YOUNG ADULTS GAMBLE LESS WHEN OBSERVED BY PEERS

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Young adults gamble less when observed by peers

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Abstract:

The impact of peer presence on the choices made by young people is yet to be fully understood. Using an incentive compatible experiment, we investigate whether: (1) young people's willingness to accept known and unknown risks varies when in the presence of an observer of the similar age compared to in private and (2) whether these preferences are affected by having observed peer's decisions. We find that young adults do not gamble more when observed by peers, rather they become more ambiguity averse.

Keywords: observation; risk; uncertainty

JEL codes: D80

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Introduction

Most decisions, even if their payoffs affect the decision maker only, are made in a social context rather than in isolation. Our choices are exposed to the judgments of observers, just as we often can observe others' decisions before we decide for ourselves. Social context is assumed to be an important factor in explaining behavior and its effect can be either positive or negative. In the context of risky behaviors of youth, the presence of peers is believed to lead to too much risk taking causing a loss in youth's welfare. Driven by this observation, many governments have introduced various laws that for example prohibit young adults from driving with other young adults as passengers during initial months of having a motor vehicle license. Despite the common belief that peers' presence has detrimental effect on youth behavior, the influence of observation on preferences has received only limited attention from economists both in terms of empirical evidence and theory. In this paper, we analyze a lab experiment with monetary rewards to better understand how individual attitudes towards known and unknown risks are affected by observation.

How and why observation affects behavior will depend fundamentally on how people are interacting with each other. In a review of the risk preferences under observation literature, Trautmann & Vieider (2011) categorize situations in which observation is potentially relevant into four distinct types: 1) a decision-maker's choice is observed by another person; 2) a decision-maker observes another agent's choice before deciding themselves; 3) a decision-maker's choice determines or influences an observer's outcome; and 4) a decision-maker's outcome depends on another agent's prior choice which they can observe. In this paper, we focus on situations where a decision-maker can only influence her own outcomes with no interdependence in monetary payoffs between the individuals (types 1 and 2 above).[1] Our focus is on the role of observation of the decision-making rather than the observation of outcomes resulting from the decision. This class of decisions includes many important real-life situations most often decided in the presence of others, such as: choosing one's own investment portfolio, insurance policy or retirement plan, participation in extreme sports; decisions about diet, truancy, usage of illegal substances, and gambling.

[1] For papers that study how the choice set that the others player faces affects own risk attitude see Linde & Sonnemans (2011) and Rohde & Rohde (2011).

Our goal is to offer a clean, separate measurement of the effect of observation on attitudes towards known and unknown risks. To do this, we defined risk attitudes according to economic theory (Neumann & Morgenstern, 1944) and adopted Knight's distinction between attitudes towards known and unknown risks (Knight, 1921). We asked 310 participants in a laboratory experiment to make consequential decisions between monetary lotteries with known and unknown odds to estimate their attitudes towards risk and ambiguity. We then investigated whether individual preferences for risk and ambiguity under observation were different than in private, and whether having observed others' decisions subsequently affected the individual's choices. Although participants made decisions that had monetary consequences, risk attitudes measured in this way have been associated with a wide range of behaviors outside financial domain, including health behaviors (Anderson & Mellor, 2008), misbehavior in school (Castillo, Jordan, & Petrie, 2018), consumption of genetically modified food (Lusk & Coble, 2005), and consumer choice (Muthukrishnan, Wathieu, & Xu, 2009).

Our results indicated that when observed by peers, young people took less risks with *unknown* (ambiguous) probabilities relative to when they were making decisions in private. The tendency to take risks with known probabilities was on average unaffected. Participants who acted as observers before making their own choices in private were not significantly more or less risk or ambiguity averse than those who had not yet been observers. Observers also showed no signs of conformity in attitudes to those they had observed.

2. Materials and methods

310 volunteers (149 male, mean age 22.28 with standard deviation 3.95) were recruited using ORSEE (Greiner, 2004) from the participant pool at the University of Sydney. The data was collected over 20 experimental sessions in August 2014 and June-August 2016 using zTree software (Fischbacher, 2007). Each session lasted approximately 50 minutes. The study was approved by the Human Research Ethics Committee at the University of Sydney. Figure 1 presents the timeline of the experiment. Appendix A contains the complete instructions as they were read aloud by the experimenter and shown on the computer screens in each session.

2.1 Experimental task

To assess participants' risk and ambiguity attitudes we asked them to choose between receiving a guaranteed $15 and a lottery where they could win some money or get nothing. Participants could also indicate indifference between the options. If they were indifferent, the program would randomly allocate them to either the lottery or the fixed option with equal chance. Figure 2 illustrates examples of a risky and an ambiguous trial. Participants were not allowed to skip trials. The guaranteed $15 was always available but the parameters of the lottery changed from trial to trial for a total of 90 unique choice situations, which appeared in a random order unique to each participant. There were 15 reward levels ranging from $15 to $91 as listed on the left column of Table D.1 in Appendix D. Half of the trials were *risky* with the exact odds of winning known (25%, 50%, or 75%). The other half of the trails were *ambiguous* with the odds of winning not precisely known but instead given as bounded within a certain range. For example, if as in Figure 2B ambiguity was equal to 50%, participants were told that they have at least 25% chance of winning and at least 25% chance of losing. Participants were also told that each of the possible winning probabilities within this range was equally likely to be implemented (which was indeed the case). The middle of that range was always at 50% chance of winning. The level of ambiguity about the true odds of winning was either 25%, 50%, or 75%. The lottery parameters (amounts and winning probabilities) were chosen to allow for identification of extreme attitudes to risk and to precisely differentiate the participants at the most commonly observed levels of risk aversion. Table D.1 in Appendix D shows the CRRA utility curvature cut-off estimates implied by our task.

6 out of the 90 trials were designed to test participants' rationality and understanding of the task. They featured a choice between a guaranteed $15 and a lottery that offered exactly the same amount, $15, at a probability known to be strictly lower than 100%. Any participant who satisfied preference monotonicity should have picked the guaranteed $15 option as it first-order stochastically dominated the lottery.

2.2 Observation implementation

Upon arrival in the lab, the participants were seated at computer stations and randomly assigned to be either the Choice-Makers or Observers. Each Choice-Maker completed the task in private (*private condition*) as well as while watched by an Observer (*observed condition*). Half of the Choice-Makers started with the observed condition

(Order 1 in Figure 1) and the other half with the private condition (Order 2 in Figure 1). By comparing the behavior of each Choice-Maker in the private and observed conditions, we could address how decision-making differs with and without observation using a within-participant analysis. Additionally, we can address the same question in a between-participant analysis by comparing the choices made only in stage 2 (Figure 1) by Choice-Makers in Order 1 (observed) and in Order 2 (private).

The Observers completed the task only once and in private. Half of the Observers completed the task prior to observing the Choice-Maker's decisions (Order 2) and the other half afterwards (Order 1). A between-participant comparison of participants who completed the task after observing choices made by Choice-Makers and Observers who completed the task before observation, was used to investigate how observing others influences decision-making.

Our lab consists of 32 computer stations organized as four rows with eight computer stations separated by an aisle in the middle. Figure D.1 presents an illustration of seating arrangements in the private and observed conditions. To ensure maximum privacy in the private condition, participants were randomly allocated to seats such that the cubicle(s) next to them were always unoccupied. In the observed condition, each Observer would get up from their allocated seat and move to sit in the seat beside their partnered Choice-Maker. The pairs were formed randomly such that the two people who sat in the same row of four cubicles were never matched together, meaning that they were only physically close to their partner in the observed condition.

We took the following measures to guarantee that participants felt observed in the observed condition and that observation was equally intense across the pairs of participants: Firstly, the physical distance between the Observer and the Choice-Maker was controlled by strapping their chairs together. The participants were also explicitly instructed to ensure that the Observer was in a position to clearly see the Choice-Maker's screen. Secondly, participants were told in advance that the Observers were financially incentivized to pay attention to their decisions. At the end of the experiment Observers were tested on their ability to recall three randomly selected Choice-Maker's choices that they witnessed and earned $1 for each correct answer (stage 4 - Test in Figure 1). Observers were not permitted to write down any notes while observing. To equalize the opportunity for earnings, at the same time each Choice-Maker was asked to

guess three of her Observer's choices. Choice-Makers and Observers were not allowed to communicate verbally.

Participants were told explicitly that the decisions made in the observed choice stage would only impact the Choice-Maker's payoffs and that the Observer would not be informed of the outcomes for the Choice-Maker resulting from their choices.

After they completed the main task and the test, all participants filled in a questionnaire about their demographics, perceptions of their partner and themselves, and the overall aims of the experiment (see full questionnaire in Appendix B).

2.3 Payment

Participants were paid according to their choice on one randomly selected trial. Participants were informed that a random number would be generated by the computer program to determine lottery outcomes. After finishing the questionnaire, the participant's screen displayed the payment trial indicating participant's choice (or computer's choice if indifferent) and the outcome of the choice if the lottery was selected. The final screen displayed the participant's overall payout from the session including the results from the test about their partner's choices (up to $3) and the $5 show-up fee. Participants made on average $32.62 (standard deviation: $25.59).

One could argue that because earnings from the lottery were determined by the computer (rather than for example a physical draw of a ball from an urn), participants could have suspected that the experimenters skewed the real odds of winning to minimize the cost of the experiment. To investigate whether this is an issue, we compared structural risk and ambiguity estimates of Observers and Choice-Makers making decisions in private (see Appendix C for description) to a corresponding sample of 21-25-year-olds from Tymula et al. (2013). In Tymula et al. (2013), lottery outcomes were realized by participants who drew a chip from a bag that contained the corresponding distribution of red and blue chips. In that study, the authors had no credible way to skew the odds of winning against the participants because in half of the trials blue chips and in the other half red chips were the winning ones. Furthermore, participants knew that they could investigate the number of chips in each bag at the conclusion of the experiment and the bags remained in the experimental room during the session. We found that risk and ambiguity estimates in these two samples were not

different suggesting that participants in our study did not display unusual levels of distrust towards the payment procedure by avoiding risky and ambiguous lotteries.[2]

3. Results

Participants chose lotteries that paid more and lotteries with larger winning probabilities more often, indicating that they understood the task. Participants chose ambiguous lotteries less often than risky lotteries and less often as the ambiguity level increased from 25% to 75%, consistent with widely observed ambiguity averse preferences in the domain of gains in similar studies (Kocher, Lahno, & Trautmann, 2018). The first-order stochastically dominated lottery of $15 (the other alternative was $15 with certainty) was chosen only 1.5% of the time. 32 participants (21 Choice-Makers) violated dominance at least once. 11 participants (7 Choice-Makers) violated dominance twice or more. Excluding those who violated dominance more than once did not qualitatively change the results. When we excluded all participants who violated dominance at least once, the significance of one result diseappeared as described below.

3.1 Estimation of risk and ambiguity attitudes

The experimental design allowed for both model-free and structural analysis of risk and ambiguity preferences. In this section, we present model-free measures that give a simple metric for the observed preferences of participants. Structural estimates are in the Appendix C. We calculated an individual's risk attitude as the proportion of times that the lottery was selected in the risky trials with known probabilities:

$$risk\ attitude = \frac{frequency\ risky\ lottery\ was\ chosen}{frequency\ risky\ lottery\ was\ offered}$$

The higher this estimate, the more risk tolerant the participant. Calculating individual ambiguity attitude was slightly more complicated because when an individual chooses an ambiguous lottery more often, it may be related to being less averse to ambiguity or less averse to risk. Therefore, an estimate of individual ambiguity attitude must account

[2] The average risk tolerance in our sample was 0.583 (95% confidence interval: (0.540-0.625)) and in Tymula et al. (2013) it was 0.535 (95% confidence interval: (0.4456-0.614)). The ambiguity tolerance in our sample was -0.340 (95% confidence interval: (-0.401,-0.278) and in Tymula et al. (2013) it was -0.452 (95% confidence interval: (-0.593,-0.310)).

for individual risk tolerance. As the ambiguity was always centered around the 50% chance of winning, we corrected the ambiguity attitude using the proportion of participant's lottery choices in the risky trials with 50% chance of winning:

$$ambiguity\ attitude = \frac{frequency\ ambiguous\ lottery\ was\ chosen}{frequency\ ambiguous\ lottery\ was\ offered} - \frac{frequency\ 50-50\ lottery\ was\ chosen}{frequency\ 50-50\ lottery\ was\ offered}$$

The higher this estimate, the more ambiguity tolerant the participant was.

We found that risk and ambiguity attitudes of Choice-Makers and Observers did not significantly differ by order and therefore we pooled the data from both orders together for analysis.[3]

3.2 Effects of being observed

Figure 3 plots the estimates of individual risk (panel A) and ambiguity (panel B) preferences in private against under observation. If the individuals were making identical choices in both conditions all the observations would have fallen on the black 45-degree line. If observation systematically made them more averse (tolerant) the observations would have fallen to the left (right) of the 45-degree line. For both risk and ambiguity attitudes, the observations are spread on both sides of the 45-degree line and there is a lot of heterogeneity in how participants changed their behavior when observed.

On aggregate, we found that the participants were more ambiguity averse when observed. Mean ambiguity tolerance in the private stage was significantly higher than in the observed stage (-0.146 versus -0.187, p=0.002 in a paired t-test). This is equivalent to a difference of 0.2 of standard deviations between the observed and private condition. A significant effect for risk attitudes was not evident. Participants chose the risky option 0.465 of the time in the private and 0.475 in the observed condition

[3] The average risk attitude of Choice-Makers in Order 1 was 0.477, which is not significantly different from 0.464 in Order 2 (two-sided p=0.634). Ambiguity attitude in Order 1 was -0.187, which is not significantly different from -0.147 in Order 2 (two-sided p=0.226). Observers' risk attitude in Order 1 was 0.476 versus 0.451 in Order 2 (two-sided p=0.418). Observers' ambiguity attitude in Order 1 was -0.195 versus -0.171 in Order 2 (two-sided p=0.486). Results are based on unpaired t-tests.

(p=0.163), which is equivalent to a difference of 0.059 of standard deviations between the observed and private condition (although not significant). Given the lack of pre-existing literature on the effect sizes expected in this kind of study, we conducted an ex-post power analysis. With a sample size of 155 Choice-Makers, assuming alpha=0.05 and power=0.80, effect sizes of 0.205 standard deviations or more could be detected.

3.2.1 Gender effects

Both males (-.195 in private versus -0.244 when observed, p=0.021) and females (-0.103 in private versus -0.137 when observed, p=0.044) were more ambiguity averse when observed. Neither males (0.510 in private versus 0.513 when observed, p=0.745) nor females (0.427 in private versus 0.442 when observed, p=0.113) showed a significant change in risk attitude under observation. Comparing risk and ambiguity attitudes of male and female Choice-Makers in the private condition, we found that compared to women, men were more risk taking (0.510 for men versus 0.427 for women, p=0.004) and more ambiguity averse (-0.195 for men versus -0.103 for women, p=0.005). Similarly, under observation males were more risk tolerant but more ambiguity averse than females.

To explicitly test whether age and gender of Choice-Makers and their Observers mediated the effect of observation on attitudes towards risk and ambiguity, for each Choice-Maker we calculated two indexes: 1) the difference in risk attitude when observed and in private and 2) the difference in ambiguity attitude when observed and in private. Table 1 presents the results of regressing these indexes on Choice-Maker's and Observer's age and gender. None of these independent variables were significant suggesting that neither age or gender of the Choice-Makers and Observers mediated the effect of observation.

3.2.2 Between-participant analysis

There is a possibility that Choice-Makers wanted to remain consistent in their choices made in private and under observation. If this were the case, our within-participant estimates of the effect of observation could have understated the effect of observation. The desire for consistency should not play a role in a between-participant analysis so we additionally compared the first set of choices that Choice-Makers made in Order 1 (under observation) with the first set of choices that different Choice-Makers made in

Order 2 (in private). We found that the between-participant results were consistent with the earlier within-participant analysis. Observed Choice-Makers (Order 1) were more ambiguity averse than those who made decisions in private (Order 2) (-0.211 versus -0.130, p=0.022).[4] However, there was no difference between risk attitudes in private (Choice-Makers in Order 2) and under observation (Choice-Makers in Order 1) (0.455 versus 0.478, p=0.387).

3.3 Preferences after observing another participant

All study participants assigned to the role of the Observer completed the task only once and in private. Half of the Observers completed the task before they observed Choice-Maker's choices (Order 2) and half after (Order1). Observers in Order 1 could have potentially conformed with the preferences of the Choice-Maker that they observed. However, we found no significant correlation between the risk (Pearson correlation coefficient = 0.114, p=0.326) or ambiguity (Pearson coefficient = 0.037, p=0.751) attitudes of Observers and the Choice-Makers that they observed. The left panels of Figure 4 show scatterplots of risk tolerance and ambiguity tolerance in Order 1.

Moreover, simply having observed another person perform the same task did not shift risk or ambiguity attitudes in a uniform direction. Observers in Order 2 did not choose the risky lotteries more, or less often on average in comparison with Observers in Order 1 who that had a chance to observe somebody else before deciding (0.476 of risky choices in Order 1 and 0.450 of risky choices in Order 2, p=0.418). There was no general effect on ambiguity attitude as well (-0.195 in Order 1 and -0.171 in Order 2, p=0.486).

3.3.1 Gender effects

To investigate whether gender affected conformity in behavior, for each Observer in Order 1 (i.e. for Observers who watched Choice-Makers' decisions before making their own decisions) we calculated the difference between their risk (ambiguity) attitude and the risk (ambiguity) attitude of their partner. We then regressed this index on Observer's and their partner's gender and age with the results shown in Table 2. None

[4] We note that this result becomes weaker when we exclude participants who violated first order stochastic dominance at least once (-0.194 versus -0.145, p=0.191). When we exclude only those who violated dominance twice or more, the result remains significant.

of these independent variables were significant, suggesting that neither age nor gender affected conformity.

4. Discussion

A growing body of literature in economics (see Trautmann & Vieider (2011) for review) and psychology (Albert, Chein, & Steinberg, 2013; Weigold & Schlenker, 1991) has produced mixed experimental results on how people's risk behaviors change when they are observed by others. To better understand these changes, we separately measured individuals' attitudes to risk and ambiguity under three conditions: in private, under observation, and after having observed somebody else's decisions. We focused on young adults, an age group believed to be particularly sensitive to observation by peers.

Results indicated that individuals on average became more ambiguity averse when they were observed. This change in preferences happened even though the observation manipulation was quite subtle. There was no interdependence in payoffs, and participants, in the clear majority of cases, had never met their observer before.[5] This result is consistent with earlier literature that established that when held accountable for their choices (for example asked to announce their choice in front of a group), people become more ambiguity averse (Curley, Yates, & Abrams, 1986; Trautmann, Vieider, & Wakker, 2008, Baltussen et. al. (2016)). It is important to note that we used different methodology than the earlier studies (Curley et al., 1986; Trautmann et al., 2008) which elicited ambiguity attitudes using the traditional Ellsberg (1961) design. The fact that this study elicited the same effect with a lottery choice task and a subtler observation treatment can be taken as evidence of the robustness of the effect. Similar effects have been established in the domain of consumer choice where participants who anticipated that others would be evaluating their choices, tended to prefer established brands to less-known brands (Muthukrishnan et al., 2009).

The ambiguity attitude finding is contrasted with the lack of significant impact on risk attitudes. Contradictory to common wisdom, the risk attitudes of participants in our study were not generally affected when individuals made decisions under observation

[5] Only 1.29% of participants reported that they have met their partner before. 3.87% of participants reproted that they have seen their partner before.

compared to in private, even when analyzed separately by gender. Previous findings on how risk attitudes change under observation were mixed. Baltussen et al., (2016) found that participants made more risk-averse choices when observed by a large audience. Weigold & Schlenker (1991), using a hypothetical lottery task, found that participants self-identifying as low risk-taking were more risk averse in their choices but there was no change in behavior for those who self-identified as high risk-takers. In contrast to these findings, Gardner & Steinberg, (2005) and Silva, Chein, & Steinberg, (2016) found that when participants believe to be observed by a peer, they are more risk taking in a driving game and are more likely to choose mixed lottery gambles (Smith, Chein, & Steinberg, 2014). These mixed results may suggest that risk attitudes do not change under observation under all circumstances (as in our study), or not strongly, or that a different preference than risk attitudes drove some of the previously reported results. There are reasons why our findings may differ from previously reported mixed results. In this study, we defined risk attitude using a precise and narrow economic definition and measured it using monetary incentives. The broader meaning that risk attitude has in psychology or in everyday language often depends on the context and may reflect risk attitude (as defined in our paper), patience, self-control, irrationality, learning abilities, subjective beliefs and other factors. It is thus possible that something other than economic risk attitude drove the behavioral change in some of the previous studies that employed a more general concept of risk taking. Moreover, our procedure of observation seems subtler than in previous studies and may thus put us below a threshold for measurable change in attitude. Previous studies involved either larger crowds of observers or observers known to the decision-maker, perhaps making the observation more salient. If this is the case, then the replication of the finding that people become more ambiguity averse when observed is even more notable.

Previous research has demonstrated that in many types of situations people follow to do what they observed others do, however only a few studies considered attitudes towards risk and ambiguity. In terms of decision making under risk, in a series of interviews Jaccard, Blanton, & Dodge (2005) found moderate to strong correlations between risk-taking behaviors of adolescent friends. Sutter (2009) found that private investment choices of the participants who performed the task earlier in a group were closer to the previous group decisions than the choices of those who only ever decided privately. Lahno & Serra-Garcia (2015) found that people imitated the decisions of

others when making decisions between safe and risky options, with conformity more likely if the other person selected the safer alternative. Cooper & Rege (2011), using a within-subject design, provided convincing evidence that "social regret" is the mechanism driving change in risk and ambiguity attitudes after observing others' choices. Our study contributes to this discussion in the literature by documenting a situation where no conformity in choices was observed. One difference between our study and previously published papers is that our task involved making many lottery choices which could have made it harder for participants to copy previously observed decisions of others.

Summing up, the young people in our study became more ambiguity averse when observed but their risk attitudes were not affected by observation. More work is needed to understand whether these findings would be different for different incentives, or if the observers were known to the decision-makers for example from work or school, or if the socioeconomic and demographic characteristics of observers and the observed varied.

Acknowledgments

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Figures and Tables

Figure 1. The timeline of the experiment. Half of the sessions were run in Order 1 and half in Order 2. Private indicates that all participants made choices in private. Observed indicates that Choice-Makers made choices under observation. Observer indicates when the Observers did not make any choices but instead acted as observers of Choice-Makers.

Session Structure				
	Order 1		Order 2	
Stage	Choice-Maker	Observer	Choice-Maker	Observer
1	Instructions			
2	Observed	Observer	Private	Private
3	Private	Private	Observed	Observer
4	Test			
5	Questionnaire			
6	Payment			

Figure 2. A screenshot of A) a risky and B) an ambiguous trial. In A) the participant is choosing between $15 for sure and 75% chance of $60. In B) the participant is choosing between $15 or an ambiguous chance of winning $60. The true odds of winning are between 25% and 75% as depicted by the gray occluder. Participants indicated their choice by pressing one of the three buttons in the bottom of the screen (left, indifferent, or right). The side where the lottery and fixed $15 option appeared and the winning lottery color were randomized on each trial.
[colour required]

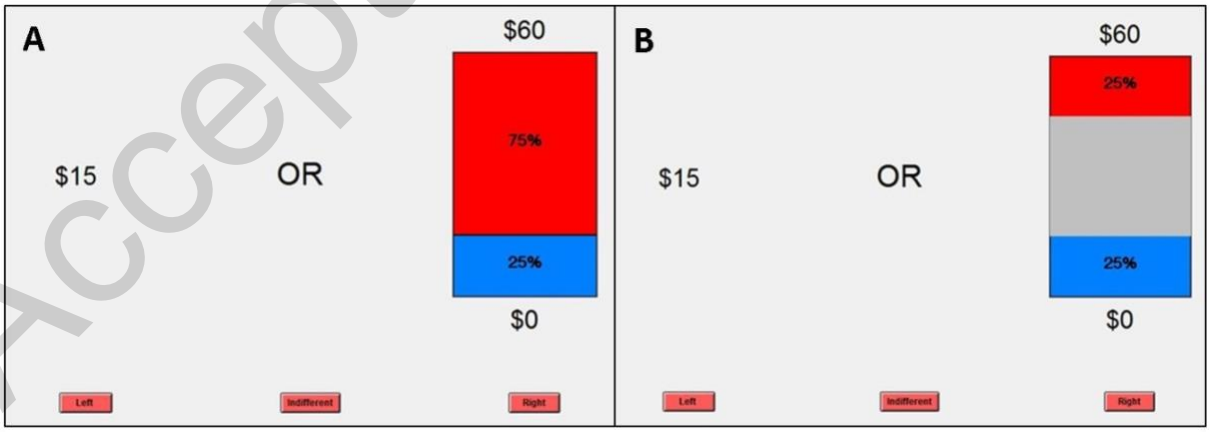


Figure 3. Relationship between A) risk and B) ambiguity attitude estimates in private and under observation. Each dot is one individual's risk (A) or ambiguity (B) attitude in private (y-axis) plotted against this individual's attitude under observation (x-axis). The green lines indicate risk and ambiguity neutral attitude. Black 45-degree line indicates no change in attitude. Red (blue) line is the the best linear fit through all the observations and the gray region is the 95% confidence interval.
[colour required]

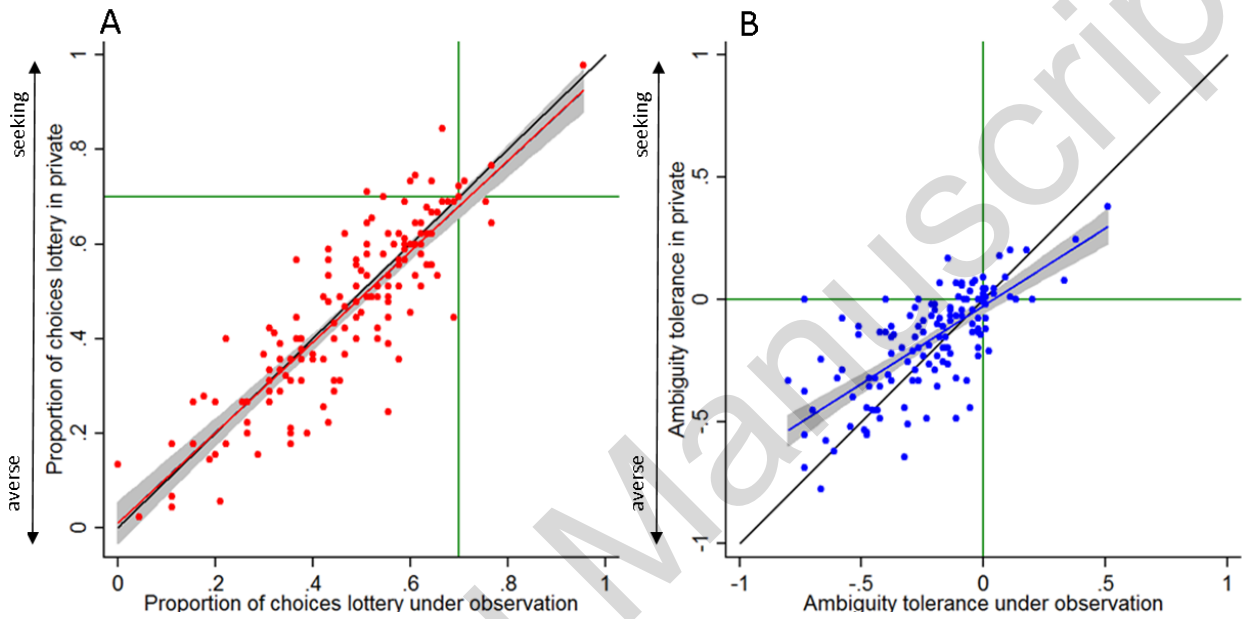


Figure 4. Relationship between Observer's and Choice-Maker's preferences. Each Observer's estimate of risk and ambiguity attitude is plotted against the risk and ambiguity attitude of the Choice-Maker that he observed. In Order 1 on the left (2 on the right) the Observer made choices after (before) having observed the Choice-Maker's choices. Best fit lines are plotted in each graph.
[colour required]

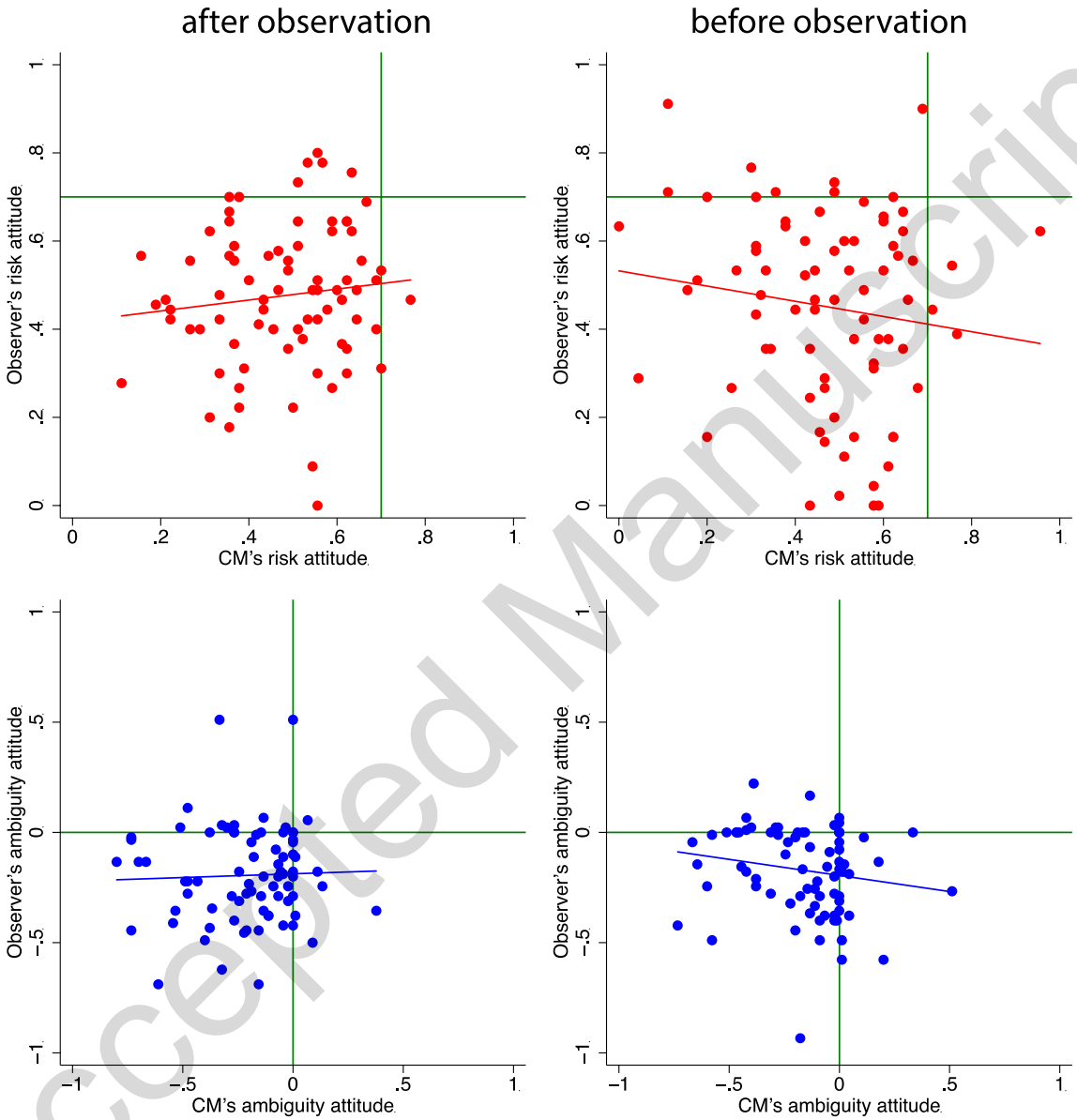


Table 1. Age and gender did not mediate the effect of observation on Choice-Makers' behavior. The dependent variables are the difference between Choice-Maker's attitudes when observed and in private**.**

	Risk Change	Ambiguity Change
Male	-0.011	-0.016
	(0.015)	(0.027)
Age	0.001	0.001
	(0.002)	(0.003)
Male Partner	0.021	-0.013
	(0.015)	(0.028)
Partner's Age	0.001	0.005*
	(0.002)	(0.003)
Constant	-0.040	-0.162*
	(0.057)	(0.095)
N	155	155

+ p<0.10, * p<0.05, ** p<0.01, *** p<0.001

Table 2. Age and gender did not mediate the effect of observation on Observer's behavior. The dependent variable Risk (ambiguity) difference is the difference between Observer's and Choice-Maker's risk (ambiguity) attitude.

	Risk difference	Ambiguity difference
Male	0.015	-0.017
	(0.047)	(0.075)
Age	0.007	-0.008
	(0.004)	(0.009)
Male Partner	-0.034	0.066
	(0.048)	(0.076)
Partner's Age	0.001	0.002
	(0.006)	(0.009)
Constant	-0.171	0.141
	(0.147)	(0.279)
N	77	77

+ p<0.10, * p<0.05, ** p<0.01, *** p<0.001

Appendix A. Instructions

Opening Instructions

Thank you for taking the time to participate in today's study with the School of Economics. The School of Economics has no deception policy when undertaking experimental studies. This session will run for around 60 minutes. As the session progresses you will be updated with instructions on what will be involved in the next part. Please let the supervisor know if you do not understand something along the way by raising your hand.

The choices you are making during the study are important because some of your payment will be based on them. There are no wrong choices in this experiment. We will ask you to state your preferences and by responding truthfully you make sure that you receive your preferred payment.

Task:

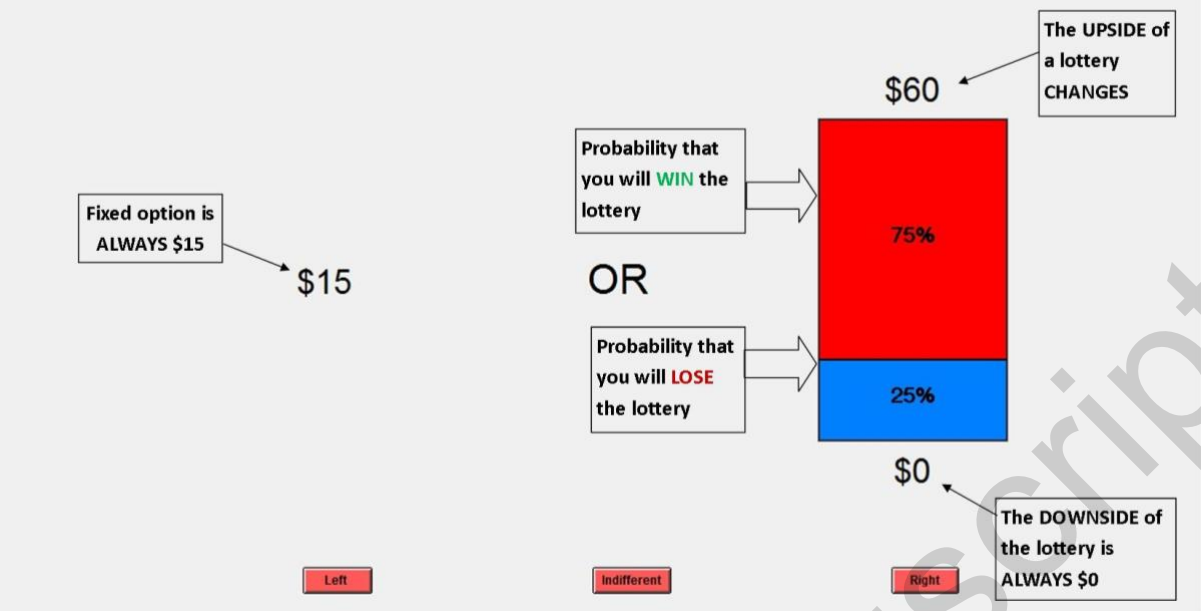
In this experiment, you will be repeatedly choosing between different monetary options. In every trial, you will be offered a choice between a fixed amount of $15 and a lottery with a chance to win a given amount or nothing. The dollar amounts are in real Australian dollars. The lotteries will vary between each trial by the probability of winning and the amount possible to win.

The lottery will be displayed as a rectangle split into two colour regions. The top colour will always represent the probability of winning and the bottom the probability of losing. However between trials the winning and losing areas may be represented in red or blue.

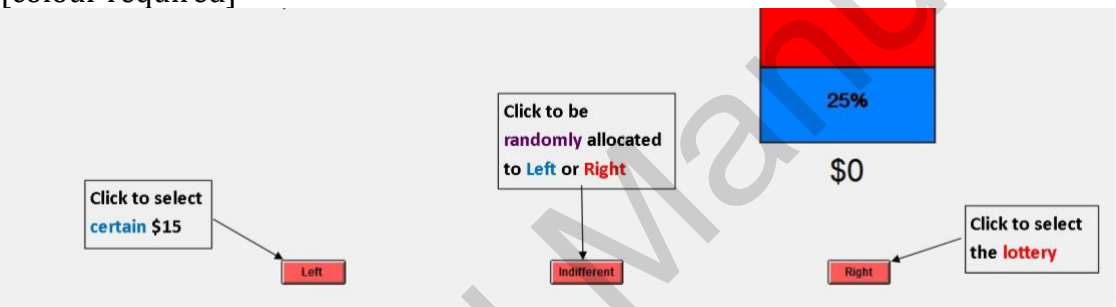
Select your preferred monetary option by clicking one of the red buttons underneath the corresponding option, labelled **Left** and **Right**. If you don't have a preference between these two choices select the **Indifferent** option.

The screen may look like the following page:

[colour required]

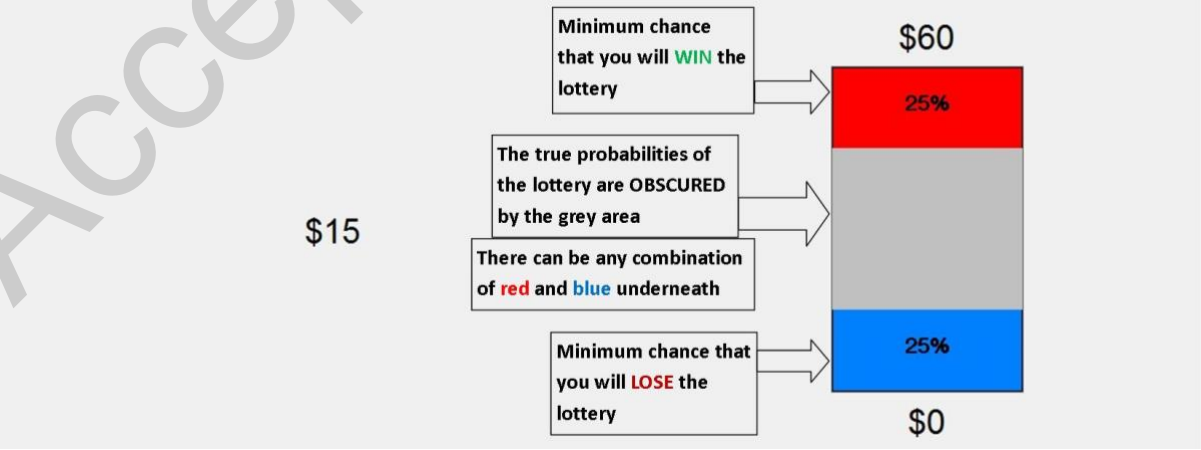


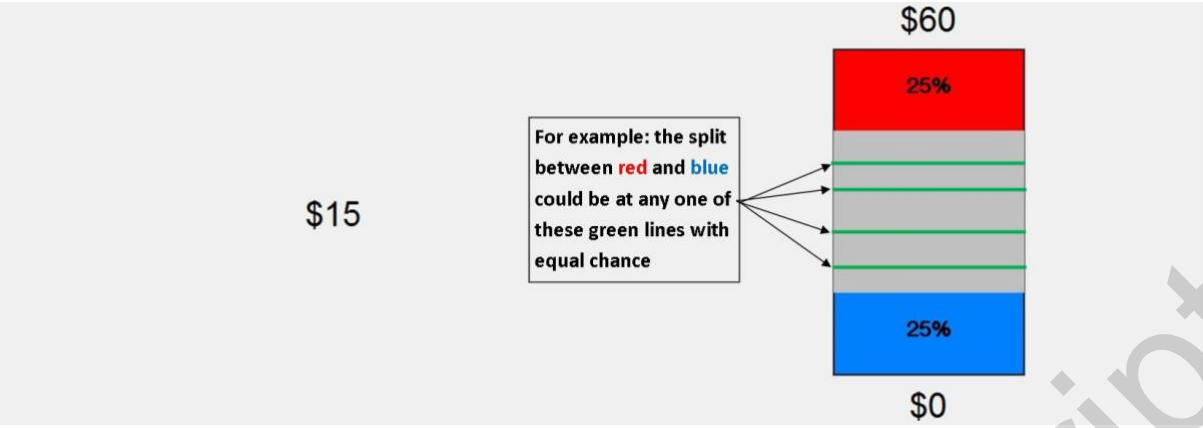
[colour required]



Some lotteries will have their proportions obscured by a grey box, such that you can only know the minimum chance of winning and a minimum chance of losing. If you are paid in this ambiguous lottery, the probability of winning will be randomly determined by the program. The probability can be any value between the minimum and maximum chance of winning, with each value equally likely to be selected.

Your screen may look like the following page:





Payment

At the end of the session, the computer will **randomly choose one of the trials for payment**. Your choice on this trial will determine your payment.

If on that trial you chose the fixed amount, you will receive that fixed amount for sure.

If you chose the lottery, it will be played by the computer. A random number between 0 and 100 will be generated from a uniform distribution, meaning that each number is equally likely to be selected. If the number is less than the shown probability of winning, you will receive the winning amount at the top of the lottery display. If the number is greater than the winning probability, you will receive nothing.

If you chose **Indifferent** then your choice will be allocated to either the **fixed amount or the lottery** will a **50-50 chance**, using a separately generated random number.

You will also receive a $5 show-up payment regardless of the task outcomes.

Your total payment will be the sum of the fixed show-up payment, the results of the randomly selected trial, and rewards from a test for which details will be given later in the session. You will receive all payments in cash at the end of the experimental session after signing a receipt form. The value of the monetary payments you receive will be **private information, only known to you**.

If you have any questions raise your hand now.

Part 1: Observation

You have been randomly paired with another person in the room for the next part of the session. You have also been randomly selected to be either a choice-maker or an observer of the choices being made in this next section.

[A subject's screen will now be displaying which they are on the next line in bold text.]

In this part of the session there are 90 choices to be made.

[From here there are different instructions for Choice-Makers and Observers.]

[Choice-Makers]

When instructed by the supervisor, your partner will come over and sit down to the right of you. You may not speak to each other during this stage of the session.

It is in your partner's best interest to pay attention to the choices you make. Later in the session, your partner will be shown a few randomly selected choices from this set, and then asked to recall which option you chose. The observer will earn money for each correctly recalled choice.

Also, **one of your choices** may be selected at random at the end of the session to be paid-out. The choices will only impact your own pay, with no effect on your partner's payoffs.

[Observers]

When instructed by the supervisor, you can start moving over to your partner and sit down to the right of them.

[Below is displayed the seat number of their partner.]

Ask a session supervisor if you need assistance finding the right seat. You may not speak to each other during this stage of the session.

It is in your best interest to pay attention to your partner's choices. Later in the session, you will be shown a few randomly selected choices from this set, and then asked to recall which option your partner chose. You will earn money for each correctly recalled choice.

Also, one of the Choice-Makers choices may be selected at random at the end of the session to be paid-out. The choice-maker's choices will only impact their own pay, with no effect on your payoffs.

Part 2: Private choice making

[Choice-Makers]

You will now be given another 90 choices between monetary options to complete. **One of these choices** may be paid out at the end of the session, or one of your choices from the previous set may be paid out. If you are an Observer,

[Observers]

You will now be given 90 choices between monetary options to complete. **One of these choices** will be paid out at the end of the session.

Testing and Questionnaire

You will now complete a test to see how well you know your partner.

[Choice-makers]

You will be shown a selection of 3 choices which were presented to your partner in their private choice task and asked to select which option they would most likely have chosen. You will be rewarded $1 for each correct answer.

[Observers]

You will be shown a selection of 3 choices which were presented to your partner while you were observing their choices and asked to recall which option they chose. You will be rewarded $1 for each correct answer.

After the test you will be required to fill out a questionnaire form. Please answer honestly, remembering all data is collected and stored anonymously.

After you have completed the questionnaire, you will see a screen showing your payment from the session along with how it was calculated.

Appendix B. Questionnaire

Page 1

1) What do you think the experiment was about?

Page 2

1) Gender
2) Age

(Choice-Makers)

3) How many of the test questions do you think your partner remembered correctly? (0,1,2,3)
4) For what proportion of your choices do you think your partner was paying attention? (slider from none to all)
5) Do you think your session partner cared about what your choices were? (Yes, No)
6) Did you try to be more consistent with your choices for your observer's benefit? (Yes, No)
7) When you were being observed did you feel more focused on the task or more distracted? (slider from distracted to focused)
8) Compared to the private choice making stage, do you think having your session partner watching made you take: (more risks, less risks, no change)
9) Compared to the private choice making stage, do you think having your session partner watching made you pay: (more attention to the task, less attention to the task, no change)

Please explain how your choices were different:

(Observers)

3) For what proportion of your partner's choice were you paying attention? (slider from none to all)
4) Did you care about what your session partner's choices were? (Yes, No)
5) Compared to their choices in the private stage, do you think having you watching made your partner take: (more risks, less risks, no change)
6) Compared to their choices in the private stage, do you think having you watching made your partner pay: (more attention to the task, less attention to the task, no change)

Please explain how you think their choices were different:

Page 3

About your partner

1) Have you met your session partner before this study? (Yes, No)
2) Do you remember ever seeing your session partner before this study? (Yes, No)
3) Do you think it is likely that your will interact with your partner after the session has ended? (slider from unlikely to very likely)
4) What is the frequency with which your partner chose the lottery instead of $15? (slider from never to always)

5) Rate your partner on a scale 1 to 5 for the following characteristics:
   (unattractive, attractive)
   (weak, strong)
   (poor, wealthy)
   (frivolous, practical)
   (irresponsible, responsible)

About yourself

6) Rate yourself on a scale of 1 to 5 for the following characteristics:
   (unattractive, attractive)
   (weak, strong)
   (poor, wealthy)
   (frivolous, practical)
   (irresponsible, responsible)
7) What is the frequency with which you chose the lottery instead of $15: (slider from never to always)

Page 4

8) Home faculty
   Second home faculty (for combined degree)
9) Year of study
10) Are you a domestic or international student?
11) How many siblings do you have?
    How many of your siblings are younger than you?
12) What do you identify as your nationality?
    If you do not identify as Australian, how long have you been living in Australia? (less than 6 months, between 6 months and 1 year, between 1 and 3 years, more than 3 years, Not applicable (I am Australian))
13) Out of the following options how would you identify your predominant ethnic heritage? (African, East Asian, European, Indigenous Australian, Middle Eastern, North/South/Central American, Pacific Islander, South Asian, South-East Asian, Other)

Appendix C. Structural analysis

In the structural model, we assumed that an individual's expected utility from choosing a lottery *(**x**, **p**, **a**)* that pays reward ***x***, with probability ***p*** and ambiguity about that probability ***a***, is given by:

$$EU(x, p, a) = \left(p + \beta \frac{a}{2}\right) x^{\alpha}$$

α - the risk attitude and β - the ambiguity attitude were estimated. Risk attitude was captured through the curvature of the utility function with $\alpha = 1$ ($<1; >1$) indicating risk neutrality (aversion; seeking). Ambiguity was introduced in the spirit of Gilboa & Schmeidler (1989). Ambiguity neutral individuals would view the chance of winning in the ambiguous lottery as 50-50 since the ambiguity is centered around 50% and would thus have $\beta = 0$. Ambiguity averse individuals would perceive the chance to win to be lower ($\beta<0$) and ambiguity seeking participants would perceive it to be higher ($\beta>0$) than 50%.

We allowed for stochasticity in choice by using a logistic choice function where the probability of choosing a lottery was given by:

$$P(\textit{chose lottery}) = \frac{1}{1 + e^{(EU(x,p,a) - EU(\$15))/\gamma}}$$

γ is a noise term controlling for the slope of the choice function.

Maximum likelihood estimation was used to fit the data to this model in a similar fashion to Harrison (2008). Throughout the paper we derive the risk (α) and ambiguity (β) parameter estimates as linear combinations of independent variables of interest. The variables are derived in the following way:

$$\alpha = \alpha_0 + \sum_i \alpha_i * y_i$$

$$\beta = \beta_0 + \sum_i \beta_i * y_i$$

where α_0 and β_0 are constants, y_i is the variable of interest, and α_i and β_i is the corresponding coefficient. We tested the impact of observation and other variables on risk and ambiguity preferences by introducing these factors as variables of interest. Throughout the analysis standard errors were clustered on the level of the participant.

Effects of being observed

In general, the model fit data well and we obtained reasonable estimates for Choice-Maker's risk and ambiguity attitudes (see Table D1, column (1)) that are in line with earlier work (comparison with the risk and ambiguity estimates fo the same age group in Tymula et al. (2013) reveals no statistically significant differences). The structural analysis presented in Table D1 (columns 2-3) confirms model-free conclusions. There was no statistically significant effect of being observed on individual risk attitudes in our sample. However, the coefficient of observation for ambiguity preference was negative and significant at the 10% level without age and gender controls and at the 5% level when we included age and gender controls. This indicates that on average participants became more ambiguity averse when observed. Male Choice-Makers were more risk tolerant but more ambiguity tolerant than females.

Preferences after observing another participant

In Table D2 we present analysis of only those Observers who observed Choice-Maker's choices before making their own decisions (Order 1). Observer's preferences were not correlated with Choice-Maker's risk (ambiguity) tolerance.

Appendix D. Figures and Tables

Table D1. A CRRA utility function ($u(x) = x^{\alpha}$) cut-off α estimates for choosing the lottery.

[colour required]

90 Choices	Probability		
Amount	0.25	0.5	0.75
15	N/A	N/A	N/A
24	2.950	1.475	0.612
27	2.358	1.179	0.489
34	1.694	0.847	0.352
36	1.583	0.792	0.329
42	1.346	0.673	0.279
46	1.237	0.619	0.257
53	1.098	0.549	0.228
57	1.038	0.519	0.215
60	1.000	0.500	0.208
63	0.966	0.483	0.200
65	0.945	0.473	0.196
77	0.847	0.424	0.176
81	0.822	0.411	0.171
91	0.769	0.384	0.160

α <1: Risk averse
α =1: Risk neutral
α >1: Risk loving
α >2: Extremely risk loving
N/A α is undefined

Table D1. The effect of observation on risk and ambiguity attitudes of Choice-Makers.
Observed is an indicator variable equal to 1 if the Choice-Maker was observed while making decisions and 0 otherwise.

	(1)	(2)	(3)
alpha (risk)			
Observed		0.011	0.013
		(0.010)	(0.009)
Male			0.134***
			(0.039)
Age			-0.006
			(0.005)
Constant	0.588***	0.583***	0.657***
	(0.020)	(0.022)	(0.101)
beta (ambiguity)			
Observed		-0.039+	-0.044*
		(0.021)	(0.021)
Male			-0.227***
			(0.061)
Age			0.001
			(0.010)
Constant	-0.359***	-0.340***	-0.247
	(0.031)	(0.031)	(0.213)
noise			
Observed		0.002	0.009
		(0.048)	(0.045)
Male			0.401*
			(0.184)
Age			-0.010
			(0.013)
Constant	1.028***	1.027***	1.065***
	(0.086)	(0.093)	(0.308)
N	27900	27900	27900
No. Clusters	155	155	155
Pseudolikelihood	-13291.96	-13288.63	-13072.36

+ p<0.10, * p<0.05, ** p<0.01, *** p<0.001
Standard errors are clustered on the subject.

Table D.2. The effect of having observed others prior to making own decisions. *Partner's risk (ambiguity) tolerance* is the model-free measure of risk (ambiguity) attitude of the partner. All observers from Order 1 are included in the analysis.

	(1)
Alpha (risk)	
Partner's risk tolerance	0.046
	(0.11)
Constant	0.597***
	(0.056)
Beta (ambiguity)	
Partner's ambiguity tolerance	-0.091
	(0.222)
Constant	-0.452***
	(0.070)
Noise	
Constant	1.091***
	(0.131)
N	6930
No. Clusters	77
Log Pseudolikelihood	-3156.783

+ p<0.10, * p<0.05, ** p<0.01, *** p<0.001
Standard errors clustered on the subject

Figure D.1 Seating arrangments in the laboratory in A: private and B: observed condition. Each cell is one computer station, separated by a partition. X indicates one participant.

A.

X		X			X		X	
X		X		aisle	X		X	
X		X			X		X	
X		X			X		X	

B.

XX					XX			
		XX		aisle			XX	
XX							XX	
XX							XX	