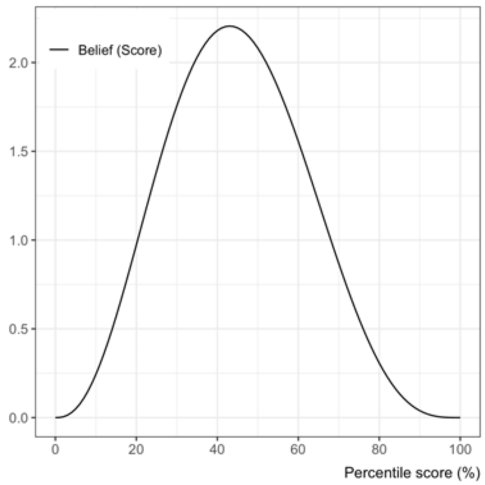


Example subject 9

Beta distribution

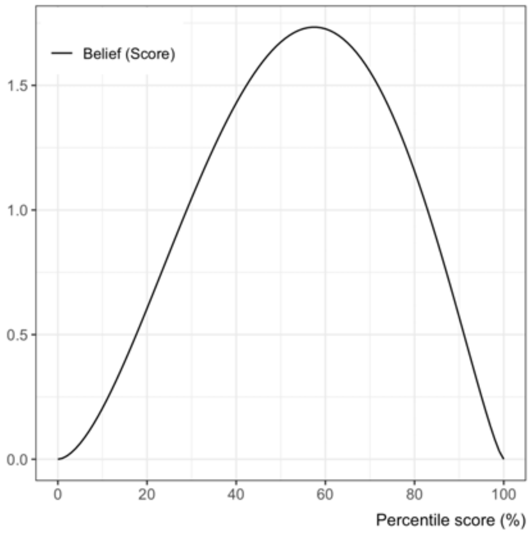
- allows for non-symmetric beliefs and for both negatively and positively skewed distributions (Berry, 1996)

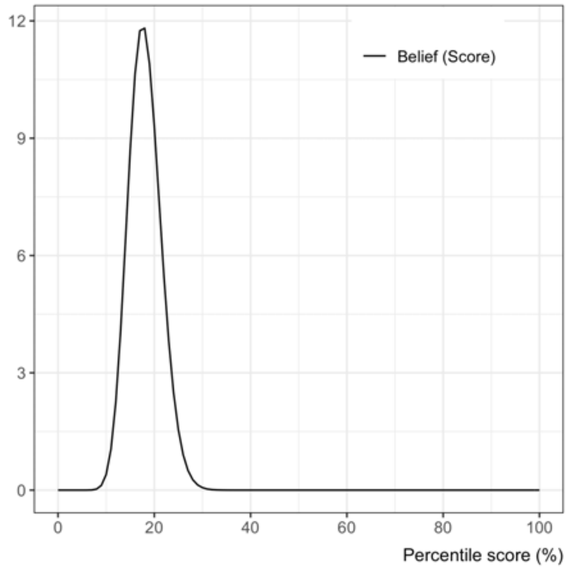
$$f(x, \alpha, \beta) = \frac{1}{B(\alpha,\beta)} x^{\alpha-1}(1-x)^{\beta-1}$$



Exp. score = 44.8
Std. dev. = 16.6

Events-exchangeability





Exp. score = 54
Std. dev. = 20

Exp. score = 18
Std. dev. = 3.4

Events-exchangeability

This method "avoids many of the limitations of the previous methods. In particular, it is robust to ambiguity aversion, is incentivized, and allows individual heterogeneity. However, **it uses chained responses** (i.e., previous elicitations are used in subsequent elicitations) and, consequently, it is vulnerable to possible error accumulation" (Abdellaoui et al. 2021).

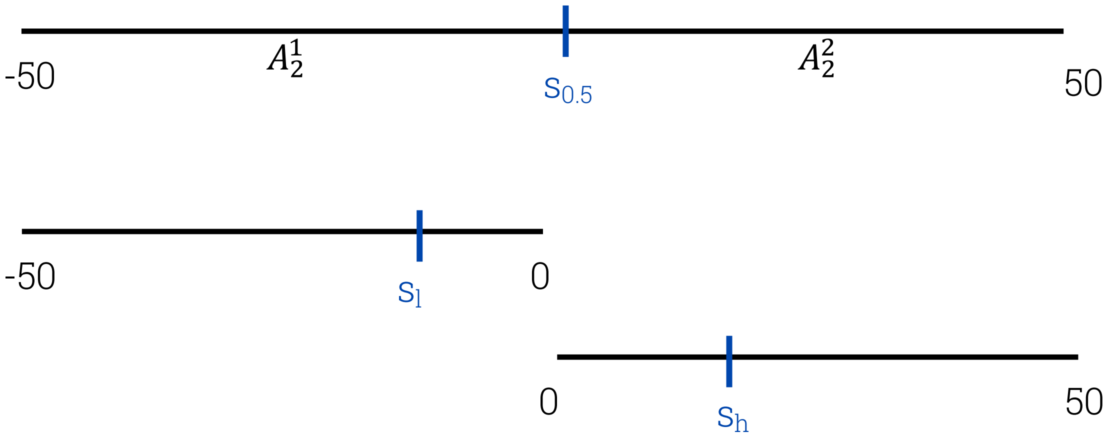
Events-exchangeability non-chained

(Abdellaoui et al. 2021)

Median $s_{0.5}$

Dispersion

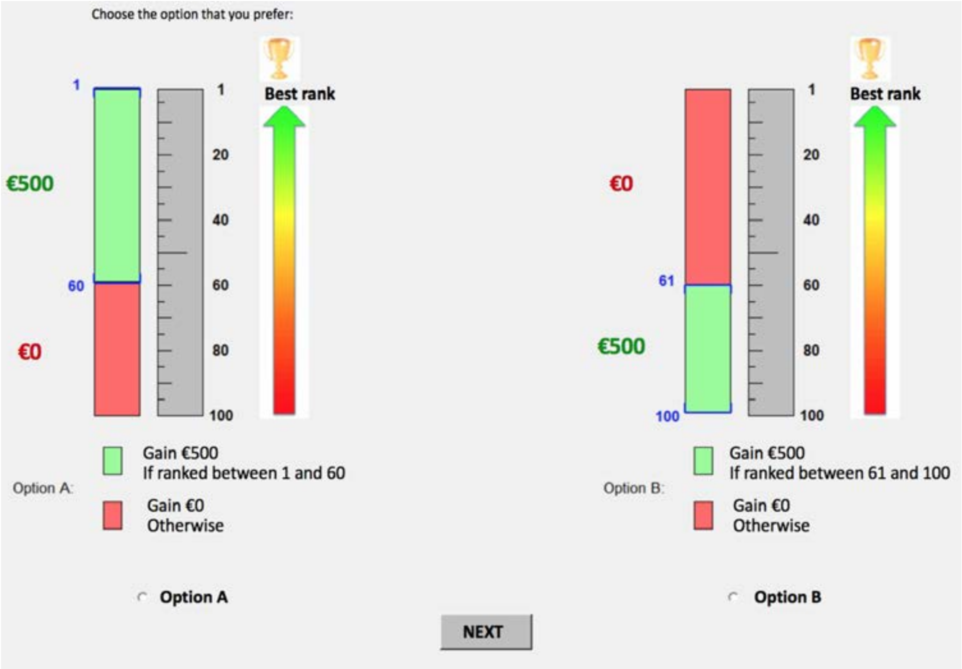
$P([s_l\text{-}s_h])=0.5$



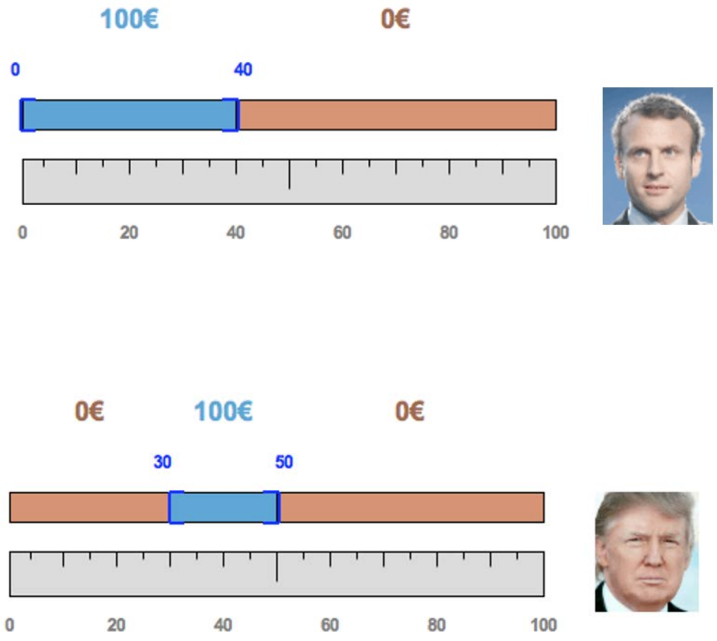
"The above analysis assumes that 0 is in [a, b] and that both [a, 0] and [0, b] have **nonzero probability mass**."

RETURN ON EXPERIENCE

Visual help

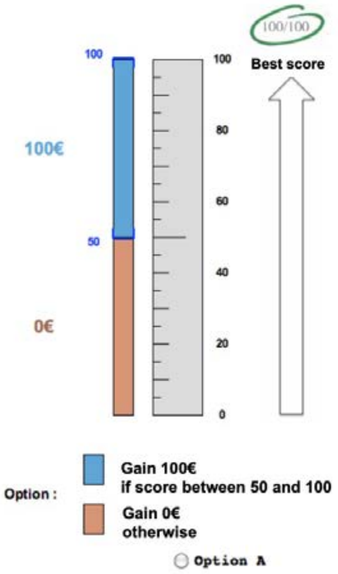


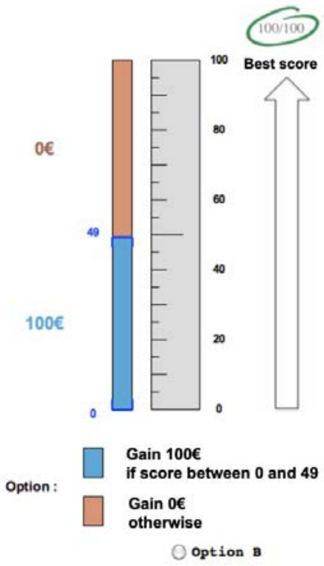
Gutierrez, C., Åstebro, T., & Obloj, T. (2020). The impact of overconfidence and ambiguity attitude on market entry. *Organization Science, 31*(2), 308-329.

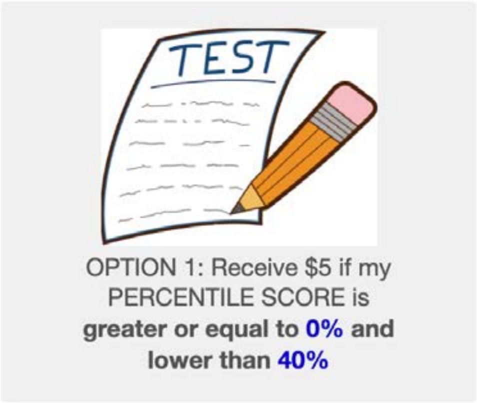


Gutierrez, C., & Kemel, E. (2023). Measuring natural source dependence.

Visual help

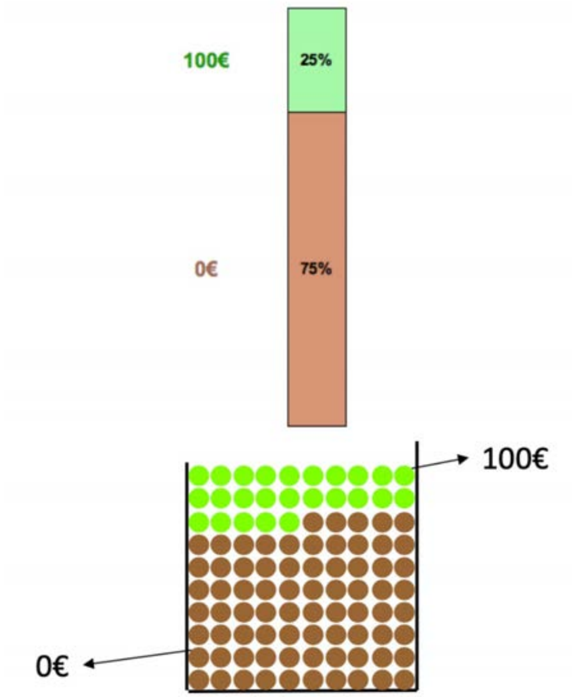






Abdellaoui M., Bleichrodt H., Gutierrez C. (2023)
“Unpacking Overconfident Behavior When Betting on Oneself”

Visual help



Abdellaoui M., Bleichrodt H., Gutierrez C. (2023)
“Unpacking Overconfident Behavior When Betting on Oneself”

Instructions and incentives

- Clear and detailed instructions about the procedure (including the incentive system)
- Comprehension questions

STUDY 1 - LAB EXPERIMENT
“Participants started by watching a 10-minute video describing the experiment. Then they completed a survey with **comprehension questions** to identify those who required additional clarifications from the research assistants. The experiment started with **several practice questions** to familiarize participants with the software.”

STUDY 2 - ONLINE EXPERIMENT
“Each block started with an explanation of the task, a practice question (see Figure 7), and a series of **comprehension questions included to check for data quality**.”

Abdellaoui M., Bleichrodt H., Gutierrez C. (2023)
“Unpacking Overconfident Behavior When Betting on Oneself”

Procedure

OPTION 1: Receive $5 if my PERCENTILE SCORE is **greater or equal to 0% and lower than 40%**

OPTION 2: Receive $5 if my PERCENTILE SCORE is **greater or equal to 40% and lower or equal to 100%**

OPTION 1: Receive $5 if my PERCENTILE SCORE is **greater or equal to 0% and lower than 20%**

OPTION 2: Receive $5 if my PERCENTILE SCORE is **greater or equal to 20% and lower or equal to 100%**

X	**Option A** $5 if score lower than X	**Option B** $5 if score greater or equal to X
0%		X
10%		X
20%		X
30%		X
40%	X	
50%	X	
60%	X	
70%	X	
80%	X	
90%	X	
100%	X	

THANK YOU

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