On the observational learning in the optimal stopping problem.

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Abstract

We experimentally test the theoretical predictions about observational learning in case of the optimal stopping problem with publicly observable behavior but privately observable payoffs. We use the two-agents two-arms bandit framework and follow the theoretical analysis of Rosenberg et al. (2007). Rational behavior in this framework implies solving a non-trivial optimization task. That raises the question whether people act according to the theoretical predictions. We find evidence that subjects overreact on their own outcomes and conform with the choices of others.

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1 Introduction

The theoretical literature widely explores the optimal stopping problem with publicly observable behavior (Bolton and Harris, 1999; Keller et al., 2005; Rosenberg et al., 2007). The problem is relevant in many economic situations where uncertainty is present and individual learning is not the sole source of information. Examples are R&D investments, identification of the new research opportunities, job candidate search or consumer research. For instance, in case of the R&D investment a firm facing uncertain outcomes of a research project can make a decision about the duration of the investment based on the current results of the project and on information about the investment period of another firm in similar project. These kinds of decisions assume solving a non-trivial optimization problem. This raises the issue, how real subjects are going to perform in this task.

In an attempt to resolve this issue we use as a workhorse the two-agent optimal stopping problem in the two-armed bandit framework with private payoffs and publicly observable actions. Each of the agents faces a choice between two alternatives: a less uncertain and a more uncertain one. The more uncertain alternative yields higher or lower payoffs than the less uncertain one conditional on the state of the world. In order to gain high payoffs the agents can experiment with the more uncertain alternative thereby updating their information about the state of the world. If the outcomes of the experimentation provide evidence against the more uncertain alternative they can irreversibly stop experimentation by switching to the less uncertain one. In addition, agents observe each other's behavior but not outcomes. Thus, they can learn not only from their own actions (individual learning), but also from the actions of the others (observational learning).

The Bayesian Nash equilibrium prescribes that rational agents combine these two streams of information and use the Bayesian updating to form their beliefs about the state of the world (Rosenberg et al., 2007). However, it is an open question whether real subjects will act according to the equilibrium strategy.

Real subjects may display systematic deviations from the equilibrium strategy. Though, there are evidence that subjects use effective learning strategies when learning individually (Schotter and Braunstein, 1981; Banks et al., 1997; Güth et al., 2006), it is not yet clear how people learn from the actions of others. People can fail to process observed behavior in the optimal stopping problem with publicly observable behavior – they can naïvly follow stopping decisions of others since the stopping decision attracts attention and resolves the silence effect of choice to continue (Bandura, 1969; Anderson and Holt, 1997; March et al., 2012). Thus, this study attempts to test whether the equilibrium predictions hold in case of the observational learning in the optimal stopping problem or if real subjects are prone to conform with stopping decision of others.

Indeed, the experimental analysis of the equilibrium predictions is valuable in itself. However, the experimental test of the optimal stopping problem with publically observable behavior is also interesting for another reason. Since the problem concerns pure information but not payoff externalities, it allows to isolate the effects of different types of learning. The experimental investigation can shed light on (1) the analysis of outcomes by subjects, (2) their mode to draw inference from others' behavior.

We find that subjects overreact on their own payoffs. Subjects stops more often when the outcomes provide inconclusive information about the uncertain alternative rather than when it is in favor of it, though the rational strategy prescribes to continue in both cases. As concerns their mode to infer from others, we provide evidence in favor of social learning theory: the subjects conform with the choice of others when this choice does not provide information about the state of the world and they follow the choice of others irrespective of its informativeness. We also find indirect evidence that stopping decisions of others attracts special attention.

The rest of the paper is organized as follows: Section two summarizes the related literature. Section three describes the model of optimal stopping problem with publicly observable behavior and presents the hypothesis. Section four depicts the experimental design and procedures. Section five reports the results of the experiment. Section six concludes.

2 Related Literature

Our theoretical analysis is based on the study of Rosenberg et al. (2007). They investigate the optimal stopping in the one-armed bandit problem, where the decision to stop the search is irreversible and agents observe each other's behavior but not each other's payoffs. The natural problem characterizing the game is the information externalities, since the other agents' behavior may reveal relevant information to the agent but also mirrors the interpretation of his own behavior by the other agent. In spite of this Rosenberg, Solan and Veille show that all equilibrium strategies process information in a relatively simple way meaning that all eqilibria are in cutoff strategies.

In earlier work Bolton and Harris (1999) obtain similar results under the assumption of publicly disclosed private information (including payoff). Regardless that the assumption of private information disclosure appears to be restrictive in many economic situations, the equilibrium solution of the model exhibits interesting features such as mitigation of the free-riding problem by the so-called encouragement effect. On the contrary, Keller et al. (2005), by modifying the assumption about payoffs probability distribution from normal to Poisson, show that the encouragement effect disappears. Following Keller et al. (2005) strategic experimentation and optimal stopping in the bandit problem with Poisson payoff probability distribution is studied by Murto and Välimäki (2006); Keller and Rady (2010); Klein and Rady (2011); Rosenberg et al. (2013).

From an experimental perspective, the optimal stopping problem with observable behavior is most closely related to the literature on endogenous-time herding models. This strand of literature is motivated by the theoretical work of Chamley and Douglas (1994). In their model agents endowed with private information decide when to make an irreversible investment decision and their decision is publicly observable. The theoretical outcomes of this situation are inefficient since the agents, strategically delaying the investment, do not reveal their information. The experimental results support the theoretical predictions. Sgroi (2003), Çelen and Hyndman (2012) corroborate the theoretical outcomes in the experiment reflecting the model of Chamley and Douglas (1994). Ivanov and Levin (2009), employing the original design to reveal the motivation of subjects, also, provide evidence in favor of the theory.

3 The General Model and Predictions

3.1 The Model and the Solution for Rational Agents

In the game there are two agents i, j and two alternatives, less uncertain (X) and more uncertain (Y). The alternative X brings the reward R_X. The alternative Y brings a big reward $R_Y >> R_X$ or a small reward r_Y but the probability of the rewards depends on the ex ante unknown state of the world, which might be either Good (G) or Bad (B). In the Good state of the world the probability of the big reward is high $\overline{p_Y}$, whereas if the state of the world is Bad the probability to receive the big reward is low $\underline{p_Y}$, $\overline{p_Y} > 1/2 > \underline{p_Y}$. The probabilities of the small reward in the world G and B are $1 - \overline{p_Y}$ and $1 - \underline{p_Y}$, respectively, and for simplicity $\overline{p_Y} = 1 - \underline{p_Y}$. The state of the world has equal probability to be either G or B, and the agents have common prior beliefs about the state of the world $Pr(G) = Pr(B) = 1/2$.

Time is discrete $t = \{1, \ldots, T\}$. In each period t, the agents simultaneously choose either alternative X or Y but if they select the certain alternative (X) their decision is irreversible. That is, an agent chooses when, if ever, to switch to less uncertain alternative and to stop experimenting with the more uncertain one. In addition, each agent observes the choice of the other agent but not each others' outcomes resulting from the choice.

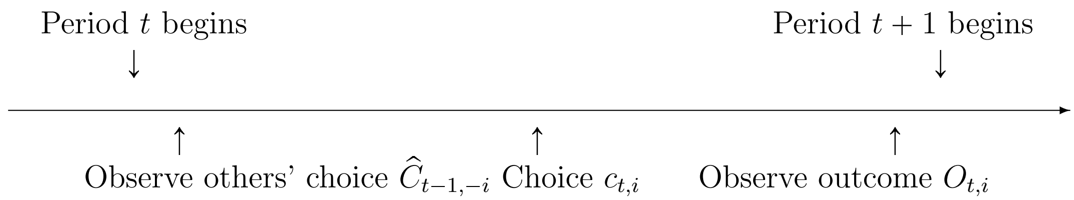

Figure 1: Timeline of actions and outcomes for an agent

The decision of the agent i is based on the private history of outcomes $\widehat{O}_{t,i} = \{O_1, \ldots, O_t\}$ and agent j's time of continuation τ_j. Interestingly, Rosenberg et al. (2007) show that in equilibrium an agent updates her beliefs about the state of the world using private history of outcomes $\pi(G|H_{t,i})$, $\pi(B|H_{t,i})$ and determines a time-dependent cut-off $\phi(t, \tau_j)$ with respect to the other agents time of continuation τ_j. Thus, she continues to experiment at period $t+1$ iff:

$$\pi(G|\widehat{O}_{t,i})(R_Y\overline{p_Y} + r_Y\underline{p_Y}) + \pi(B|\widehat{O}_{t,i})(R_Y\underline{p_Y} + r_Y\overline{p_Y}) - R_X > \phi(t, \tau_j), \qquad (1)$$

where $\phi(t, \tau_j)$ is non-increasing in time.

3.2 Behavior of the Boundedly Rational Agents

It is a demanding task to calculate optimal choice using backward induction and interpret the behavior of the other agents in a Bayesian fashion. Instead real subjects may rely on count rules to learn from their private outcomes and comply with behavior of the other subjects: they simply can count difference between big and small rewards to decide in which state of the world they are and use the behavior of the others as justification for their actions.

Indeed, count heuristics well explain the participants' behavior in the experiments with one- and two-armed bandit problems(Banks et al., 1997; Grosse and Kirchkamp, 2009). However, it is an open question how people learn from the others if the action of the others can attract different level of attention. The theory of social learning suggests (Bandura, 1965, 1969) that the observational learning is contingent on the level of attention. In the optimal stopping problem the stopping decision may attract more attention since it is more tractable than decision to continue and it surpasses silence effect of the continuation. Therefore, the subjects may react on the stopping decision of the other subjects stronger than on the decision to continue. On the contrary, rational agents acting with respect to a time dependent cutoff equally consider the other agents decision to stop or continue.

H 1 *The subject follows in the next period the action of the other subject on average more often when the action of the other subject is to stop than when it is to continue.*

Suppose the game lasts for three periods ($T = 3$). The big reward (R_Y) is 100 and the small reward (r_Y) is 1. The probability of the big reward in the Good state of the world is $\overline{p_Y} = 4/5$. The less uncertain alternative (X) brings the reward $R_X = 40$.

Under the conditions specified below rational strategy always prescribes to choose Y in the first period. Nevertheless, subjects using count rules can exhibit out of equilibrium behavior. That raises the question how real subjects interpret such actions. The expectation is that the subjects attracted by the stopping decision of the others consider it as informative and stop as well.

H 2 *The subject follows stopping decision of the others when stopping behavior of the other subject is not predicted by perfect Bayesian Nash Equilibrium.*

A rational agent considers some choices of the other agent as uninformative and should ignore them. For instance, the decision to continue in the first round is uninformative for a rational agent – she knows that the other agent makes this choice before receiving any outcome and, hence, one can not learn from this action the actual state of the world. However, the stopping decision may still attract more attention than the decision to continue. Therefore, even if the others' subject choice does not bring information about the state of the world, people may stop more often observing the stopping decision of the others rather than the decision of the others to continue.

H 3 *The subject follows the action of the others more often when the other subjects stop than when she continues if the actions of the other subjects do not provide an information about the state of the world.*

Rational agents are able to perfectly extract information from the actions of the others. Moreover, under certain circumstances they are able to infer the exact history of outcomes of the other agent. If the rational agent i in period 3 observes stopping decision $X_{2,j}$, she infers that the agent j stops only if $\widehat{O}_{2,j} = \{1\}$. In turn, if the rational agent i observes that the other agent makes choice to continue in the second period, then, she deduces that the agent j received big reward in the first period of the game $\widehat{O}_{2,j} = \{100\}$.

Combining private information and information inferred from the decision of the others the rational agent updates her beliefs. Given this new beliefs she calculates expected utility for each of the actions and choose the one with highest expected utility (see fig. 2). As a consequence, in period 3 a rational agent continues in 3 out 4 possible cases if the other player continues in the second round and stops in 3 out of 4 possible cases if the other player stops in the second round. Put it differently, her average propensity to comply with the choice of other agent in the third round is independent from the choice of the other agent in the second round. Nevertheless, the subject that is more likely to comply with the action that attracts more attention may stop more often when other the subject stops.

H 4 *The subject follows the action of the others more often when the other subjects stop than when they continue even when the Bayesian reasoning allows to perfectly infer the exact history of outcomes of the other subjects.*

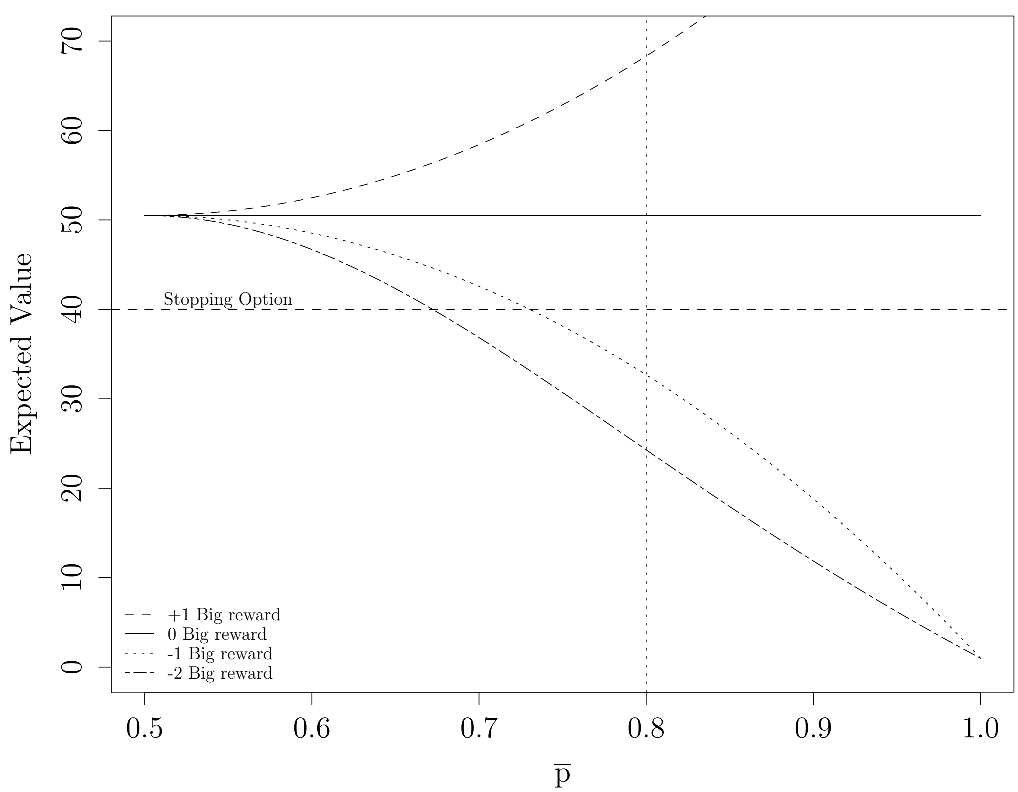

Figure 2: Expected value given different history of outcomes

The standard assumption in rational choice theory is that agents are risk-neutral and act in accordance with the Savage sure-things principle. However, numerous experimental evidences show systematic violation of these assumptions (Allais, 1953; Ellsberg, 1961; Tversky and Kahneman, 1974; Halevy, 2007). Therefore, we expect that if one decreases the certainty level of the more certain option by making the outcome of more certain option depended on chance, the subjects' behavior changes.

Suppose more certain option X does not bring the reward of 40 for sure but it brings the reward of either 30 or 50 with equal chance. In this case the X option has the same expected value as if it is completely certain and second-order stochastic relations with the option Y is preserved. As a consequence, the behavior of the risk neutral agents is unchanged. However, the risk-averse subjects should be less likely to switch to the option X since now it is less attractive for them.

H 5 *The subjects are less likely to stop if the outcomes of the alternative X is more uncertain.*

More importantly, the risk-averse subjects are less sure about the outcomes of their choice in more uncertain environment and they can compensate this uncertainty by complying to the choice of the others. Therefore, we expect the higher rate of compliance to the choice of the others the if the option X is more uncertain.

H 6 *The subjects are more likely to comply to the choice of the others if the outcomes of the alternative X are more uncertain.*

4 Experiment

4.1 Experimental Design

To test the hypotheses we use 6 different tasks and four treatments. One treatment variable is the level of inducement of the social cohesion and the other one is the level of uncertainty of the less uncertain option in the optimal stopping task. The experiment consists of 5 parts and proceeds as follows.

Part 1. In the first part of the experiment we use **the problem solving task** developed by Chen and Chen (2011). In this task the subjects review five pairs of paintings for five minutes having information about the authors of the paintings. Afterwards, they have to determine who draws next two pairs of paintings and they can receive 100 points for each correct answer.

We randomly match subjects in pairs and inform them that they stay with the same partner till the end of experiment. Depending on the treatment, we allow half of the subjects to communicate with their partner via chat to help each other with the task and we ban the chat option for the other half of the subjects.

Part 2, 3. In the second and the third part of the experiment the subjects face two versions of **the optimal stopping problem** in different order depending on the treatment they are assigned to. In each version of the problem two subjects choose simultaneously either to continue experimenting with more uncertain alternative (Y) or to stop and switch to the less uncertain one (X). They make their choice for three periods $T = 3$. The stopping choice – the choice of the less uncertain alternative is irreversible and this fact is known to the subjects. The subjects are matched with the same partner as in the previous part of the experiment and they know it.

Each of them knows that more uncertain alternative Y brings either the reward $R_Y = 100$ or $r_Y = 1$. The probability of the rewards depends on the unknown state of the world. Subjects know that in one state of the world the probability to receive the big reward R_Y is $\overline{p_Y} = 4/5$ and the small reward r_Y is $\underline{p_Y} = 1/5$, whereas in the other state of the world, vice versa, R_Y is received with probability $\underline{p_Y} = 1/5$ and r_Y with $\overline{p_Y} = 4/5$. Subjects also know that the each of the worlds is equally probable and stays the same during the game. All probability values are expressed in frequencies as well as depicted as colored balls in different urns.

The two versions of the optimal stopping problem differ in the level of certainty about the outcomes of stopping decision – the choice of the less uncertain alternative X. In the one version – certain version – stopping choice X simply brings the reward $R_X = 40$ in each period left, whereas, in the another one – uncertain version – the stopping choice can bring either the reward 30 or 50 with equal chance in each period.

We use the strategy method to obtain a complete set of the subjects' choices: Subjects indicate their choice in all possible histories and then a computer acts according to their strategies. Since the stopping choice assumes that some histories can not be realized in the next round, the choice in corresponding histories is contrafactual and can be only hypothetical. Therefore, we inform subjects in advance that the some choices can be hypothetical and payoff-irrelevant. Given their choices in previous round(s) we notify the subjects which choices exactly are hypothetical but we ask subjects to consider them seriously as well.

Part 4. In the fourth part of the experiment we elicit subjects cognitive abilities. All subjects have to pass **the cognitive reflection test** (Frederick, 2005) that has a good correlation with standard measures of cognitive abilities e.g. American College Test (ACT), Scholastic Achievement Test (SAT), Wonderlic Personnel Test (WPT). It consist of only three questions and one can easily guess the answer at the first glance, however, the correct answer is "counter-intuitive" and demands additional reflection. In the experiment each correct answer brings 100 points to the subjects.

Part 5. In the last part of the experiment, we measure the subjects' risk preferences and the attitudes towards ambiguity. We employ **the risk and ambiguity elicitation** procedure as in Cettolin and Riedl (2011).

To measure the subjects' risk preferences we use 6 different lotteries with two outcomes eliciting the subjects certainty equivalents. Table 1 shows the outcomes as well as the probabilities used. In each lottery subjects face the description of the lottery and a list of 20 sure amounts. The sure amounts decrease with equal step from the lottery's highest to lowest outcome. The probabilities are expressed both in percentages and in form of the pie chart. In each lottery subjects have to make a choice between a lottery and a sure amount 20 times. The subjects are not allowed to switch back and forth between the sure amount and the lottery. Thus, we elicit a unique switching point for each lottery. To elicit subjects' attitudes towards ambiguity we confront subjects with 6 decision problems where they make choices between an ambiguous lottery and a number of risky ones. In the same decision problem both the ambiguous lottery and the risky lotteries have the same pairs of outcome and the outcomes are the same as in the table 1. In each decision problem the subjects see a description of the ambiguous lottery and a table of 20 risky lotteries. The first and the last risky lotteries in the table are degenerate: They guarantee the high and the low outcome of the lottery. From the first to the last risk lottery the probability of the high outcome decreases by 5% and the probability of the low outcome increases by 5%. Similarly to the risk elicitation task the subjects can switch only once from the risky to the ambiguous lottery. The structure of the experiment is surmised in the table 2.

Table 1: Lotteries, p is the probability of winning r_1 points.

Lottery	p	r_1	r_2
1	0.20	400	0
2	0.50	160	0
3	0.80	100	0
4	0.50	120	40
5	0.25	160	40
6	0.33	120	0

Table 2: Experimental design

Part	Treatment 1 (2)	Treatment 3 (4)
1	Problem Solving Task (No Chat)	Problem Solving Task (No Chat)
2	Optimal Stopping Pr. - certain	Optimal Stopping Pr. - uncertain
3	Optimal Stopping Pr. - uncertain	Optimal Stopping Pr. - certain
4	Cognitive Reflection Test	Cognitive Reflection Test
5	Risk & Ambiguity Elicitation	Risk & Ambiguity Elicitation

4.2 Conducting the Experiment

We conducted the experiment in the laboratory of the Friedrich Schiller University, Jena, in May, June, October, and November, 2014. Eighteen sessions were run, each of them lasting about 70 minutes and employing 8 experimental subjects. We recruited the experimental subjects using the ORSEE system (Greiner, 2004) and the experiment was implemented with the help of z-Tree software (Fischbacher, 2007).

The subjects are assigned to the treatments at random. We vary the possibility to use chat option between subjects and the level of uncertainty in the optimal stopping task within subjects. The order of the optimal stopping tasks (certain and uncertain) is varied within the same session to control for session specific effects.

The subjects receive a paper version of the instructions as well as they can read them on the computer screen. They receive the instructions for each part separately so that they do not know what will be the next task. They also do not receive feedback about their performance in each part of the experiment until the experiment is finished. The experiment finishes with an end session questionnaire.

To avoid income effects the subjects are paid for one choice that is randomly selected at the end of the experiment. The subjects privately receive their payments with respect to the points they gained in the experiment. The Points are converted to Euros at the ratio 10 points for €1. Including a participation fee of €2.50 the subjects earned on average € 7.74 with minimum €2.5 and maximum €42.5.

We almost perfectly balanced the sample on gender across the experiment (ratio of female participants: 0.51) and across sessions (ratio of female participants per session: 0.38, 0.5, 0.5, 0.5, 0.5, 0.5, 0.5, 0.62, 0.62, 0.5, 0.38, 0.5, 0.5, 0.62, 0.5, 0.5, 0.5, 0.62). Also, we covered different age groups from 16 to 37 with median age of participants equal to 23.

As concerns the complexity of the experiment, the subjects report fairly

Table 3: Participants characteristics

Statistic	N	Mean	St. Dev.	Min	Max
Money Earned (€)	144	7.74	5.70	2.50	42.50
Age	144	23.90	3.41	16	37
Share of Females (♀)	144	0.51	0.50	0	1
Exp. Interesting	144	5.51	2.48	1	10
Exp. Length	144	4.06	1.72	1	9
Exp. Understandable	144	6.45	2.56	1	10
Task difficulty	143	4.99	2.06	1	10

good level of understanding of instructions with average value of 6.45 on scale from 1 to 10 and the task difficulty on average with mean 4.99 on scale from 1 to 10 as well.

5 Results

5.1 Descriptive Analysis

Optimal stopping problem. At first we provide a descriptive analysis of the subjects behavior in the optimal stopping problem. Figure 3 plots average propensity to stop conditioned on the treatment and round. One can see that the subjects display similar behavior across treatments with different level of uncertainty in all three rounds, whereas people stop more often in the round three in the treatment without inducement of social cohesion (no chat option),

To explain the distinctive behavior under the different level of social cohesion we first have to have a closer look on the subjects propensity to stop conditioned on the history of their own outcomes and the partners' choice (see figure 4).

Let's note that almost all subjects do not stop in the first round: average propensity to stop is only 0.146. The subjects act rationally given that in the first round the expected payoff is much higher when subjects continue than when they stop. The fact that people continue in the first round allows us to focus on the aim of our study: the learning patterns when the information about the others' behavior is present – the behavior in the second and the third round.

Clearly, in second and third round subjects behavior depends on (1) the choice of other subjects and (2) the history of outcomes. Namely, subjects stop more often if their partners stopped then when they continue and subjects

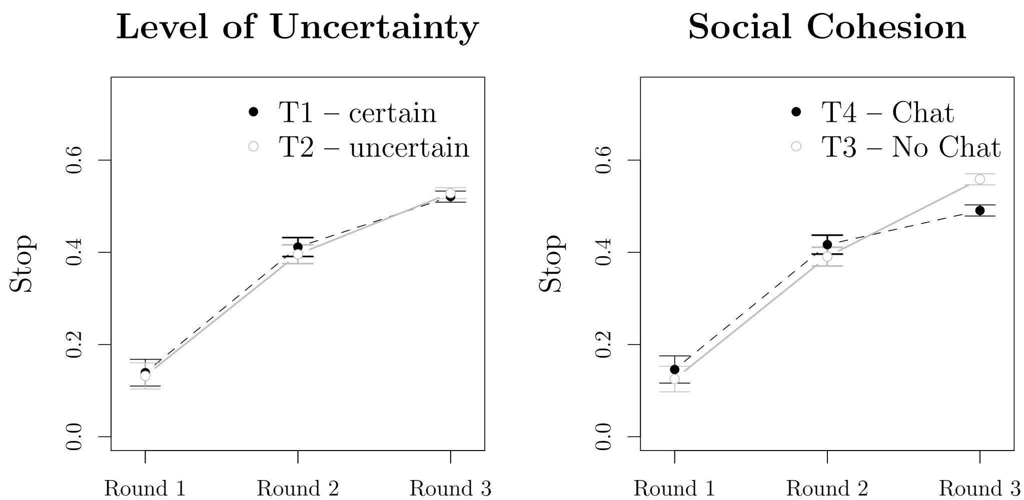

Figure 3: Average propensity to stop by treatements and round. Error bars indicate the standard error of the mean.

propensity to stop is higher when they get small rewards (1 point) than when they get big rewards (100).

Let's first consider the fact that subjects stops more often if their partner stops. It is perfectly rational to stop when the partner stops but only if she stops in the second round (expect when the subjects' private history of outcomes is $\widehat{O}_{2,j} = \{100, 100\}$). The subjects, however, stop when their partner stops in the first round. Moreover, they tend to stop more often when their partner stops in the first round than when she stops in the second one.

This finding strikes since the first choice of other subject can not bring any information about the state of the world, while the second choice of the partner can. This behavior is hard to explain from Bayesian Nash Equilibrium perspective but it goes in lines with the hypotheses 2,3 and provide evidence in favor of the social learning theory.

The reaction on own outcomes goes in line with rational choice theory: Expected value of the choice to continue is lower than of the stopping choice if the previous outcome(s) is small but it is higher if the outcome is big. However, in the third round Bayesian Nash Equilibrium prescribes to stop only if the history of the outcomes is $\widehat{O}_{2,j} = \{1, 1\}$ and the other subject stops, whereas subjects respond to any change in their outcomes. The possible explanation for this observation is that subjects learn from their outcome about the state of the world and given their risk preferences make their choice.

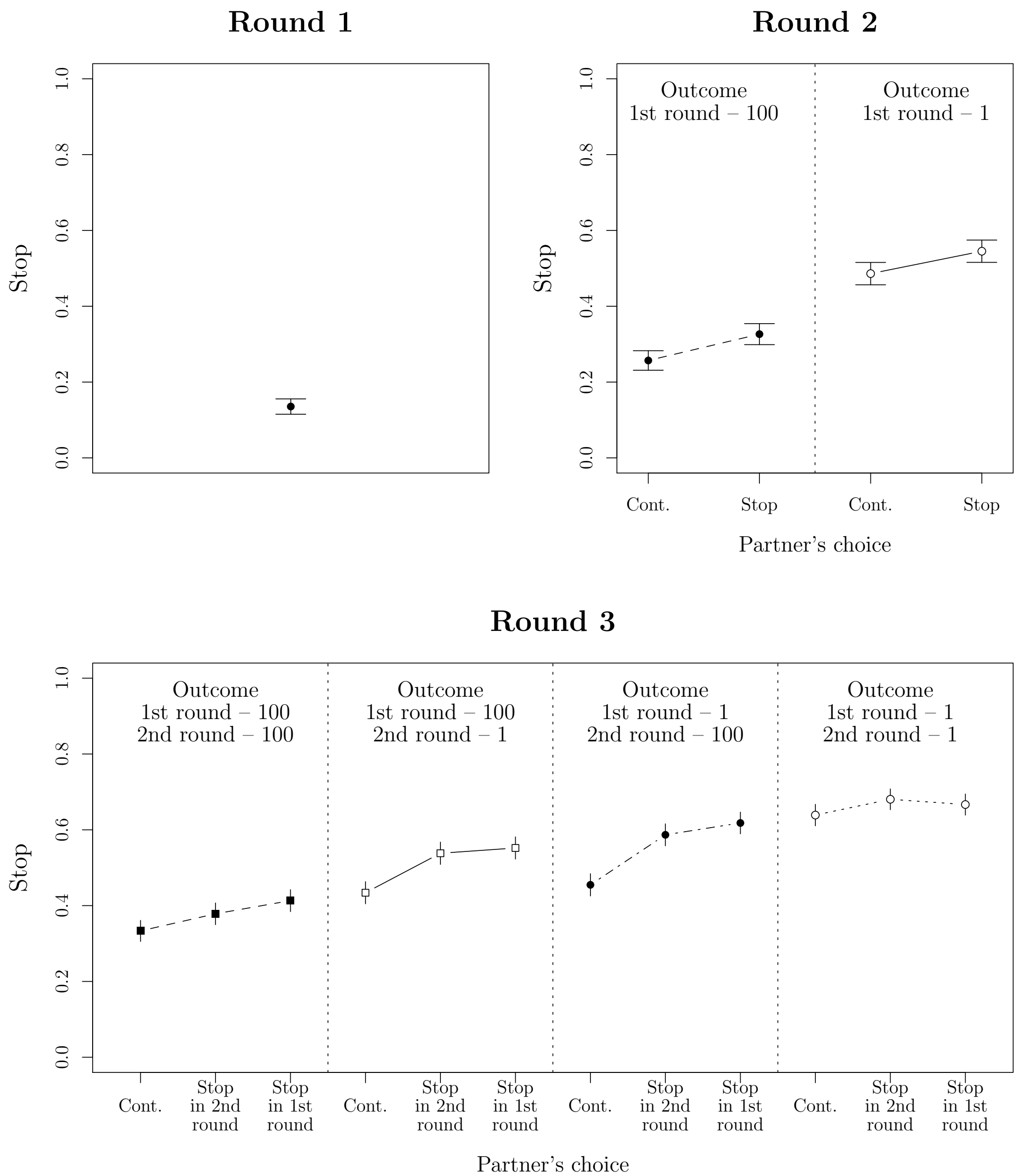

Figure 4: Average propensity to stop contingent on the outcomes history (indicated on top of the boxes) and partners' choice (provided on the x-axis). Error bars indicate the standard error of the mean.

Now, we can analyze the variation in the stopping choice under the different level of social cohesion conditioned on the history of outcomes and partners' choice(see figure 5). Again, we do not see the difference in the round one and two, but surprising patterns comes out in the third round: People more often stops in the treatment with no chat option specifically when they observe the stopping decision of others.

This finding is remarkable. First, it shows that people, indeed, treat the stopping decision in a specific way that gives additional support for the social learning theory. Second, counterintuitively, the social cohesion (chatting) do not seem to increase harmful conforming behavior and, instead, induce more rational decisions. Perhaps, subjects doubt the informativeness of others actions if they communicate with them and, hence, derive a "benefit of doubt". This explanation, nonetheless, needs further investigation.

Risk and ambiguity attitudes. First, we estimate the subjects risk attitudes we calculate subjects' i certainty equivalents $ce_{i,n}$ for each risky lottery n by taking the arithmetic mean of the smallest sure amount preferred to the lottery and the next sure amount in the list. We assume CRRA utility function $U(r) = r^\alpha$, where $0 < \alpha < 1$ indicates risk aversion, $\alpha = 1$ denotes risk neutrality and $\alpha > 1$ implies risk seeking preferences. We estimate α by minimizing the sum of squares difference between theoretically predicted certainty equivalent for each lottery n and the elicited certainty equivalent of subject i for corresponding lottery:[1]

$$\min_\alpha \sum_{n=1}^{6} [(p_n r_{1,n}^\alpha + (1-p_n) r_{2,n}^\alpha)^{\frac{1}{\alpha}} - ce_{i,n}]^2. \tag{2}$$

The risk elicitation task indicate that the average subject is risk-averse with $\alpha = 0.76$ ($s.e. = 0.06$) that is consistent with the previous studies (Holt and Laury, 2002; Cettolin and Riedl, 2011).

If we relate the risk attitudes and subjects' propensity to stop (see figure 13 in appendix B), we observe slightly negative association between these two variables. Thus, we have to account for the subjects' risk preferences in our further analysis.

Second, we asses ambiguity attitudes by comparing choices between ambiguous and risky lotteries. We calculate subjects prior belief on the ambiguous event for each of the six choices and construct a variable called "prior-belief" by averaging these beliefs for each of the subjects. The average prior-belief is equal to 0.47 ($s.e. = 0.01$)that is very close to 50%. It indicates that subjects are just slightly averse to ambiguity.

We investigate association between the ambiguity attitudes and stopping decisions. Figure 14 in appendix B does not show any relation. This finding is consistent with the experimental results that behavior under uncertainty in the dynamic framework is difficult to reconcile with ambiguity attitudes elicited in static setting (Seta et al., 2012).

[1] We correct for heteroscedasticity by normalizing the payoffs of lotteries to uniform length.

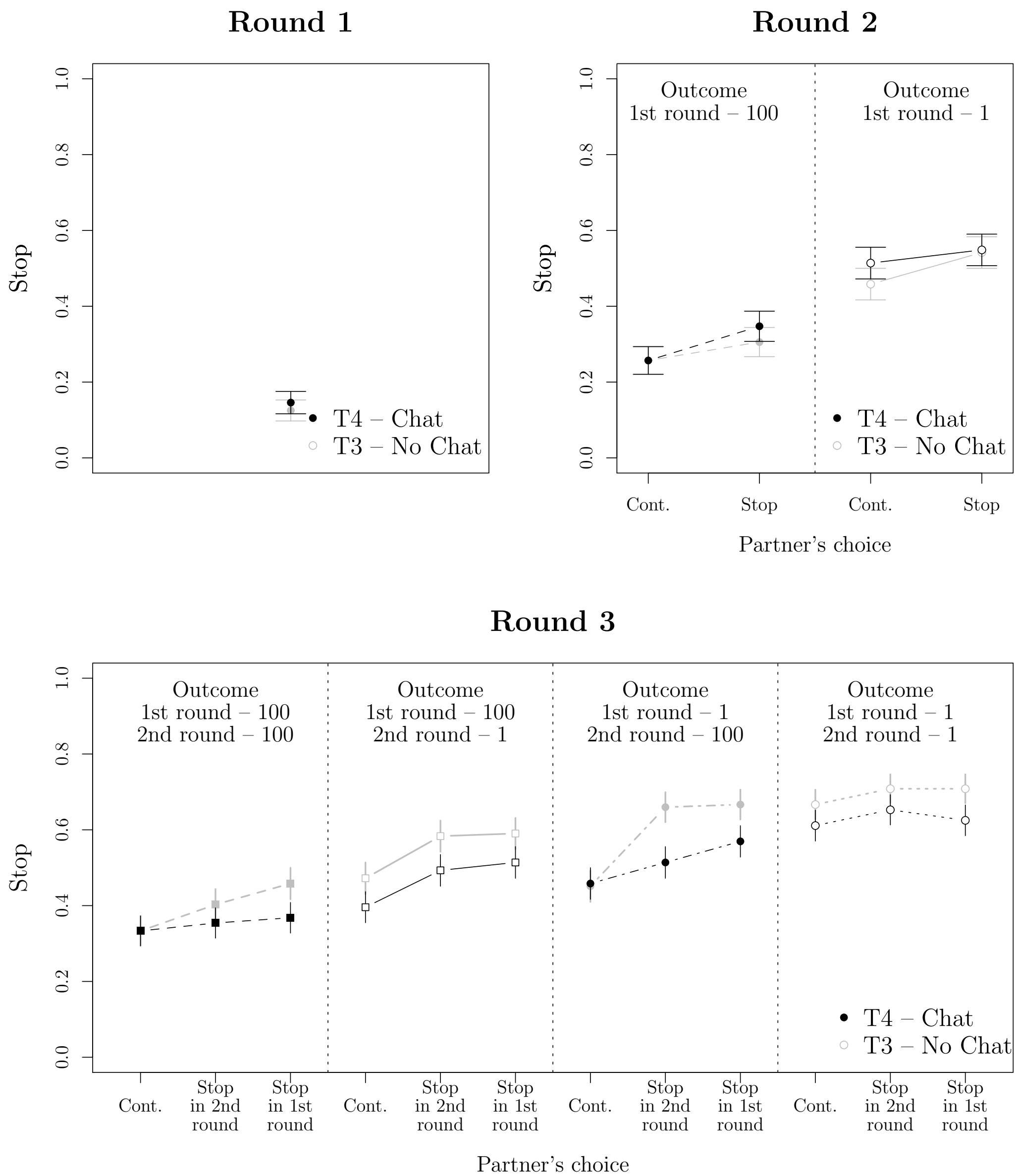

Figure 5: Average propensity to stop in treatement with and without inducement of social cohesion contingent on the outcomes history (indicated on top of the boxes) and partners' choice (provided on the x-axis). Error bars indicate the standard error of the mean.

Cognitive reflection test. In the cognitive reflection test subjects correctly answer on average on 1.61 (*s.e.* = 0.14) question out of 3 and the percentage of 0 or 1 correct answers is lower than the proportion of 2 or 3 correct answers: 0 correct - 0.25%, 1 correct - 0.18%, 2 correct - 0.28%, 3 correct - 0.29%. This result goes in line with previous findings (Frederick, 2005).

Now, it is interesting to consider the relation between performance in the cognitive reflection test and the subjects' choice in the optimal stopping problem(see figure 15 in appendix B). We do not find any substantial difference in propensity to continue depending on the number of correct answers in the cognitive reflection test. It suggests that observed difference in behavior is not driven by cognitive abilities.

5.2 Regression Analysis of Stopping Choice

We provide regression analysis of stopping choice in each of three rounds to understand the significance of our results. First, we estimate the determinants of stopping choice S by using the next three mixed-effect logistic models. For the first round we use the following model:

$$Pr(S) = \mathcal{L}(\beta_0+\beta_{Tnc}T_i^{nc}+\beta_T T_i+\beta_\alpha \alpha_i+\beta_A A_i+\beta_C C_i+\beta_{♀}♀_i+\beta_{\odot}\odot_i+\upsilon_s+\upsilon_i), \quad (3)$$

where $\mathcal{L}$ is the standard logistic function, T is a treatment dummy that is equal to one for treatment T2-uncertain, T_{nc} – treatment dummy that is equal to one for treatment T3-no chat. Set of control variables: α and A corresponds to risk and ambiguity preferences of subject, C – subjects' score in the cognitive reflection test,♀ – dummy equal to one for female subject, $\beta_{\odot}\odot_i$ – treatments order that is equal to 1 if the treatment T2-uncertain is first applied within subject. υ_s and υ_i are random effects for session s and subject i, respectively.

For the second round:

$$Pr(S) = \mathcal{L}(\beta_0 + \beta_{S_1^p}S_1^p + \beta_{Tnc}T_i^{nc} + \beta_T T_i + \beta_{\widehat{O}_1}\widehat{O}_1 + \beta_H H + controls + \upsilon_s + \upsilon_i), \quad (4)$$

where S_1^p indicates partners choice in the first round that is equal to 1 if the partner stops and 0 otherwise; $\widehat{O}_1$ is dummy variable that is 1 if the outcome in the first round is small (1) and 0 if it is big (100); H denotes the hypothetical choice that is 1 if the subject stops in the previous round and 0 if she continues.

For the third round:

$$Pr(S) = \mathcal{L}(\beta_0 + \sum \beta_{S_m^p}S_m^p + \beta_{Tnc}T_i^{nc} + \beta_T T_i + \sum \beta_{\widehat{O}_2^k}\widehat{O}_2^k + \beta_H H + controls + \upsilon_s + \upsilon_i), \quad (5)$$

where S_m^P denotes dummy variables S_1^P and S_2^P that are equal to 1 if the partner stops in the first or in the second round, respectively; $\widehat{O}_{2,k}$ is a dummies that corresponds to the one of the four histories of private outcomes k: $\widehat{O}_2^1 = \{100, 100\}$, $\widehat{O}_2^2 = \{100, 1\}$, $\widehat{O}_2^3 = \{1, 100\}$, $\widehat{O}_2^4 = \{1, 1\}$; H denotes if the subject stops in one of the previous rounds. The results are presented in the table 4.

Table 4: Determinants of Stopping choice by round

	Propensity to Stop, $Pr(S)$		
	Round 1	Round 2	Round 3
	(1)	(2)	(3)
Partner Stops in the 1st round (S_1^P)		0.365***	0.420***
		(0.138)	(0.100)
Partner Stops in the 2nd round (S_2^P)			0.274***
			(0.101)
TC-No social Cohesion(T^{nc})	0.629	−0.159	0.446*
	(8.711)	(0.220)	(0.252)
T2-uncertain (T)	−0.420	−0.071	0.073
	(1.487)	(0.138)	(0.080)
1st round outcome: $\widehat{O}_1 = \{1\}$		1.243***	
		(0.141)	
2nd round outcomes: $\widehat{O}_2^2 = \{100, 1\}$			0.737***
			(0.113)
2nd round outcomes: $\widehat{O}_2^3 = \{1, 100\}$			0.924***
			(0.113)
2nd round outcomes: $\widehat{O}_2^4 = \{1, 1\}$			1.543***
			(0.117)
Hypotheical choice (H)		2.252***	0.675***
		(0.301)	(0.098)
Risk preference (α)	−1.139	0.020	−0.265
	(14.552)	(0.146)	(0.163)
Ambguity (A)	0.498	−0.869	0.535
	(26.574)	(0.863)	(0.957)
Cognitive abilities (C)	−0.123	0.097	−0.100
	(5.071)	(0.102)	(0.113)
Gender (♀)	0.207	−0.366	−0.422*
	(11.694)	(0.225)	(0.247)
Treatment order ($\odot$)	4.627***	−0.048	0.217***
	(1.488)	(0.138)	(0.080)
Constant	−15.192	−1.066**	−1.184**
	(13.161)	(0.438)	(0.478)
Observations	288	1,152	3,456
Log Likelihood	−65.024	−660.935	−1,957.800
Akaike Inf. Crit.	150.049	1,347.870	3,947.590
Bayesian Inf. Crit.	186.678	1,413.510	4,045.960
Note:			*p<0.1; **p<0.05; ***p<0.01

Result 1. We find that people are more likely to stop in third round if the chat option is absent $\beta_{T^{nc}} = 0.446$ ($e^{\beta_{T^{nc}}} = 1.56161$), though we can reject the null-hypothesis only at 10% level ($p = 0.077$). However, the non-parametric exact paired Wilcoxon test applied across aggregated averages over the sessions also rejects the hypothesis that there is no difference between the stopping propensity between treatments with and without chat option in the round three ($p = 0.063$) suggesting that the result is robust.

Result 2a. As social learning theory predicts, we observe that people are significantly more likely to stop if their partner stops rather than if she continues in the first round (see the first row in the table 4). The conformity with stopping decision of other subject shows up both in the second $\beta_{S_1^p} = 0.365$ ($e^{\beta_{S_1^p}} = 1.44024$; $p = 0.008$) and third rounds $\beta_{S_1^p} = 0.42$ ($e^{\beta_{S_1^p}} = 1.52142$; $p = 0.00002$).

Moreover, applying the non-parametric exact paired Wilcoxon test across aggregated averages over the sessions we also can reject the null-hypothesis both in the second ($p = 0.004$) and third round ($p = 0.00004$) that subjects stop irrespective from the stopping decision of their partner in the first round. Put it differently, we find strong evidence that the subjects react on the choice of their partner in the first round though it does not bring any information about the state of the world.

Result 2b. Subjects have significantly higher propensity ($p = 0.006$) to stop if they observe the stopping decision of their partner in the second round, but it does not exceed the stopping propensity conditioned on stopping decision of their partner in the first round (see the first two rows in the table 4). Though the second choice of the partner can be informative, we see that the reaction level on the stopping decision of the partner in the second round is lower than on the stopping choice in the first round $\beta_{S_2^p} = 0.274 < \beta_{S_1^p} = 0.42$ ($e^{\beta_{S_2^p}} = 1.31582 < e^{\beta_{S_1^p}} = 1.52142$).

That is, the subjects follow the second choice of their partner at not higher level than the first choice despite the fact that the partner' second choice can be informative, whereas the first is not. Thus, subjects do not seem to discriminate informativeness of the actions but rather simply conform with the stopping decision of others.

Result 3. If we consider subjects' choice conditioned on their own outcomes we observe the behavior that conflicts with perfect rationality in the third round: they stop with significantly higher probability when the history of their private outcomes is $\{100, 1\}$ or $\{1, 100\}$ rather than when it is $\{100, 100\}$. Indeed, the coefficient $\beta_{\hat{O}_2^2}$ associated with history of private outcomes $\{100, 1\}$ is positive $\beta_{\hat{O}_2^2} = 0.737$ ($e^{\beta_{\hat{O}_2^2}} = 2.08975$) and significantly different from zero $p < 0.001$; the parameter $\beta_{\hat{O}_2^3}$ related to the history of outcomes $\{1, 100\}$ is equal to 0.924 ($e^{\beta_{\hat{O}_2^3}} = 2.51901$) with $p < 0.001$.[2]

Perhaps, the observed pattern can be explained by the subjects' risk preferences. The expected payoff from the choice to continue is higher when the history of private outcomes is $\{100, 100\}$ than when it is either $\{100, 1\}$ or $\{1, 100\}$. Hence, the risk-averse subject is more likely to stop. However, since we control for risk aversion in the regression we can not attribute the overreacting on the private outcomes to the risk attitudes.

Result 4. Finally, we asses if the difference between treatments with and without inducement of social cohesion is driven by reaction on the stopping choice of others. We do it with help of the following regression:

$$Pr(S) = \mathcal{L}(\beta_0+\beta_{S^p}S^p+\beta_{T^{nc}}T_i^{nc}+\beta_{S^p\times T^{nc}}S^p\times T^{nc}+\beta_T T_i+\sum\beta_{\hat{O}_2^k}\hat{O}_2^k+\beta_H H+controls+\upsilon_s+\upsilon_i), \quad (6)$$

where S^p is equal to 1 if the partner stops either in the first or second round. The result are reported in the appendix B in table 5.

The estimations show that if subjects observe stopping decision of others, they are more likely to stop in the treatment without chat option than in the treatment with it: $\beta_{S^p\times T^{nc}} = 0.287$ ($e^{\beta_{S^p\times T^{nc}}} = 1.333$, $p = 0.08984$). Thus, the difference in the behavior between treatments with and without induced level of social cohesion can be attributed to the way how subjects treat the stopping choice of their partner.

To sum up, we find that (1) propensity to stop is associated with level of social cohesion, (2) the subjects follow the choice of their partner irrespective of its informativeness, (3) the subjects overreact on their private outcomes, and (4) their reaction to the level of social cohesion is contingent on stopping decision of others.

6 Conclusion

This study shed light on the learning from the behavior of the others and from the own outcomes in the optimal stopping problem. We experimentally analyze human choice in the optimal stopping problem with publicly observable behavior but privately observable payoffs. The results of the experiment provide evidence in favor of social learning theory (Bandura, 1965, 1969) and question the predictive power of Bayesian Nash Equilibrium. Namely, the sub-

[2] The fact that $\beta_{\hat{O}_2^3} > \beta_{\hat{O}_2^2}$ could be attributed to the gamblers fallacy (Tversky and Kahneman, 1974). Subjects may think that if they receive a certain reward it is less probable to receive the same reward again. However, we suppose that observed relation can have another source as well since we explicitly stated in the instructions that the chances in each round stays the same as well as all subjects successfully passed the control questions where they were asked whether the chances change from round to round.

jects conform with the decision of their partner despite that this decision is uninformative from the Bayesian Nash Equilibrium perspective and they do not discriminate informativeness of stopping decisions of others. Moreover, their reaction on the social cohesion is contingent on the stopping decision of their partner pointing out that stopping decision attracts special attention.

In addition, we find that the subjects react on their private outcomes when the rational solution prescribes to preserve status quo. The overreaction pattern can have two main explanations. First, the subjects can act in accordance with their aspiration level. Indeed, previous studies of the optimal stopping problem suggest that people can stop too early when they reach aspired payoffs level (Sonnemans, 1998). This, however, can only partially explain the subjects choice in our experiment since the subjects stop more often in the cases when the outcomes are low rather than when they are high.

Second explanation is that they use monotone strategies insensitive to actual parameters such as simple counting. Indeed, experimental studies show that subjects use the monotone strategies to learn from their outcomes (Banks et al., 1997; Brindisi et al., 2009). In our experiment if the subjects observe good outcomes they can conclude that the good state of the world is more likely and, therefore, they continue, whereas when the outcomes are not conclusive they stop experimentation. Nonetheless, further research is needed to make more certain judgement.

In a nutshell, we observe that the subjects deviate from the rational strategy when they learn form their own outcomes and act in lines with predictions of social learning theory: conform with the others. It suggests considering the social learning theory in the domain of observational learning. Moreover, it implies that departure from the rational choice in situations where subjects may learn from the others such as R&D races or publicly observable investments in the uncertain option (Zizzo, 2002; Breitmoser et al., 2009; Çelen and Hyndman, 2012) can be attributed to imperfect inference and conformity with the others.

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A Experimental Instructions

Welcome to the experiment!

Thank you very much for participating. We hope that you feel comfortable. For our research it is important that you remain quiet and do not to communicate with any other participant unless you asked to do so. Please understand that in case you do communicate with other participants we will have to exclude you from the experiment without payment. If you have any questions please raise your hand and wait for the experimenter to come to you.

The experiment will consist of 5 parts. You will receive the instructions for each part only after the previous part has ended.

In each part of the experiment you will make a‘ number of choices. At the end of the experiment you will be paid out the earnings of one choice you have made in one of the parts of the experiment. Which choice this will be is determined at random at the end of the experiment. Each choice in each part is equally likely to be chosen. Therefore, **you should view each of your choices as the one that determines your earnings** unless it is explicitly indicated that it is not relevant for your earnings. During the experiment the earnings will be calculated in points and will be converted to Euros according to following rate:

10 Points = 1 Euro

In addition to the earnings from the choice you made, you will receive 2.50 Euro as a compensation for showing up on time.

Part 1[3]

In the first part for the experiment you will be randomly matched with another participant. This is your partner that will remain the same throughout the experiment.

Afterwards, everyone will be shown 5 pairs of paintings by two artists. You will have 5 minutes to study these paintings. Then you will be asked to answer questions about two other paintings. Each correct answer will bring you 100 points. ⟨You may get help from or help your partner while answering the questions.⟩

At the end of the experiment one of the questions will be selected at random and if the answer on this question is correct you get 100 point if not

[3] ( ) – indicate the instructions for the treatment T1.-certain; [ ] – indicate T2. - uncertain; ⟨⟩ – indicate the instructions for the treatment with chat option T4.-chat.

you get 0. The points you gain in this part of the experiment and whether this part is selected for payment will be shown at the end of the experiment.

Part 2

In the second part of the experiment you and your partner will have to independently formulate a strategy for the following decision problem. There are three rounds in the decision problem.

In each round it is possible to choose either **to stop** or **to continue** making decisions that will be considered for the earnings. **If you decide to stop** in a round then you receive [either 30 points or 50 points with equal chance] (40 points) **in each round that is left**, and the decisions you have to make in the remaining rounds in the cases that corresponds to your previous stopping decision(s) are hypothetical and will not be relevant for your earnings. It will be displayed which choices are hypothetical; however, we would much appreciate if you consider them seriously as well.

If you decide to continue in a round you will either receive 100 points or 1 point and you will have to decide whether to stop or to continue in the next round again.

This chance to receive 100 points or 1 point is determined with a 'coin toss' by a computer before you have made any decision. The coin has **equal chance** to fall on each side. The side on which it falls determines in which of two possible situations **you and your partner** both are.

In **the situation 1**, in each round in which you decide to continue, there is a chance of 4 out of 5 (that is, 80 percent) to receive 100 points and a chance of 1 out of 5 (that is, 20 percent) to receive 1 point.

In **the situation 2**, in each round in which you decide to continue, there is a chance of 1 out of 5 (that is, 20 percent) to receive 100 points and a chance of 4 out of 5 (that is, 80 percent) to receive 1 point. In other words:

In **the situation 1**, in each round in which you decide to continue **one ball is taken randomly** from the urn that contains **four 100 points balls and one 1 point ball.**

In the **situation 2**, in each round in which you decide to continue **one ball is taken randomly** from the urn that contains **four 1 point balls and one 100 points ball.**

(In case you decide to stop one 40 points ball is taken in each round left.) [In case you decide to stop one ball is taken randomly in each round left form the urn that always contains one 30 points ball and one 50 points ball.]

The following scheme summarizes these two situations: **You and your partner are in the same situation but you both do not know in which one.** The situation is same for all three rounds **and the chance** to receive

Figure 6: Scheme – T1-certain.

100 points or 1 point **is exactly the same in each round** in which you decide to continue.

In each round you observe **potential outcomes of your previous choices.** Also, you observe **potential choices of your partner but not the outcomes of the choices of your partner.** In each round you and your partner make your choices **simultaneously** and **independently**.

Suppose you have decided to continue in the round 1. Then in the round 2 you will make four decision in the following 4 cases **that corresponds to 4 potential cases** in which you can be (See the screenshot).

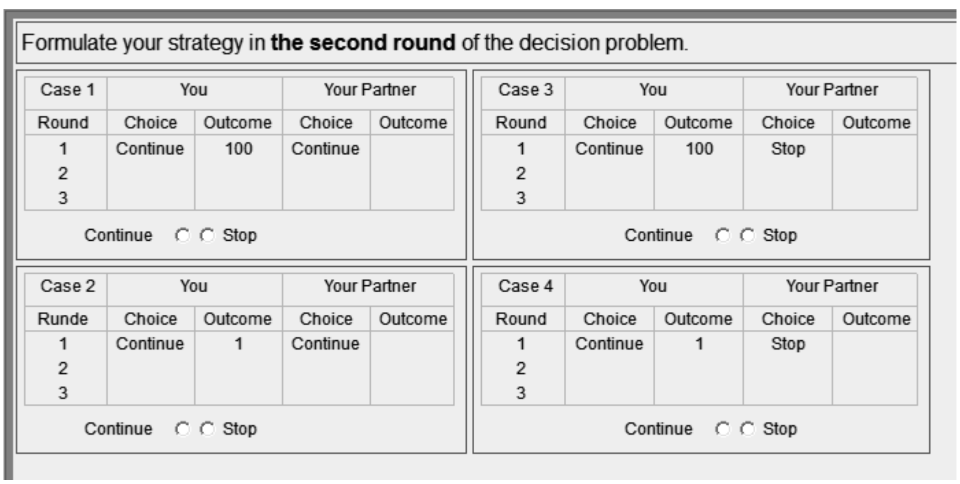


Figure 7: Screenshot – Round 2 (Part 2).

After you and your partner have made all choices, **the computer will implement your and your partners strategy - it will act according to the choices you and your partner have made.** When **the computer has finished**, it will select **one round at random**. The results in this round will determine the points you gain in this part of the experiment and your earnings in the experiment, if this part of the experiment is selected for the payment.

The points you gain in this part of the experiment and whether this part is selected for payment will be shown at the end of the experiment.

Part 3

In the third part of the experiment you and your partner will have to make choices in a decision problem that is similar to the decision problem in Part 2 except that if you stop you receive (either 30 points or 50 points with equal chance) [40 points] in each round that is left.

Thus, there are three rounds in the decision problem. **In each round** it is possible to choose either **to stop** or **to continue** making decisions that will be considered for the earnings. **If you decide to stop** in a round then you receive (either 30 points or 50 points with equal chance) [40 points] **in each round that is left**, and the decisions you have to make in the remaining rounds in the cases that corresponds to your previous stopping decision(s) are hypothetical and will not be relevant for your earnings. It will be displayed which choices are hypothetical; however, we would much appreciate if you consider them seriously as well.

If you decide to continue in a round you will either receive 100 points or 1 point and you will have to decide whether to stop or to continue in the next round again.

This chance to receive 100 points or 1 point is determined with a 'coin toss' by a computer before you have made any decision. The coin has **equal chance** to fall on each side. The side on which it falls determines in which of two possible situations **you and your partner** both are.

In **the situation 1**, in each round in which you decide to continue, there is a chance of 4 out of 5 (that is, 80 percent) to receive 100 points and a chance of 1 out of 5 (that is, 20 percent) to receive 1 point.

In **the situation 2**, in each round in which you decide to continue, there is a chance of 1 out of 5 (that is, 20 percent) to receive 100 points and a chance of 4 out of 5 (that is, 80 percent) to receive 1 point. In other words:

In **the situation 1**, in each round in which you decide to continue **one ball is taken randomly** from the urn that contains **four 100 points balls and one 1 point ball.**

In the **situation 2**, in each round in which you decide to continue **one ball is taken randomly** from the urn that contains **four 1 point balls and one 100 points ball.**

[In case you decide to stop one 40 points ball is taken in each round left.] (In case you decide to stop one ball is taken randomly in each round left form the urn that always contains one 30 points ball and one 50 points ball.)

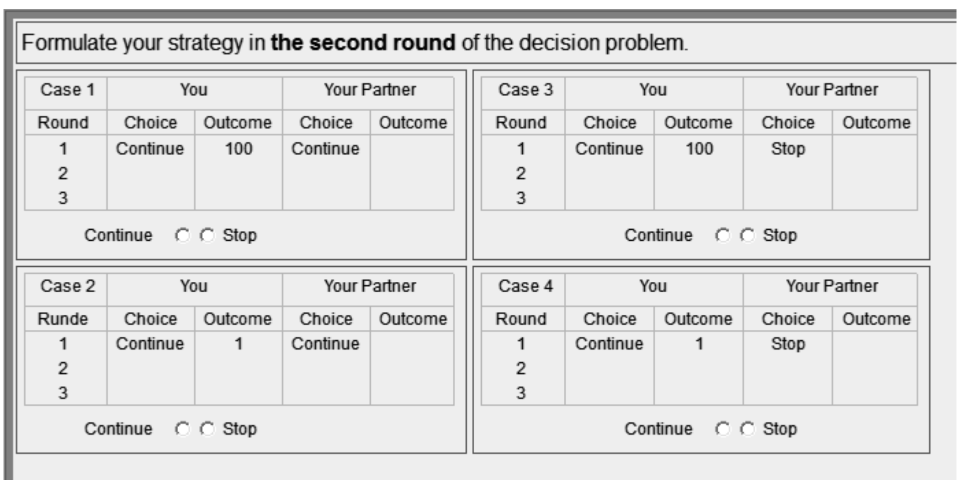
The following scheme summarizes these two situations:

Figure 8: Scheme – T2-uncertain.

You and your partner are in the same situation but you both do not know in which one. The situation is same for all three rounds **and the chance** to receive 100 points or 1 point **is exactly the same in each round** in which you decide to continue.

In each round you observe **potential outcomes of your previous choices.** Also, you observe **potential choices of your partner but not the outcomes of the choices of your partner.** In each round you and your partner make your choices **simultaneously** and **independently**.

Suppose you have decided to continue in the round 1. Then in the round 2 you will make four decision in the following 4 cases **that corresponds to 4 potential cases** in which you can be (See the screenshot).



Formulate your strategy in **the second round** of the decision problem.

Case 1	You		Your Partner	
Round	Choice	Outcome	Choice	Outcome
1	Continue	100	Continue	
2				
3				

Continue ○ ○ Stop

Case 2	You		Your Partner	
Runde	Choice	Outcome	Choice	Outcome
1	Continue	1	Continue	
2				
3				

Continue ○ ○ Stop

Case 3	You		Your Partner	
Round	Choice	Outcome	Choice	Outcome
1	Continue	100	Stop	
2				
3				

Continue ○ ○ Stop

Case 4	You		Your Partner	
Round	Choice	Outcome	Choice	Outcome
1	Continue	1	Stop	
2				
3				

Continue ○ ○ Stop

Figure 9: Screenshot – Round 2 (Part 3).

After you and your partner have made all choices, **the computer will implement your and your partners strategy - it will act according to the choices you and your partner have made.** When **the computer has finished**, it will select **one round at random**. The results in this round will determine the points you gain in this part of the experiment and your earnings in the experiment, if this part of the experiment is selected for the payment.

The points you gain in this part of the experiment and whether this part is selected for payment will be shown at the end of the experiment.

Part 4

In this part of the experiment you will be asked to answer three questions. One of the questions will be selected at random. If your answer on this question is correct you will gain 100 points. If it is incorrect you will gain 0 points. The points you gain will determine your earnings in the experiment, if this part of the experiment is selected for the payment.

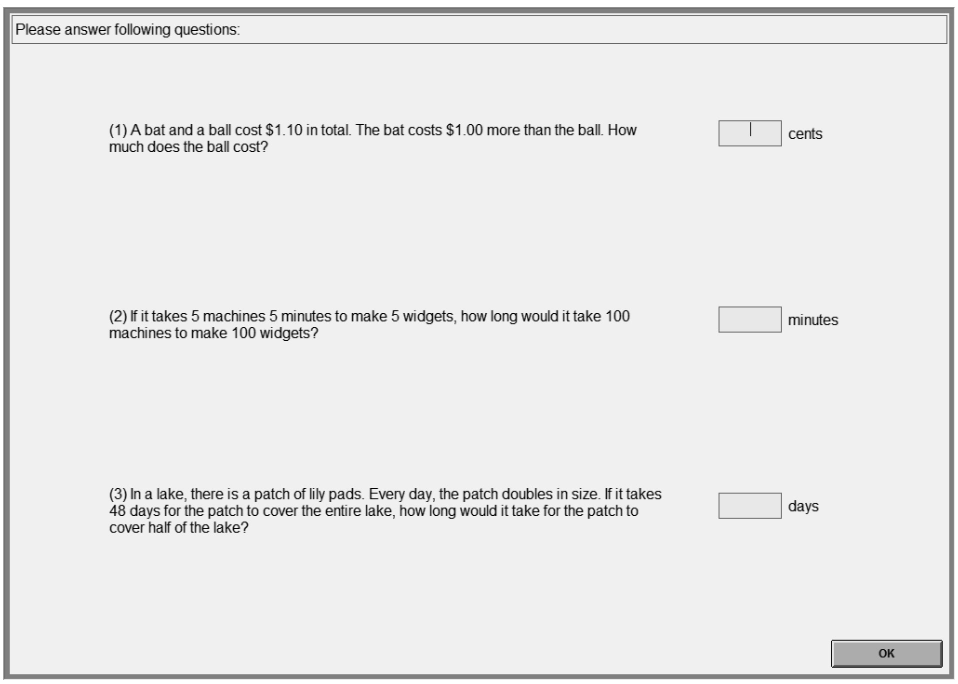


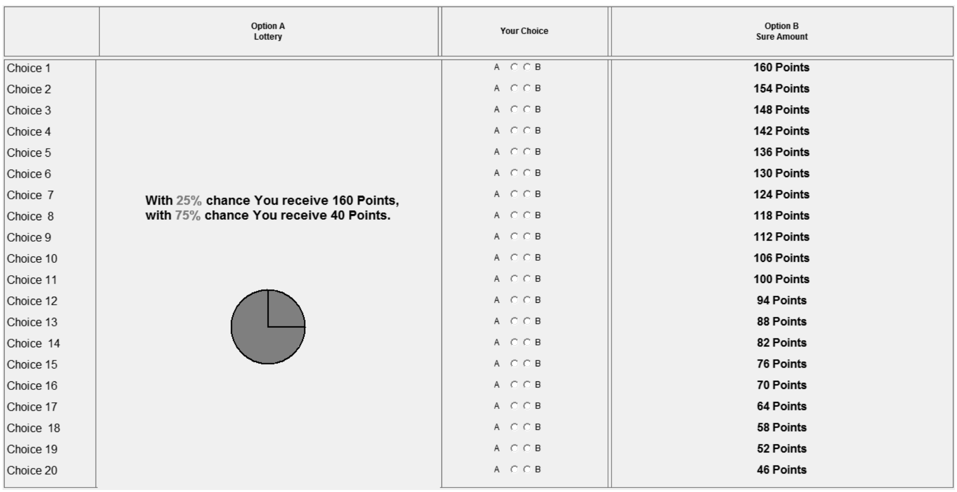
Figure 10: Computer Screen – Cognitive Reflection Test (Part 4).

Part 5

You will be confronted with 12 decision situations. 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 the same for every row in a given decision situation, while option B takes 20 different values, one for each row. Note that within a decision situation you can only switch once from option B to option A: if you switch more than once a warning message will appear on the screen and you will be asked to change your decisions. By clicking on NEXT you will see some examples screens of decision situations.

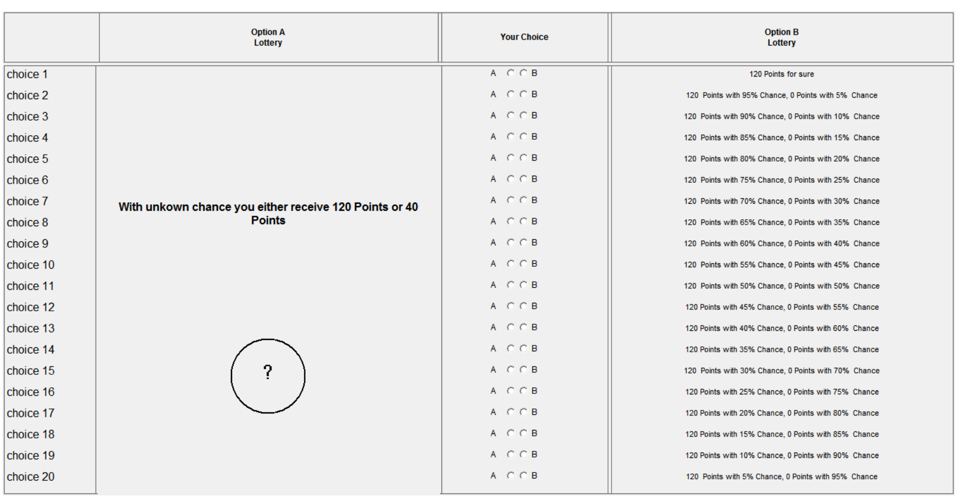
This is a screen shot of a typical decision situation that you are going to face. You are not asked to make choices now! Please have a careful look. Thereafter click on NEXT to proceed.



	Option A Lottery	Your Choice	Option B Sure Amount
Choice 1	With 25% chance You receive 160 Points, with 75% chance You receive 40 Points.	A ○ ○ B	160 Points
Choice 2		A ○ ○ B	154 Points
Choice 3		A ○ ○ B	148 Points
Choice 4		A ○ ○ B	142 Points
Choice 5		A ○ ○ B	136 Points
Choice 6		A ○ ○ B	130 Points
Choice 7		A ○ ○ B	124 Points
Choice 8		A ○ ○ B	118 Points
Choice 9		A ○ ○ B	112 Points
Choice 10		A ○ ○ B	106 Points
Choice 11		A ○ ○ B	100 Points
Choice 12		A ○ ○ B	94 Points
Choice 13		A ○ ○ B	88 Points
Choice 14		A ○ ○ B	82 Points
Choice 15		A ○ ○ B	76 Points
Choice 16		A ○ ○ B	70 Points
Choice 17		A ○ ○ B	64 Points
Choice 18		A ○ ○ B	58 Points
Choice 19		A ○ ○ B	52 Points
Choice 20		A ○ ○ B	46 Points

Figure 11: Computer Screen – Risk Elicitation Task (Part 5).

This is another screen shot of a typical decision situation that you are going to face. If you want to review the previous example click on BACK, otherwise click on NEXT to proceed.



	Option A Lottery	Your Choice	Option B Lottery
choice 1	With unkown chance you either receive 120 Points or 40 Points	A ○ ○ B	120 Points for sure
choice 2		A ○ ○ B	120 Points with 95% Chance, 0 Points with 5% Chance
choice 3		A ○ ○ B	120 Points with 90% Chance, 0 Points with 10% Chance
choice 4		A ○ ○ B	120 Points with 85% Chance, 0 Points with 15% Chance
choice 5		A ○ ○ B	120 Points with 80% Chance, 0 Points with 20% Chance
choice 6		A ○ ○ B	120 Points with 75% Chance, 0 Points with 25% Chance
choice 7		A ○ ○ B	120 Points with 70% Chance, 0 Points with 30% Chance
choice 8		A ○ ○ B	120 Points with 65% Chance, 0 Points with 35% Chance
choice 9		A ○ ○ B	120 Points with 60% Chance, 0 Points with 40% Chance
choice 10		A ○ ○ B	120 Points with 55% Chance, 0 Points with 45% Chance
choice 11		A ○ ○ B	120 Points with 50% Chance, 0 Points with 50% Chance
choice 12		A ○ ○ B	120 Points with 45% Chance, 0 Points with 55% Chance
choice 13		A ○ ○ B	120 Points with 40% Chance, 0 Points with 60% Chance
choice 14		A ○ ○ B	120 Points with 35% Chance, 0 Points with 65% Chance
choice 15	?	A ○ ○ B	120 Points with 30% Chance, 0 Points with 70% Chance
choice 16		A ○ ○ B	120 Points with 25% Chance, 0 Points with 75% Chance
choice 17		A ○ ○ B	120 Points with 20% Chance, 0 Points with 80% Chance
choice 18		A ○ ○ B	120 Points with 15% Chance, 0 Points with 85% Chance
choice 19		A ○ ○ B	120 Points with 10% Chance, 0 Points with 90% Chance
choice 20		A ○ ○ B	120 Points with 5% Chance, 0 Points with 95% Chance

Figure 12: Computer Screen – Ambiguity Elicitation Task (Part 5).

One of the 12 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 in the experiment, if this part of the experiment is selected for the payment.

Consider, for instance, the first screen shot that you have seen. Option A gives you a 25% chance to earn 160 points and a 75% chance to earn 40 points. Option B is always a sure amount that ranges from 160 points in the first row, to 46 points in the 20th row. Suppose that the 12th row is randomly selected. If you would have selected option B, you would receive 94 points. If, instead, you would have selected option A, the outcome of the lottery determines your earnings.

Consider now the second screen shot that you have seen. Option A gives you an unknown chance to earn 120 points and an unknown chance to earn 40 points. Option B is always a lottery that gives you different chances to earn 120 points or 40 points. Suppose that the 10th row is randomly selected. If you would have selected option B, you would receive 120 points with 55% chance and 40 points with 45% chance. If, instead, you would have selected option A, you earn 120 points with the chance X that is chosen at random between 0% and 100% and 40 points with the chance 1-X. This chance is unknown to you and to us as well.

B Addtional Estimations and Figures

Table 5: Determinants of Stopping choice

	Propensity to Stop, $Pr(S)$
	Round 3
Partner Stops (S^P)	0.198
	(0.124)
Partner Stops and No Social Cohesion ($S^P \times T^{nc}$)	0.287*
	(0.169)
TC-No Social Cohesion(T^{nc})	0.252
	(0.275)
T2-uncertain (T)	0.072
	(0.080)
1st round outcome: $\widehat{O}_1 = \{1\}$	0.738***
	(0.113)
2nd round outcomes: $\widehat{O}_2^2 = \{100, 1\}$	0.925***
	(0.114)
2nd round outcomes: $\widehat{O}_2^3 = \{1, 100\}$	1.544***
	(0.117)
2nd round outcomes: $\widehat{O}_2^4 = \{1, 1\}$	0.667***
	(0.098)
Hypotheical choice (H)	−0.265
	(0.163)
Risk preference (α)	0.544
	(0.957)
Ambguity (A)	−0.100
	(0.113)
Cognitive abilities (C)	−0.424*
	(0.247)
Gender (♀)	0.217***
	(0.080)
Treatment order ($\odot$)	−1.085**
	(0.481)
Observations	3,456
Log Likelihood	−1,957.490
Akaike Inf. Crit.	3,946.990
Bayesian Inf. Crit.	4,045.360
Note:	*p<0.1; **p<0.05; ***p<0.01

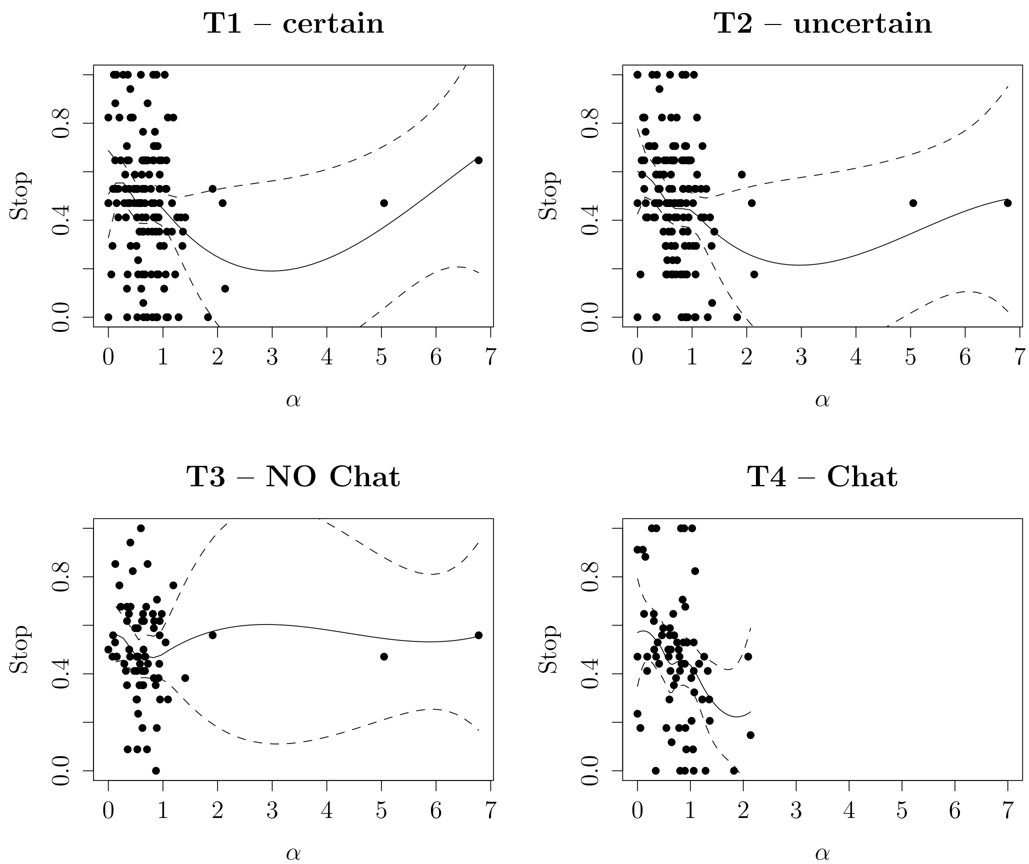


Figure 13: Relation between risk attitudes and propensity to stop by treatment.

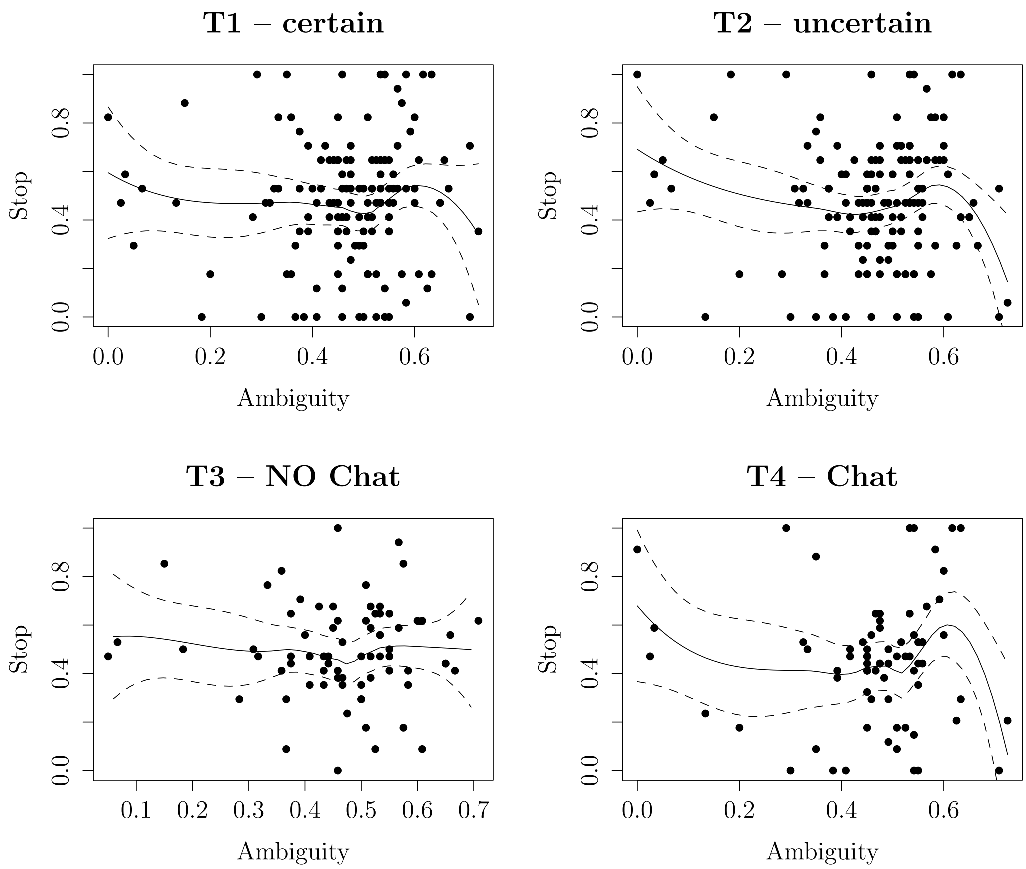


Figure 14: Relation between ambiguity attitudes and propensity to stop by treatment.

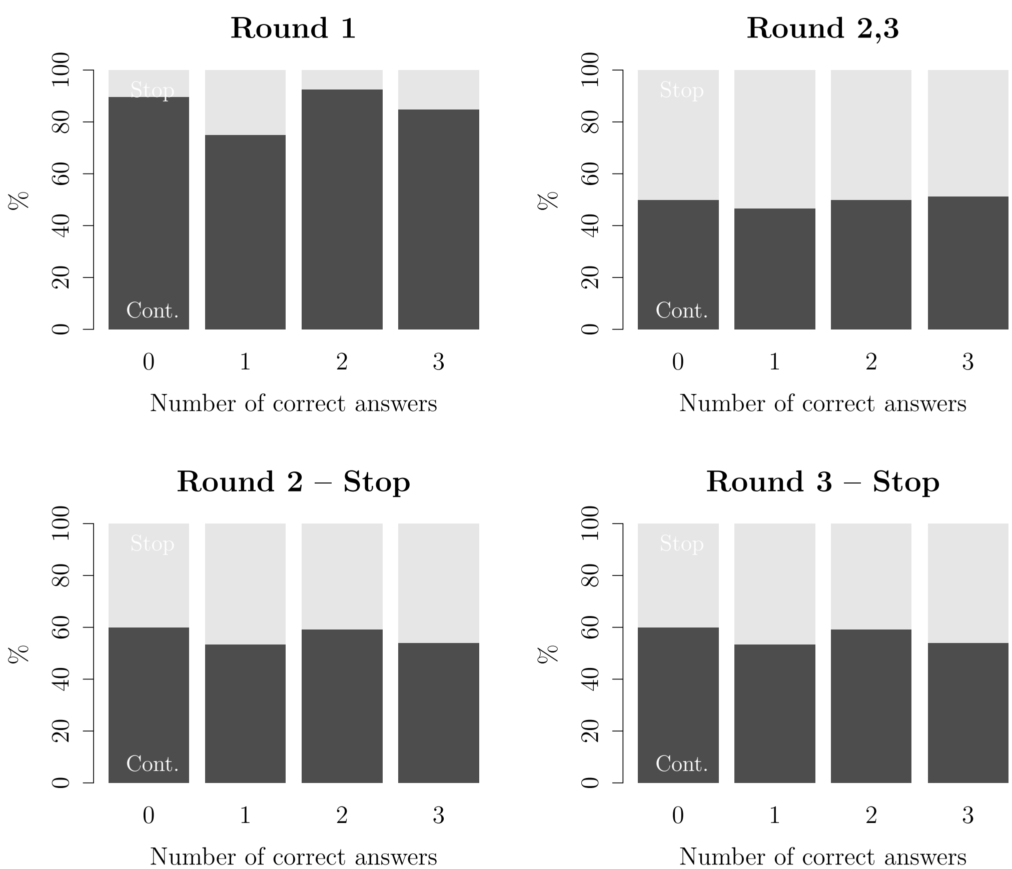


Figure 15: Percentage of choices to continue and to stop contingent on the number of correct answers in the cognitive reflection test.