Indecisiveness under Uncertainty: Incomplete Preferences in Disguise

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Preliminary - Comments highly welcome.

Abstract

In this paper we experimentally document the existence of indecisiveness in decision making under uncertainty. In a series of incentivized decision tasks subjects have to choose between a risky and an ambiguous prospect. Active choices between prospects could be avoided by selecting a fair chance device that eventually assigns one of the two prospects to the decision maker. We observe that half of the subjects are indecisive as they repeatedly choose the chance device. We show that this behavior can be reconciled neither with standard theories assuming a single prior nor with prominent behavioral decision making models. In a second experiment we show that indecisiveness is robust to a prize variation and verify that the observed behavior is consistent with the existence of incomplete preferences relations. We also find a strong gender effect: female subjects are much more likely to be indecisive.

1 Introduction

Most decision making models assume that individuals are always able to pair-wise compare two, or more, available options. In other words, it is assumed that decision makers have complete preferences. However, completeness has long been recognized as a problematic assumption. The following sentence by Aumann (1962) describes this issue concisely: 'Of all the axioms of utility theory, the completeness axiom is perhaps the most questionable. Like others of the axioms, it is inaccurate as a description of real life; but unlike them, we find it hard to accept even from the normative viewpoint'.

Starting with Aumann (1962) decision theorists have proposed models that allow a decision maker to be occasionally indecisive. Some authors have linked incomplete preferences with multi-objective (or multi-self) decision making under risk and certainty (see, for instance, Ok, 2002 and Dubra, 2004). In these models preferences may be incomplete when the decision maker (from now onwards DM) is characterized by two selves that pursue possibly orthogonal objectives. Other decision theorists have developed models where preferences between uncertain prospects may be incomplete because of Knightian uncertainty (Bewley 2002 and Gilboa et al., 2010). In this case incompleteness is ascribed to the presence of multiple representations of the same prospect, which originate from the DM set of priors on the uncertain event. In other words, incomplete preferences stem from the fact that the DM lacks information to determine which option is best.

Albeit important, so far theoretical accomplishments were not paired with rigorous empirical evidence on the existence of incomplete preferences. Experiments in economics and psychology document that complex choice situations may lead decision makers to be indecisive but the observed indecisiveness may be attributed to factors other than incompleteness of preferences. For instance, Shafir and Tversky (1992) show that large choice sets constituted by similar items induce people to stick to the status quo, even though each of the available items is preferred to it. This result suggests that a potentially complete preference relation becomes incomplete in some circumstances: however, competing explanations exists, like decision costs that increase in the number of alternatives or regret aversion.[1]

The major obstacle to obtaining empirical evidence on incompleteness resides in one of the founding blocks of modern economics, the revealed preferences approach. Choices reveal

[1] Similar experiments were also run by Redelmaier and Shafir (1995) who find that the tendency to stick to the status quo is common among professionals. See also Shafir (1993) and Simonson (1989) for experiments describing behavior that could be the product of incomplete preference relations.

preferences and as a consequence the incompleteness of a preference relation is difficult to judge from observed choice behavior. Further, within this approach indecisiveness cannot be distinguished from indifference, the latter meaning that two options are considered equally attractive while the former indicating the inability to pair-wise rank options.[2]

In this paper we experimentally investigate choice behavior in decision situations where preferences may be incomplete because of uncertainty. The study is composed of two main experiments. In the first experiment subjects are asked to make a series of choices between a risky two-outcomes prospect (known probabilities) and an ambiguous two-outcomes prospect (unknown probabilities). Outcomes are the same in all prospects and the level and source of ambiguity is kept constant in all decision situations. Instead, the winning probability of the risky prospect varies in each decision situation, ranging from certainty to win the high outcome to certainty to loose it. In each decision situation, we allow subjects to avoid choosing between prospects. This can be done by selecting a third option which consists of a chance device that assigns either the ambiguous or the risk prospect to the DM, with equal probability.

We find that half of the subjects in our experiment avoid several choices between prospects, this evidence representing a so far unexplored behavioral anomaly. Indeed, we show that the observed behavior cannot be reconciled with the most popular models of decision making under uncertainty, such as Maxmin Expected Utility (Gilboa and Schmeidler, 1989), Cumulative Prospect Theory (Tversky and Kahneman, 1992) and Regret theory (Loomes and Sugden, 1982).

In the second experiment we test whether subjects' behavior may be rationalized by an incomplete preference relation due to uncertainty, as in Gilboa et al. (2010). To this end we increase the high outcome associated to the ambiguous prospect, keeping everything else equal to the first experiment. If the observed behavioral anomaly is the product of incomplete preferences, we should observe that subjects still avoid making choices but in different decision situations. We find that subjects' choices in the second experiment are largely consistent with the hypothesis that active choices are avoided when preferences are incomplete.

Our results call attention on the kind of decision rules that individuals adopt when decid-

[2] An exception is constituted by Eliaz and Ok, 2006. The authors relax the Weak Axiom of Revealed Preferences to propose a theory of decision making that allows identifying indecisiveness and indifference from observable choice behavior.

ing under uncertainty. The observed choice behavior implies that subjects are not averse to ambiguity when they do not *have* to choose between uncertain prospects. Ambiguity aversion (Ellsberg, 1961) is considered an important violation of rationality and decades of research in experimental economics show that the majority of subjects display such aversion (for a review see Camerer and Weber, 1992). We show that the possibility to avoid active decision making is sufficient for ambiguity aversion to disappear. We also go a little bit further and suggest that the observed behavioral anomaly is consistent with the existence of incomplete preferences relations. Models that allow preferences to be incomplete have already proven successful in explaining behavioral anomalies such as the status quo bias (Masatlioglu and Ok, 2005), the endowment effect (Mandler, 2004) and preference reversals (Eliaz and Ok, 2006). Our results confirm that relaxing completeness is a worthy effort in the quest for descriptively accurate models of decision making.

The reminder of the paper is organized as follows. Section 2 describes the design of the first experiment and section 3 presents and discusses the results. Section 4 presents our second experiment and its results. Section 5 describes which individual characteristics are related to indecisiveness. Conclusions are drawn in section 6.

2 An experiment on choice under uncertainty

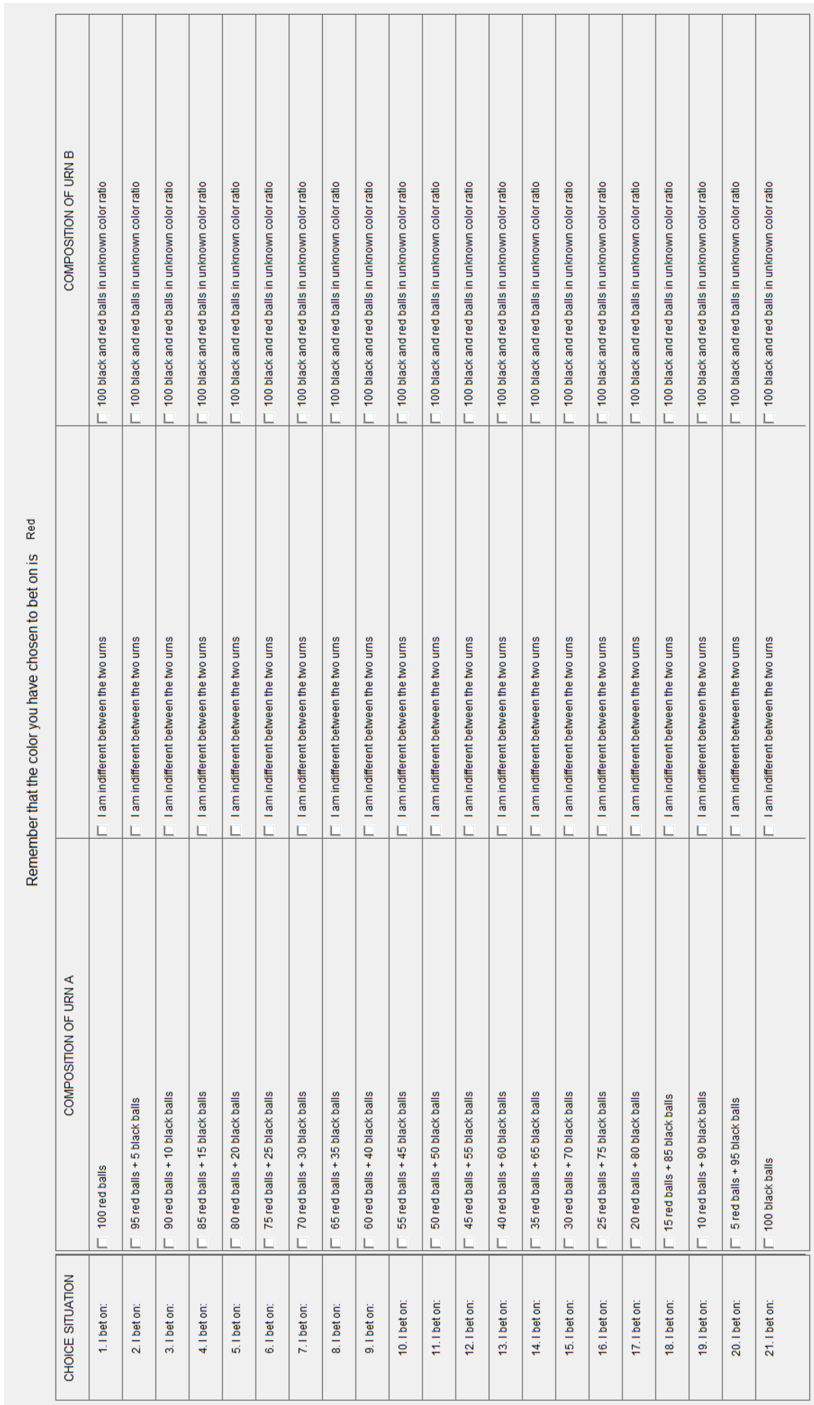
The main purpose of this experiment is to investigate people's choice behavior in decision situations where uncertainty may cause preferences to be incomplete. To this end, in the first part of the experiment subjects face a series of incentivized choices between risky and ambiguous prospects, with the option to remain indecisive between them. Being indecisive in a certain choice situation implies that a fair chance device selects which prospect, risky or ambiguous, is assigned to the subject in that situation.

It has been shown that accounting for the way people think about probabilities can highly improve the descriptive validity of models of decision making under risk (Tversky and Kahneman, 1979). In the first part of our experiment participants have to make choices between prospects with known probabilities (risk) and prospects with unknown probability (ambiguity). Hence, we are interested in exploring whether subjects' perception of probabilities contributes to explaining their choices. The second part of the experiment consists of a series of incentivized choices between lotteries and sure amounts which allow us to jointly estimate the parameter values of subjects' utility and probability weighting function. Finally, we are interested in exploring how subjects' cognitive abilities and thinking styles affect decision making under uncertainty. The last part of the experiment includes psychological questionnaires that measure such characteristics.

Note that subjects were not informed about the structure of the experiment: instructions were administered on the computer screen before the beginning of each part. In the following the experimental procedures for the three parts are described in detail.

Choices under uncertainty In the first part of the experiment subjects go through a series of choices between one ambiguous and one risky prospect. Before that, subjects select a color (red or black) which will be their winning one in each choice situation. Two urns are used to generate uncertainty. The risky urn, Urn A, contains 100 balls colored red and black, and its composition varies in each choice situation. The proportion of colored balls is modified in steps of 5, starting with 100 red balls and ending with 100 black ones. Hence, there are 21 choices in total, all displayed on one table.[3] Figure 1 displays a screen shot of the table. Risky prospects offer increasingly worse (better) chances to win for subjects betting on red (black). The ambiguous urn, Urn B, also contains 100 red and black balls but their proportion is unknown to the subjects as well as to the experimenter. Both urns are visibly placed in the experimental lab and subjects are informed that they are free to inspect their content after the experiment is over. A colleague of us composed the ambiguous urn, being free to put as many red and as many black balls in the urn, provided that the total number had to be 100. The urn was then sealed and nobody except the composer, who was in no way involved in the experiment, was aware of its composition. In each of the 21 choice situations subjects choose whether they want to bet on their winning color from the urn with known composition or from the ambiguous one. Subjects can also avoid to actively choose one of the prospects by selecting the middle option in the decision table. In formulating this option in the experiment we use the expression "I am indifferent between the two urns". The word indifferent seems a quite natural choice in this context as in everyday language it is used to indicate lack of a precise preference. Further other terms, such as indecisive or insecure, may be more likely to create experimental demand effects. We did not impose any consistency requirement on subjects' choices, such as to allow switching from one type of urn to the other only once.

[3] In the empirical literature, tables with paired lotteries are commonly used to elicit risk attitudes (Holt and Laury, 2002) and less often to elicit attitude to uncertainty (Cohen et al., 1987).



Remember that the color you have chosen to bet on is Red

CHOICE SITUATION	COMPOSITION OF URN A		COMPOSITION OF URN B
1. I bet on:	100 red balls	I am indifferent between the two urns	100 black and red balls in unknown color ratio
2. I bet on:	95 red balls + 5 black balls	I am indifferent between the two urns	100 black and red balls in unknown color ratio
3. I bet on:	90 red balls + 10 black balls	I am indifferent between the two urns	100 black and red balls in unknown color ratio
4. I bet on:	85 red balls + 15 black balls	I am indifferent between the two urns	100 black and red balls in unknown color ratio
5. I bet on:	80 red balls + 20 black balls	I am indifferent between the two urns	100 black and red balls in unknown color ratio
6. I bet on:	75 red balls + 25 black balls	I am indifferent between the two urns	100 black and red balls in unknown color ratio
7. I bet on:	70 red balls + 30 black balls	I am indifferent between the two urns	100 black and red balls in unknown color ratio
8. I bet on:	65 red balls + 35 black balls	I am indifferent between the two urns	100 black and red balls in unknown color ratio
9. I bet on:	60 red balls + 40 black balls	I am indifferent between the two urns	100 black and red balls in unknown color ratio
10. I bet on:	55 red balls + 45 black balls	I am indifferent between the two urns	100 black and red balls in unknown color ratio
11. I bet on:	50 red balls + 50 black balls	I am indifferent between the two urns	100 black and red balls in unknown color ratio
12. I bet on:	45 red balls + 55 black balls	I am indifferent between the two urns	100 black and red balls in unknown color ratio
13. I bet on:	40 red balls + 60 black balls	I am indifferent between the two urns	100 black and red balls in unknown color ratio
14. I bet on:	35 red balls + 65 black balls	I am indifferent between the two urns	100 black and red balls in unknown color ratio
15. I bet on:	30 red balls + 70 black balls	I am indifferent between the two urns	100 black and red balls in unknown color ratio
16. I bet on:	25 red balls + 75 black balls	I am indifferent between the two urns	100 black and red balls in unknown color ratio
17. I bet on:	20 red balls + 80 black balls	I am indifferent between the two urns	100 black and red balls in unknown color ratio
18. I bet on:	15 red balls + 85 black balls	I am indifferent between the two urns	100 black and red balls in unknown color ratio
19. I bet on:	10 red balls + 90 black balls	I am indifferent between the two urns	100 black and red balls in unknown color ratio
20. I bet on:	5 red balls + 95 black balls	I am indifferent between the two urns	100 black and red balls in unknown color ratio
21. I bet on:	100 black balls	I am indifferent between the two urns	100 black and red balls in unknown color ratio

Figure 1: Screen shot test

Incentive compatibility is obtained with the random-lottery method.[4] Before making their choices, participants are informed that each of the 21 choice situations is equally likely to be

[4]See *http://people.few.eur.nl/wakker/miscella/debates/randomlinc.htm* for a discussion on the appropriateness of the random-lottery incentives scheme.

selected for payment. If a winning ball is drawn from the chosen urn the subject earns $e15$, otherwise she/he earns nothing. If a choice situation where the subject was indecisive is relevant for payment, a fair chance device is used to select one of the two urns. All the described procedure took place publicly at the end of the experiment so that subjects could witness how the chance devices were operated.
After making the 21 choices, subjects proceed to a different screen where they are asked to provide their best estimate of the ambiguous urn's composition. Subjects can click on any of 20 check boxes that indicate the number of red balls in the ambiguous urn in intervals of 5 balls. Note that we explicitly mention the possibility to click on more than one check box. This task is not incentivized.

Probability weighting and utility function The second part of the experiment is designed to jointly estimate the utility and probability weighting function parameters at the individual level (Fehr-Duda et al., 2006). Subjects' certainty equivalents are elicited for a series of 33 two outcomes lotteries. Table 1 shows the outcomes (in Euro) and probabilities employed. For each lottery subjects are presented with a decision screen that contains a description of the lottery and a list of 20 equally spaced sure amounts, ranging from the lottery's highest to lowest outcome. In order to facilitate comprehension, the lottery odds are expressed both in percentage points and with the aid of a pie chart. Figure 2 displays a decision screen.

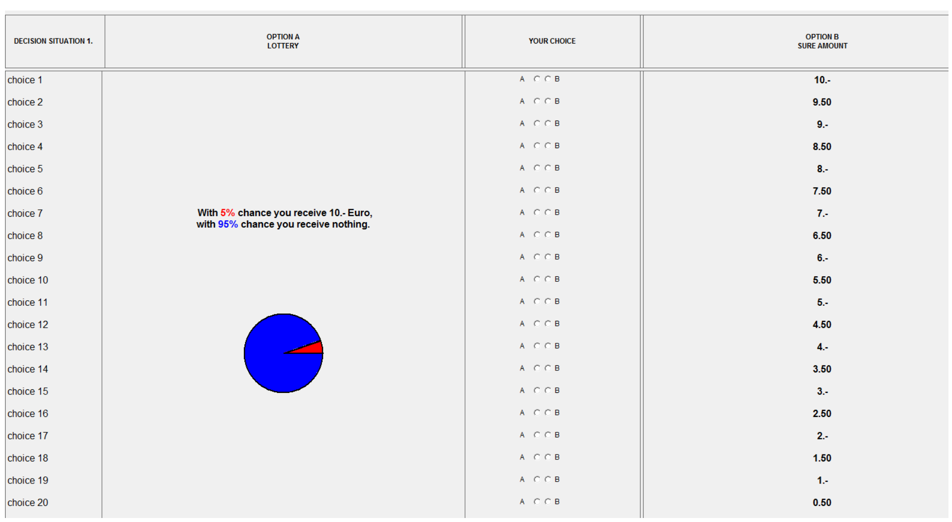


Figure 2: Screen shot of a typical decision screen of part 2.

In each row of the decision screen subjects have to make a choice between the lottery and the sure amount. Certainty equivalents are then calculated as the arithmetic mean of the

Table 1: Lotteries, p_1 indicates the probability of winning x_1 Euro.

p_1	x_1	x_2	p_1	x_1	x_2	p_1	x_1	x_2
0.05	10	0	0.35	25	10	0.65	20	5
0.05	20	5	0.45	10	0	0.65	25	10
0.05	25	10	0.45	20	5	0.75	10	0
0.1	5	0	0.45	25	10	0.75	20	5
0.1	10	5	0.5	5	0	0.75	25	10
0.1	25	0	0.5	20	5	0.9	5	0
0.25	10	0	0.5	25	10	0.9	10	5
0.25	20	5	0.55	20	5	0.9	25	0
0.25	25	10	0.55	25	10	0.95	10	0
0.35	10	0	0.55	10	0	0.95	20	5
0.35	20	5	0.65	10	0	0.95	25	10

smallest sure amount preferred to the lottery and the consecutive sure amount on the list.

At the end of the experiment one decision screen and one row within the decision screen are randomly selected for payment. The relevant lottery is then publicly played out and earnings are added to those of the first part.

Psychological measures In the last part of the experiment subjects are asked to answer questions from the Cognitive Reflection Test (CRT) by Frederick (2005). The CRT is a 3 items test that measures the ability to reflect on a problem, the first answer that comes to ones' mind being always wrong. Furthermore, performance in the CRT has been found to be positively and significantly correlated with standard measures of cognitive ability. Subjects are rewarded with €0.50 for each correct answer and have a limited time to provide their answers.

Thereafter, subjects go through the 31 items of the Rational-Experiential Inventory (REI, Epstein et al., 1996). REI includes 19 items on a 5 points scale that measure analytical-rational processing and 12 items, also on a 5 points scale, that measure engagement and confidence in one's intuitive abilities. Analytical and intuitive modes represent two fundamental ways in which people process information. In fact, differences in thinking modes can explain a wide variety of behaviors and possibly also to the way in which people make decisions under uncertainty. In the final part, subjects are asked a few socioeconomic questions and then they are privately paid out in cash and dismissed.

55 students from Maastricht University participated in the computerized experiment which was conducted in March 2009 in the Behavioral and Experimental Lab (BEElab) at the Maastricht University School of Business and Economics, using the Z-Tree software (Fischbacher, 2007). 90% of the subjects were enrolled in the Faculty of Economics and Business Administration and 58% of them were male. The average age was 23 years. The experiment lasted on average 90 minutes and the average earnings per subjects were €32.95.

3 Results

For ease of understanding and for convenience, in what follows subjects' choices in the first part of the experiment are recoded and then analyzed as if red had been selected as winning color by everybody.[5]

We find that as long as it gives a winning probability of at least 0.5, the risky urn is the most common choice. However, when the winning probability drops to 0.45 the ambiguous urn becomes the most popular option for all consecutive choice situations. In other words, by varying the winning probability of the risky prospect between 1 and 0, we observe that the majority of people prefers the risky prospect to the ambiguous one only in 11 out of 21 choice situations. If in each choice situation we assign half of the indecisive choices to the risky option and the other half to the ambiguous one, in a given situation we can use a binomial test to verify whether choices in favor of one option are significantly larger than 50%. It turns out that choices favoring the risky prospect are significantly larger than 50% at the 1% significance level in all choice situations characterized by a winning probability $p \geq 0.5$. On the other hand, choices favoring the ambiguous prospect are significantly larger than 50% at the 1% significance level in all choice situations characterized by a winning probability $p \leq 0.4$. When the winning probability of the risky prospect is equal to 0.45 the number of choices favoring the risky prospect is not significantly different than the number of choices favoring the ambiguous prospect (p=0.14). This evidence suggests that subjects in the experiment are only moderately averse to ambiguity. Several investigations have shown that ambiguity aversion is

[5]We exclude from the analysis 1 subject who switched back and forth between the three options of the first task 11 times, thus displaying random behavior. We also exclude 1 subject who displayed a highly inconsistent behavior in several lotteries of the second part.

negatively related to the decision maker's familiarity with the source of uncertainty (Fox and Tversky, 1995, Fox and Weber, 2002). In this experiment ambiguity is artificially generated in the laboratory using an urn with unknown composition, which is a rather unfamiliar source of uncertainty. Hence, since subjects have never participated in similar experiments before, the moderate aversion to ambiguity we observe cannot be explained by a sense of familiarity with the decision context.

In fact, the most striking feature emerging from our data is that a large number of subjects do not actively avoid the ambiguous prospects. Subjects are often indecisive, particularly for choice situations where the winning probability of the risky prospect is between 0.5 and 0.35. When the winning probability is 0.5, 36% of the subjects choose the fair chance device. Similarly, 37% of the subjects choose the fair chance device when the winning probability is 0.45 and 36% when the winning probability is 0.4 and 0.35. In all the other choice situations less than 23% of the subjects choose the device. These figures already suggest that some subjects chose the fair chance device more than once. The histogram in Figure 3 confirms this by showing the relative frequency of choices in favor of the chance device.[6]

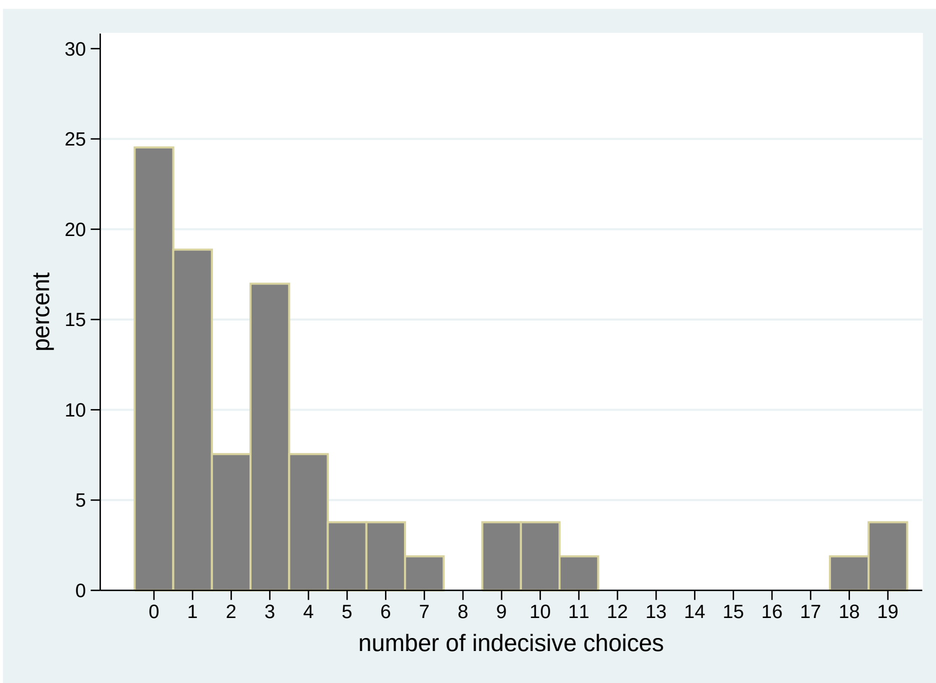


Figure 3: Relative frequency of indecisive choices.

[6]The histogram does not include decisions made in the first and in the last choice situations, where the choosing the chance device may only be a mistake. In any case, the classification of subjects in indecisive and non-indecisive would not change if those choice situations are also included.

Subjective Expected Utility theory (SEU, Savage, 1954) is the equivalent of Expected Utility theory when probabilities are unknown to the decision maker. According to SEU theory subjects would choose the chance device only when the winning chance of the risky prospect equals their subjective prior on the ambiguous urn. Stated differently, subjects would choose the device when they are truly indifferent between the two prospects. The device is never chosen by only 24.5% of the subjects and 19% choose it exactly once. Hence, behavior 43.5% of the subjects is in accordance with SEU theory. The remaining 56.5% of the subjects choose the device in at least two choice situations. The most common situation is to select the fair chance device in three choices (17% of the participants), followed by four choices (7.5% of the participants). A few subjects even choose the fair chance device in almost all situations. Note that most subjects that choose the chance device do this in consecutive situations of the table.[7]

Result 1. *More than half of the subjects are indecisive between risky and ambiguous prospects at least 2 times, mainly in consecutive choice situations.*

In the following we refer to subjects that chose the chance device at most once as "decisive" and to subjects who chose the chance device at least two times as "indecisive". Interestingly, self reported estimates on the composition of the ambiguous urn reveal that on average decisive subjects believe that there are 50 winning balls and indecisive subjects 51 winning balls, this difference being insignificant (Mann Whitney test p=0.46). Notwithstanding this similarity in beliefs, SEU theory is clearly not suited to account for indecisive subjects' choices.[8] In the following we show that many other theories of decision making under uncertainty are also unable to account for repeated choice of the chance device.

Multiple priors models In these family of models consider, for instance, α Maxmin Expected Utility ($\alpha-$MEU) theory (Ghirardato, Maccheroni and Marinacci, 2004), which is a development of Maxmin Expected Utility theory (Gilboa and Schmeidler, 1989) that explicitly accounts for attitude to ambiguity. In this model the decision maker may hold a set of priors on the ambiguous event and is characterized by an index α which captures attitude to ambiguity. Repeatedly choosing the chance device implies that either the prior on the ambiguous event or ones' attitude to ambiguity, the index α, are revised in each choice

[7] Only 15% of the subjects do not display compact intervals.

[8] Actually, the limits of SEU theory in describing choice under uncertainty are known since Ellsberg's seminal two colors example (Ellsberg, 1961).

situation.[9] In our view, the assumption of continuous revision of beliefs and preferences does not appear as a plausible mechanism underlying choice behavior.

As a next candidate for explaining repeated choice of the chance device we consider a descriptive model of decision making under uncertainty, Cumulative Prospect Theory (CPT, Tversky and Kahneman, 1992). CPT allows for the existence of sub-additive decision weights reflecting the idea that people have preferences over sources of uncertainty even when the beliefs associated with each source are the same (Tversky and Wakker, 1995). In general, more familiar and intelligible sources of uncertainty receive higher decision weights than less familiar ones. In our experiment, repeated choice of the chance device would imply that different probabilities values are all equally weighted.[10] Thus, the more a subject is indecisive, the flatter the subject's probability weighting function. In other words, CPT may account for repeated choice of the chance device only if indecisive subjects are characterized by extreme insensiti lges.xpirical literature on probability weighting already suggests that this explanation can be ruled out because likelihood insensitivity, although widespread, is usually not too extreme (see, for instance, Abdellaoui, 2000). The second part of our experiment allows to directly test the descriptive validity of CPT by estimating the parameters of the value and probability weighting function at the individual level.

Probability weighting In order to make CPT operational, we have to assume specific functional forms for the value function $v(x)$ and for the probability weighting function $w(p)$. We use the specifications proposed by Kahneman and Tversky (1992) because they combine goodness of fit with parsimony. Thus, we assume $v(x) = x^\alpha$, where $\alpha = 1$ indicates a linear value function, $\alpha > 1$ a convex one and $0 < \alpha < 1$ a concave value function and

$$w(p) = \frac{p^\gamma}{(p^\gamma + (1-p)^\gamma)^{1/\gamma}}$$

where $\gamma = 1$ indicates linear weighting. For values of $\gamma < 1$ the function has an inverted-s shape and for $\gamma > 1$ the function is s-shaped.

Under these parametric assumptions, we estimate the parameter values of α and γ for each subject by minimizing the sums of squared distances (Wakker, 2009) that is:

$$\sum_{i=1}^{33}(l_i - ce_i)^2$$

[9] This can be easily proven, but it requires some tedious algebra. We invite the reader to refer to the appendix.

[10] Again, we invite the reader to refer to the appendix for a formal proof.

where l_i is the CPT value of lottery i and ce_i is the CPT certainty equivalent of lottery i.[11] Subjects are free to switch back and forth between the lottery and the sure amount. Since the calculation of certainty equivalents requires subjects to switch from the lottery to the sure amount just once, we can only use decisions screens that meet this condition. However, since we need estimates of the relevant parameters for each individual we cannot exclude too many decisions. Thus, the following rule is employed: if a subject switches back and forth between the lottery and the sure amount in more than four lotteries, all her decisions are excluded from the experiment. In fact, only one subject had to be excluded from the analysis. Subjects with less than four inconsistent decision sheets are considered in the analysis but the inconsistent decision sheets are dropped.

Recall that the chance device is mostly chosen when the risky prospect has a winning probability that lies within 0.35 and 0.5. Probabilities in the interval $[0.35, 0.5]$ are all differently weighted if $\gamma \geq 0.37$. On the other hand, $\gamma \leq 0.25$ implies that all probabilities in the interval receive equal weight. Unless stated otherwise, all statistical tests in this paper are two tailed. We find that on average decisive and indecisive subjects are characterized by an identical value of $\gamma = 0.62$ which is not significantly different in the two groups (Mannn Whitney test $p = 0.36$).[12] Among decisive subjects, only 2 out of 23 are characterized by a $\gamma < 0.37$ and nobody appears to hold a completely flat weighting function in the relevant probability interval. Similarly, only 2 out of 30 indecisive subjects are characterized by a $\gamma < 0.37$ and nobody by a $\gamma \leq 0.25$. As a consequence, the hypothesis that indecisiveness follows from flatness of the probability weighting function can be ruled out.

Probabilistic choice We now consider the possibility that repeated choice of the chance device derives from a probabilistic choice process (Harrison, 2008). Probabilistic choice models extend traditional theories of decision making by allowing for decision errors. These models assume that the probability of choosing a prospect is not equal to one when its expected utility exceeds the expected utility of the alternative prospect. Instead, the likelihood of choosing a prospect is a function of the expected utility difference existing between the available prospects. The larger the expected utility difference, the higher the likelihood of choosing the better prospect. In our experiment choosing the chance device is equivalent to receiving the ambiguous or the risky prospect with equal probability. This implies that the chance

[11] To correct for heteroscedasticity prospects are normalized to uniform length.

[12] The estimates of α indicate moderate concavity of the value function, in accord with the common hypothesis that utility is almost linear for small stakes. The estimated α of indecisive subjects is not significantly different than that of decisive subjects (0.90 and 0.85 respectively, Mann Whitney test $p = 0.17$).

device is only selected when the utility difference between the two prospects is sufficiently small. However, when this is the case, the three available options (the risky prospect, the ambiguous one and the chance device) are equally attractive and should be chosen with equal probability. Given that the chance device is chosen almost exclusively in consecutive choice situations, our data do not seem consistent with a probabilistic choice model. In order to make this argument more robust we run an experiment where subjects had to make a series of choices between risky prospects and a sure amount. The risky prospects are exactly the same as those in the decision table of part 1, while the sure amount is fixed in every choice situation and is equal to €7.50. As in the first experiment, in each situation subjects can avoid making active choices by selecting a fair chance device. The experimental procedures and all the other parts of the experiment are identical to those in our first experiment. If repeated choice of the chance device has to be ascribed to a probabilistic choice process, we would expect that subjects also choose the chance device in a number of decision situations in this experiment. Indeed, given that the sure amount lies between the two possible outcomes of the lottery (which are €0 and €15), theoretically for each subject there exists at least one situation where the utility difference between the risky option and the sure amount is very small. A number of 50 subjects participated in this experiment; we exclude from the analysis 4 subjects who switched back and forth between the lotteries and the sure amount, thereby violating monotonicity. Figure 4 shows the relative frequency of choices in favor of the chance device.

It appears that only 11% of the subjects choose the chance device more than once, in contrast to the 56.5% share observed in the first experiment. This result clearly indicates that the high number of choices in favor of the chance device under ambiguity cannot be explained by arguments based on the existence of a small utility difference between prospects.

Regret aversion At last, we test whether Regret theory (Loomes and Sugden, 1982) can explain the repeated preference for the chance device. Regret theory predicts that between two options a DM chooses the one that maximizes a modified utility function which, for each state of nature, compares alternatives in terms of their outcomes and potential regret/rejoice feelings. Consider, for instance, choosing between two options, A and B, when only two states of the world are possible. If in a given state option A yields a more desirable consequence than option B, the individual anticipates that he may feel regret by choosing B: he may reflect on how his position would have been had he chosen option A, and this thought may reduce the utility that he derives from the outcome of option B. Conversely, if in another

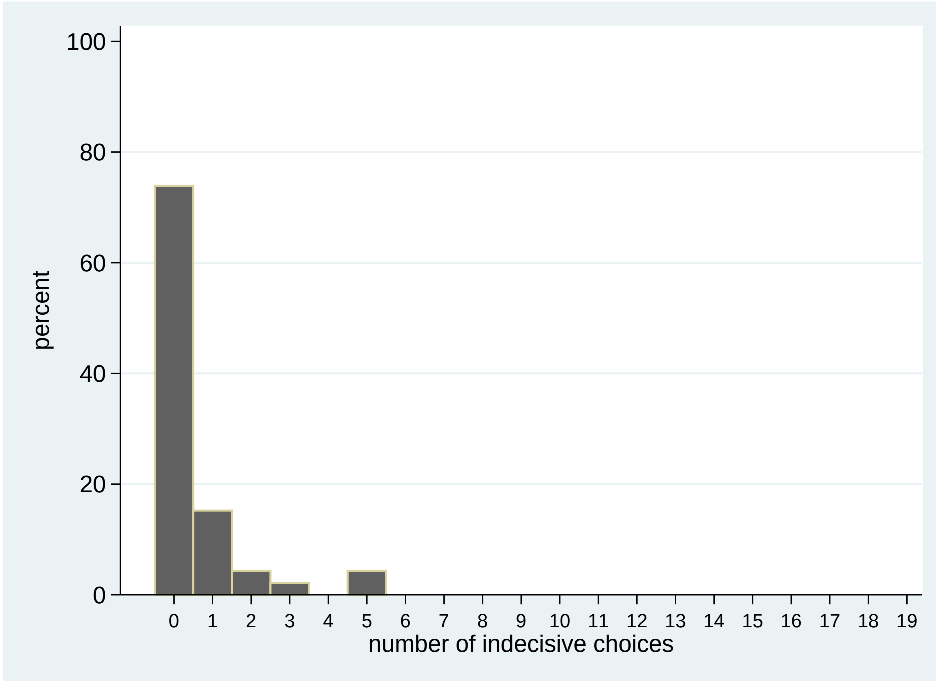


Figure 4: Relative frequency of indecisive choices under risk.

state of nature option B yields the more desirable consequence, by choosing B the DM may experience what has been called rejoicing, that is extra pleasure associated with knowing that the best option has been chosen. The DM will ultimately choose B if its modified utility, that is B's utility plus the anticipated rejoice and minus the anticipated regret, is larger than A's modified utility, which is calculated in the same way.

Several scholars suggested that the chance device may be chosen in order to avoid regret feelings that can arise when actively choosing between the ambiguous and the risky prospect. First of all, we would like to point out that this interpretation may have some explanatory power only if we are ready to assume that anticipated feelings can exclusively arise when choosing between prospects and not when selecting the chance device. Indeed, if anticipated feelings would also be experienced when selecting the chance device, Regret theory would predict that the chance device is chosen only when the winning probability of the risky prospect is equal to the prior belief on the ambiguous event.[13] The intuition behind this prediction is that all the three choice options in our experiment are characterized by the same potential outcomes which implies that only outcomes' likelihoods matter for decision making. Second, we need an additional assumption for Regret theory to be able to explain our data, namely

[13]Regret theory does not explicitly model decision making when probabilities are unknown: here we assume that subjects hold a unique prior belief on the ambiguous event.

that regret and rejoice are not equally strong feelings. In the appendix we formally show that if both the first assumption (only active choices generate anticipated feelings) and the second assumption (regret and rejoice are not equally strong feelings) hold then Regret theory may explain repeated choice of the chance device. In particular, the chance device would be chosen more often the stronger the difference between regret and rejoice feelings. In the appendix we also show that under these assumptions, Regret theory would predict that the chance device is repeatedly selected when the choice problem involves comparing a risky prospect to a safe payment, like in the experiment described in the previous paragraph. However, Figure 4 shows that indecisive choice are hardly observed when subjects face choices between risky prospects and safe options. We conclude that Regret theory can only explain repeated choice of the chance device when ad hoc assumptions are made and, more importantly, only if we restrict our attention to choices between ambiguous and risky prospects.

Result 2. *Several normative and descriptive models of decision making under uncertainty fail to account for repeated choice of the chance device.*

3.1 Are preferences of indecisive subjects incomplete?

Our results show that more than half of the subjects appear to be indecisive between risky and ambiguous prospects in at least three choice situations. Repeated choice of the chance device is inconsistent with the predictions of many decision making models: we have shown that neither normative models of decision making nor descriptive ones can account for it. In general, our results suggests that people may not always hold preferences for one source of uncertainty over another, even when they compare a familiar source, the risky prospect, with a less familiar one, the ambiguous prospect. This suggests that subjects repeatedly choosing the chance device may have incomplete preferences over uncertain prospects. Here we focus on models that allow preferences between two options to be incomplete when the DM holds multiple priors about an uncertain event, her utility function being well defined (Bewley, 2002 and Gilboa et al., 2010).

Consider Gilboa et al. (2010) decision making model. The authors introduce a preference relation that satisfies some basic conditions[14], plus Independence and C-Completeness. The latter condition verifies that preferences between risky acts are complete; incompleteness may

[14]The basic conditions of the preference relation are reflexivity, transitivity, monotonicity, Archimedean continuity and non triviality.

only arise when the DM has multiple prior beliefs about an ambiguous act. The authors then prove (Theorem 1) that such a preference relation is equivalent to the following:

$$x \succeq y \;\Leftrightarrow\; E_p(x) \geqslant E_p(y) \;\; \forall p \in C \tag{1}$$

That is, an act x is weakly preferred over an act y if and only if the expected utility of act x is at least as large as the expected utility of act y for each and every prior belief p belonging to the closed and convex set of priors C. An act is strictly preferred to the other if it is in expectation always as good as the other and larger than the other according to at least one prior belief. Indifference holds when both acts are in expectation equal according to each and every prior belief. Conversely, a preference relation is incomplete whenever according to some beliefs x yields a higher expected utility than y and according to other beliefs y yields a higher utility than x.

In our experiment, the acts x and y represent the choice to bet on the risky and ambiguous urn respectively. Thus, $E_p(y)$ is the expected utility of y relative to a certain prior p. Consider, for instance, that one believes that the probability of drawing a winning ball from the ambiguous urn can take any value between 0.3 and 0.65, inclusive. In the choice situation where the winning probability of the risky prospect is 0.3 the ambiguous prospect is in expectation at least as good as the risky one. Thus, the preference relation between prospects is complete, the ambiguous prospect being strictly preferred to the risky one. Consider now the consecutive choice situation which entails a risky prospect with a winning probability of 0.35. In this case, the ambiguous prospect is at least as good as the risky prospect according to all prior beliefs but one, for which the expected utility of the ambiguous prospect is lower than that of the risky one. It follows that the preference relation is now incomplete. As a matter of fact, preferences may be incomplete in each and every choice situation where the winning probability of the risky urn lies within one's interval of prior beliefs.

The idea that repeated choice of the chance device follows from incomplete preference relations is a hypothesis that needs to be backed by further evidence. A problematic aspect is that subjects *have* to make choices in experiments and hence incomplete preferences are never fully observable. However, psychological and decision making literature suggest that choosing the chance device may be optimal when preferences are incomplete. People like to be able to justify their choices, to themselves and to others (Simonson, 1989). This need may be explained with several motives, like cognitive dissonance (Festinger, 1957) or the anticipation that others will be observing the decisions made (Lerner and Tetlock, 1999). When preferences are incomplete, there is obviously no good reason to choose one prospect or the other: any choice would be difficult to justify. Thus, it seems conceivable that the random device becomes an appealing option.

In the next paragraph we propose an experiment to test whether the choice behavior of indecisive subjects is consistent with an incomplete preference relation.

4 An experiment to test the completeness of preferences

The purpose of our second experiment is to test whether repeated choice of the chance device is consistent with the potentially incomplete preference relation described in Gilboa et al. (2010). To this end, we increase the prize of the ambiguous prospect by a positive amount, while holding everything else the same as in the first experiment. We assume that on average subjects' prior beliefs on the composition of the ambiguous urn do not differ in the two experiments.[15] Hence, for any belief on the ambiguous urn, the ambiguous prospect in experiment 2 has a higher expected value compared to experiment 1. If people choose the chance device when preferences are incomplete, the situations where the chance device is mostly chosen should be different in the two experiments. In particular, in experiment 2 such choice situations should entail risky prospects with higher winning odds compared to those in experiment 1. In what follows the argument is formally developed.

Consider the 21 choice situations in the first part of the experiment. We indicate with p_n the winning probability of the risky prospect in choice situation n where $p_1 = 1$ and $p_{21} = 0$ (choices are recoded as if red were to be the winning color for all subjects). Recall that according to (1) a subject may have incomplete preferences whenever p_n lies strictly within her interval of prior beliefs about the winning probability of the ambiguous urn. A subject's worst prior for the composition of the ambiguous urn is defined as $w = p_l - \varepsilon$ where p_l is the lowest p_n among the situations where the random device is chosen and $0 < \varepsilon < 0.05$. We refer to p_l as the lower bound of the indecisiveness interval. Similarly, $b = p_h + \varepsilon$ is the subject's best prior for the composition of the ambiguous urn, where p_h is the highest p_n among the situations where the random device is chosen. We refer to p_h as the upper bound of the indecisiveness interval. The prospects positive outcome is x_1, while the zero outcome is x_2. Suppose that we want to induce complete preferences for those choice situations characterized by a $p_n \in [p_l; \widetilde{p}]$, with $\widetilde{p} \in [p_l; p_h]$, the latter being the interval where a subject chooses the chance device. To induce complete preferences in the interval $[p_l; \widetilde{p}]$, the prize increase x that

[15]The elicitation of subjects' beliefs confirms that on aggregate the distribution of priors is not significantly different in the two experiments (Kolmogorov Smirnov test $p = 0.74$).

has to be added to the regular prize x_1 has to satisfy:

$$w \times U(x_1 + x) + (1 - w) \times U(x_2) \geq \widetilde{p} \times U(x_1) + (1 - \widetilde{p}) \times U(x_2) \tag{2}$$

That is, the expected utility of the ambiguous prospects according to the subject's worst prior should be at least as large as the expected utility of the risky prospect characterized by a winning probability equal to $\widetilde{p}$.

Given the stakes employed in the experiment, we can make the simplifying assumption that utility is linear, that is $U(x) = x$. Since $x_2 = 0$ it follows that:

$$x \geq \frac{(\widetilde{p} - w)}{w} x_1 \tag{3}$$

In addition, x should be such that choices in favor of the chance device are not completely crowded out when the winning probability of the risky urn is larger than $\widetilde{p}$. To guarantee this x has to satisfy:

$$w \times (x_1 + x) + (1 - w) \times x_2 < (\widetilde{p} + \varepsilon) \times x_1 + (1 - \widetilde{p} - \varepsilon) \times x_2 \tag{4}$$

That is, the expected utility of the ambiguous prospects according to the worst prior, w, should be smaller than the expected utility of the risky prospect characterized by a winning probability slightly larger than $\widetilde{p}$. This reduces to:

$$x < \frac{(\widetilde{p} - w + \varepsilon)}{w} x_1 \tag{5}$$

From (3) and (5) it is easy to see that $x = \frac{(\widetilde{p} - w)}{w} x_1$ satisfies both conditions.

In sum, a subject's preferences shall become complete following an appropriate increase in the prize associated to the ambiguous prospect. Notice that subjects participating in experiment 1 do not take part in experiment 2. Hence, in experiment 2 we set a prize increase x that is equal for all subjects and is based on the choices of participants in experiment 1. Recall that in experiment 1 choices in favor of the chance device are most frequent when $p_n \in [0.35; 0.5]$. Also recall that $x_1 = e15$ and $x_2 = e0$. It follows that in order to increase the number of subjects having complete preferences in choice situations characterized by $p_n \in [0.35; 0.45]$, in experiment 2 we have to increase the $e15$ prize by $x = e5$.

By setting $x = e5$ we can make the following predictions: i) The chance device is chosen less often in experiment 2 compared to experiment 1 in all those choice situations where $0.35 \leq p_n \leq 0.45$. On the other hand, the chance device is chosen more often in experiment 2 than in experiment 1 in the choice situations characterized by $0.50 \leq p_n \leq 0.65$. ii) Subjects in experiment 2 are characterized by higher values of p_l compared to subjects in experiment 1. iii) Subjects in experiment 2 are characterized by higher values of p_h compared to subjects in experiment 1. iv) Overall, the chance device is chosen less often in experiment 2 than in experiment 1 because the prize increase may be sufficiently high to make preferences of some subjects, those with a small interval of priors, always complete.

To summarize, experiment 2 presents subjects with the same series of 21 choice situations as in experiment 1, with the only difference that the prize attached to the ambiguous prospect is now €20. All the other aspects of the experiment are exactly the same as in experiment 1. 53 students from Maastricht University participated in the experiment which was conducted in March 2009. 78% of the subjects were enrolled in the Faculty of Economics and Business Administration and 49% of them were male. The average age was 25 years. The experiment lasted on average 90 minutes and the average earnings per subjects were €28.7.

4.1 Results

The choices of subjects participating in experiment 2 show that results obtained in experiment 1 are robust.[16] First of all, the number of choices in favor of the risky prospect are significantly larger than 50% in all choice situations where $p_n \geq 0.55$ (binomial test p=0.01). Conversely, choices in favor of the ambiguous prospect are significantly larger than 50% in all choice situations where $p_n \leq 0.45$ (binomial test p=0.01). When the winning probability of the risky prospect equals 50% the number of choices in favor of the risky urn is not significantly different than the number of choices in favor of the ambiguous urn (binomial test p=0.19). Thus, we can conclude that subjects in this experiment are moderately averse to ambiguity. Figure 5 shows a histogram of the relative frequency of choices in favor of the chance device in experiment 2. Notice that a large number of subjects repeatedly choose the chance device. Indeed, 44% of the subjects fall in the category of decisive subjects, while the remaining 56% choose the chance device in at least three choice situations. Hence, this experiment confirms that repeated choice of the chance device is a robust anomaly.

We now move on to compare the results of the two experiments. Table 2 shows data on the comparison of subjects' choices in the first part of the experiments.

We find that in experiment 2 starting from the situation where $p_n = 0.45$ choices in favor of the chance device are less frequent compared to experiment 1. On the other hand, the

[16] We exclude from the analysis 5 subjects who switched back and forth between the three options more than 4 times, thus displaying too noisy behavior. We also had to exclude 3 subjects that made highly inconsistent choices in the second part of the experiment.

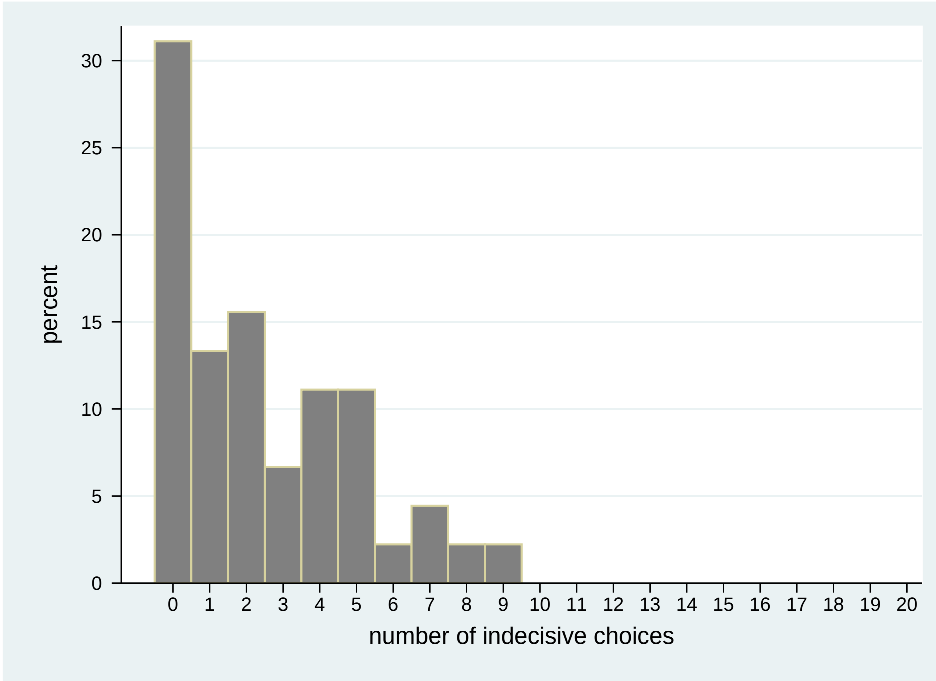


Figure 5: Relative frequency of indecisive choices.

Table 2: Intervals of indecisive choices.

	experiment 1	experiment 2
mean p_l	0.33	0.40
mean p_h	0.60	0.54
indecisive choices per subject	3.7	2.5

relative frequency of choices in favor of the chance device is higher in experiment 2 for those situations characterized by $0.5 \leq p_n < 0.65$. Choices in favor of the chance device are less frequent in experiment 2 when $p_n = 0.65$, a results that may be explained by the fact that fewer indecisive choices are predicted in experiment 2 (see point iv). In sum, the theoretical predictions in i) hold true.

In order to test the validity of theoretical prediction ii) we look at the lower bound of the indecisiveness interval. In experiment 1 $p_l = 0.33$ on average, while in experiment 2 $p_l = 0.40$ on average; a one tailed Mann Whitney test shows that subjects in experiment 2 are characterized by a significantly higher value of p_l (p=0.04).[17] The second theoretical

[17] If we exclude from both experiments those subjects who do not have connected intervals results are qualitatively unchanged but statistically insignificant.

prediction ii) relates to the interval upper bound. In experiment 1 $p_h = 0.6$ on average, while in experiment 2 $p_h = 0.54$ on average; a one tailed Mann Whitney test shows that values of p_h are not significantly different in the two experiments (p=0.46). This result is actually not surprising because, as already mentioned, the prize increase may have been high enough to make preferences of some subjects complete. Indeed, the percentage of subjects who never choose the chance device increases from 24.5% in experiment 1 to 31% in experiment 2. Overall, the chance device is chosen less often in experiment 2 compared to experiment 1, though this difference is not significant (one tailed Mann Whitney test $p = 0.22$).

Result 3. *In experiment 2 choices in favor of the chance device are distributed differently over decision situations compared to experiment 1. The change in the distribution is consistent with the existence of an incomplete preference relation between prospects.*

Experiment 2 confirms that a large fraction of subjects repeatedly choose the chance device instead of selecting one prospect. Furthermore, it shows that choices of these subjects are consistent with the existence of an incomplete preference relation due to uncertainty. In the next section we investigate whether indecisiveness is related to individual characteristics of the decision maker.

5 Individual characteristics

Table 3 shows descriptive statistics on the relation between individual characteristics and indecisiveness for both experiments. First of all note that the level of experience with laboratory experiments, measured as the mean number of attended experiments, is not significantly different for indecisive subjects and decisive ones. The two groups are also not significantly different in terms of their performance in the CRT, measured as the number of correct answers. The parameters' values of the utility and probability weighting function are also not significantly different between indecisive subjects and decisive ones. These results are particularly interesting when compared to recent findings on the relation between cognitive abilities and risk attitude (Frederick, 2005 and Dohmen et al., 2010). Compared to subjects with low cognitive abilities, subjects with high cognitive abilities have been found to be less risk averse for small stakes. Our data show that neither risk attitude nor cognitive ability are systematically related to indecisiveness in choice under uncertainty. One can speculate that smart subjects may appear more rational in experiments on decision making under risk because being rational in those experiments requires the ability to deal with numbers. On the contrary, in most real life situations and in our experiment as well, probabilistic information is not available. In such situations, cognitive ability may not always help to make decisions consistent with the axioms of rational choice.

Table 3: Individual characteristics, standard deviations in parenthesis.

	experiment 1		experiment 2	
	decisive	indecisive	decisive	indecisive
mean of attended experiments	2.5(1.86)	2.5 (1.94)	2.5 (1.76)	2.4 (1.89)
median α	0.84 (0.19)	0.90(0.20)	0.61 (0.14)	0.70 (0.14)
median γ	0.62 (0.18)	0.62 (0.29)	0.60 (0.11)	0.59 (0.12)
mean CRT score	1.61 (1.12)	1.60 (0.93)	1.80 (1.1)	1.60 (1.12)
mean NFC	3.92 (0.62)	3.71(0.62)	3.74 (0.58)	3.72(0.64)
mean FI	3.3 (0.70)	3.56 (0.57)	3.44 (0.41)	3.53 (0.49)
gender (% of male subjects)	78	43	65	36

Recall that the Rational-Experiential Inventory consists of two scales: the Need for Cognition scale (NFC) and the Faith in Intuition scale (FI) which measure respectively analytical and intuitive processing. After dropping the items that load less than 0.3 on the respective factor, both scales are constituted of 11 items and are highly reliable (Cronbach's $\alpha = 0.82$ for NFC, and $\alpha = 0.79$ for FI). Furthermore, NFC and FI are not significantly related to each other (correlation coefficient $r = -0.13$), which means that analytical and intuitive processing are two independent constructs. Hence, for each subject we can compute the NFC and the FI score as the mean of the answers to the 11 items (recall that answers are on a 5 points scale). Given that repeated choice of the chance device violates rational choice, we expect subjects who are prone to it to be more inclined to think in an intuitive manner, rather than in a rational-analytical one. Indeed, indecisive subjects score slightly lower on the NFC scale and higher on the FI scale as compared to decisive subjects, but these differences are not statistically significant. In both experiments we observe that the group of decisive subjects is mainly composed by male subjects. Indeed, gender appears to be the only variable which significantly affects the probability of being indecisive, as shown by the results in Table 4.

The probability of being a indecisive is regressed on subject's individual characteristics. Since subjects in the two experiments are not significantly different, we pool data from the two experiments.[18] Note that only being a male subject significantly and negatively affects the

[18] In fact, subjects in experiment 2 are characterized by a lower value of α. Nevertheless, aggregation is warranted because the coefficient of the variable interacting a dummy for the experiment with α is not

Table 4: Explaining indecisiveness, logit regression results.

Variable	**Coefficient** (Std. Err.)
attended experiments	0.002
	(0.122)
CRT score	0.003
	(0.220)
NFC score	-0.360
	(0.390)
FI score	0.290
	(0.421)
alpha	1.509
	(1.185)
gamma	2.121
	(1.524)
male	-1.589**
	(0.523)
Intercept	-0.975
	(2.548)
N	98
Log-likelihood	-59.153
$\chi^2_{(7)}$	16.078

probability of being indecisive. Though not significantly, a higher need for cognition negatively affects the probability of being indecisive, whereas a higher faith in intuition increases the probability of choosing the chance device. Conversely, a higher value of γ, of α and a higher score in the CRT positively, but not significantly, affect the probability of being indecisive.

6 Conclusions

In this paper we experimentally study the behavior of subjects facing a series of choices between a risky and an ambiguous two-outcomes prospect. The possible outcomes and the level of ambiguity are the same in each choice situation, while risky prospects are characterized by different combinations of probability-outcomes. Our data show that half of the subjects in the experiment often choose a chance device to select between two prospects instead of actively picking one. The observed choice behavior is not consistent with the existence of a preference relation of true indifference, but rather indicates that subjects are indecisive when facing choices under uncertainty. Furthermore, the fact that subjects repeatedly choose the chance device constitutes a so far unexplored behavioral anomaly in decision making under uncertainty. Indeed, we have shown that both normative and descriptive models of decision making under uncertainty cannot account for it.

In our experiment, a DM with multiple prior beliefs on the ambiguous event is necessarily confronted with choice situations where her preferences may be incomplete. The larger the interval of prior beliefs, the more the choice situations where a DM may not have complete preferences. The observed behavioral anomaly seems consistent with the idea that a DM with incomplete preferences chooses the fair chance device. We use results from our first experiment to make choice predictions based on the incomplete preferences relation in Gilboa et al. (2010). Such predictions are then tested in a successive experiment: data are consistent with the hypothesis that avoidance of active decision making may follow from incomplete preference relations.

Other anomalies, such as preference reversals (Eliaz and Ok, 2006) and the status quo bias (Mandler, 2004), have already been accounted by arguments based on incompleteness. Our results confirm that relaxing completeness may be a promising avenue in the development of descriptively valid decision making models. The results of our investigation offer as well interesting behavioral insights on choice behavior under uncertainty. The observed anomaly is in contrast with uncertainty aversion, which constitutes a well established empirical regularity.

significant.

We suggest that uncertainty aversion may emerge in decision situations where people are "forced" to pick one of the available alternatives. On the other hand, when given a way out to the choice dilemma (the chance device in our case) many people do not actively select the more familiar risky prospects. Notably, in our experiment the chance device is neither a default option nor the status quo. Subjects explicitly choose a mechanism that decides instead of themselves.

In real life decision making is often performed under uncertainty. Financial investments, medical treatments and career choices for instance, are often chosen with a limited knowledge about the associated likelihood of success and failure. Our results suggest that in such decision situations many people may prefer not to choose by themselves when given the possibility to do so. Clearly, this behavior can have important economic consequences if not choosing comes at a cost for the decision maker: we believe that future research should be aimed at investigating this aspect.

References

[1] Abdellaoui, M. (2000). Parameter-Free Elicitation of Utility and Probability Weighting Functions. *Management Science*, 46(11): 1497-1512.

[2] Aumann, R. (1962). Utility theory without the completeness axiom. *Econometrica*, 30: 445-462.

[3] Bell, D. (1982). Regret in Decision Making under Uncertainty. *Operations Research*, 30(5): 961-981.

[4] Bewley, T. F. (2002). Knightian decision theory. Part I. *Decisions in Economic and Finance*, 25: 79-110.

[5] Camerer, C., Weber, M. (1992). Recent Developments in Modeling Preferences: Uncertainty and Ambiguity. *Journal of Risk and Uncertainty*, 5: 325-370.

[6] Cohen, M., Jaffray, J. Y., Said, T. (1987). Experimental Comparison of Individual Behavior under Risk and under Uncertainty for Gains and for Losses. *Organizational Behavior and Human Decision Processes*, 39: 1-22.

[7] Dohmen, T., Falk, A., Huffman, D., Sunde, U. (2007). Are Risk Aversion and Impatience Related to Cognitive Ability?*American Economic Review*, forthcoming.

[8] Eliaz, K., Ok, E. (2006). Indifference or indecisiveness? Choice theoretic foundations of incomplete preferences. *Games and Economic Behavior*, 56: 6186.

[9] Ellsberg, D. (1961). Risk, Ambiguity, and the Savage Axiom. *The Quarterly Journal of Economics*, 75(4): 643-669.

[10] Epstein, S., Pacini, R., Denes-Raj, V., Heier, H. (1996). Individual Differences in Intuitive-Experiential and Analytical-Rational Thinking Styles. *Journal of Personality and Social Psychology*, 71(2): 390-405.

[11] Fehr-Duda, H., Di Gennaro, M., Schubert, R. (2006). Gender, Financial Risk, and Probability Weights. *Theory and Decision*, 60: 283-313.

[12] Festinger, L. (1957). A Theory of Cognitive Dissonance, Evanston, IL: Row Peterson.

[13] Fischbacher, U. (2007). Z-Tree: Zurich Toolbox for Ready-made Economic experiments. *Experimental Economics*, 10(2): 171-178.

[14] Fox, C. R., Tversky, A. (1995). Ambiguity Aversion and Comparative Ignorance. *The Quarterly Journal of Economics*, 110(3): 585-603.

[15] Fox, C., Weber, M. (2002), Ambiguity Aversion, Comparative Ignorance, and Decision Context. *Organizational Behavior and Human Decision Processes*, 88: 476-498.

[16] Frederick, S. (2005). Cognitive Reflection and Decision Making. *Journal of Economic Perspectives*, 19(4): 25-42.

[17] Ghirardato, P., Maccheroni. F., Marinacci, M. (2004). Differentiating ambiguity and ambiguity attitude. *Journal of Economic Theory*, 118: 133-173.

[18] Gilboa, I., Maccheroni, F., Marinacci, M., Schmeidler, D. (2010). Objective and Subjective Rationality in a Multiple Prior Model. *Econometrica*, 78(2): 755-770.

[19] Gilboa, I., Schmeidler, D. (1989). Maxmin Expected Utility With Non Unique Prior. *Journal of Mathematical Economics*, 18: 141-153.

[20] Harrison, G. W., Rustrom, E., (2008). Risk Aversion in Experiments. *Research in Experimental Economics*, Volume 12. J.C. Cox and G.W. Harrison (eds.).

[21] Holt, C., Laury, S. (2002). Risk Aversion and Incentive Effects. *American Economic Review*, 92(5): 1644-1655.

[22] Lerner, J., Tetlock, P. E. (1999). Accounting for the Effects of Accountability. *Psychological Bulletin*, 125(2): 255-275.

[23] Loomes, G., Sugden, R. (1982). Regret Theory: An Alternative Theory of Rational Choice Under Uncertainty. *The Economic Journal*, 92: 805-824.

[24] Mandler, M. (2004). Status quo maintenance reconsidered: changing or incomplete preferences. *Economic Journal*, 114: 518-535.

[25] Ok, E. A. (2002). Utility representation of an incomplete preference relation. *Journal of Economic Theory*, 104: 429-449.

[26] Savage, L. (1954). The Foundations of Statistics. New York: Wiley.

[27] Simonson, I. (1989). Choice Based on Reasons: The case of Attraction and Compromise Effects. *Journal of Consumer Research*, 16: 158-174.

[28] Starmer, C., Sugden, R. (1991). Does the Random-Lottery Incentive System Elicit True Preferences? An Experimental Investigation. *The American Economic Review*, 81(4): 971-978.

[29] Tversky, A., Kahneman, D. (1979). Prospect Theory: An Analysis of Decision under Risk. *Econometrica*, 47(2): 263-292.

[30] Tversky, A., Kahneman, D. (1992). Advances in Prospect Theory: Cumulative Representation of Uncertainty. *Journal of Risk and Uncertainty*, 5: 297-323.

[31] Tversky, A., Wakker, P. (1995). Risk Attitudes and Decision Weights. *Econometrica*, 63: 1255-1280.

[32] Wakker, P. (2009). Prospect Theory for Risk and Ambiguity. Cambridge University Press, Cambridge, UK; forthcoming.

Appendix

A Models of decision making under risk and uncertainty that cannot explain observed behavior

In the following we consider the discussed models of decision making under uncertainty and prove that they cannot account for the repeated avoidance of active choice.

A.1 α-maxmin Expected Utility Theory

Consider $\alpha-$ maxmin Expected Utility Theory. The decision maker holds a set of prior $C = [\underline{c}, \overline{c}] \subseteq [0, 1]$ on the ambiguous event and is characterized by an index α which captures attitude to ambiguity. The index varies from 0 to 1 and can be viewed as the weight that the decision maker places on the most pessimistic scenario, given his set of prior C. The utility function $U(\cdot)$ is the same assumed in expected utility theory. In our experiment, subjects would evaluate ambiguous prospects as follows:

$$\alpha \min_{q \in [\underline{c}, \overline{c}]} [qU(x_1) + (1 - q)U(x_2)] + (1 - \alpha) \max_{q \in [\underline{c}, \overline{c}]} [qU(x_1) + (1 - q)U(x_2)]$$

Where q is the (unknown) winning probability of the ambiguous prospect, x_1 is the monetary prize equal to €15 and x_2 is the €0 outcome. Since the subject's worst prior is $\underline{c}$ and his best prior is $\overline{c}$ and $U(x_2)$ can be normalized to 0, the above function can be written as:

$$\alpha \underline{c} U(x_1) + (1 - \alpha) \overline{c} U(x_1)$$

If the decision maker chooses to delegate his decision in a given situation n, the lottery that assigns equal probability to the risky and to the ambiguous prospect is at least as good as the risky prospect characterized by a winning probability p_n:

$$\frac{1}{2} [\alpha \underline{c} U(x_1) + (1 - \alpha) \overline{c} U(x_1)] + \frac{1}{2} p_n U(x_1) \geq p_n U(x_1)$$

In addition he deems the lottery to be at least as good as the ambiguous prospect:

$$\frac{1}{2} [\alpha \underline{c} U(x_1) + (1 - \alpha) \overline{c} U(x_1)] + \frac{1}{2} p_n U(x_1) \geq \alpha \underline{c} U(x_1) + (1 - \alpha) \overline{c} U(x_1)$$

The above expressions can be rewritten as:

$$\frac{1}{2} [\alpha \underline{c} U(x_1) + (1 - \alpha) \overline{c} U(x_1)] \geq \frac{1}{2} p_n U(x_1)$$

$$\frac{1}{2} [\alpha \underline{c} U(x_1) + (1 - \alpha) \overline{c} U(x_1)] \leq \frac{1}{2} p_n U(x_1)$$

It follows that:

$$p_n = \alpha \underline{c} + (1 - \alpha) \overline{c}$$

Which means that α-maxmin Expected Utility theory can account for indecisiveness only if $\underline{c}$, $\overline{c}$ and α change in each decision situation.

A.2 Cumulative Prospect Theory

In order to apply CPT to choices in the table we need to recall that decision makers are assumed go through an initial editing phase. In this phase, complex choice problems are simplified by means of various routines (Starmer and Sugden, 1991). One of these routines is related to compound lotteries and leads to the so called isolation effect. If an individual is asked to make a choice between two lotteries, each of which is contingent on the occurrence of the same random event, then the choice is made as if that event is certain to occur. Assume that subjects employ this routine when evaluating prospects. When an indecisive choice is made the following equality holds:

$$w^+(p_n)v(x_1) + (1 - w^+(p_n))v(x_2) = W^+(A)v(x_1) + (1 - W^+(A))v(x_2)$$

where $v(\cdot)$ indicates the value function, x_1 is the monetary prize equal to €15 and x_2 is the €0 outcome. The letter A indicates the event "drawing a winning ball from the ambiguous urn" and p_n is the winning probability of the risky prospect in choice situation n. w^+ and W^+ are the weighting functions for risk and for uncertainty respectively. Since $v(x_2)$ can be normalized to 0, from the equality above it follows that:

$$W^+(A) = w^+(p_n)$$

That is event A has the same decision weight as probability p_n. Assume now that the decision maker delegates his decision between the prospects in the successive choice situation of the table. It follows that the weight of p_{n+1} equals the weight given to event A. Since $W^+(A)$ should not change during the elicitation, the equality above implies that $w^+(p_n) = w^+(p_{n+1})$. In general, if choices are delegated in n consecutive decision situations in the table, it follows that:

$$w^+(p_n) = w^+(p_{n+1}) = ..., = w^+(p_N)$$

which means that probabilities are equally wighted in all the decision situation where the decision maker appears to be indecisive.

A.3 Regret Aversion

Consider the 21 decisions between the risky and the ambiguous prospects in the first experiment and assume that red is the winning color. In what follows the possible states of the world are listed, where R_R means that a red ball is extracted from the risky urn, R_A means that a red ball is extracted from the ambiguous urn, etc. L_R means that the risky lottery matters for the payment of indecisive subjects, while L_A means that the ambiguous lottery matters for the indecisive subjects.

$$R_R, \overset{S_1}{L_R}, R_A \quad R_R, \overset{S_2}{L_A}, R_A \quad B_R, \overset{S_3}{L_R}, R_A \quad B_R, \overset{S_4}{L_A}, R_A$$

$$B_R, \overset{S_5}{L_R}, B_A \quad B_R, \overset{S_6}{L_A}, B_A \quad R_R, \overset{S_7}{L_R}, B_A \quad R_R, \overset{S_8}{L_A}, B_A$$

We define: $p(S_n)$: probability of state of the world n

p_n: winning probability risky urn in decision situation n

q: winning probability ambiguous urn

x_1: high prize, 15 Euro in the experiment

x_2: low prize, 0 Euro in the experiment

$R(\cdot)$: regret-rejoice function

Assume that in a given decision situation regret and rejoice can only be experienced when an active choice between the risky and the ambiguous prospect is made: choosing the chance device does not generate such feelings. Following Looms and Sugden (1982) the expected utility of the risky prospect is larger equal than the expected utility of the chance device, that is $EU(risky) \geq EU(device)$, if:

$$\begin{aligned}
p(S_1)[x_1 - x_1 + R(x_1 - x_1)] + p(S_2)[x_1 - x_1 + R(x_1 - x_1)] + p(S_3)[x_2 - x_2 + R(x_2 - x_2)] + \\
p(S_4)[x_2 - x_1 + R(x_2 - x_1)] + p(S_5)[x_2 - x_2 + R(x_2 - x_2)] + p(S_6)[x_2 - x_2 + R(x_2 - x_2)] + \\
p(S_7)[x_1 - x_1 + R(x_1 - x_1)] + p(S_8)[x_1 - x_2 + R(x_1 - x_2)] \geq 0 \\
\Leftrightarrow \\
p(S_4)[x_2 - x_1 + R(x_2 - x_1)] + p(S_8)[x_1 - x_2 + R(x_1 - x_2)] \geq 0 \\
\Leftrightarrow \\
(1 - p_n)\frac{1}{2}q[x_2 - x_1 + R(x_2 - x_1)] + p_n\frac{1}{2}(1 - q)[x_1 - x_2 + R(x_1 - x_2)] \geq 0 \\
\Leftrightarrow \\
(1 - p_n)\frac{1}{2}q[-x_1 + R(-x_1)] + p_n\frac{1}{2}(1 - q)[x_1 + R(x_1)] \geq 0 \\
\Leftrightarrow \\
q[-x_1 + R(-x_1)] - p_n q[-x_1 + R(-x_1)] + p_n[x_1 + R(x_1)] - p_n q[x_1 + R(x_1)] \geq 0 \\
\Leftrightarrow \\
q[-x_1 + R(-x_1) - p_n R(-x_1) - p_n R(x_1)] \geq -p_n x_1 - p_n R(x_1) \\
\Leftrightarrow \\
q[x_1 - R(-x_1) + p_n R(-x_1) + p_n R(x_1)] \leq p_n(x_1 + R(x_1)) \\
\Leftrightarrow
\end{aligned}$$

$$q \leq \frac{p_n(x_1 + R(x_1))}{x_1 - R(-x_1) + p_n R(-x_1) + p_n R(x_1)} \qquad (6)$$

Further, the expected utility of the ambiguous prospect is larger equal than the expected utility of the chance device, that is $EU(ambiguous) \geq EU(device)$, if:

$$\begin{aligned}
p(S_1)[x_1 - x_1 + R(x_1 - x_1)] + p(S_2)[x_1 - x_1 + R(x_1 - x_1)] + p(S_3)[x_1 - x_2 + R(x_1 - x_2)] + \\
p(S_4)[x_1 - x_1 + R(x_1 - x_1)] + p(S_5)[x_2 - x_2 + R(x_2 - x_2)] + p(S_6)[x_2 - x_2 + R(x_2 - x_2)] + \\
p(S_7)[x_2 - x_1 + R(x_2 - x_1)] + p(S_8)[x_2 - x_2 + R(x_2 - x_2)] \geq 0 \\
\Leftrightarrow \\
p(S_3)[x_1 - x_2 + R(x_1 - x_2)] + p(S_7)[x_2 - x + R(x_2 - x_1)] \geq 0 \\
\Leftrightarrow \\
(1 - p_n)\frac{1}{2}q[x_1 - x_2 + R(x_1 - x_2)] + p_n\frac{1}{2}(1 - q)[x_2 - x + R(x_2 - x_1)] \geq 0 \\
\Leftrightarrow \\
(1 - p_n)\frac{1}{2}q[x_1 + R(x_1)] + p_n\frac{1}{2}(1 - q)[-x_1 + R(-x_1)] \geq 0 \\
\Leftrightarrow \\
q[x_1 + R(x_1)] - p_n q[x_1 + R(x_1)] + p_n[-x_1 + R(-x_1)] - p_n q[-x_1 + R(-x_1)] \geq 0 \\
\Leftrightarrow \\
q[x_1 + R(x_1) - p_n R(x_1) - p_n R(-x_1)] \geq p_n x_1 - p_n R(-x_1) \\
\Leftrightarrow \\
q[x_1 + R(x_1) - p_n R(x_1) - p_n R(-x_1)] \geq p_n(x_1 - R(-x_1)) \\
\Leftrightarrow
\end{aligned}$$

$$q \geq \frac{p_n(x_1 - R(-x_1))}{x_1 + R(x_1) - p_n R(x_1) - p_n R(-x_1)} \tag{7}$$

If we assume that regret and rejoice are symmetric, that is $R(-x) = -R(x)$, conditions (6) and (7) imply that the chance device is chosen if $q \geq p_n$ and $q \leq p_n$. That is, the chance device is chosen only in the decision situation where $p_n = q$.

If we assume instead that regret and rejoice are not equally strong feelings, for example $|R(-x)| > R(x)$, conditions (6) and (7) imply that thick indecisiveness intervals can be justified by appropriate assumptions on the values of $R(-x)$ and $R(x)$. In particular, the stronger the difference between regret and rejoice feelings the larger the interval of indecisive choices.

We now consider our second experiment and test whether the observed shift in the indecisiveness interval is consistent with the existence of asymmetric regret and rejoice feelings.
We define:

$p(S_n)$: probability of state of the world n

p_n: winning probability risky urn in decision situation n

q: winning probability ambiguous urn

x_1: high outcome risky prospect, 15 Euro in the experiment

x_2: low outcome, 0 Euro in the experiment

z: high outcome ambiguous prospect, 20 Euro in the experimentIn this experiment the expected utility of the risky prospect is larger equal than the expected utility of the chance device, that is $EU(risky) \geq EU(device)$, if:

$$\begin{aligned}
p(S_1)[x_1 - x_1 + R(x_1 - x_1)] + p(S_2)[x_1 - z + R(x_1 - z)] + p(S_3)[x_2 - x_2 + R(x_2 - x_2)] + \\
p(S_4)[x_2 - z + R(x_2 - z)] + p(S_5)[x_2 - x_2 + R(x_2 - x_2)] + p(S_6)[x_2 - x_2 + R(x_2 - x_2)] + \\
p(S_7)[x_1 - x_1 + R(x_1 - x_1)] + p(S_8)[x_1 - x_2 + R(x_1 - x_2)] \geq 0 \\
\Leftrightarrow \\
p(S_2)[x_1 - z + R(x_1 - z)] + p(S_4)[x_2 - z + R(x_2 - z)] + p(S_8)[x_1 - x_2 + R(x_1 - x_2)] \geq 0 \\
\Leftrightarrow \\
p_n \frac{1}{2} q[x_1 - z + R(x_1 - z)] + (1 - p_n) \frac{1}{2} q[x_2 - z + R(x_2 - z)] + \\
p_n \frac{1}{2} (1 - q)[x_1 - x_2 + R(x_1 - x_2)] \geq 0 \\
\Leftrightarrow \\
p_n \frac{1}{2} q[x_1 - z + R(x_1 - z)] + (1 - p_n) \frac{1}{2} q[-z + R(-z)] + p_n \frac{1}{2} (1 - q)[x_1 + R(x_1)] \geq 0 \\
\Leftrightarrow \\
p_n q[x_1 - z + R(x_1 - z)] + q[-z + R(-z)] - p_n q[-z + R(-z)] + p_n[x_1 + R(x_1)] \\
-p_n q[x_1 + R(x_1)] \geq 0 \\
\Leftrightarrow \\
q p_n[x_1 - z + R(x_1 - z)] - z + R(-z) - p_n[-z + R(-z)] - p_n[x_1 + R(x_1)] \geq -p_n[x_1 + R(x_1)] \\
\Leftrightarrow
\end{aligned}$$

$$q \leq \frac{p_n(x_1 + R(x_1))}{p_n R(x_1 - z) - z + R(-z)(1 - p_n) - p_n R(x_1)} \quad (8)$$

The expected utility of the ambiguous prospect is larger equal than the expected utility of the chance device, $EU(ambiguous) \geq EU(device)$, if:

$$
\begin{aligned}
p(S_1)[z - x_1 + R(z - x_1)] + p(S_2)[z - z + R(z - z)] + p(S_3)[z - x_2 + R(z - x_2)] + \\
p(S_4)[z - z + R(z - z)] + p(S_5)[x_2 - x_2 + R(x_2 - x_2)] + p(S_6)[x_2 - x_2 + R(x_2 - x_2)] + \\
p(S_7)[x_2 - x_1 + R(x_2 - x_1)] + p(S_8)[x_2 - x_2 + R(x_2 - x_2)] \geq 0 \\
\Leftrightarrow \\
p(S_1)[z - x_1 + R(z - x_1)] + p(S_3)[z - x_2 + R(z - x_2)] + p(S_7)[x_2 - x_1 + R(y - x_1)] \geq 0 \\
\Leftrightarrow \\
p_n \frac{1}{2} q[z - x_1 + R(z - x_1)] + (1 - p_n)\frac{1}{2} q[z + R(z)] + p_n \frac{1}{2}(1 - q)[-x_1 + R(-x_1)] \geq 0 \\
\Leftrightarrow \\
p_n q[z - x_1 + R(z - x_1)] + q[z + R(z)] - p_n q[z + R(z)] + p_n[-x_1 + R(-x_1)] \\
-p_n q[-x_1 + R(-x_1)] \geq 0 \\
\Leftrightarrow \\
q p_n[z - x_1 + R(z - x_1)] + [z + R(z)] - p_n[z + R(z)] - p_n[-x_1 + R(-x_1)] \\
\geq -p_n[-x_1 + R(-x_1)] \\
\Leftrightarrow
\end{aligned}
$$

$$
q \geq \frac{p_n(x_1 - R(x_1))}{p_n R(z - x_1) + z + R(z)(1 - p_n) - p_n R(-x_1)} \tag{9}
$$

Conditions (8) and (9) imply that in a certain decision situation the chance device is the utility maximizing choice if the DM believes that q takes a value in the interval of priors identified by the conditions. In fact, for an arbitrary value of q the chance device is the optimal choice when the risky prospect is characterized by a higher winning likelihood as compared to the one which justifies choosing the chance device in the first experiment. Hence, indecisiveness in our experiments can be explained assuming that regret and rejoice are not equally strong feelings that are only experienced when making an active choice.

The validity of an explanation based on anticipated feelings can be further tested by considering choice in the experiment described at page 11.

Subjects made 21 decisions between varying risky lotteries and a fixed sure payment: the possible states of the world are listed below, where R_R (B_R) means that a red (black) ball is extracted from the risky urn. The letter R indicate that the risky prospect is relevant, while the letter S indicates that the sure payment is relevant, for the payment of indecisive subjects. As before, we assume that red is the winning color. Since the high prize of the risky prospect is 15 Euro and the low prize is 0 Euro, we use the letters x_1 and x_2 as before. The sure payment always equals 7.5 Euro and we indicate it with $\frac{x_1}{2}$.

$\overset{S_1}{R_R}, R \quad \overset{S_2}{R_R}, S \quad \overset{S_3}{B_R}, R \quad \overset{S_4}{B_R}, S$

The expected utility of the risky prospect is larger equal the expected utility of chance device, that is $EU(risky) \geq EU(device)$, if:

$$
\begin{aligned}
p(S_1)[x_1 - x_1 + R(x_1 - x_1)] + p(S_2)[x_1 - \frac{x_1}{2} + R(x_1 - \frac{x_1}{2})] \\
+p(S_3)[x_2 - x_2 + R(x_2 - x_2)] + p(S_4)[x_2 - \frac{x_1}{2} + R(x_2 - \frac{x_1}{2})] \geq 0 \\
\Leftrightarrow \\
p_n \frac{1}{2}[x_1 - \frac{x_1}{2} + R(x_1 - \frac{x_1}{2})] + (1 - p_n)\frac{1}{2}[-\frac{x_1}{2} + R(-\frac{x_1}{2})] \geq 0 \\
\Leftrightarrow \\
p_n[\frac{x_1}{2} + R(\frac{x_1}{2}) + \frac{x_1}{2} - R(-\frac{x_1}{2})] \geq \frac{x_1}{2} - R(-\frac{x_1}{2}) \\
\Leftrightarrow \\
p_n[x_1 + R(\frac{x_1}{2}) - R(-\frac{x_1}{2})] \geq \frac{x_1}{2} - R(-\frac{x_1}{2}) \\
\Leftrightarrow
\end{aligned}
$$

$$p_n \geq \frac{\frac{x_1}{2} - R(-\frac{x_1}{2})}{x_1 + R(\frac{x_1}{2}) - R(-\frac{x_1}{2})} \tag{10}$$

The expected utility of the safe payment is larger equal the expected utility of the chance device, that is $EU(safe) \geq EU(device)$, if:

$$p(S_1)[\frac{x_1}{2} - x_1 + R(\frac{x_1}{2} - x_1)] + p(S_2)[\frac{x_1}{2} - \frac{x_1}{2} + R(\frac{x_1}{2} - \frac{x_1}{2})]$$
$$+p(S_3)[\frac{x_1}{2} - x_2 + R(\frac{x_1}{2} - x_2)] + p(S_4)[\frac{x_1}{2} - \frac{x_1}{2} + R(\frac{x_1}{2} - \frac{x_1}{2})] \geq 0$$
$$\Leftrightarrow$$
$$p_n\frac{1}{2}[\frac{x_1}{2} - x_1 + R(\frac{x_1}{2} - x_1)] + (1-p_n)\frac{1}{2}[\frac{x_1}{2} + R(\frac{x_1}{2})] \geq 0$$
$$\Leftrightarrow$$
$$p_n[\frac{x_1}{2} - x_1 + R(\frac{x_1}{2} - x_1) - \frac{x_1}{2} - R(\frac{x_1}{2})] \geq -[\frac{x_1}{2} + R(\frac{x_1}{2})]$$
$$\Leftrightarrow$$
$$p_n[-\frac{x_1}{2} + R(-\frac{x_1}{2}) - \frac{x_1}{2} - R(\frac{x_1}{2})] \geq -[\frac{x_1}{2} + R(\frac{x_1}{2})]$$
$$\Leftrightarrow$$
$$p_n[-x_1 + R(-\frac{x_1}{2}) - R(\frac{x_1}{2})] \geq -[\frac{x_1}{2} + R(\frac{x_1}{2})]$$
$$\Leftrightarrow$$
$$p_n[x_1 - R(-\frac{x_1}{2}) + R(\frac{x_1}{2})] \leq \frac{x_1}{2} + R(\frac{x_1}{2})$$
$$\Leftrightarrow$$

$$p_n \leq \frac{\frac{x_1}{2} + R(\frac{x_1}{2})}{x_1 - R(-\frac{x_1}{2}) + R(\frac{x_1}{2})} \tag{11}$$

Condition (10) and (11) imply that we should observe large intervals of indecisive choices in this experiment. However, as this is not the case, we can at reject the hypothesis that indecisiveness is motivated by anticipated regret for active choices.

B Instructions of the experiment

We report here the original instructions used in the first experiment and in brackets the parts changing in the experiment investigating delegation in risky choices. The instructions used in the second experiment are similar and available upon request. Notice that the instructions were computerized.

Part 1

Shortly you are going to face 21 choice situations (situations 1-21). These choice situations will involve two urns (i.e. boxes). These urns really exist and they will play an important role in determining your earnings. You might have seen them on the table when you entered the lab. At the end of the experiment you will have the possibility to personally check their content.

In one urn there are 100 balls colored black and red. The exact number of black and red balls contained in this urn is always displayed in the decision table that you will see shortly. For convenience we call this urn **Urn A**. The other urn, that we call **Urn B**, contains 100 balls as well. However, the **exact number of black and red balls in this urn is unknown** to you. In fact, the composition of Urn B is also unknown to us because it was composed by a colleague of us and sealed thereafter, while we were absent. Our colleague was free to put any number of red and/or black balls into this urn provided the total number of balls is 100.

In each choice situation you will be asked to bet on a draw of a ball of a certain color by selecting one of the two different types of urns. You are first given the possibility to select the color (black or red) that you like to bet on. The color you select will neither be to your advantage nor to your disadvantage. Also note that you will choose the color once for all choice situations.

[Shortly you are going to face 21 choice situations (situations 1-21). These choice situations will involve one urn (i.e. a box). This urn really exists and it will play an important role in determining your earnings. In the urn there are 100 balls colored black and red. The exact number of black and red balls contained in the urn changes in each choice situation and is always displayed in the decision table that you will see shortly. In each choice situation you will be asked whether you want to bet on a draw of a ball of a certain color from the urn or whether you prefer to receive a certain amount of money. You are first given the possibility to select the color (black or red) that you like to bet on. The color you select will neither be to your advantage nor to your disadvantage. Also note that you will choose the color once for all choice situations.]

This is a **screen shot** of a part of the table you are going to see. Each row of the table represents one choice situation:

In each row you have to decide between **Urn A** and **Urn B** to bet on the color you have selected. You can also state that you are indifferent between the two urns.

Recall that Urn B contains an unknown proportion of 100 black and red balls. Urn A contains 100 balls as well: the proportion of black and red balls is always displayed in the table.

[In each row you have to decide whether you want to bet on the color you have selected or whether you want to receive 7.50 Euro for sure. You can also state that you are indifferent between these two

Remember that the color you have chosen to bet on is Red

CHOICE SITUATION	COMPOSITION OF URN A		COMPOSITION OF URN B
1. I bet on:	☐ 100 red balls	☐ I am indifferent between the two urns	☐ 100 black and red balls in unknown color ratio
2. I bet on:	☐ 95 red balls + 5 black balls	☐ I am indifferent between the two urns	☐ 100 black and red balls in unknown color ratio
3. I bet on:	☐ 90 red balls + 10 black balls	☐ I am indifferent between the two urns	☐ 100 black and red balls in unknown color ratio
4. I bet on:	☐ 85 red balls + 15 black balls	☐ I am indifferent between the two urns	☐ 100 black and red balls in unknown color ratio
5. I bet on:	☐ 80 red balls + 20 black balls	☐ I am indifferent between the two urns	☐ 100 black and red balls in unknown color ratio
6. I bet on:	☐ 75 red balls + 25 black balls	☐ I am indifferent between the two urns	☐ 100 black and red balls in unknown color ratio
7. I bet on:	☐ 70 red balls + 30 black balls	☐ I am indifferent between the two urns	☐ 100 black and red balls in unknown color ratio
8. I bet on:	☐ 65 red balls + 35 black balls	☐ I am indifferent between the two urns	☐ 100 black and red balls in unknown color ratio
9. I bet on:	☐ 60 red balls + 40 black balls	☐ I am indifferent between the two urns	☐ 100 black and red balls in unknown color ratio
10. I bet on:	☐ 55 red balls + 45 black balls	☐ I am indifferent between the two urns	☐ 100 black and red balls in unknown color ratio
11. I bet on:	☐ 50 red balls + 50 black balls	☐ I am indifferent between the two urns	☐ 100 black and red balls in unknown color ratio
12. I bet on:	☐ 45 red balls + 55 black balls	☐ I am indifferent between the two urns	☐ 100 black and red balls in unknown color ratio
[illegible]	[illegible]	[illegible]	[illegible]

options.]

Determination of earnings

At the end of the experiment one of the choice situations in the table is randomly selected with equal probability to determine your earnings. Thereafter, a ball is drawn from the urn you decided to bet on in the choice situation that was randomly selected.

Suppose, for example, that red is your color and that choice situation 7 is randomly selected. Suppose further that you decided to bet on Urn A in that choice situation. At the end of the experiment, a ball is drawn from Urn A, which contains 70 red balls and 30 black balls in choice situation 7. You receive 15 Euro if the ball is red and nothing otherwise.

Similarly, if in choice situation 7 you have decided to bet on Urn B, which contains 100 balls in unknown color composition, a ball is drawn from it. You receive 15 Euro if the ball is red and nothing otherwise. In case you were indifferent between the two urns, one is randomly selected with equal probability to determine your earnings.

[At the end of the experiment one of the choice situations in the table is randomly selected with equal probability to determine your earnings. Depending on which choice situation is selected, the experimenter will put the appropriate number of red and black balls in the urn. For instance, if choice situation 12 is selected for payment, the experimenter will put 55 red balls and 45 black balls in the urn. At the end of the experiment you will have the possibility to personally check the content of the urn.

Suppose, for example, that you selected red and that choice situation 7 is randomly selected at the end of the experiment. Suppose further that you chose to bet on the urn in that choice situation. A ball is then drawn from the urn which contains 70 red balls and 30 black balls in situation 7. You receive 15 Euro if the ball is red and nothing otherwise.

Differently, the ball drawn from the urn does not influence your earnings if in choice situation 7 you decided that you prefer to get 7.50 Euro for sure. In case you were indifferent between betting on the urn and earning 7.50 Euro for sure, one of these two options is randomly selected with equal probability to determine your earnings.]

Estimation of the composition of Urn B

Now that you have made your choices, we would like to ask you for your **best estimate of the color composition of Urn B.**

The categories below are intervals indicating the number of red balls that might be contained in Urn B. Please click on the check box that represents your best estimate. You can also click on more than one box.

Consider the following random examples.

For instance, if you believe that there are between 12 and 34 red balls in Urn B, you should click on the 3rd, 4th, 5th 6th and 7th check box from the left.

For instance, if you believe that there are between 72 and 74 red balls in Urn B than you should click on the 15th check box form the left.

For instance, if you believe that there are exactly 6 red balls in Urn B than you should click on the 2nd check box from the left.

If you believe that there between 17 and 24 red balls or between 63 and 69 red balls in Urn B then you should click on the 4th, 5th, 13th and 14th check box. *Notice that this part was not included in the experiment about delegation under risk.*

Part 2

You are now going to make another series of choices. These choices will not influence your earnings from the choices you just made, nor will your earlier choices influence the earnings from the choices you are going to make. After you have made the these choices you will be asked to answer some questions. Thereafter the experiment will be over.

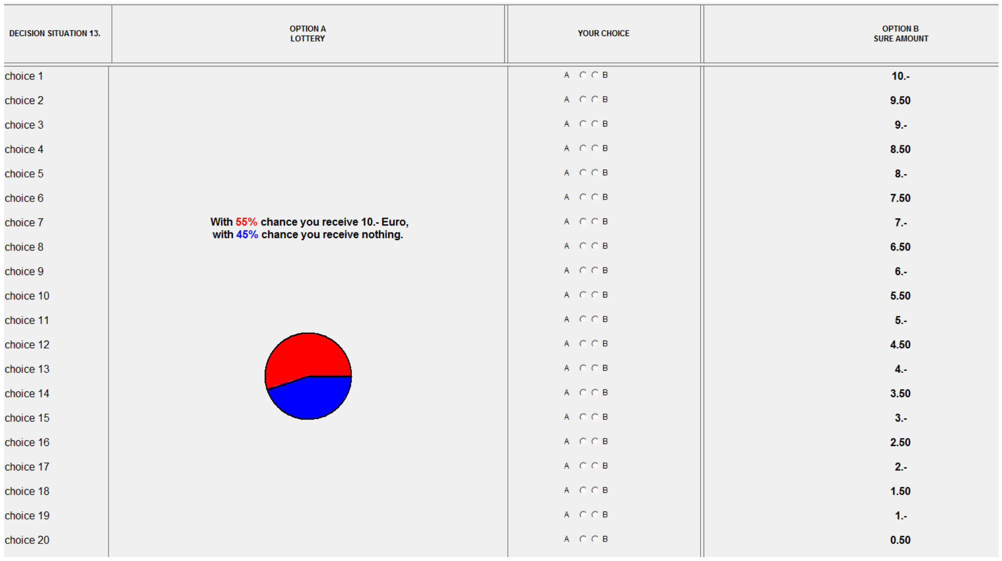
In the following, you will be confronted with a **series of 33 decision situations** that will appear in random order on the screen. All these decision situations are completely independent of each other. A choice you made in one decision situation does not affect any of the other following decision situations. Each decision situation is displayed on a screen. The screen consists of 20 rows. You have to decide for **every** row whether you prefer **option A** or **option B**. Option A is a lottery and is the same for every row in a given decision situation, while the secure option B takes 20 different values, one for each row. By clicking on NEXT you will see an example screen of a decision situation.

This is a **screen shot** of one decision situation you are going to face. You are not asked to make choices now! Please have a careful look.

Determination of earnings

At the end of the experiment one of the 33 decision situations will be randomly selected with equal probability. Once the decision situation is selected, one of the 20 rows in this decision situation will be randomly selected with equal probability.

The choice you have made in this specific row will determine your earnings. Consider, for instance, the screen shot that you have just seen.



DECISION SITUATION 13.	OPTION A LOTTERY	YOUR CHOICE	OPTION B SURE AMOUNT
choice 1	With 55% chance you receive 10.- Euro, with 45% chance you receive nothing.	A ○ ○ B	10.-
choice 2		A ○ ○ B	9.50
choice 3		A ○ ○ B	9.-
choice 4		A ○ ○ B	8.50
choice 5		A ○ ○ B	8.-
choice 6		A ○ ○ B	7.50
choice 7		A ○ ○ B	7.-
choice 8		A ○ ○ B	6.50
choice 9		A ○ ○ B	6.-
choice 10		A ○ ○ B	5.50
choice 11		A ○ ○ B	5.-
choice 12		A ○ ○ B	4.50
choice 13		A ○ ○ B	4.-
choice 14		A ○ ○ B	3.50
choice 15		A ○ ○ B	3.-
choice 16		A ○ ○ B	2.50
choice 17		A ○ ○ B	2.-
choice 18		A ○ ○ B	1.50
choice 19		A ○ ○ B	1.-
choice 20		A ○ ○ B	0.50

Option A gives you a 55% chance to earn 10.- Euro and a 45% chance to earn nothing. Option B is always a sure amount that ranges from 10.- Euro in the first row, to 0.50 Euro in the 20th row. Suppose that the 12th row is randomly selected. If you would have selected option B, you would receive 4.50 Euro. If, instead, you would have selected option A, the outcome of the lottery determines your earnings. The lottery will be paid out by publicly drawing a card from a stack of numbered cards.
Please note that each decision situation has the same likelihood to be the one that is relevant for your earnings. Therefore, you should **view each decision independently** and consider all your choices carefully.

Part 3

Cognitive Reflection Test

You have now finished with the 33 decision situations. In the following screens we ask you to answer some questions. Please read the following questions carefully and type your answer in the boxes. You will earn 0.50 Euro for each correct answer provided.

(1) A bat and a ball cost 1.10 Euro in total. The bat costs 1.00 Euro more than the ball. How many cents does the ball cost?

(2) If it takes 5 machines 5 minutes to make 5 widgets, how long (in minutes) would it take 100 machines to make 100 widgets?

(3) In a lake, there is a patch of lily pads. Every day, the patch doubles in size. If it takes 48 days for the patch to cover the entire lake, how many days would it take for the patch to cover half of the lake?

(4) Two cars are on a collision course, traveling towards each other in the same lane. Car A is traveling 70 km an hour. Car B is traveling 80 km an hour. How far apart are the cars one minute before they collide? Please answer in km.[19]

Rational Experiential Inventory

What is your opinion on the following statements?(subjects had to answer on a 5 point scale, where 1="completely false"; 5="completely true")

1. I would rather do something that requires little thought than something that is sure to challenge my thinking abilities
2. I don't like to have the responsibility of handling a situation that requires a lot of thinking.
3. I would prefer complex to simple problems.
4. I find little satisfaction in deliberating hard and for long hours.
5. Thinking is not my idea of fun.
6. The notion of thinking abstractly is not appealing to me.
7. I prefer my life to be filled with puzzles that I must solve.
8. Simply knowing the answer rather than understanding the reasons for the answer to a problem is fine with me.
9. I don't reason well under pressure.
10. The idea of relying on thought to make my way to the top does not appeal to me.
11. I prefer to talk about international problems rather than gossip about celebrities.
12. Learning new ways to think doesn't excite me very much.
13. I would prefer a task that is intellectual, difficult, and important to one that is somewhat important but does not require much thought.
14. I generally prefer to accept things as they are rather than to question them.
15. It is enough for me that something gets the job done, I don't care how or why it works.
16. I tend to set goals that can be accomplished only by expending considerable mental effort.
17. I have difficulty thinking in new and unfamiliar situations.
18. I feel relief rather than satisfaction after completing a task that required a lot of mental effort.
19. I try to anticipate and avoid situations where there is a likely chance I will have to think in depth about something.
20. My initial impressions of people are almost always right.
21. I trust my initial feelings about people.
22. When it comes to trusting people, I can usually rely on my "gut feelings."
23. I believe in trusting my hunches.
24. I can usually feel when a person is right or wrong even if I can't explain how I know.

[19] This question is not part of the original CRT by Shane (2005). We added it to increase the complexity of the task. However, in the data analysis we do not consider answers to this question.

25. I am a very intuitive person.
26. I can typically sense right away when a person is lying.
27. I am quick to form impressions about people.
28. I believe I can judge character pretty well from a person's appearance.
29. I often have clear visual images of things.
30. I have a very good sense of rhythm.
31. I am good at visualizing things.