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Assessing Mental Models via Recording the Decision Deliberations of Pairs

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Abstract

Two participants have to decide jointly, with the discussions preceding their choice being video/audiotaped. For two tasks, one with and one without strategic interaction, we refer to obvious reasoning styles as mental models. The videotaped discussions are analyzed according to which mental models are mentioned by one or both participants in the same pair and how decisive such arguments were. The mental models for the risky choice task are "analytic approach," "commitment mode," and "avoid chance," and for the outside-option game "equality seeking," "backward induction," and "forward induction." We classify each pair according to their mental constellation in both tasks and assess mental models in addition to collecting choice data. Altogether, this allows for better explanations, especially of heterogeneity in reasoning and deciding.

JEL classification: C72, C90, D03, G11

Keywords: behavioral principles, videotaped experiments, outside option games

1 Introduction

The world which we encounter is often highly complex. Although experimental settings abstract from most aspects of real-world decision problems, even stylized experimental decision tasks may not be cognitively perceived as experimentally implemented. With regard to the ultimatum experiment, for example, it has been argued (Pull, 1999, 2003, and Selten, 2000) that participants neglect its sequential nature and perceive it as a symmetric demand game for which the 50:50 split is focal. Rather than speculating along such lines, we try to directly assess the mental models of participants by confronting participants with two decision tasks when making their choices.

The first task is an isolated but stochastic choice problem, the second an outside option game. Pairs of participants decide jointly, and we video/audiotape the discussions preceding their choice. Rather than analyzing the tapes word for word, it is only assessed which mental models are mentioned by the participants in the same pair and how decisive these were for their choice. For each of the two tasks, we specified three candidate mental models which we describe after introducing the two tasks in Sections 2 and 3, respectively.

Mental modeling is the first stage in the cognitive process of decision making (see Güth, 2012, for a dynamic framework allowing for various feedback loops). This process requires no probabilistic beliefs but does not exclude them either . Rather, one generates scenarios, i.e., situations which should not be neglected, without necessarily being able to specify how probable they are. Moreover, mental modeling does not impose intrapersonal payoff aggregation as is the case, for instance, in expected utility or prospect theory. Rather, one generates aspirations for each scenario before successively searching for a satisficing option.

Whereas the methods for directly observing[1] scenario generation, aspiration formation, and satisficing search are rather obvious, albeit not necessarily unproblematic, assessing how participants mentally perceive a decision task is far more difficult. We do not claim that our method is superior to others such as making individual decision makers "speak aloud." However, it has its specific advantages, which we try to demonstrate.

To focus (pairs of) participants on mental modeling, participants are subjected to time pressure to crowd out the usual gossiping. Although the

[1]This, of course, means to go beyond the revealed motives approach (in economics: revealed preference approach) by trying to infer motives only from choice data.

second task is slightly more complex, we allowed only 6 minutes of discussion in both tasks before a final minute to fill in decisions. A pilot experiment showed that this yielded video/audiotapes which could be analyzed according to the prespecified mental models.

Our paper is organized as follows: Section 2 introduces the risky choice task and the mental models we distinguish: "analytic approach (AA)," "commitment mode (CM)," and "avoid chance (AC)." Section 3 presents the outside option game with its two benchmark solutions, the forward induction (FI) equilibrium based on normal-form players (Kohlberg and Mertens, 1986) and the backward induction equilibrium (BI) based on payoff monotonicity and isomorphic invariance in equilibrium selection (Harsanyi and Selten, 1988). In addition, we distinguish "equality seeking (ES)" as a further mental model. The experimental protocol is described in Section 4. Section 5 presents our main results, and Section 6 concludes.

2 The risk neutral decision problem

It is important to first test the assessing of mental models for decision problems without strategic interaction before allowing for the latter.

The decision task is illustrated by the same decision tree (Fig. 1) as in the instructions (Appendix A.1), which should be self-explanatory. All personal and chance moves are binary, and all chance moves are equally probable. Payoffs at the endpoints are success numbers n, linearly determining the probability $n/30$, respectively $(30-n)/30$, of winning the high (€15), respectively the low (€5), premium. These payoffs are the personal earnings of both participants in the same pair, i.e., participants in the same pair do not only have to come up with the same decision but also face the same chances. The binary lottery incentives imply risk neutrality.[2] Clearly, in expectation that

- (invest, stop investing) yields $n = \frac{24}{2} + \frac{12}{2} = 18$,
- (invest, continue investing) $n = \frac{24}{2} + \frac{1}{2}(\frac{2}{2} + \frac{18}{2}) = 17$, and
- (not investing) only $n = 15$,

[2]This merely assumes that more money (€15) is better than less money (€5) and that probabilities are calculated properly.

it can be shown that the three options can be ordered from best to worst as above.

The first of the three mental models is the

> ANALYTIC APPROACH (AA) where one engages first in "invest" and then in "stop investing" since $n = \frac{24}{2} + \frac{12}{2} = 18$ is better than $n = \frac{24}{2} + \frac{2}{4} + \frac{18}{4} = 17$ which is better than 15.

However, we predict that only a few participants will employ (AA) while others rather rely on the

> COMMITMENT MODE (CM) where, if one engages in "invest" and then sticks to one's plan, one therefore "continues investing."

Evidence for (CM) are firms staying too long in the same industry and educational choices where individuals stick to early plans and decisions even after learning that these yield worse earning prospects than other opportunities still available.

Further, one can also try to reduce chance effects by using

> AVOID CHANCE (AC), with "not investing" guaranteeing the success probability 1/2 for €15 (and €5), irrespective of the chance moves in Figure 1.

Of course, (AC) does not rule out the basic uncertainty whether one earns €15 or €5, which is positive for all possible success measures n in Figure 1 due to $2 \leq n \leq 24$. But participants may forget or neglect this basic uncertainty and focus on the success measure n as if it was a monetary reward, for example, by preferring a "safer" n over an "uncertain" n. One could account for such attitudes by ambiguity aversion (Ellsberg, 1961, and Camerer and Weber, 1992).

Pairs of participants decide jointly on one of the three options: "not investing," "investing" & "stop investing," and "investing" & "continue investing." By video/audiotaping their discussions, the underlying mental modes can be assessed in addition to the final decisions they take. We refrained from influencing the mechanism by which pairs reach a decision. All that was imposed was that discussions could go on at most for 6 minutes, including the final minute for submitting the choice via the computer. When facing the first task, participants were not (yet) aware that they, as the same pair, would face a second task.

3 The outside option game

In the second task, the outside option game, we substitute probabilistic uncertainty in the risk neutral decision problem by strategic interaction. We consider a two-player two-stage game with imperfect information, where player 1 has the option either to take an outside option to end the game or to choose an action against her opponent player who chooses her action without being informed about player 1's action choice. In the experiment, we did not implement an arbitrary sequencing of simultaneous moves which justifies the normal presentation of the proper subgame in Figure 2 (see also the instructions in Appendix A.2).

By the payoff specification we intentionally wanted to trigger

> Equality Seeking (ES) where, if there is a choice constellation yielding reasonable, equal payoffs, participants might choose this right away.

We expect (ES) not only for pair 1 but also for pair 2. Both pairs may argue that they should aim at "equal success for both pairs." This renders their choices for the subgame after "interaction" arbitrary, e.g., in the sense of not being well considered, which could mean that the choices after "interaction" are more noisy for (ES) pairs.

Note that equal payoffs could have been assumed also for constellations after interaction, e.g., when players are discoordinated, both might earn the same positive amount. In future research, we want to analyze some games where equality seeking is not at all in line with subgame perfectness.[3]

The two other mental models do not assume that the subgame after "interaction" is neglected, but they do this in quite different ways:

> Backward Induction (BI): solving the subgame after "interaction" with its two strict equilibria, (both U) and (both V), and assuming isomorphic invariance and payoff monotonicity unambiguously predicts[4] (both U), suggesting "no interaction" for pair 1.

[3] In their experimental test of equilibrium selection theories, Balkenborg and Nagel (2008) employed the outside option game with equal payoffs for the backward induction solution rather than the forward induction solution.

[4] If (both U) yielded €4 for pair 1 instead of €6, the game would be symmetric so that

(ES) and (BI) predict the same play, namely pair 1 using "no interaction," but differ[5] in how carefully one decides in the counterfactually, respectively unexpectedly, reached subgame after "interaction." The two mental models, (ES) and (BI), illustrate the limitations of the revealed preference approach which essentially tries to infer reasoning styles only from choice behavior, directly demonstrating the importance of assessing mental modeling. We intentionally designed a game with such confounding predictions, hoping that it is nevertheless possible to distinguish the reasoning behind (ES) versus (BI) on the basis of the arguments used when discussing how to behave in the game.

> FORWARD INDUCTION (FI) basically relies on the normal-form player notion, meaning that pair 1 will see that their choice (of "interaction" and U) is dominated by "no interaction" and that this will also be understood and anticipated by pair 2. Thus both should choose V after "interaction," the only equilibrium remaining after eliminating pair 1's choice of U, which induces pair 1 to choose "interaction."

The notion of the normal-form player (or the so-called omnipotent player, see Güth, 1991) has been propagated by von Neumann and Morgenstern (1944) and more recently by Kohlberg and Mertens (1986) via their set-valued stability refinement. What this basically denies is embedding invariance, which, for the case at hand (Figure 2), would mean to solve the subgame after "interaction" without considering how it has been reached. (FI) predicts for both pairs the V-choice and for pair 1 to choose "interaction."

We are not the first to study the outside option game experimentally. Balkenberg and Nagel (2008) use a numerical specification where equality seeking is in line with the risk dominant equilibrium of the subgame following interaction (see their Fig. 1) and compare the play of the outside option game with the case where this subgame is not induced by player 1 opting for "interaction" but due to a prior chance move (see their Fig. 2). Contrary to our interest in the reasoning of pairs how to play the game, the authors

isomorphic invariance forbids any selection. But since pair 1 earn €6 rather than only €4 in case of (both U), (payoff) monotonicity selects (both U) as the unique solution (see Harsanyi and Selten, 1988).

[5]For the game studied by Balkenborg and Nagel, 2008, (ES) would predict differently from (BI).

mainly[6] compare and test equilibrium selection, namely the forward induction solution based on a normal-form equilibrium refinement (Kohlberg and Mertens, 1986) and the backward induction solution based on equilibrium selection in subgames independent of their embedding (Harsanyi and Selten, 1988).

4 Experimental protocol

Since our main goal is to classify cognitive types, we rely on the strategy vector method (each pair of participants decide for both roles in the outside option game and for all information sets) providing the most informative decision data. We avoid counterfactual considerations, however, by not asking in the isolated decision task for a choice between "stop or continue investing" after "not investing" and by asking pair 1 of the outside option game choosing "no interaction" what they would have chosen if they had decided otherwise.

In addition to their own choice, each pair is also asked what they expect to be the most frequent choices of the other pairs. We elicit such (point) expectations to help them prepare their own choice and as indicators whether participants perceive themselves as untypical or similar to the other pairs. This is also the reason for eliciting beliefs in task 1 where no first order action beliefs are required.

Each pair of participants face the same decision sequence, namely

- first, task 1 with neither social nor strategic interaction but with random events and no awareness of the second task until actually confronting it,

- then task 2, involving strategic interaction but no random events.

Pairs of pairs were randomly matched after collecting all decision data in order to determine the payoffs from playing the outside option game. Only then were participant pairs informed whether, according to their success number n in task 1, they earned €15 or only €5. No feedback information was provided between the two tasks.

[6]Balkenborg and Nagel additionally equilibrate other behaviors by allowing for social preferences which, in our approach, would be captured by a mental mode like (ES).

The experiments were conducted in the video cubicles of the Max Planck Institute of Economics in Jena. Thirty-two subjects participated in the experiment, yielding 16 pairs. Each pair contributed one independent observation. In each session, eight pairs were placed in the eight video/audio equipped cubicles available at the Institute. We did not induce any gender balance but formed only unisex pairs and did not control for subjects of study to avoid any specific demand effect. Thus we mainly confined ourselves to classifying cognitive types by discussion and decision types of pairs.

5 Results

In order to analyze the videotapes, we transcribed the dialogue of each pair. In the following, we report the main findings in the order of their experimental elicitation.

5.1 Risk neutral decision problem

Table 1 reports the frequencies of decisions and the corresponding expectations regarding the risky choice task. Most pairs (10 out of 16) expect other pairs to choose as they do.

Eleven pairs out of 16 choose "invest" and "stop investing" (I & SI). However, despite this decision, participants do not rely on the ANALYTIC APPROACH (AA) in their discussions. Only two pairs, choosing "invest" and "stop investing," try to figure out the best alternative. However, both pairs explicitly admit to being unable to derive what is optimal. Six out of 11 pairs, choosing I & SI, state that the potential outcome of $n = 2$ prevents them from choosing "invest and continue investing (I & CI)" – it would be "odd to receive n=2." Other pairs prefer "invest & stop investing" in order to allow for $n = 24$. Six out of 11 pairs, choosing I & SI, state they want to get the chance of winning $n = 24$.

Four pairs out of 16 decide to "invest & continue investing (I & CI)." One of the pairs state that they do not mind to continue gambling ("we are courageous"). Another pair explicitly refer to a committing effect (COMMITMENT MODE - CM): "Once investing, one has to continue!"

Only one pair of subjects opt for "not to invest (NI)." The underlying mental model is AVOID CHANCE (AC) ("we hate risk") in spite of the

		Decision			
		Not investing (NI)	Invest and stop investing (I & SI)	Invest and continue investing (I & CI)	$\sum$
Expetation	NI	1	3	1	5
	I & SI	–	8	2	10
	I & CI	–	–	1	1
	$\sum$	1	11	4	16

Table 1: Frequencies of decision and expectations

unavoidable chance move between low and high premium. The low frequency of "not investing" may also be due to an experimental demand effect.

Concerning expectations, "not investing (NI)," in contrast to "investing & continue investing (I & CI)," is more often expected than actually chosen. Several pairs, while engaging in intermediate risk by "investing & stop investing (I & SI)," apparently expect others to be either risk shy or risk seeking ("one cannot really predict whether others are willing to incur risk"). But the majority of those relying on "invest & stop investing (I & SI)" think others reason as they do.

To summarize, among the pairs whose reasoning style could be clearly assessed (10 out of 16 pairs), one pair simply refuse any voluntary risk and choose "not investing (NI)" accordingly. Of the other nine pairs with "investing & stop investing (I & SI)" most (seven pairs) view one but not two chance moves as acceptable ("no two voluntary risks"), two feel compelled (by positively framed "investing") but are afraid to end with $n = 2$ ("let us invest but exclude 2"). None of the pairs calculate the expected n correctly and hardly any pair attempts this at all. Expected utility maximization fails to predict behavior even under its most favorable circumstances (induced risk neutrality, no social scenario, and no strategic interaction), whereas the prespecified reasoning styles, framed as mental models, are often but rather unsystematically considered and used.

We find that subjects often use similar lines of argumentation when supporting a particular decision in the investment problem. To contrast the arguments in the investment decision problem with those in the outside option game, we reclassify them as follows: On a more general level, we classify the arguments either as "analytic" or as "nonanalytic," where analytic arguments coincide with reasoning according to the (AA) style. Nonanalytic arguments, in contrast, are rather compatible with the remaining mental models (AC) and (CM). To a smaller extent, the analytic arguments are either concerned with "no risk bearing" (directly compatible with (AC)) or with "risk bearing at all stages of the decision problem," i.e., with "risk twice" (contradicting (AC). Further, one pair directly refer to (CM) reasoning. To a larger extent, the nonanalytic reasoning styles include arguments where pairs justify their choice of I & SI: some pairs justify their decision by avoiding the minimum result of 2 points without giving up the chance to win the maximum result of 24. We characterize these types of arguments as "Max/min." Moreover, pairs choosing the I&SI strategy often argue that one should not challenge fortune by taking the risk of a wrong decision at two stages. We subsume these kinds of arguments under the heading "don't overdo" which is related to the (AC) reasoning style. Table 2 summarizes the refined classification scheme.

Analytic	Nonanalytic			
	No risk	Risk twice	I & SI	
			Max/min	Don't overdo

Table 2: Refined argumentation scheme for task 1

5.2 The outside option game

Table 3 displays the frequencies of decisions and expectations in the outside option game. All but one pair choose "not to interact (NInt)." Pairs mostly expect other pairs to make the same choice: 13 of 16 pairs do not expect others to deviate from their own choice. For example, pairs choosing not to interact expect other pairs not to interact either. The dialogues reveal that some (nonequilibrium) form of BACKWARD INDUCTION (BI) is the reason for "no interaction." All pairs choosing not to interact mention the risk of coordination failure with zero payoffs for both pairs. One pair conjecture that there is a probability of less than half to receive €12 when opting for "interact," inducing them not to interact. Another pair state that the low chance of receiving 4 additional euros (€12 instead of €8 when not interacting) does not justify to choose "interaction."

Although nearly all pairs prefer not to interact and expect others not to interact either, they vividly discuss their decisions in the role of player 2. Although they mostly believe that pairs in the role of player 1 do not opt for interaction, they also evaluate the choices they expected from player 1 in case they interacted. Eleven out of 16 pairs choose U in the role of player 2. Some of these pairs choose U, although they expect player 1 to use V. For example, one pair state that player 1 would surely opt for V. But as U yields a higher payoff for player 2, they choose U. One pair mention that player 1 might anticipate their choice of U and may, therefore, also choose U. Two pairs who decided for U as player 2 say that they prefer to receive €0 when player 1 chooses V to earning €4 via (V,V). Three pairs think that (U,U) ranks higher in fairness than outcome (V,V) due to its higher gains for both pairs. Five out of 16 pairs use V as player 2. They all expect player 1 to choose V. One pair argue that no one in the role of player 1 would rely on "interacting & U (Int & U)."

Only one pair who opt for interaction as player 1 choose U, which yields a lower payoff than choosing "no interaction."

Pair 1:

		Decision			
		No interaction (NIint)	Interaction and U (Int & U)	Interaction and V (Int & V)	$\sum$
Expeta-tion	NInt	13	1	–	14
	Int & U	–	–	–	0
	Int & V	2	–	–	2
	$\sum$	15	1	–	16

Pair 2:

		Decision		
		U	V	$\sum$
Expeta-tion	U	10	2	12
	V	1	3	4
	$\sum$	11	5	16

Table 3: Frequencies of decision and expectations

It is not always easy to disentangle the arguments for U and V in either role, player 1 or player 2. Pairs typically argue from the viewpoint of player 1 when discussing "interaction," while they usually consider the choice between U and V from the viewpoint of player 2. Altogether, only one pair choose "interaction" and U in both roles. Two pairs clearly understand that "interaction & U" is dominated for player 1 but dare not opt for "interaction & V." Thus there are some hints of game theoretic reasoning styles such as

- elimination of dominated strategies
- expectation about others, others' beliefs concerning own behavior, and own beliefs concerning others' beliefs (reasoning about knowledge)

but no indication of trust in subgame perfect equilibrium behavior. Altogether, the overwhelming attitude seems to be fear of mis-coordination and, albeit less frequently, EQUALITY SEEKING (ES).

It was no easy task to assign the arguments observed in the pairs' discussions to the particular mental models introduced in the previous sections. This was especially true for pairs arguing in favor of "no interaction" because they feared possible coordination failure when deciding simultaneously.

When comparing behavior in both tasks in the next section, we will refute this argument by "fear of (0,0)" as is sometimes explicitly stated in discussions. Pairs subscribing to this argument could be assigned either to the (BI) or to the (FI) reasoning style. Therefore, we decided to introduce it in the next section as a separate category relating arguments across tasks. Table 4 gives a short overview of the categories we use to classify the arguments of participants in task 2.

(FI)	(BI)	(ES)	Fear of (0,0)	Other

Table 4: Refined argumentation scheme for task 2

5.3 Categorizing cognitive styles across tasks

In the previous sections, we analyzed behavior and reasoning of the pairs separately for each task. Due to our "within subject design," we are able to correlate the pairs' arguments and actions taken in both tasks to obtain more precise information on motives and reasoning styles. We start with crossing the various strategies of the same pairs in task 1 and task 2: three of the four pairs who decide for "investing & continue investing (I & CI)" in the first task choose "no interaction (NInt)" in the outside option game. One pair choose "interaction and U" (Int & U) and state that they "enjoy risk..." but do not go along with the courageous "invest & continue investing (I & CI)" behavior. The only pair shying away from any (additional) chance move in the first task ("not investing" - AVOID CHANCE) choose no interaction in the outside option game, which seems reasonable. Thus we are left with the 11 pairs who decide to "invest and stop investing (I & SI)" in the risk neutral decision problem. All of them opt for "no interaction (NInt)" in the role of player 1. In the role of player 2, seven choose U and four V. Our results concerning the choices in both tasks are summarized in Table 5.

We are not only interested in choices but also want to check the arguments behind them. Table 6 reveals these arguments behind the choices in both tasks. In contrast to our convention in the previous tables where numbers denote absolute frequencies, the numbers in the cells of Table 6 denote specific pairs numbered (arbitrarily) from 1 to 16. Often the arguments offered are only loosely connected with the actual choice. Arguments concerning forward induction, for example, were made by some pairs, but not followed in task

			Task 1			
			NI	I&SI	I&CI	$\sum$
	Pair 1	Pair 2				
Task 2	NInt	U	1	7	2	10
	NInt	V	–	4	1	5
	Int& U	U	–	–	1	1
		$\sum$	1	11	4	16

Table 5: Actual strategy choices in both tasks

2. Therefore, we classified all arguments as either leading to the respective decision (in both tasks) or to a different decision (in at least one task). In the latter case, we indicated this by bracketing the pairs using, but not following, such arguments. We tried to classify the arguments unambiguously according to the categories indicated by the rows and the columns in Table 6. For task 1 we used the refined argumentation scheme introduced at the end of subsection 5.1. Concerning task 2, we added "fear of (0,0)," which was mentioned by almost all pairs.

		TASK 1				
		Analytic	Nonanalytic			
			No risk	Risk twice	I & SI	
					Max/min	Don't overdo it
TASK 2	(FI)			(3)	(15),(16)	(11)
	(BI)		2	8	(8),13	7
	(ES)				(6),(14)	(7)
	Fear of (0,0)	(6),(12)	(1),(12)	1, 3	5, 6, 12, 14, 15, 16	4, 10, 11
	Other			9		

Table 6: Reasons discussed (parentheses show those reasoning styles that are mentioned but not followed)

Most pairs use Max/min reasoning[7] in the risk neutral decision problem

[7]In our view, "Max/min reasoning" stands for all arguments of pairs involving the

and, at the same time, choose no interaction as they fear the outcome of zero. Although not guiding their actual choice, four pairs discuss (FI) but then decide for no interaction. Three pairs point out equality seeking (ES) as their leading motive for not choosing "interact" in the outside option game. (BI) is the reasoning behind no interaction for four pairs of participants. But the main reason for most pairs (11 out of 16 pairs) not to interact is because they fear the outcome of (0,0).

6 Conclusions

To learn more about reasoning styles and what these suggest more generally for mental modeling when a pair face a risky decision task and a strategic game, pairs of participants were confronted with either task. For the sake of gaining more informative data, we confronted these pairs with both roles in the game, i.e., we employed the strategy vector method but avoided counterfactual considerations in both tasks. Furthermore, we elicited (point) beliefs about how one expects other pairs to behave in order to learn whether pairs view their behavior as typical respectively more or less extraordinary. The major findings are the following:

(i) even when pairs choose what is optimal, they do so without proper reasoning,

(ii) although pairs expect other pairs to behave and reason as they do, the fear of non-solution outcomes and improper reasoning predominates,

(iii) pairs often reason consistently, for example, in the sense of avoiding too much risk (two voluntary chance moves in the first task) and interaction in the second,

(iv) more often than not the decisive reason is to avoid something bad (n=2 in task 1 and (0,0) payoffs in task 2) rather than hoping for something good (except for the "Max" reasoning).

Altogether, we hope our findings convincingly illustrate that directly observing how participants reason when considering how to behave in addition

worst case (ending up with 2!) and/or the best case (ending up with 24!) in justifying their decisions.

to the usual choice elicitation allows for more reliable inferences about motives and boundedly rational decision deliberations. By this, we do not want to discourage the standard studies which restrict themselves to eliciting only the standard choice data. We want to supplement such experimental studies by attempts which directly assess how we reason when engaging in a forward-looking but usually only boundedly rational deliberation of choices.

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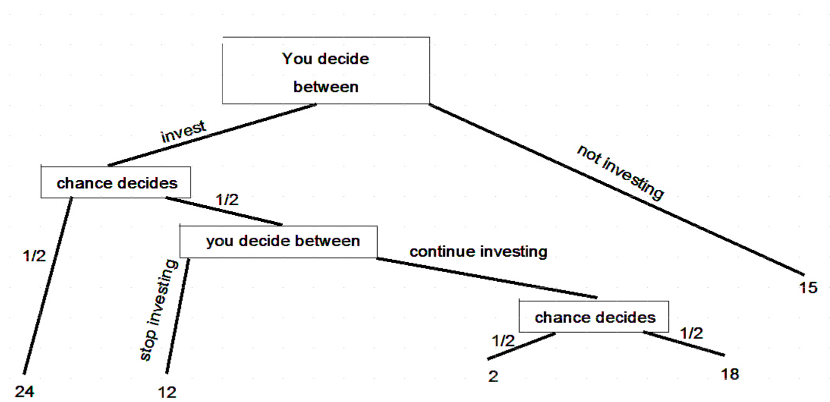
A Appendix

A.1 Instructions 1 (Risk Neutral Decision Game)

In this experiment you will have to make either one or two decisions. How successful you will be depends on your choices as well as on chance. Success will be measured by the number n of points which you earn. Your success number n will always be positive and smaller than 30. Actually, your monetary payment will either be €5 or €15. Which of the two you will earn depends on your success number n. You will earn €15 with probability $n/30$, i.e., when taking a ball from an urn with altogether 30 balls of which n are winning balls and the randomly drawn ball is a winning ball, you will earn €15. Similarly, you will earn €5 with probability $(30 - n)/30$, i.e., when the randomly drawn ball is a losing ball, you will earn only €5. Since n is always positive and smaller than 30, both payoffs (€15 and €5) will result with positive probability irrespective of your success number n.

How is n determined by your choices and chance? This is illustrated by the following decision tree:



(Thus) You first decide between "invest" and "not investing." When "not investing" is chosen, your success number n is 15 and you do not have to make another decision.

When you choose "invest," a chance move can either determine that $n = 24$ or that you have to make another decision, namely between "stop investing" and "continue investing." If you have to make another decision and choose "stop investing," your success number n is 12, whereas in case of "continue investing" it is either 2 or 18.

All chance moves are equally likely, i.e., each of them occurs with probability 1/2, and will be realized only after you have decided. Accordingly, you have to choose one of the following three options:

☐ "not investing," yielding success number $n = 15$

☐ "invest" and "stop investing," yielding success number $n = 24$ or $n = 12$, each with probability 1/2

☐ "invest" and "continue investing," yielding success number $n = 24$ with probability 1/2 or, with probability 1/2, another chance move yielding $n = 2$, respectively $n = 18$, each with probability 1/2 (each)

Please decide (now): ☐ ☐ ☐

Please decide which choice you expect to be the most frequent one of the other pairs:

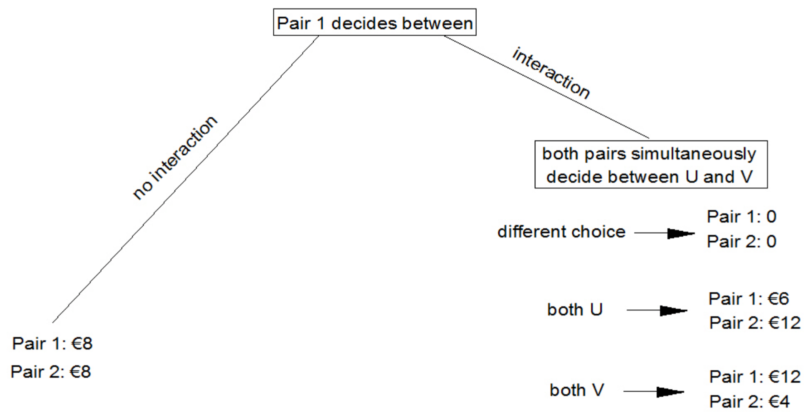
I expect the most frequent choice to be

☐ "not investing"

- ☐ “invest” and “stop investing”
- ☐ “invest” and “continue investing”

A.2 Instructions 2 (Outside Option Game)

In this second and last task you will be interacting with another pair of participants. What you will earn depends on your and the other pair's behavior. How your monetary payoff is derived from the choices by both pairs is illustrated by the decision tree:



Thus pair 1 have three options, namely

- ☐ "no interaction"
- ☐ "interaction" and "U"
- ☐ "interaction" and "V"

whereas pair 2 only have two options between

- ☐ "U"
- ☐ "V"

Since after collecting all decisions it will be randomly determined which pair decide as pair 1, respectively pair 2, you have to tick one of the two boxes for both possibilities. Subsequently, you have to tick one of the three options of pair 1 and one of the two options of pair 2.

Please tick:

as pair 1: ☐

as pair 2: ☐

Please tick which choice you expect to be the most frequent one of the other pairs:

I expect the most frequent choice of pair 1 to be

☐ "no interaction"

☐ "interaction" and "U"

☐ "interaction" and "V"

I expect the most frequent choice of pair 2 to be:

☐ "U"

☐ "V"