Economics Working Paper Series

2015 - 8

Watched by a Stranger: Influence of Observation on Individual Decision Making under Risk and Ambiguity

Agnieszka Tymula & Jackson Whitehair

April 2015

Watched by a Stranger: Influence of Observation on Individual Decision Making under Risk and Ambiguity

Agnieszka Tymula[1,2*] and Jackson Whitehair[1]

Abstract:

Presence of peers is often identified as the main source of welfare-decreasing decision-making in young adulthood and adolescence. The mechanism through which peers exert this influence is not fully understood. In this paper, using an incentive compatible experiment, we investigate whether young people's willingness to accept known and unknown risks changes in the presence of a stranger of the same age compared to in private and whether preferences are affected by having observed others decisions. We find that behavioural changes caused by observation are different for men and women and are mediated through beliefs on own and observer's risk-taking. The results suggest that different approaches should be useful to mitigate consequences of observation on behaviour.

Keywords: observation, peer effects, risk, uncertainty

JEL codes: D80

[1]School of Economics, University of Sydney, H04 - Merewether, room 370, Sydney, NSW 2006, Australia.
[2]Institute for the Interdisciplinary Study of Decision Making, New York University, 300 Cadman Plaza West, 7th floor, Brooklyn, NY 11201, USA.
[*]Correspondence to: Agnieszka Tymula, agnieszka.tymula@sydney.edu.au, Phone: +61 2 9351 2840, Fax: +61 2 9351 4341.

Introduction

Most decisions, even if their payoffs are only relevant to the person making the decision, are made in a social context rather than in isolation. Our choices are often made publicly and exposed to the judgments of others. We often have the opportunity to observe others' decisions before we decide for ourselves. Common wisdom identifies such social contexts as the principal factors in explaining behaviour: peers' presence is blamed for poor decision-making in young adulthood and adolescence, people are commonly believed to behave differently among people of the same and the opposite gender, educators believe that the optimal student composition (by gender, age or ability) in a class drives success. Many governments have even devised a range of tools to protect, in particular young adults, from their own choices made in the presence of peers. We have legal age limits for gambling, voting, driving, use of alcohol and tobacco, restrictions for young adults on transporting other young adults during initial months of licensing and required hours of adult supervision. There have been attempts to mix as well as to separate high-risk and low-risk students at schools. All these interventions are based on the premise and hope that they will improve young adults' welfare but findings on the effectiveness of these interventions are mixed. Despite its prevalence, the influence of observation on preferences has received only limited attention from economists both in terms of theory and empirical evidence.

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

participation in extreme sports, decisions about diet, truancy and usage of illegal substances, all of which we most often decide about in the presence of others.

In the paper, we use an incentive-compatible and widely-applied experimental method (based on Hey & Orme (1994) and Tymula, Rosenberg, Ruderman, Glimcher, & Levy (2013)) to estimate individual attitudes towards risk and ambiguity and investigate: 1) whether individual preferences under observation are different than in private, and 2) whether having observed others' decisions subsequently affects choices for oneself. We hypothesize that in both types of observation, the interaction of the observer's and chooser's individual characteristics will be an important mediating factor. In the paper we focus on two factors: gender and individual's beliefs about the other person's preferences. Below we outline the rationale and relevant literature for each observation type and the role of gender and beliefs.

Decisions under observation

If we assume that a part of an agent's utility function depends on how her decisions are perceived by others, the mere fact that others observe decisions should influence choice. Experimental evidence so far has suggested that when observed people are more generous (Ekström, 2012, Haley & Fessler, 2005), work harder (Falk & Ichino, 2006, Mas & Moretti, 2009), and behave more aggressively in prisoner's dilemma and battle of the sexes games (Charness, Rigotti, & Rustichini, 2007), even if their behaviour does not affect the observer's payoff. The literature clearly suggests that people derive utility from how others perceive them and want to present themselves as more generous, hardworking and productive than they would be privately.

In situations that involve decision-making under risk, one could hypothesize that people change their behaviour for the same reason that they change their effort and generosity when observed; they want to create a positive image of themselves by presenting themselves as good decision makers. Economists, unlike psychologists, generally assume that there is no right or wrong risk or ambiguity attitude. Nevertheless, it is possible that people want to project a specific risk attitude to others. For example, they may want to present themselves to others as being financially successful, high-status individuals. This may motivate them to become more ambiguity and risk neutral when observed as such behaviour leads to higher average payoffs. Alternatively, instead of projecting themselves as maximizing monetary payoff, people may want to project

themselves as behaving according to some accepted norm of behaviour. Likely these norms depend on the observers' as well as decision-makers' characteristics.

The evidence on whether people change their risk and ambiguity attitudes under observation is scarce, sometimes contradictory, and comes mostly from the literature in psychology. Therefore, in reviewing the literature in the paragraphs below we use the term 'risk' attitude in a loose form, more in line with the approach in psychology rather than the precise meaning that it has in economics. When possible we distinguish between findings on risk and ambiguity preferences.

When people are asked to rationalize their decisions, alternatives with ambiguous options tend to be avoided. Curley, Yates, & Abrams (1986), in an incentivized Ellsberg paradox Ellsberg (1961) experiment, found that people become significantly more ambiguity averse when required to announce their choice in front of a group. They argued that ambiguity aversion was the most socially justifiable decision and that subjects decided against ambiguous lotteries for fear of negative evaluation by others. In support of these early explanations, Trautmann, Vieider, & Wakker (2008) found that removing all choice accountability eliminates ambiguity aversion. Muthukrishnan, Wathieu, & Xu (2009) were able to replicate the finding of increased ambiguity avoidance under observation in the domain of consumer preferences. When subjects anticipated that others would be evaluating their choices, they tended to prefer established brands over less-known brands seen as having a more ambiguous level of quality. Brand choices were highly correlated with subjects' ambiguity attitudes measured in a lottery task.

Weigold & Schlenker (1991) found that subjects systematically changed their risk attitudes in a hypothetical lottery task when asked to explain and justify their decisions. After introducing accountability subjects self-identifying as low risk-taking were more risk-averse in their choices. There was no significant shift in choices for high risk-takers. To the contrary, a study by Gardner & Steinberg (2005) found that people generally make riskier decisions in a video driving game when around friends than when alone. Smith, Chein, & Steinberg (2014) found similar effects also in a hypothetical lottery task with an anonymous, not physically present observer of the same age and gender as the participant. Cowell (2013) reported that under observation subjects significantly increased their risk-taking in a Balloon Analogue Risk Task (BART).

Decisions after having observed others' decisions

Previous research has demonstrated that in many types of behaviours people conform to what they observed others do, however little of this has related to attitudes towards risk. Falk & Ichino (2006) showed experimentally that standard deviations in output are lower when subjects worked alongside another subject than when they were alone. Similarly Mas & Moretti (2009) found strong effort spill-overs from highly-productive to less productive personnel, mediated by the frequency of interactions. The famous study of the Dartmouth University students Sacerdote (2001) found that college roommates converged in the level of academic effort and decisions about social life, but not in important life decisions such as the choice of major. In terms of decision making under risk, in a series of interviews Jaccard, Blanton, & Dodge (2005) found moderate to strong correlations between risk-taking behaviours of adolescent friends. Sutter (2009) found that private investment choices of the subjects 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 (20015) found that when making decisions between safe and risky options people like to immitate others, in particular if the other person selected the safer alternative.

The role of observer and decision-maker characteristics

Overall, it is not straightforward to put the findings cited above in the context of microeconomic choice theory as the experimental tasks in the papers cited above are all fundamentally different and potentially measure a different psychological concept of risk taking. To an economist many of these risk measures are confounded with other preferences such as attitudes towards ambiguity, patience, propensity to behave in an irrational way, and learning abilities. Moreover, the differences in participants' characteristics are rarely accounted for. In particular, to date the role of gender and perceptions of own and observer's risk attitudes have not been fully investigated. Most studies confined experimental conditions to the observers of the same gender (or gender was not mentioned at all) and did not elicit self-beliefs and judgments about the risk-taking of others.

Nevertheless, there are good reasons to believe that gender and beliefs about others mediate the effects of observation. For instance, hormones, and testosterone in particular, have been implicated as determinants of risk attitudes, at least partially

accounting for the gender gap in risk tolerance (Schipper, 2012 and see Croson & Gneezy (2009) for review on gender differences in risk attitudes.) Interestingly, the presence of an attractive person of the other but not the same gender induces testosterone release both in men (Ronay & Hippel, 2010) and in women (López, Hay, & Conklin, 2009) suggesting that the gender of the observer may be important for shifting the risk attitude. In line with this hypothesis, Ronay and Hippel (2010) have shown that the presence of an attractive woman elevates testosterone and increases physical risk taking for men. It is unclear whether the effect holds only in the presence of someone the participant finds attractive or rather it is general. The evidence that women's behaviour in competitive settings (believed to be mediated through risk preference) is affected by the gender composition of the group of not necessarily the most attractive people suggests that this may be a widely observed phenomenon not restricted only to the presence of the most attractive people of the opposite gender (Kuhnen & Tymula, 2012; Wozniak, Harbaugh, & Mayr, 2014).

A participant's perception of how their observers would behave in their situation is likely a key factor driving the results of peer effects studies. Eckel and Grossman (2002) found that subjects overestimated the risk-aversion of others, especially women. Stereotypes about gender differences in risk attitudes prevail leading to biased estimates conforming to the belief that men are more likely to take risks than women. If observed subjects are primed to conform with the believed behaviour of their observer we would expect observation of men (women) by women (men) to lead to less (more) risk taking.

In this paper, we employed a standard, incentive compatible task based on Hey and Orme (1994) and further developed by Levy, Snell, Nelson, Rustichini and Glimcher (2010), and Tymula et al. (2012) to estimate individual risk and ambiguity attitudes in private, under observation, and after observing somebody else's choices. To keep the environment as simple as possible participants in our experiment did not know each other and had minimal chances of interacting in the future. This allowed us to abstract from any subtleties in ongoing human relationships and interactions and to provide a baseline for studies of such interactions in the future. In this set up, we found that the effects of observation were gender dependent and mediated through perceptions of own and observer's risk attitude. Generally speaking, the effect of being observed was

mediated through perceptions of own (for men) and observer's (for women) risk attitudes. The more risk-tolerant men perceived themselves, the more risk they took when observed by other men. Women, on the other hand, took fewer risks when they were observed by someone they perceived to be more risky. Observing another person's choices prior to deciding for themselves affected men and women differently as well. Men's risk attitudes were positively correlated with the risk attitude of the person that they observed. Women, on the other hand, became more ambiguity tolerant, the more ambiguity tolerant the man that they observed was. Risk attitudes of women and ambiguity attitudes of men were not affected by observing another person's choices. These results suggest that different motives and processes may underlie male and female behavioural responses to being observed, which we elaborate on in more detail in the discussion.

Experimental Design

160 volunteers (73 male, mean age 22.23 with standard deviation 3.93) were recruited using ORSEE (Greiner, 2004) from the subject pool at the University of Sydney. The data was collected over 10 experimental sessions (each with 16 participants) in August 2014 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 illustrates the timeline of the experiment and further details are explained below.

Task

Participants' risk and ambiguity parameters were assessed using a well-established and incentive-compatible technique (based on Tymula et al. (2012), Tymula et al. (2013), Hey & Orme (1994), Holt & Laury (2002)). In the task the participants decided between receiving $15 for sure and playing a lottery where they could win a given amount of money or get nothing. The parameters of the lottery changed from trial to trial for a total of 90 unique choice situations. There were 15 reward levels ranging from $15 to $91. In half of the trials, the *risky trials*, the exact odds of winning were known (25%, 50%, or 75%). In the other half, the *ambiguous trials*, the odds of winning were not precisely known but instead given as bounded within a certain range. The ambiguity was always centered at the objective winning probability of 50%. The level of ambiguity

about the true odds of winning varied: 25%, 50% or 75%. Figure 2 shows examples of a risky and an ambiguous trial. The lottery parameters 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 A1 in the appendix shows the power utility curvature cut-off estimates implied by our task. On each trial instead of making a choice the subject could indicate indifference between the options. If relevant for payment, indifference was resolved at random by the computer at the very end of the experiment. Participants were not allowed to skip trials.

6 out of the 90 trials were designed to test participants' rationality and understanding of the task. They featured a choice between $15 for sure and a lottery that offered exactly the same amount, $15, at a probability known to be strictly lower than 100%. Any participant, who satisfies monotonicity, should pick the sure option as it first-order stochastically dominates the lottery. These questions serve as a comprehension and attention check.

Participants were given verbal and written instructions prior to the task. They were encouraged to ask for clarification if anything was unclear.

Observation implementation

The experiment was designed to evaluate the effects of two types of observation: 1) how decision-making changes when subjects are observed versus when they make their choices in private, and 2) how privately made choices are affected by prior observation of another person's decisions.

Upon arrival in the lab the participants were seated at the computer stations and randomly assigned to be either the Choice-Makers or Observers. The Choice-Makers completed the task in private (*private condition*) as well as while watched by an Observer (*observed condition*). In half of the sessions Choice-Makers started with the observed condition (order 1), in the other half with the private condition (order 2), see Figure 1. By comparing behaviour of Choice-Makers in the private and observed conditions we can address how decision-making differs with and without observation using a within-subject analysis.

The Observers completed the task only once and in private. Half of the Observers completed the task prior to observing Choice-Maker's decisions (order 2) and half after

(order 1). A between-subject comparison of participants who completed the task after observing to choices made by Choice-Makers and Observers who completed the task before observation, addresses how observing others influences decision-making.

To ensure maximum privacy in the private condition, subjects were seated such that the cubicle next to them was always unoccupied. Several measures were taken to guarantee that subjects 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, Choice-Makers knew in advance that the Observers were financially incentivized to pay attention to their decisions. At the end of the experiment Observers would be asked to recall several of the Choice-Maker's choices that they witnessed and earned $1 for each correct answer (test stage in Figure 1). (To equalize the opportunity for earnings, at the same time each Choice-Maker was asked to guess three of her Observer's choices.) Observers were not permitted to write down any notes. Thirdly, to the extent possible we controlled for how familiar participants in a pair were. The observation treatment was designed in such a way that the Choice-Maker would be experiencing observation from an almost perfect stranger whom they were not allowed to communicate with verbally. The pairs were formed randomly and 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 later debriefed the participants whether they knew their partner or not and whether their partner paid attention to their choices.

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 never find out the outcomes of the Choice-Maker's choices.

Questionnaire

All participants filled in a questionnaire about their demographics, perceptions of their partner and themselves and the overall aims of the experiment (full questionnaire is available in the Appendix 2). Importantly, from each subject we elicited her belief of how risky her own and her partner's choices were. We asked the participants to judge on a scale from 1 to 10 "What is the frequency with which you chose the lottery instead

of $15?" and "What is the frequency with which your partner chose the lottery instead of $15?" To verify whether subjects were indeed strangers we asked if they had ever met their partner before and how likely they were to interact with them again. To verify that the subjects felt observed we asked "For what proportion of your choices do you think your partner was paying attention?"

Payment

Subjects were paid according to their choice on one randomly selected trial. 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 subject's overall payout from the session including results from the test (up to $3) and the $5 show-up fee. Subjects made on average $32.62 (standard deviation: $25.59).

Results

The implementation of the stranger condition was successful. None of the participants had ever met their partner before and only two could recall ever having seen their partner before the session. When subjects were asked the likelihood of interacting with their partner at any point after the study 101 (out of 160) answered "unlikely" and only 6 believed it more likely than unlikely. The 76% of Choice-Makers believed that Observers were paying attention to the majority of their choices.

Overall, subjects selected the first-order stochastically dominated lottery only 3.9% of the time. Excluding subjects who violated dominance more than twice (out of a possible 6 times) did not qualitatively change our results. Figure 3 shows that the participants chose lotteries that paid more and lotteries with a larger winning probability more often, indicating that they understood the task. It seems that subjects were on average risk averse because they choose the lottery only if its expected value was much higher than $15 (Figure 1A). Participants chose lotteries less and less often as the ambiguity level increased from 25% to 75% (Figure 1B), consistent with ambiguity averse preferences.

Econometric approach

Our experimental design allows for both model-free and structural analysis of risk and ambiguity preferences. We first present model-free measures to provide the reader with the general sense of the data. Then we estimate a structural model.

The simplest way to calculate risk and ambiguity attitudes in our dataset is to compute the proportion of times that an individual selected the lottery. To estimate individual risk attitude we calculated the proportion of times that the lottery was selected in the risky trials with known probabilities:

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

The higher this estimate, the more risk tolerant the participant. Calculating individual ambiguity attitude is only slightly more complicated. When an individual chooses an ambiguous lottery more often it may be because either she is less averse to ambiguity or because she is less averse to risk. Therefore an estimate of individual ambiguity attitude has to take into account individual tolerance towards risk. In our case, because the ambiguity was always cantered around the 50% chance of winning, we correct the ambiguity attitude using the proportion of participant's lottery choices in the risky trials with 50% chance of winning. We estimated ambiguity attitude for each individual by:

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

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

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

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

where $\boldsymbol{\alpha}$ is the risk attitude and $\boldsymbol{\beta}$ is the ambiguity attitude to be estimated. Risk attitude is therefore captured through the curvature of the utility function with $\boldsymbol{\alpha} = 1$ (*<1; >1*) indicating risk neutrality (aversion; seeking). Ambiguity is introduced in the spirit of Gilboa and Schmeidler (1989). Ambiguity neutral individual will view the chance of winning in the ambiguous lottery as 50-50 since the ambiguity is cantered around 50%

and will thus have $\beta = 0$. Ambiguity averse individual will perceive the chance to win to be lower ($\beta<0$) and ambiguity seeking subjects will 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 is given by:

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

where gamma is the noise term that controls the slope of the choice function. Maximum likelihood was used to fit the data (Harrison, 2008). Throughout the paper, to test the impact of observation and other variables on preferences, we derive the risk (α) and ambiguity (β) parameter estimates as a linear combination of the 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 are the corresponding coefficients.

We pooled the data from order 1 and order 2 (see Figure 1) together because the order had no effect on the risk and ambiguity estimates (see Table A2 in the appendix). In all of the analysis standard errors are clustered on the level of the subject. In general the model fit data well and we obtained reasonable estimates for risk (α_0 = 0.583, SE 0.021) and ambiguity (β_0 = -0.329, SE 0.03) attitude with log-pseudolikelihood -10204.8.

Effects of being observed on risk and ambiguity

Overall, we do not find a systematic and general effect of being observed on individual risk and ambiguity preferences with neither the model-free nor structural approach. Figure 4 plots individual risk (panel A) and ambiguity (panel B) model-free estimates in private choices against the estimates calculated for choices under observation. If the individuals were making identical choices in both conditions all the observations should fall on the black 45-degree line. If observation systematically made them more averse (tolerant) the observations should all fall to the left (right) of the 45-degree line. It is clear that the majority of observations do not fall exactly neither on the 45 degree line

nor to its left (right). Instead for both risk and ambiguity attitudes, the observations spread on both sides of the 45-degree line. In a paired t-test mean mmodel-free ambiguity tolerance in the private stage (-0.127) is significantly higher than when observed (-0.162) with a p-value of 0.033 but certainly there is a lot of heterogeneity in how subjects change their behaviour when observed. The risk attitude does not change between private and observed condition on the level of the population.

We then investigated whether the absence of a clear effect is a consequence of the averaging of the opposite effects of observation at small versus large stakes, and small versus large probability and ambiguity levels. Figure 5 plots the proportion of times individuals selected risky (panel A) and ambiguous (panel B) options at different reward, probability and ambiguity levels separately for choices made in private (crosses) and under observation (dots). The attitudes towards risk and ambiguity do not seem to be affected by observation at any reward, probability and ambiguity level.

The simple analysis so far while informative does not take into account any demographic variables and the beliefs that Choice-Makers hold about their Observer's risk-taking, both of which can be relevant. We now turn to a structural estimation approach that takes these factors into account. As shown below, using such approach we were able to discover under what conditions observation plays a role.

The structural analysis confirms that there is no uniform and statistically significant effect of being observed on own risk attitude (Table 1, model 1) or ambiguity attitude (Table 2, model 1). This lack of effect is not caused by an averaging of opposing gender effects. To test this, we first introduced separate dummy variables for being observed by a male and female Observer (Table 1 and Table 2, model 2). While the coefficients corresponding to the dummy variables have opposing signs, they are highly insignificant. Another possibility would be that male subjects are differently affected by observation than female subjects. To test this idea we divided the sample into male and female participants and estimated the model separately for each group (Table 1 and Table 2, models 3 – 6). Overall, subjects from neither gender were significantly affected by observation whether observed by someone of the same or opposite gender.

Finally, we investigated whether the effect of observation is conditional on an individual's perceptions of their own risk-taking behaviour and that of their partner. In the questionnaire conducted at the end of the study we asked participants to rank how

often they think they and their partner chose a lottery on a Likert scale ranging from never (1) to always (10). A subject's belief about their own risk-taking (*Own Riskiness*) was significant in explaining actual overall risk attitudes only for women (Table 3, models 5 & 6). We found that for both men and women these subjective reports of risk-taking behaviour modulated behavioural response to being observed, but in a different way for each gender.

Men with different perceptions of their own risk-taking responded to observation differently when they were observed by men versus when they were observed by women. The more risk-taking men perceived themselves to be, the more (less) risks they took when observed by a male (female) Observer (Table 3, model 4). These opposing effects likely explain why there are no significant effects for male participants in the analysis that did not account for how perceptions of own and partner's riskiness interact with the gender of the Observer (Table 3, model 3). Men were nevertheless significantly and substantially more risk tolerant when observed by a woman after controlling for perceptions. From jointly looking at the coefficient on *Obs Female* and *Obs Female*Own Riskiness* we estimate that an average men who perceived themselves to be more (less) risk taking than 4 out of 10 became more (less) risk averse when watched by a woman. Generally speaking, we see men who perceive themselves as risk-averters become more risk tolerant and those who perceive themselves as more tolerant to risk become less risk tolerant when observed by women.

While women were more accurate than men in their beliefs about own risk attitude, it did not influence the strength of their response to observation. Instead, they were affected by the beliefs that they held about the observer and tended to take fewer risks the more risk taking they perceived their observer to be (Table 3, model 5).

Risk and ambiguity attitudes after observing another subject

Our experimental design allows us to assess whether people's preferences are affected by having observed other people's decisions. 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 a Choice-Maker's choices and half after. Therefore, we can analyze whether those who completed the task after having observed a Choice-Maker's choices behave in a fundamentally different way to those who completed the task prior to observation. In the group that observed Choice-Makers first

we can test for conformity to the choices that were observed and test whether the effects are gender dependent.

We find that overall simply having observed another person perform the same task does not shift risk or ambiguity attitudes in any particular direction. Table 4 and 5 (model 1) show that the coefficient on a dummy variable indicating a subject made decisions after having observed somebody else is not significant. Nevertheless, men who observed another man prior to making their own decision took more risks than men who made their choices first (Table 4, model 4). However, after controlling for the risk-attitude of the person they were observing, the difference in risk attitudes between those who observed men versus those who observed women prior to making their own decisions was not significant (in Table 6, models 2-4, *Post Obs Male* is not significant).

We then examined whether participants were affected by the specific risk and ambiguity attitude of the person that they observed. Figure 6 suggests that in general such effects do not exist. In Figure 6 each Observer's risk (ambiguity) attitude is plotted against the risk (ambiguity) attitude of the Choice-Maker that the Observer was paired with. We plot these separately for order 1 and order 2. In order 2 we do not expect any relationship because the Observers made their choices before knowing who they are paired with, let alone having observed a Choice-Maker's decisions. Indeed as the right panels (B and D) of Figure 6 show there is no such relationship. Interestingly, when Observers made their choices after having observed Choice-Makers, their choices seem to be equally unaffected (Figure 6 A and C). However, these graphical results may be obscuring opposing effects from participants of different genders, an issue which can be addressed with a structural estimation.

Structural analysis of the Observers in order 1, who had a chance to observe Choice-Maker's decisions before making their own, revealed that men's but not women's risk attitudes were influenced to conform with the risk attitude of the person that they observed no matter whether they observed a woman or a man (Table 6, model 3). Women, on the other hand, become more ambiguity tolerant after having observed a man and this effect is stronger the more ambiguity tolerant that man was (Table 7, model 4). Overall, we interpret the results from Table 6 and 7 with caution because they are based on quite a small sample of participants.

Discussion

A growing body of literature in economics (see Trautmann & Vieider (2011) for review) and psychology (Albert, Chein, & Steinberg, 2013) argued that people make different choices in private than when observed by others. To better understand these changes, we employed a classical task from experimental economics to precisely measure individual's attitudes to risk and ambiguity in privately made decisions, under observation and after having observed somebody else's decisions. We focused on young adults, an age group which is believed to be very sensitive to observation by others.

The key finding was that young women and men are differently affected by observation. The key variables mediating the effect were beliefs about own risk taking (for men) and beliefs about risk taking of others (for women). The more risk-taking men perceive themselves to be, the more risks they take when observed by another man relative to when they make choices in private. Overall, men who perceived themselves as more (less) risk taking became more risk averse (tolerant) when observed by a woman than in private. Women took less risks, the more risk taking they believed their observer to be. Men who observed another man prior to making their own decisions, took more risks than those who did not observe anybody prior to making their decisions. Independent of the gender of the person they observed, men were more risk tolerant the more risk tolerant choices they observed prior to making their own decisions. Women became more ambiguity tolerant after observing a man with tolerance increasing the more ambiguity tolerant this male was. Strikingly, these effects happen even though our observation manipulation was quite subtle. There was no interdependence in payoffs, and participants didn't really know or expected to interact in the future with the observers. What are the possible explanations of such behaviours then? Since there is no possible financial reason to change behaviour, we suspect there may be hardwired biological motives that may lead our subjects to adjust their behaviour to signal biologically superior preferences to their observers. Indeed, the findings of the paper fit in the context of the existing literature from biology on status seeking, and from economics with regard to gender differences in behaviour in social contexts.

From studies of our close relatives in the animal kingdom, we know that establishing a place in a hierarchy is one of the most important activities giving access to food, mating opportunities and safety (Lee, 1990). The ways in which such status is achieved are often dramatically different for adult males and females. For females, their place in the hierarchy is relatively stable and established by kinship – the rank of the family and birth order – with the oldest female from the highest-ranked family at the top of the hierarchy. Adult females do not maintain their hierarchy by displaying their size, strength and aggression. Instead, they use subtle strategies to form, sustain, expand and threaten alliances to maintain their rank. For adult males, the rank is typically less stable and depends on relative strength, size, age and fighting ability. To improve and maintain their rank, males have to engage in constant renegotiation and confrontation with others involving risky behaviours. We theorize that if such behaviours are what humans are predisposed for evolutionary (which seems likely given what economics found on gender differences in competitive settings (Wozniak et al., 2014)), then male but not female participants would see our task as an opportunity to establish their rank.

More precisely, we would expect that especially men who perceive themselves as more risk taking will be willing to take even more risks when observed by other men and that observing a male will lead to more risk taking later, which is exactly what we observe in the data. Interestingly, these effects are present even though these men are unlikely to interact at any time in the future and the task is not competitive suggesting that if indeed these are the mechanisms, they are deeply rooted in our nature.

While risky behaviours in front of other men may lead to increases in social status, it may not necessarily be the best strategy for men when a woman observes them. Since the extremely high risk seeking or extremely risk averse males are the least likely to reach the top of the hierarchy, it may be optimal for males to signal some intermediate risk preferences to females. Consistently with this story, men who perceive themselves as more risk tolerant (averse) decrease (increase) their level of risk taking when observed by a woman. Perhaps surprisingly, whether watched by a man or a woman, men do not adjust their behaviour according to their beliefs about risk-taking of their observer.

As mentioned earlier, based on the animal literature we would not expect women to see our task as an opportunity to establish status. However, from now rich literature in economics, we know that women shy away from competition (for review see Niederle & Vesterlund (2010)), especially when they are competing against men (Kuhnen & Tymula, 2012). A couple of explanations have been suggested for why this is the case, including lower confidence in own ability, and lower tolerance towards risks inherent in competitive settings (Niedrele & Vesterlund, 2007). Our paper suggests, one more explanation. Relative to private choices, when observed women become more risk averse the more risk tolerant they perceive their observer to be. Given that males are usually perceived as more risk seeking (Eckel & Grossman, 2002; Eckel & Grossman, 2008), the finding that women in particular shy away from competing with men could be explained by increased risk aversion caused by the company of men.

With regard to the research on conformity of behaviour, our results suggest that risk and ambiguity preferences are less clearly convergent than effort levels. As the study did not find the perceptions of partner's risk attitudes to be positively significant, we cannot conclude that Choice-Makers tried to become more like their observer. Also, behaviour of Observers post-observation was not consistent with convergence in attitudes in general. Only men's risk tolerance and women's ambiguity tolerance (and only after observing men) demonstrated significant influence from observation.

Our results confirm the validity of the popular idea, which nevertheless has not received much attention from empirical or theoretical economists, that people make different decisions when observed rather than when in private. These effects are not simple and uniform across individuals, but rather depend on individual's gender and beliefs in a way consistent with previous findings about risky behaviours in social context. More work is needed to understand whether the effects are stronger or different when people expect to interact in the future with the observers, as in for example peer groups at work and school, and how these effects change as socioeconomic and demographic characteristics of observers and observees vary.

Acknowledgments

We would like to thank Bob Slonim, Stephanie Heger, Stephen Cheung, Pablo Guillen Alvarez, for useful comments on the project. Tymula acknowledges the financial support from the Australian Research Council grant number DE150101032.

Bibliography

Albert, D., Chein, J., & Steinberg, L. (2013). The Teenage Brain: Peer Influences on Adolescent Decision Making. *Current Directions in Psychological Science*, *22*(2), 114–120. doi:10.1177/0963721412471347

Charness, G., Rigotti, L., & Rustichini, A. (2007). Individual behavior and group membership. *The American Economic Review*, *97*(4), 1340–1352.

Cowell, R. (2013). *Do Peers Alter Decision Making Processes in Adolescence ? An Examination of Peer Influence on Cool and Hot Executive Function.* University of Minnesota.

Croson, R., & Gneezy, U. (2009). Gender Differences in Preferences. *Journal of Economic Literature*, *47*(2), 448–474. doi:10.1257/jel.47.2.448

Curley, S. P., Yates, J. F., & Abrams, R. A. (1986). Psychological sources of ambiguity avoidance. *Organizational Behavior and Human Decision Processes*, *38*(2), 230–256. doi:10.1016/0749-5978(86)90018-X

Eckel, C. C., & Grossman, P. J. (2002). Sex differences and statistical stereotyping in attitudes toward financial risk. *Evolution and Human Behavior*, *23*(4), 281–295. doi:10.1016/S1090-5138(02)00097-1

Eckel, C. C., & Grossman, P. J. (2008). Forecasting risk attitudes: An experimental study using actual and forecast gamble choices. *Journal of Economic Behavior & Organization*, *68*(1), 1–17. doi:10.1016/j.jebo.2008.04.006

Ekström, M. (2012). Do watching eyes affect charitable giving? Evidence from a field experiment. *Experimental Economics*, *15*(3), 530–546. doi:10.1007/s10683-011-9312-6

Ellsberg, D. (1961). Risk, Ambiguity, and the Savage Axioms. *Quarterly Journal of Economics*, *75*(4), 643–669.

Falk, A., & Ichino, A. (2006). Clean evidence on peer effects. *Journal of Labor Economics*, *24*(1), 39–57.

Fischbacher, U. (2007). Z-Tree: Zurich toolbox for ready-made economic experiments. *Experimental Economics*, *10*, 171–178. doi:10.1007/s10683-006-9159-4

Gardner, M., & Steinberg, L. (2005). Peer influence on risk taking, risk preference, and risky decision making in adolescence and adulthood: an experimental study. *Developmental Psychology*, *41*(4), 625–35. doi:10.1037/0012-1649.41.4.625

Greiner, B. (2004). An Online Recruitment System for Economic Experiments. *Forschung Und Wissenschaftliches Rechnen, GWDG Bericht 63*, 79–93.

Haley, K. J., & Fessler, D. M. T. (2005). Nobody's watching? Subtle cues affect generosity an anonymous economic game. *Evolution and Human Behavior*, *26*(3), 245–256. doi:10.1016/j.evolhumbehav.2005.01.002

Hey, J., & Orme, C. (1994). Investigating generalizations of expected utility theory using experimental data. *Econometrica: Journal of the Econometric Society*, *62*(6), 1291–1326.

Holt, C., & Laury, S. (2002). Risk aversion and incentive effects. *American Economic Review*, *92*(5), 1644–1655.

Jaccard, J., Blanton, H., & Dodge, T. (2005). Peer influences on risk behavior: an analysis of the effects of a close friend. *Developmental Psychology*, *41*(1), 135–47. doi:10.1037/0012-1649.41.1.135

Kuhnen, C. M., & Tymula, A. (2012). Feedback, Self-Esteem, and Performance in Organizations. *Management Science*, *58*(1), 94–113. doi:10.1287/mnsc.1110.1379

Lahno, A. M., & Serra-Garcia, M. (20015). Peer effects in risk taking: Envy or conformity? *Journal of Risk and Uncertainty*, *50*, 73–95.

Levy, I., Snell, J., Nelson, A. J., Rustichini, A., & Glimcher, P. W. (2010). Neural representation of subjective value under risk and ambiguity. *Journal of Neurophysiology*, *103*(2), 1036–47. doi:10.1152/jn.00853.2009

López, H. H., Hay, A. C., & Conklin, P. H. (2009). Attractive men induce testosterone and cortisol release in women. *Hormones and Behavior*, *56*(1), 84–92. doi:10.1016/j.yhbeh.2009.03.004

Mas, A., & Moretti, E. (2009). Peers at Work. *American Economic Review*, *99*(1), 112–145. doi:10.1257/aer.99.1.112

Muthukrishnan, A. V., Wathieu, L., & Xu, A. J. (2009). Ambiguity aversion and the preference for established brands. *Management Science*, *55*(12), 1933–1941. doi:10.1287/mnsc.1090.1087

Niederle, M., & Vesterlund, L. (2010). Explaining the Gender Gap in Math Test Scores: The Role of Competition. *Journal of Economic Perspectives*, *24*(2), 129–144. doi:10.1257/jep.24.2.129

Ronay, R., & Hippel, W. V. (2010). The Presence of an Attractive Woman Elevates Testosterone and Physical Risk Taking in Young Men. *Social Psychological and Personality Science*, *1*(1), 57–64. doi:10.1177/1948550609352807

Sacerdote, B. (2001). Peer effects with random assignment: Results for Dartmouth roommates. *The Quarterly Journal of Economics*, (May).

Schipper, B. (2012). Sex hormones and choice under risk. *UC Davis Department of Economics Working Paper Series*, *12*(7).

Smith, A. R., Chein, J., & Steinberg, L. (2014). Peers increase adolescent risk taking even when the probabilities of negative outcomes are known. *Developmental Psychology*, *50*(5), 1564–8. doi:10.1037/a0035696

Sutter, M. (2009). Individual behavior and group membership: Comment. *American Economic Review*, *99*(5), 2247–2257.

Trautmann, S. T., & Vieider, F. M. (2011). Social influences on risk attitudes: Applications in economics. In *Handbook of risk theory* (pp. 575–600).

Trautmann, S. T., Vieider, F. M., & Wakker, P. P. (2008). Causes of ambiguity aversion: Known versus unknown preferences. *Journal of Risk and Uncertainty*, *36*(3), 225–243. doi:10.1007/s11166-008-9038-9

Tymula, A., Rosenberg Belmaker, L. a, Ruderman, L., Glimcher, P. W., & Levy, I. (2013). Like cognitive function, decision making across the life span shows profound age-related changes. *Proceedings of the National Academy of Sciences of the United States of America*, *110*(42), 17143–8. doi:10.1073/pnas.1309909110

Tymula, A., Rosenberg Belmaker, L. A., Roy, A. K., Ruderman, L., Manson, K., Glimcher, P. W., & Levy, I. (2012). Adolescents' risk-taking behavior is driven by tolerance to ambiguity. *Proceedings of the National Academy of Sciences of the United States of America*, *109*(42), 135–140. doi:10.1073/pnas.1207144109

Weigold, M., & Schlenker, B. (1991). Accountability and risk taking. *Personality and Social Psychology Bulletin*, *17*(1), 25–29. doi:10.1177/0146167291171004

Wozniak, D., Harbaugh, W. T., & Mayr, U. (2014). The Menstrual Cycle and Performance Feedback Alter Gender Differences in Competitive Choices. *Journal of Labor Economics*, *32*(1), 161–198.

Figures and Tables

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

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 subject is choosing between $15 for sure and 75% chance of $60. In B) the subject 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 option appeared and the winning lottery color were randomized on each trial.

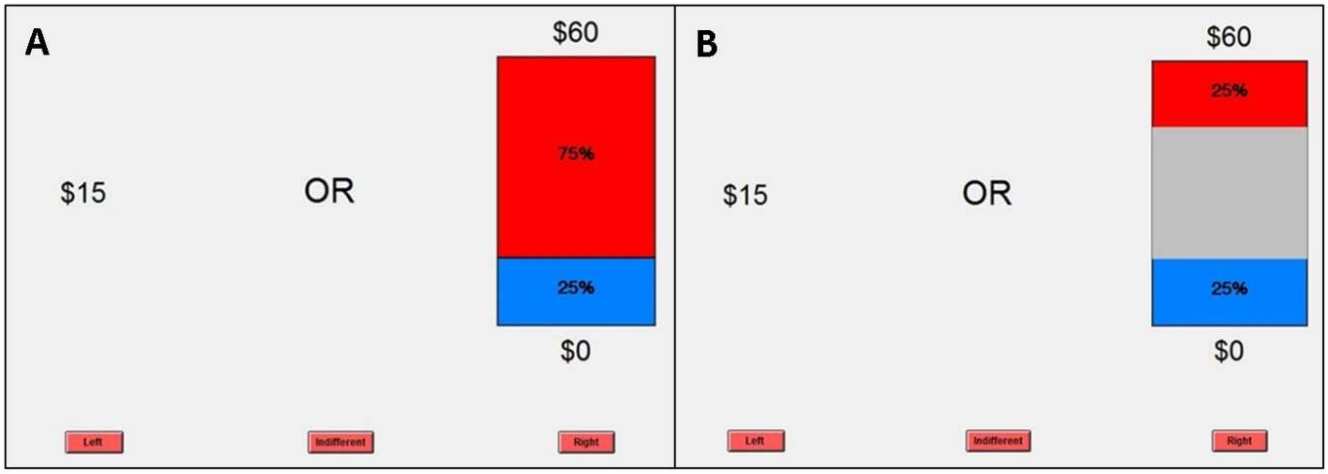

Figure 3. Proportion of lottery choices for each A) risky and B) ambiguous lottery type. Color indicates the probability (Figure 3A) and ambiguity (Figure 3B) level. The dots represent proportion of lottery choices in the population. The curves are logistic choice curves fitted based on all choice data (see Results – Econometric approach for details). The vertical dashed lines indicate a cut-off amount at which the risk neutral and ambiguity neutral chooser would switch from choosing sure $15 to choosing a lottery.

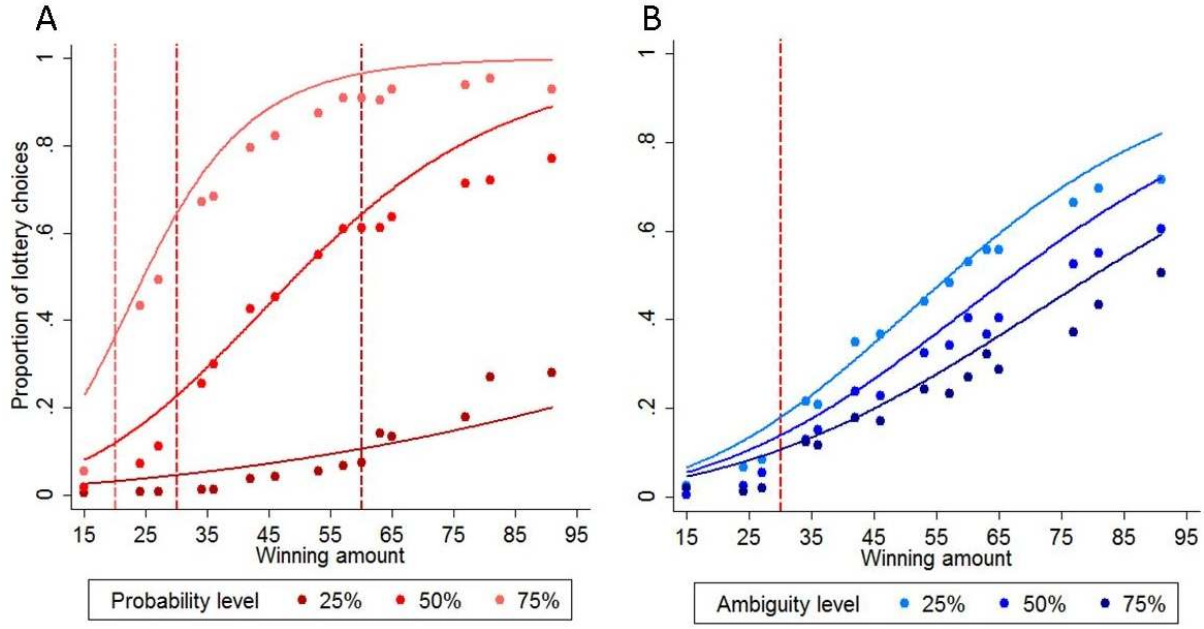

Figure 4. Relationship between model-free A) risk and B) ambiguity attitude estimates in private and under observation. Each dot is one individual's model-free risk (A) or ambiguity (B) attitude in private (y-axis) plotted against this individual's attitude under observation (x-axis). The green lines indicate risk and ambiguity neutral attitude. Red (blue) line is the the best linear fit through all the observations and the gray region is the 95% confidence interval.

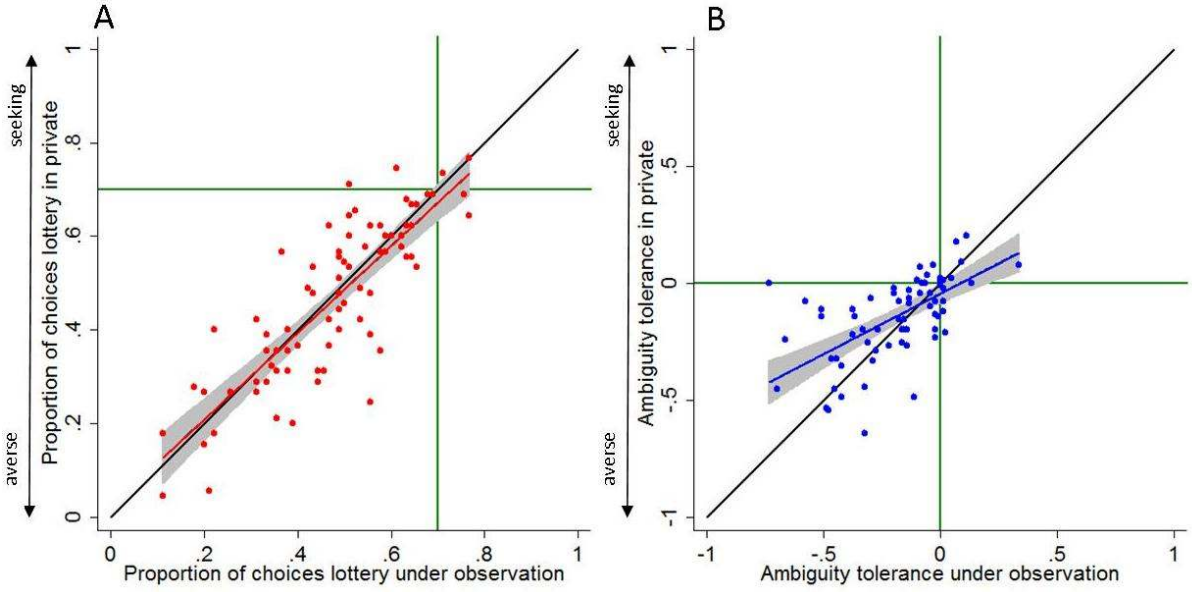

Figure 5. Averaged proportion with which participants selected a lottery with a given reward and A) probability and B) ambiguity level. Dots (crosses) indicate averages calculated for choices under observation (in private).

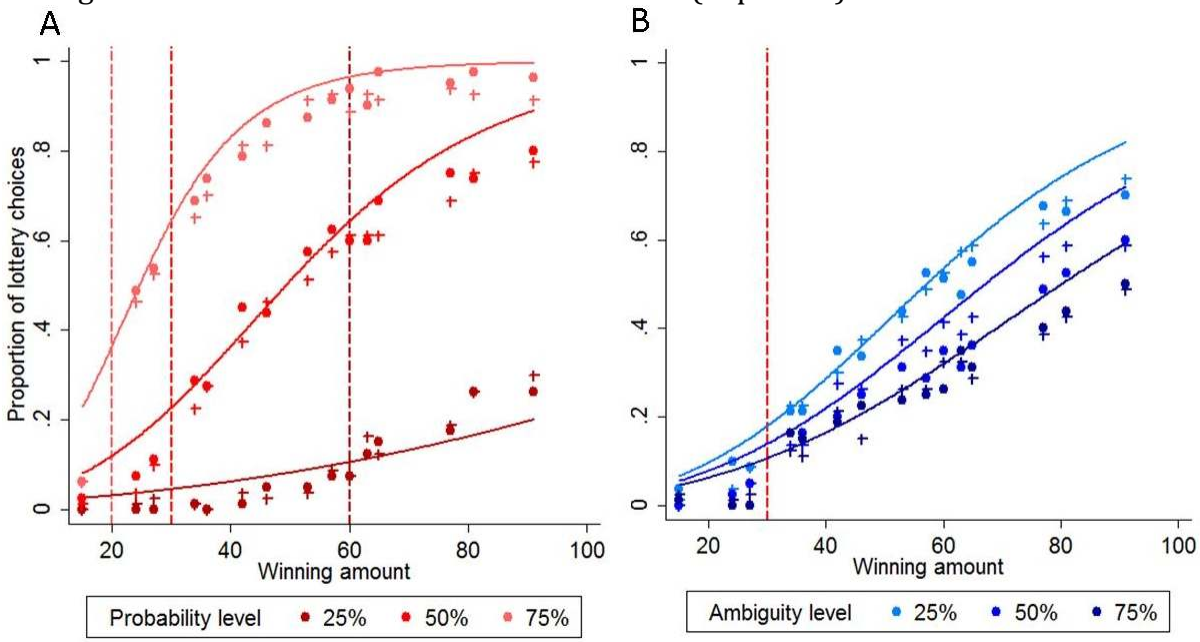

Figure 6. Relationship between Observer's and Choice-Maker's preferences. Each Observer's model-free estimate of risk and ambiguity attitude is plotted against the risk and ambiguity attitude of the Choice-Maker that he observed. In order 1 (2) the Observer made choices after (before) having observed the Choice-Maker decide.

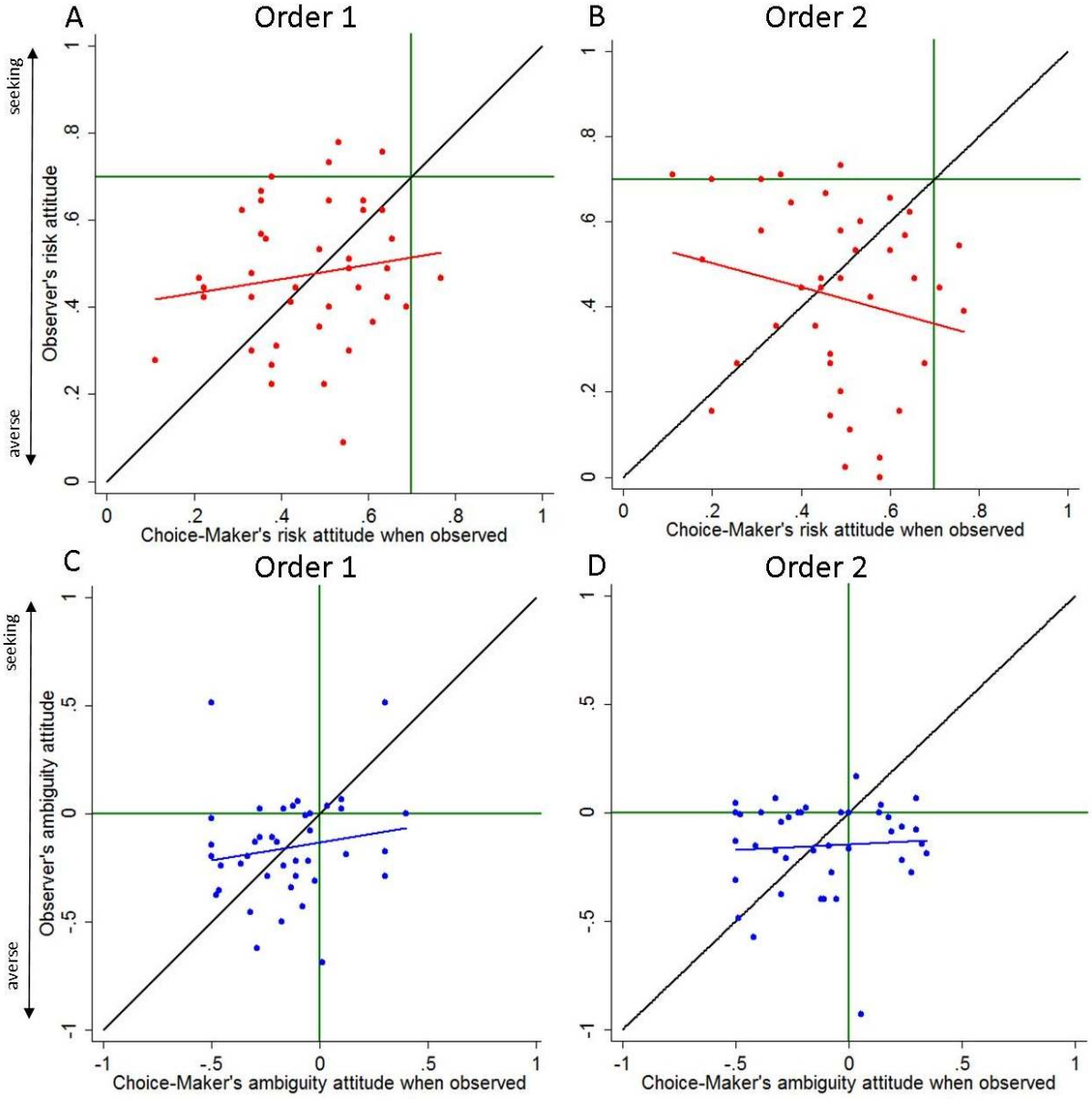

Table 1. The effect of observation on risk attitudes. *Observed* is an indicator variable equal to 1 if the subject was observed while making decisions and 0 otherwise. *Obs Male (Female)* is an indicator variable equal to 1 if the subject was observed by a man (woman). Models 1-2 present results for all Choice-Makers (CMs). Models 3-4 (5-6) focus on male (female) Choice-Makers only.

	All CMs		Male CMs		Female CMs	
	(1)	(2)	(3)	(4)	(5)	(6)
Alpha (risk)						
Observed	0.006		0.004		0.01	
	(0.009)		(0.014)		(0.012)	
Obs Male		-0.009		-0.015		-0.005
		(0.020)		(0.029)		(0.028)
Obs Female		0.02		0.019		0.025
		(0.018)		(0.027)		(0.024)
Constant	0.587***	0.587***	0.601***	0.602***	0.573***	0.573***
	(0.028)	(0.028)	(0.042)	(0.042)	(0.038)	(0.038)
Beta (ambiguity)						
Constant	-0.326***	-0.326***	-0.400***	-0.403***	-0.256***	-0.256***
	(0.037)	(0.037)	(0.046)	(0.045)	(0.057)	(0.057)
Noise						
Constant	0.974***	0.974***	1.041***	1.044***	0.915***	0.913***
	(0.109)	(0.109)	(0.180)	(0.180)	(0.133)	(0.133)
N	14400	14400	6660	6660	7740	7740
No. Clusters	80	80	37	37	43	43
Log Pseudolikelihood	-6741.435	-6735.289	-3070.029	-3066.413	-3658.452	-3654.929

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

Table 2. The effect of observation on ambiguity attitudes. *Observed* is an indicator variable equal to 1 if the subject was observed while making decisions and 0 otherwise. *Obs Male (Female)* is an indicator variable equal to 1 if the subject was observed by a man (woman). Models 1-2 present results for all Choice-Makers (CMs). Models 3-4 (5-6) focus on male (female) Choice-Makers only.

	All CMs		Male CMs		Female CMs	
	(1)	(2)	(3)	(4)	(5)	(6)
Alpha (risk)						
Constant	0.590***	0.590***	0.603***	0.603***	0.578***	0.578***
	(0.027)	(0.027)	(0.039)	(0.039)	(0.038)	(0.038)
Beta (ambiguity)						
Observed	-0.002		-0.04		0.032	
	(0.027)		(0.035)		(0.040)	
Obs Male		-0.054		-0.047		-0.062
		(0.069)		(0.114)		(0.086)
Obs Female		0.039		-0.035		0.116
		(0.059)		(0.085)		(0.087)
Constant	-0.324***	-0.324***	-0.380***	-0.380***	-0.273***	-0.273***
	(0.038)	(0.038)	(0.042)	(0.042)	(0.061)	(0.061)
Noise						
Constant	0.974***	0.973***	1.040***	1.040***	0.915***	0.914***
	(0.109)	(0.108)	(0.180)	(0.180)	(0.133)	(0.133)
N	14400	14400	6660	6660	7740	7740
No Clusters	80	80	37	37	43	43
Log Pseudolikelihood	-6741.998	-6736.695	-3069.191	-3069.151	-3658.473	-3648.157

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

Table 3. The effect of observation is mediated through perceptions of own and Observer's attitude to risk. *Own* and *Partner Riskiness* are subject's beliefs assessed on 1 to 10 Likert scale with 1 (10) being most risk averse (seeking). *Observed* is an indicator variable equal to 1 if the subject was observed while making decisions and 0 otherwise. *Obs Male (Female)* is an indicator variable equal to 1 if the subject was observed by a man (woman). Models 1-2 present results for all Choice-Makers (CMs). Models 3-4 (5-6) focus on male (female) Choice-Makers only.

	All CMs		Male CMs		Female CMs	
	(1)	(2)	(3)	(4)	(5)	(6)
Alpha (risk)						
Own Riskiness	0.030**	0.030**	0.024	0.024	0.040***	0.040***
	(0.011)	(0.011)	(0.018)	(0.018)	(0.011)	(0.011)
Partner Riskiness	0.009	0.009	0.029	0.029	-0.002	-0.002
	(0.009)	(0.010)	(0.022)	(0.022)	(0.008)	(0.008)
Observed	0.018		0.028		-0.001	
	(0.030)		(0.057)		(0.032)	
*Observed*Own Riskiness*	0.002		-0.003		0.011+	
	(0.004)		(0.007)		(0.006)	
*Observed*Partner Riskiness*	-0.005		-0.002		-0.010**	
	(0.004)		(0.009)		(0.004)	
Obs Male		-0.121		-0.098		-0.109
		(0.073)		(0.088)		(0.095)
*Obs Male*Own Riskiness*		0.033*		0.057**		0.022+
		(0.013)		(0.022)		(0.013)
*Obs Male*Partner Riskiness*		-0.009		-0.027		-0.003
		(0.010)		(0.021)		(0.008)
Obs Female		0.106*		0.162*		0.067
		(0.044)		(0.079)		(0.067)
*Obs Female*Own Riskiness*		-0.027*		-0.036**		0.011
		(0.011)		(0.014)		(0.019)
*Obs Female*Partner Riskiness*		0.012		0.01		-0.022
		(0.011)		(0.014)		(0.015)
Constant	0.373***	0.372***	0.331***	0.328***	0.345***	0.345***
	(0.053)	(0.053)	(0.094)	(0.097)	(0.077)	(0.077)
Beta (ambiguity)						
Constant	-0.313***	-0.317***	-0.368***	-0.380***	-0.258***	-0.256***
	(0.037)	(0.037)	(0.045)	(0.049)	(0.057)	(0.057)
Noise						
Constant	0.924***	0.913***	0.960***	0.921***	0.864***	0.860***
	(0.105)	(0.102)	(0.157)	(0.146)	(0.134)	(0.133)
N	14400	14400	6660	6660	7740	7740
No Clusters	80	80	37	37	43	43
Log Pseudolikelihood	-6403.363	-6320.69	-2883.006	-2775.438	-3444.289	-3434.739

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

Standard errors are clustered on the subject.

Table 4. The effect of having observed other's choices on Observer's risk attitude. *Post Observing* is an indicator variable for Observers in order 1 who completed the task after having observed the Choice-Makers. The reference category are Observers in order 2 and Choice-Makers in private condition. *Post Obs Female (Male)* is an indicator variable equal to 1 for Observers who completed the task after observing a female (male) Choice-Maker.

	All Observers		Male Observers		Female Observers	
	(1)	(2)	(3)	(4)	(5)	(6)
Alpha (risk)						
Post Observing	0.047		0.055		0.044	
	(0.030)		(0.044)		(0.040)	
Post Obs Female		0.043		0.034		0.048
		(0.034)		(0.055)		(0.041)
Post Obs Male		0.052		0.092**		0.04
		(0.040)		(0.046)		(0.054)
Constant	0.556***	0.556***	0.597***	0.597***	0.521***	0.521***
	(0.028)	(0.028)	(0.038)	(0.038)	(0.040)	(0.040)
Beta (ambiguity)						
Constant	-0.332***	-0.331***	-0.391***	-0.391***	-0.281***	-0.281***
	(0.038)	(0.038)	(0.044)	(0.044)	(0.060)	(0.060)
Noise						
Constant	0.966***	0.966***	1.021***	1.019***	0.908***	0.908***
	(0.091)	(0.091)	(0.135)	(0.135)	(0.124)	(0.125)
N	10800	10800	4860	4860	5940	5940
No. of clusters	120	120	54	54	66	66
Log pseudolikelihood	-5129.27	-5128.99	-2177.75	-2171.79	-2917.46	-2917.34

* p<0.10, ** p<0.05, *** p<0.01

Standard errors are clustered on the subject.

Table 5. The effect of having observed other's choices on Observer's ambiguity attitude. *Post Observing* is an indicator variable for Observers in order 1 who completed the task after having observed the Choice-Makers. The reference category is composed of Observers in order 2 and Choice-Makers in private condition. *Post Obs Female (Male)* is an indicator variable equal to 1 for Observers who completed the task after observing a female (male) Choice-Maker.

	All Observers		Male Observers		Female Observers	
	(1)	(2)	(3)	(4)	(5)	(6)
Alpha (risk)						
Constant	0.571***	0.571***	0.613***	0.613***	0.535***	0.535***
	(0.025)	(0.025)	(0.034)	(0.034)	(0.035)	(0.035)
Beta (ambiguity)						
Post Observing	0.062		0.083		0.042	
	(0.095)		(0.122)		(0.145)	
Post Obs Female		-0.027		-0.008		-0.056
		(0.110)		(0.144)		(0.167)
Post Obs Male		0.146		0.211		0.108
		(0.129)		(0.164)		(0.189)
Constant	-0.347***	-0.347***	-0.411***	-0.411***	-0.290***	-0.290***
	(0.046)	(0.046)	(0.062)	(0.062)	(0.066)	(0.066)
Noise						
Constant	0.965***	0.964***	1.019***	1.017***	0.907***	0.906***
	(0.090)	(0.090)	(0.134)	(0.133)	(0.123)	(0.122)
N	10800	10800	4860	4860	5940	5940
No. of clusters	120	120	54	54	66	66
Log pseudolikelihood	-5146.18	-5137.43	-2188.14	-2180.61	-2925.65	-2922.08

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

Table 6. The effect of observed risk attitude on Observer's risk attitude. *CM's Risk Attitude* is the model-free risk attitude estimate based on the Choice-Maker's decisions under observation. *Partner Male* is an indicator variable equal to 1 for Observers who completed the task after observing a male Choice-Maker. Models 1-2 present results for all Observers in order 1. Models 3 (4) are for male (female) Observers in order 1.

	All Observers		Male Observers	Female Observers
	(1)	(2)	(3)	(4)
Alpha (risk)				
CM's Risk Attitude	0.224+	0.371*	0.433*	0.233
	(0.120)	(0.157)	(0.207)	(0.249)
Post Obs Male		0.123	0.236	0.066
		(0.103)	(0.144)	(0.203)
*CM's Risk Attitude*Partner Male*		-0.266	-0.398	-0.172
		(0.233)	(0.255)	(0.533)
Constant	0.517***	0.454***	0.455***	0.485***
	(0.062)	(0.081)	(0.137)	(0.107)
Beta (ambiguity)				
Constant	-0.365***	-0.378***	-0.441***	-0.331*
	(0.070)	(0.070)	(0.072)	(0.149)
Noise				
Constant	1.055***	1.065***	1.125***	0.992***
	(0.174)	(0.175)	(0.278)	(0.222)
N	3600	3600	1620	1980
No. of Clusters	40	40	18	22
Log Psueudolikelihood	-1637.561	-1632.615	-677.2038	-935.9673

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

Table 7. The effect of observed risk attitude on Observer's ambiguity attitude. *CM's Ambiguity Attitude* is the model-free ambiguity attitude estimate based on the Choice-Maker's decisions under observation. *Post Obs Male* is an indicator variable equal to 1 for Observers who completed the task after observing a male Choice-Maker. Models 1-2 present results for all Observers in order 1. Models 3 (4) are for male (female) Observers in order 1.

	All Observers		Male Observers	Female Observers
	(1)	(2)	(3)	(4)
Alpha (risk)				
Constant	0.621***	0.620***	0.673***	0.583***
	(0.040)	(0.039)	(0.057)	(0.054)
Beta (ambiguity)				
CM's Ambiguity Attitude	0.249	-0.265	0.011	-0.538
	(0.315)	(0.511)	(0.699)	(0.692)
Post Obs Male		0.274+	0.124	0.536*
		(0.164)	(0.200)	(0.229)
*CM's Ambiguity Attitude*Post Obs Male*		0.708	-0.579	2.289**
		(0.641)	(0.802)	(0.838)
Constant	-0.340***	-0.504***	-0.516***	-0.509***
	(0.084)	(0.103)	(0.153)	(0.152)
Noise				
Constant	1.072***	1.064***	1.141***	0.958***
	(0.178)	(0.175)	(0.258)	(0.224)
N	3600	3600	1620	1980
No. of Clusters	40	40	18	22
Log Pseudolikelihood	-1648.254	-1631.817	-682.1342	-872.2123

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

Appendix 1 – Figures and Tables

Table A1. A CRRA utility function ($u(x) = x^{\alpha}$) cut-off α estimates for choosing the lottery.

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 A2. Maximum likelihood estimates showing that the order did not affect participant's preferences.

	Constant estimates	Order effect
Alpha (risk)		
Order 1 (d)		0.024
		(0.023)
Constant	0.583***	0.571***
	(0.021)	(0.025)
Beta (ambiguity)		
Order 1 (d)		-0.027
		(0.072)
Male (d)		
Constant	-0.329***	-0.315***
	(0.030)	(0.047)
Noise		
Constant	0.977***	0.976***
	(0.081)	(0.081)
N	21600	21600
No. Clusters	160	160
Log pseudolikelihood	-10204.8	-10195.05

* p<0.10, ** p<0.05, *** p<0.01.
(d) denotes dummy variable
Estimates clustered by subject

Appendix 2. 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)