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Abstract

Tournament incentives prevail in labor markets, in particular with respect to promotions. Yet, it is often unclear to competitors how many winners there will be or how many applicants compete in the tournament. While it is hard to measure how this uncertainty affects work performance and willingness to compete in the field, it can be studied in a controlled lab experiment. We present a novel experiment where subjects can compete against each other, but where the number of winners is either uncertain (i.e., unknown numbers of winners, but known probabilities) or ambiguous (unknown probabilities for different numbers of winners). We compare these two conditions with a control treatment with a known number of winners. We find that ambiguity induces a significant increase in performance of men, while we observe no change for women. Both men and women increase their willingness to enter competition with uncertainty and ambiguity, but men react slightly more than women. Overall, both effects contribute to men winning the tournament significantly more often than women under uncertainty and ambiguity. Hence, previous experiments on gender differences in competition may have measured a lower bound of differences between men and women.

Keywords: Gender, competition, uncertainty, ambiguity, experiment

JEL: C91; D03; D09

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1. Introduction

Tournament based incentive schemes are ubiquitous in the labor market, as many companies across practically all industries use them for determining in particular promotions or wages. Despite large improvements over the past decades, there are still large gender differences with respect to wages and promotion opportunities, especially with respect to the fraction of women in high level executive positions and at high income levels (Weichselbaumer and Winter-Ebmer, 2007; Blau and Kahn, 2017). For instance, at the beginning of 2017, women accounted for less than 6% of CEOs within the S&P 500 and the Fortune 500.1 Although some of these differences can be explained by sorting effects, there is still a persistent gender gap in firm-specific pay (Card et al., 2016) and the gender pay gap remains even after parenting and family concerns are taken into account (Angelov et al., 2016). Besides long-standing demand side explanations such as, e.g., discrimination against women, there is mounting evidence that the supply side of labor markets also contributes to the gender gap in wages and promotion.

There has been an ever growing literature showing that women perform often worse under competitive pressure than men (pioneered by Gneezy et al., 2003; see also Gneezy and Rustichini 2004; Antonovics et al.. 2009; Gill and Prowse, 2014; Almås et al., 2016) and that women shy away from competition much more often than men (seminal paper by Niederle and Vesterlund, 2007; see also Booth and Nolen, 2012; Datta Gupta et al., 2013; Brandts et al., 2014; Buser et al. 2014; Sutter and Glätzle-Rützler, 2015; Flory et al., 2015; Saccardo et al. 2017).2 Since firms often use tournament payment and promotion schemes (Eriksson, 1999; Bognanno, 2001), a lower inclination of women towards competition can help explain to some extent why they are less often promoted and end up with lower wages.3 Providing empirical evidence in this vein, McGee et al. (2015) show on the basis of US data that women are less likely than men to be remunerated with a competitive compensation package and that this can explain part of the wage gap between the two genders.

Interestingly, and only with a few exceptions discussed below, the extensive (lab and field) experimental literature on gender differences in competitive behavior has mainly investigated situations where subjects who may compete in a tournament are fully informed of the number of potential competitors and the number of winning positions in the tournament. Of course, competition on labor markets rarely meets such a stylized situation. In reality, it is highly un-

1 Data for the S&P500 CEOs is from, *Women CEOs of the S&P500,* available at www.catalyst.org (accessed May 19, 2017)*;* Data for the Fortune 500 list is from *Female Fortune 500 CEOs Are Poised to Break This Record in 2017*, available at http://fortune.com/2016/12/22/female-fortune-500-ceos-2017/ (accessed August 19, 2017).

2 Recent research shows that affirmative action policies can be successful in increasing women's willingness to compete, with only limited harmful side-effects (Balafoutas and Sutter, 2012; Villeval, 2012; Niederle et al., 2013; Calsamiglia et al., 2013; Banerjee et al., 2016; Sutter et al., 2016; Kölle, 2017; Maggian and Montinari, 2017). Additional recent research on gender and competitiveness studies competitive behavior in adolescence (Dreber et al., 2011; 2014; Sutter and Glätzle-Rützler, 2015) or the impact of family background (Almås et al., 2016), advice (Brandts et al., 2014), stress (Buser et al., 2017), and team decision-making on competitive behavior (Healy and Pate, 2011, Dargnies, 2012).

3 A somewhat related factor contributing to the gender gap is that there appear to be differences in salary negotiations between men and women (Leibbrandt and List, 2014; Card et al., 2016; Rigdon, 2016).

likely that individuals in the labor market know the environment surrounding a (promotional) tournament with perfect information. For example, consider an associate at a law firm who knows that he or she competes in a tournament with other lawyers at the firm to be promoted. Often this individual does not know how many individuals will be promoted by the firm, and therefore is unaware of the ex ante likelihood of being promoted even if the number of competitors were known. How does the uncertainty in such a situation affect the associate's incentives to perform and does it influence the associate's likelihood to seek promotion in such a vague environment? These are the questions that are at the core of our paper.

We present an experiment that – while building on the classical design of Niederle and Vesterlund (2007) to measure the willingness to compete – is novel in the sense that it introduces uncertainty and ambiguity into a tournament with respect to the number of winners and therefore allows examining how uncertainty and ambiguity affect (i) workers' performance and (ii) their willingness to enter a competition. With our design, we can measure whether the gender differences with respect to performance under competition and willingness to compete depend on whether the tournament environment is characterized by uncertainty and ambiguity.[4]

We are not aware of any study that can measure the effects of uncertainty or ambiguity on both performance and the willingness to compete of potential competitors. Yet, there are a few related studies that implemented tournaments with imperfect information and how the latter may affect subjects' willingness to compete. Most notably, Flory et al (2015) examine in their field experiment the application rates for job advertisements where they alter the payment scheme (making it more or less competitive), showing that fewer women apply if a portion of the pay is based on a competitive payment scheme (relative performance) or is uncertain (if the work led to a published paper for the authors), compared to a flat hourly wage payment scheme. Based on these findings, they raise the point that "high wage uncertainty may be just as important as competition per se in affecting job-entry choices and the gender gap" (p. 125). In their experiment there is, of course, ambiguity about the number of applicants, but they don't have a control treatment where this ambiguity is resolved – making it impossible to investigate the pure effects of ambiguity on the gender difference in the willingness to compete. Moreover, Flory et al. (2015) were interested in application rates, but not in competitors' performance, an issue that we can also study in our design. In a field experiment using LinkedIn, Gee (2017) varies the information available to potential applicants when applying for a job. When potential job applicants have information regarding how many individuals have clicked on the application link already, there is some evidence that this leads to an increase in the likelihood of women (but not men) completing the job application. Such behavior would be consistent with women being more averse than men towards an ambiguous

4 Implementing uncertainty or ambiguity about the number of winners in case of a known number of potential competitors is the mirror image of having uncertainty or ambiguity about the number of competitors in case of a known number of winners. The implementation of our approach has been easier for the experimental design and also allows comparing our results in the control treatment (with certainty) to the results in the tradition of Niederle and Vesterlund (2007).

tournament environment. Moreover, providing this information leads to an increase in the likelihood of women applying for a male-dominated job. Hence, it seems that resolving ambiguity has different effects on men and women with respect to their willingness to compete. Again, Gee (2017) differs from our work since performance is not a relevant measure in her experiment. More remotely related to our paper is Leibbrant and List (2014) who find that women negotiate their wage more often when the uncertainty on whether wages are negotiable or not is removed, indicating again an influence of ambiguity on the labor market behavior of men and women.

Our paper examines gender differences in work performance and in the willingness to compete under different tournament environments: While we keep the number of potential competitors constant and known, we vary the information about the number of winners as follows: (1) We implement a control treatment where the number of tournament winners is certain and known. (2) We design a tournament where the number of winners is uncertain ex-ante, but the probabilities of how many winners there will be are known. (3) We have an ambiguous treatment where the number of winners is uncertain and the probabilities of how many winners there will be are unknown. Thus, we compare a tournament with certainty regarding the number of winners against a tournament with uncertainty and against a tournament with ambiguity. We have argued that uncertain environments are important to study and that they can often better capture the characteristics of labor markets. Our study may also have policy implications if we find that uncertainty and ambiguity affect men and women differently on labor markets, which would suggest that companies can influence male and female behavior (such as the willingness to compete or performance incentives) by changing the available information to competitors. The latter might be a non-expensive and much less invasive alternative to institutionalized interventions such as affirmation action programs.

We find that men significantly increase their performance when the number of tournament winners becomes uncertain or ambiguous, while the performance of women decreases on average, albeit not significantly. Uncertainty and ambiguity cause both men and women to increase their likelihood to enter competition, and the effect is significant for the ambiguous tournament in the case of men. The gender gap in the willingness to compete increases on average (but not significantly) with uncertainty or ambiguity, compared to the control treatment with certainty. In combination, the effects of uncertainty and ambiguity on performance and willingness to compete lead to our final finding that men win the tournament significantly more often than women whenever either uncertainty or ambiguity is involved. Hence, given that competition on labor markets is very often characterized by uncertainty and ambiguity, the previous experimental studies with perfect information and certainty about the number of competitors and winners might have measured only a lower bound for the gender differences in competitive behavior.

Our paper proceeds as follows. Section 2 introduces the experimental design and our expectations about male and female behavior in the different treatments. Section 3 presents the experimental results, and section 4 concludes the paper by discussing our main results and putting them into perspective.

2. Experimental Design

We build our design on Niederle and Vesterlund (2007) and then modify the control treatment to introduce uncertainty and ambiguity. All three experimental treatments share the following characteristics. At the beginning of the experiment groups of four (composed of two men and two women) were formed randomly and remained unchanged throughout the experiment. Subjects knew that there would be four stages in the experiment, but only received instructions for the next stage after completing the previous one (instructions are provided in the online appendix). In Stages 1-3, subjects worked on adding as many sets of five two-digit numbers as possible within four minutes. Subjects were not allowed to use calculators, but scratch paper and pens were provided to them. After each attempted solution to an addition problem, subjects were informed if their answer was correct or not, and they received a new problem. The four stages looked as follows:

Stage 1 – Piece Rate: Each subject received €1 for each problem correctly solved within the four minutes' time frame. Subjects were informed how many addition problems they had solved correctly at the end of this stage. Prior to Stage 1, subjects had one minute as a practice round to familiarize themselves with the task.

Stage 2 – Tournament: In this stage, the four subjects within a group competed against each other. The group member who solved the most addition problems in four minutes received €4 per correct problem solved, while the other three group members received no payment. Ties were broken randomly. Subjects were informed how many addition problems they had solved correctly at the end of this stage, yet they were only informed at the end of the experiment whether they had won or not. Group size and gender composition of the group were revealed to subjects prior to the start of Stage 2.

Stage 3 – Tournament Choice: At the beginning of this stage each group member chose whether he or she wanted to solve the addition problems under a piece-rate scheme as in Stage 1 or under a tournament scheme. If the subject chose the tournament scheme, then that subject's Stage 3 performance was compared to his or her group members' Stage 2 performances.[5] Any ties were broken randomly. The rules for determining tournament winners were varied across our three treatments as follows:

5 The attractive feature of this design choice is that subjects are competing against other subjects' (past) performance under a tournament scheme, while at the same time each subject's entry choice does not affect other participants as the pool of competitors is fixed. Hence, a subject's entry decision has no externalities on others and the entry decision cannot depend on the subject's expectation about the potential competitors' entry decisions.

1. **Certain Number of Winners (CERTAIN):** There were two winners in Stage 3 for certain. The two[6] group members with the largest number of correct additions won the tournament. Subjects who won the tournament in Stage 3 received €2 per correct problem, while subjects who lost the tournament received no payment for this stage.

2. **Uncertain Number of Winners (UNCERTAIN):** There was an uncertain number of winners. Specifically, with 1/3 probability there would be either one, two, or three tournament winners. If there was one winner, the person with the largest number of correctly solved addition problems received €4 for each correct solution. If there were two winners, the same rules as in CERTAIN applied (€2 per correct solution for each of the two winners). If there were three winners, a subject had to solve more problems than at least one of his or her group members in order to win, and each of the three winners received €1.33 for each correct problem solved. All of these design details were known to subjects. Note that in UNCERTAIN the expected number of winners and payment per correct addition problem was the same as in CERTAIN, but uncertainty about this number was added to the environment. Subjects were only informed about the number of winners and whether they won the tournament at the end of the experiment.

3. **Ambiguous Number of Winners (AMBIGUOUS):** This treatment was similar to the UNCERTAIN treatment, except that subjects did not know the likelihood of there being one, two, or three tournament winners – in contrast to UNCERTAIN. Subjects still knew how the payments were conditional on the number of winners. Hence, the only change compared to the UNCERTAIN treatment was that the probabilities were unknown, meaning that ambiguity was additionally introduced into the tournament. Actually, we used the same probabilities as in CERTAIN, but subjects were unaware of this. Again, subjects were only informed about the number of winners and whether they won the tournament at the end of the experiment.

We used a between-subjects design, meaning that each subject participated in only one of the three treatments. After Stage 1 we elicited beliefs on which quartile subjects believed they ranked within the entire session (of 20 subjects each). After Stage 2 we elicited beliefs on where subjects think they ranked within their group of four. Both belief elicitation questions were unannounced to subjects before they occurred. Subjects received €1 for each correct belief. Feedback about beliefs was provided only at the end of the experiment.

In Stage 4, risk and ambiguity attitudes were elicited via the Ellsberg two-color choice task (Ellsberg, 1961). Subjects were presented with 20 choices of choosing between a sure amount of money and drawing a ball from a virtual bag (with balls of two different colors) for a

6 Recall that in Stage 2 we had only one winner per group. Changing the tournament from having one winner (in Stage 2) to two winners (in Stage 3) in CERTAIN means that even participants in CERTAIN face a change in the rules between the two stages – for which reason Stage 3 is not a simple replication of Stage 2 for them. Since subjects in UNCERTAIN and AMBIGUOUS face a change from Stage 2 to Stage 3 for sure (see description of these treatments), we think this design avoids a potential confound which would arise if CERTAIN was a mere replication of Stage 2, while the other two treatments were not.

chance to receive €6. The sure amount increased from €0.30 to €6 in increments of €0.30 (see also appendix). When eliciting risk attitudes, subjects were told that when drawing from the virtual bag there was an equal chance to win (by drawing an orange ball) or lose (by drawing a white ball). A subject is classified as risk averse if he or she prefers any amount below €3 over the lottery, as risk loving if she prefers the lottery over any amount larger than €3, and as risk neutral otherwise. In the ambiguity experiment, subjects were not told the distribution of white and orange balls, but were informed that each distribution was equally likely (which keeps the expected winning probability at 50%, like in the risk elicitation task). Again, subjects won €6 if they drew an orange ball. A subject's attitude towards ambiguity can be measured as the difference between the certainty equivalent in the risk elicitation experiment (CE_r) and the certainty equivalent in the ambiguity aversion experiment (CE_a). A subject is classified as ambiguity averse if $CE_a < CE_r$, ambiguity loving if $CE_a > CE_r$, and ambiguity neutral otherwise. We control for risk and ambiguity aversion since our experimental treatments vary the degree of risk and ambiguity to which the experimental subjects are exposed.

Subjects were paid for one of the stages 1, 2, or 3 (chosen randomly), their beliefs, one randomly selected decision from the 20 decisions in the risk task, and one randomly selected decision from the 20 decisions from the ambiguity task in Stage 4. The order in which the risk and ambiguity tasks were presented in Stage 4 varied between sessions (yet we found no order effects). Subjects were informed about the actual payments only at the end of the experiment.

The experiment was run with the z-tree software (Fischbacher, 2007) in the EconLab at the University of Innsbruck. A total of 240 subjects participated in the experiment and they were recruited via h-root (Bock et al., 2014). Sessions lasted approximately 60 minutes and the average payment per subject was €19.02.

We expected to replicate the stylized finding of men choosing competition significantly more often than women in CERTAIN. Many papers have found a ratio in the willingness to compete of men and women close to 2:1 (e.g., Niederle and Vesterlund, 2007; Sutter and Glätzle-Rützler, 2015), and we expected a similar ratio. In many of the experiments that use adding up numbers as experimental tasks, men perform slightly better than women, but frequently the difference is insignificant. So, we expected performance levels of men and women to be fairly close to each other.

Given a large literature showing that women are typically more risk averse than men (e.g. Croson and Gneezy, 2009; Borghans et al., 2009; Charness and Gneezy, 2012), and in addition assuming that a higher degree of risk aversion leads to a lower willingness to enter competitive environments (Niederle and Vesterlund, 2007), we expected that the gender gap in the willingness to compete should be larger in UNCERTAIN than in CERTAIN. It is a priori less clear what to expect with respect to performance levels of men and women in UNCERTAIN. While we expected fewer women to enter competition, *conditional on having chosen competition (or opted out)* we did not expect performance differences in comparison to CERTAIN. In combination, this would imply an overall lower performance level in UNCERTAIN than in

CERTAIN, under the assumption that those women who opt into competition perform better than those who opt out (which is an empirical regularity that is typically found in the literature).

Concerning gender differences in ambiguity aversion, the evidence itself is ambiguous. Some studies find that women are more ambiguity averse (e.g., Powell and Ansic, 1997), a majority of studies find little or no difference (e.g., Borghans et al., 2009; Sutter et al., 2013), and a few studies report less ambiguity aversion of women in some domains (e.g., Schubert et al., 2000). Assuming that there is no gender difference in ambiguity aversion in our pool, our expectations for AMBIGUOUS would match those for UNCERTAIN. If we found women to be more ambiguity averse, the gender gap in the willingness to compete should increase from UNCERTAIN to AMBIGUOUS, increasing also the gap in average performance between men and women.

3. Results

3.1 Performance

Table 1 reports mean performance (correctly solved exercises) of men and women, by treatment and stage. Recall that Stages 1 and 2 did not differ across treatments. The data in Table 1 show that there is no significant gender difference in Stage 1 performance, neither when we pool across all treatments (8.13 vs. 7.80, p=0.69, Mann Whitney test)[7] nor when we look at individual treatments. The same applies to Stage 2 where there is also no gender difference in performance (8.97 for men vs. 8.63 for women, p=0.38).[8] However, both men and women increase their performance from Stage 1 to Stage 2 significantly (men: 8.97 vs. 8.13, p<0.01; women: 8.63 vs. 7.80, p<0.01, Wilcoxon signed-rank tests).

When we compare performances in Stage 2 and Stage 3, we see no significant differences in CERTAIN and in UNCERTAIN, both when looking at overall data and when splitting the data by gender (p>0.13 for all comparisons, Wilcoxon signed-rank tests). In AMBIGUOUS, however, subjects increase their performance in Stage 3 relative to Stage 2, (8.75 in Stage 2 vs. 9.45 in Stage 3; p<0.01). This effect is significant for men (p<0.01) and for women (p=0.03).

Uncertain tournament environments may induce different performance levels in Stage 3 when comparing subjects across treatments (panels c and d in Table 1). Considering all subjects regardless of their competition entry choice (in panel c), we see that performance by men increases significantly in the presence of uncertainty or ambiguity about the number of winners (CERTAIN vs. UNCERTAIN: p=0.05; CERTAIN vs. AMBIGUOUS: p=0.02; Mann-

7 We note that all p-values reported in the analysis refer to two-sided tests.

8 We confirm with a series of Kruskal-Wallis tests that there is no difference in performance in Stage 1 or Stage 2 across treatments for any of the two genders (p>0.52 for all comparisons), which indicates that randomization has been successful.

Whitney tests). The corresponding differences for women are insignificant ($p>0.33$ in all tests). Disaggregating this analysis by Stage 3 choice (see panel d of Table 1), we see that men who enter competition have a performance of 9.08 in CERTAIN, which is significantly less than the performance of 10.61 in UNCERTAIN ($p=0.08$) and 10.78 in AMBIGUOUS ($p=0.04$). Contrary to this, women who select the tournament have a *lower* performance in UNCERTAIN and in AMBIGUOUS than in CERTAIN, although treatment differences are not significant ($p>0.22$). Moreover, as expected, there is no significant difference in performance across treatments for those subjects (male, female, or pooled) who chose the piece-rate payment scheme in Stage 3 ($p>0.36$).[9] The above analysis allows us to state our first result on the relationship between tournament uncertainty or ambiguity and performance.

Result 1: Introducing uncertainty or ambiguity into the tournament setting increases the performance of men significantly (compared to the baseline treatment CERTAIN), but there is no such effect on women's performance. Hence, gender differences in performance get larger when the tournament involves uncertainty or ambiguity.

Table 1. Performance in Stages 1, 2 and 3, by Treatment and Gender

	Panel a: Stage 1			Panel b: Stage 2		
	Men	Women	Overall	Men	Women	Overall
CERTAIN	7.96	8.08	8.02	8.58	8.88	8.73
	(0.83)	(0.64)	(0.52)	(0.92)	(0.71)	(0.57)
UNCERTAIN	7.98	7.85	7.92	9.08	8.69	8.89
	(0.6)	(0.42)	(0.37)	(0.58)	(0.45)	(0.37)
AMIBGUOUS	8.38	7.60	7.99	9.04	8.46	8.75
	(0.46)	(0.43)	(0.32)	(0.41)	(0.41)	(0.29)
Overall	8.13	7.80	7.97	8.97	8.63	8.80
	(0.34)	(0.27)	(0.22)	(0.34)	(0.28)	(0.22)

Standard errors in parentheses.

Panel c: Stage 3 (all subjects)

	Pooled	Men	Women
CERTAIN	9.00	8.54	9.46
	(0.58)	(0.99)	(0.61)
UNCERTAIN	9.27	9.77	8.77
	(0.36)	(0.53)	(0.47)
AMBIGUOUS	9.45	9.85	9.04
	(0.30)	(0.42)	(0.43)
OVERALL	9.29	9.56	9.02
	(0.22)	(0.34)	(0.28)

9 For completeness we note here that subjects who selected competition had a higher performance overall than those who opted for the piece rate in Stage 3 ($p<0.01$, Mann-Whitney test). Aggregating over all three treatments, this is true for men ($p<0.01$) as well as for women ($p=0.02$). The difference is insignificant in CERTAIN, but significant in UNCERTAIN and AMBIGUOUS ($p<0.01$ in the latter two treatments).

Panel d: Stage 3

	Selected Tournament			Selected Piece-Rate		
	Men	Women	Overall	Men	Women	Overall
CERTAIN	9.08	11.17	9.78	8.00	8.89	8.53
	(1.54)	(1.19)	(1.10)	(1.31)	(0.68)	(0.66)
UNCERTAIN	10.61	10.15	10.45	8.6	8.26	8.38
	(0.73)	(0.89)	(0.57)	(0.69)	(0.53)	(0.42)
AMBIGUOUS	10.78	9.13	10.26	8.00	9.00	8.67
	(0.5)	(0.79)	(0.43)	(0.55)	(0.51)	(0.39)
Overall	10.43	9.88	10.25	8.25	8.67	8.52
	(0.44)	(0.53)	(0.34)	(0.46)	(0.32)	(0.27)

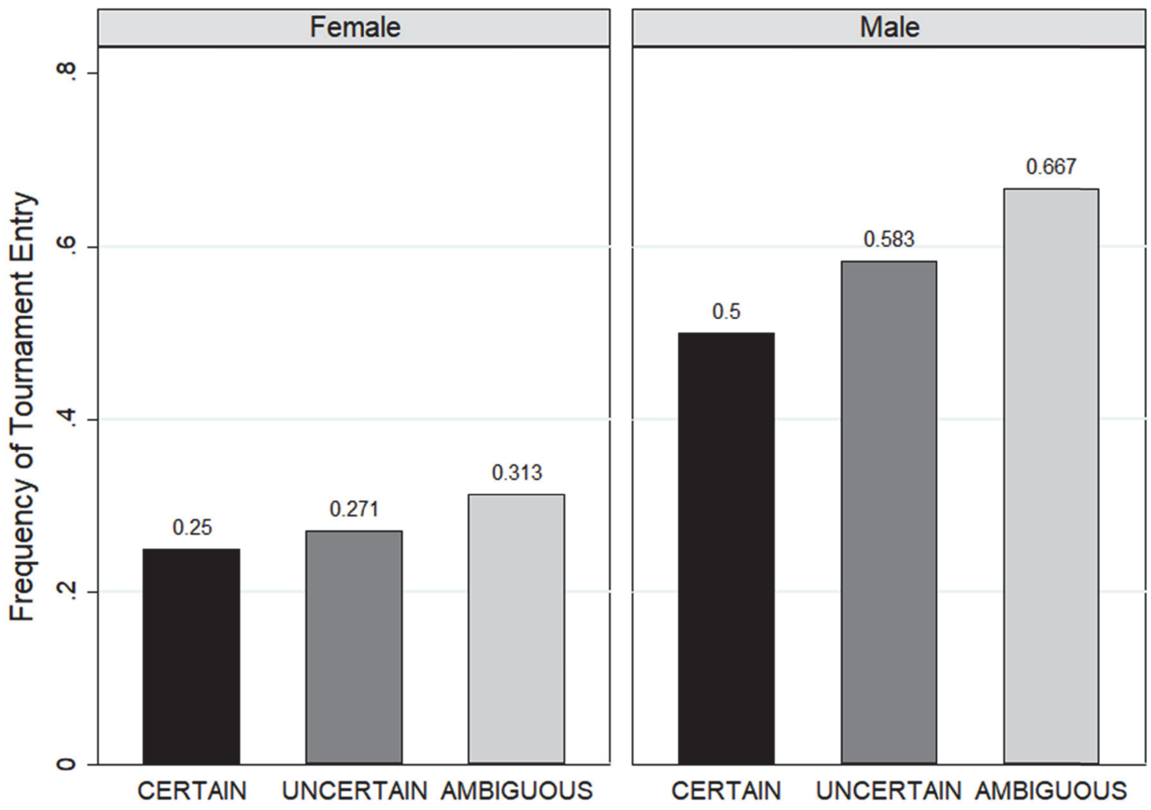
Standard errors in parentheses.

3.2 Willingness to compete

Figure 1 shows the relative frequency of entry into competition, broken down by gender and treatment. Consistent with the literature and with our expectations, men enter competition at higher rates than women in all treatments (CERTAIN, p=0.08; UNCERTAIN, p<0.01; AMBIGUOUS, p<0.01; χ^2 tests). In CERTAIN, the entry ratio is exactly 2:1, which matches previous findings (Niederle and Vesterlund, 2007; Balafoutas and Sutter, 2012).

Contrary to our expectations, women slightly increase their likelihood to compete in UNCERTAIN and AMBIGUOUS, moving up the entry-rate from 25% in CERTAIN to 27% in UNCERTAIN and 31% in AMBIGUOUS. None of these differences is significant, however. Men also increase their likelihood to compete from 50% in CERTAIN to 58% in UNCERTAIN and 67% in AMBIGUOUS. The difference between CERTAIN and AMBIGUOUS is insignificant using a two-sided χ^2 test (p=0.17), although we will show in the regression analysis that controlling for other variables leads to a significant effect of ambiguity on men's willingness to compete. As a result of the above patterns, the gender gap in the willingness to compete increases from 25 percentage points in CERTAIN to 31.2 percentage points in UNCERTAIN and 35.4 percentage points in AMBIGUOUS.

Figure 1. Relative Frequency of Tournament Entry by Gender and Treatment



A multivariate analysis of entry into competition is provided in Table 2, which shows marginal effects of Probit regressions. The dependent variable is choosing to enter the tournament in Stage 3. The right hand side variables are the following: *Male* is a dummy variable equal to 1 for men and 0 for women; *Uncertain* is a dummy variable equal to 1 when the treatment is UNCERTAIN and 0 otherwise; *Ambiguity* is a dummy variable equal to 1 in treatment AMBIGUOUS and 0 otherwise; *Belief2* is a subject's reported belief about his or her rank in the Stage 2 tournament (recall that lower ranks indicate better performance); *Correct2* is a measure of performance in a competitive situation, namely the number of problems the subject solved correctly in Stage 2; *Risk Measure* and *Ambiguity Measure* are the subjects' elicited risk and ambiguity measures in Stage 4. The risk measure ranges from 0 (most risk seeking) to 1 (most risk averse), with 0.5 indicating risk neutrality. The ambiguity measure has positive values for ambiguity aversion, zero for ambiguity neutrality and negative values for ambiguity loving. Specifications 4 and 5 also include interaction terms of *Uncertain* and *Ambiguity* with gender, with both interaction terms having no significant effect on tournament entry.

The regression estimates in Table 2 confirm our graphical impression regarding tournament entry. Men enter competition significantly more often than women: this is captured by the significant positive coefficient on *Male* in models (1) and (2), and by the significant joint coefficients of *Male* with the relevant interaction terms in model (3) ($p<0.01$, χ^2 test), model 4 ($p=0.10$), and model 5 ($p<0.01$). In terms of treatment effects, introducing uncertainty is not enough to lead to a significant increase in competition entry rates compared to the baseline as shown by the lack of significance on the *Uncertain* coefficient. However, treatment AMBIGUOUS does have a significant impact on competition entry as seen by the significant coefficient for *Ambiguous* in model (2). Adding interactions with gender reveals that the effect of ambiguity is driven by men: moving from the certain to the ambiguous environment significantly increases male tournament entry rates, as captured by the joint coefficient *(Ambiguous + Ambiguous x Male)* in models (3) and (4) (p=0.05, p=0.06, respectively).

Table 2. Regression Estimates for Entry into Competition

	(1)	(2)	(3)	(4)	(5)
Male	0.319***	0.251***	0.217**	0.171	-0.398
	(0.061)	(0.069)	(0.093)	(0.165)	(0.291)
Uncertain	0.057	0.127	0.126	0.088	0.046
	(0.093)	(0.105)	(0.104)	(0.142)	(0.14)
Ambiguous	0.124	0.214**	0.172	0.147	0.147
	(0.092)	(0.103)	(0.126)	(0.14)	(0.138)
Belief2		-0.264***	-0.267***	-0.268***	-0.281***
		(0.052)	(0.052)	(0.052)	(0.054)
Correct2		0.03**	0.029**	0.029**	0.034***
		(0.012)	(0.012)	(0.012)	(0.012)
Uncertain x Male				0.07	0.066
				(0.205)	(0.221)
Ambiguous x Male			0.084	0.132	0.134
			(0.147)	(0.203)	(0.213)
Risk Measure					-1.263***
					(0.354)
Risk Measure x Male					1.111**
					(0.516)
Ambiguity Measure					-0.653*
					(0.368)
Ambiguity Measure x Male					1.124**
					(0.543)
Observations	240	240	240	240	231

Robust standard errors in parentheses. ***, **, * indicates significance at the 1%, 5%, and 10% level, respectively. Models are Probit with marginal effects reported. Dependent variable is choosing to enter competition in Stage 3. Nine observations are dropped in Model 5 as nine subjects had inconsistent choices in either the risk or ambiguity measurement in Stage 4.

Result 2: Introducing uncertainty and ambiguity increases competition entry rates by men and by women, contrary to expectations, but the difference in entry rates across treatments is not significant with the exception of tournament entry by men in the AMBIGUOUS treatment. The gender gap in entry rates becomes larger with uncertainty and ambiguity in absolute terms, but the increase is not significant.

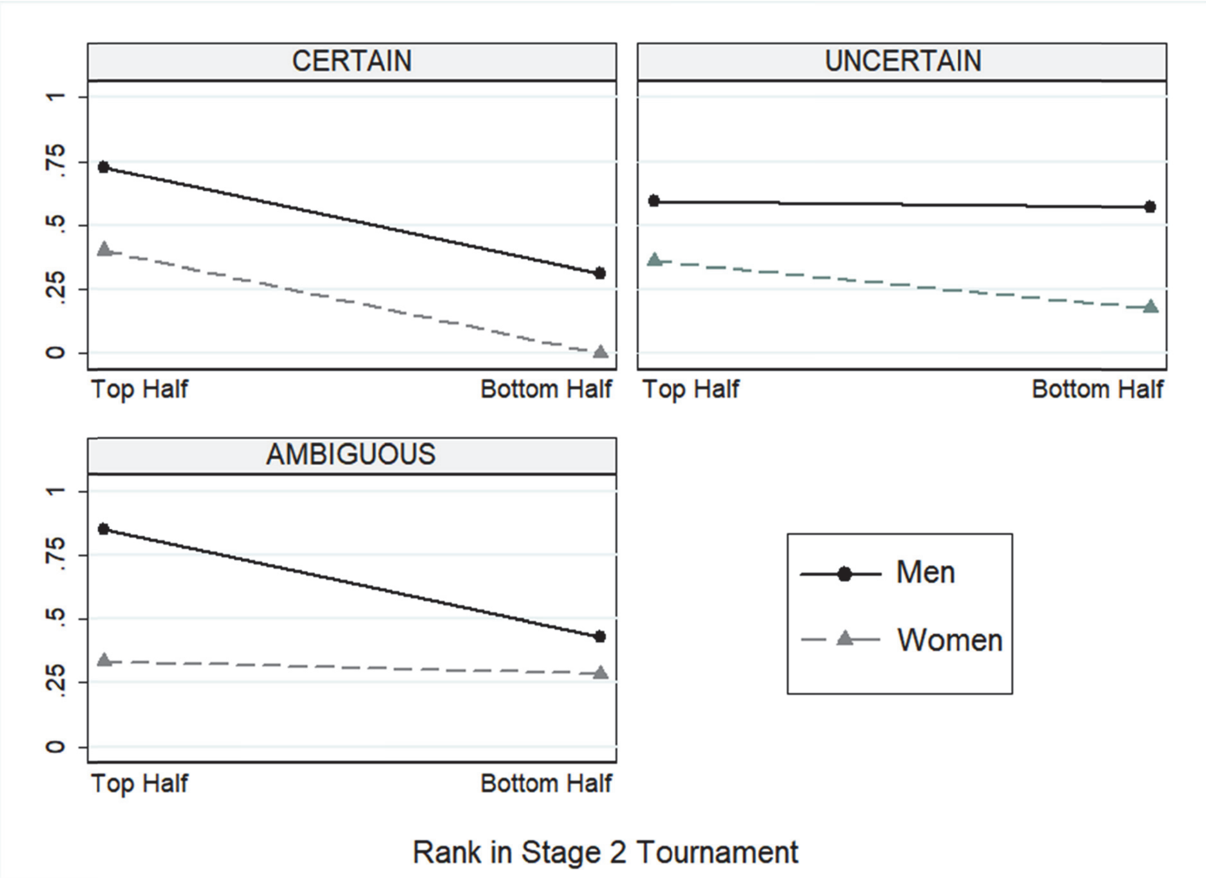
We also briefly turn to our control variables. As expected, we find that subjects enter competition more often when they solve more problems in Stage 2 (*Correct2*) and when they believe they ranked better within their group in Stage 2 (i.e., when their perceived rank *Belief2* is lower).[10] Model (5) includes the measures of risk and ambiguity, as well as interaction terms of these measures with gender. The coefficient on *Risk Measure* is significant and in the expected direction, i.e., a higher degree of risk aversion leads to a lower likelihood of competition entry. This effect is restricted to female subjects, as seen by the interaction term of the risk and ambiguity measure with *Male* that leads to an insignificant joint coefficient (*Risk Measure + Risk Measure x Male,* p=0.68, χ^2 test). Ambiguity has a negative coefficient, suggesting that more ambiguity averse female subjects are also less likely to choose the tournament payment, while the effect is reversed and becomes insignificantly positive in the case of men (*Ambiguity Measure + Ambiguity Measure x Male,* p=0.23).

Introducing uncertainty and ambiguity into the tournament environment may not only affect the absolute frequency of tournament entry, but also the entry rates conditional on individual performance. Figure 2 shows tournament entry conditional on a subject's performance rank in Stage 2. As we have two winners in expectation, Figure 2 is grouped by subjects who either rank in the top half (rank 1 and 2) or the bottom half (ranks 3 and 4).

It is straightforward to see that men enter competition more often than women at all performance ranks and in all three treatments. Looking at the top–half performers, the difference in entry rates between men and women is impressive and large in all treatments. In CERTAIN, it is 33 percentage points (72.7% for men in the top half, compared to 40.0% for women in the top half; p=0.10, χ^2 test). In UNCERTAIN, it is 23 percentage points (59.3% vs. 36.0%; p=0.09), and in AMBIGUOUS it is most pronounced with 52 percentage points (85.2% vs. 33.3%; p<0.01). Among subjects who perform in the bottom half, men enter the competition more than women in CERTAIN (30.8% vs 0%, p=0.07), UNCERTAIN (57.1% vs. 17.4%, p=0.01), and AMBIGUOUS (42.9% vs. 28.6%, p=0.33).

10 Consistent with previous studies (see Croson and Gneezy, 2009, for a short summary) we find that men are much more confident about their performance than women. In Table A1 in the online appendix we report elicited beliefs about one's rank within a group in Stages 1 and 2. Men report significantly lower expected ranks than women for their performance (i.e., they are more confident about having a good rank) in Stage 1 and in Stage 2 (p<0.01 for each stage, $\chi 2$ tests).

Figure 2. Tournament Entry by Performance Rank in Stage 2 (Relative Frequencies)



A large gender gap for those who rank in the top half is particularly worrisome in terms of securing a gender-balanced pool of tournament winners, since individuals with better performances in Stage 2 are also most likely to win the tournament in Stage 3. Taking into account additionally the fact that men increase their performance under uncertainty and ambiguity, while women do not, this gives rise to the conjecture that the fraction of men winning in the tournament should increase in UNCERTAIN and AMBIGUOUS. Indeed, this is what we find: the two treatments with uncertainty and ambiguity are characterized by an unbalanced pool of tournament winners in Stage 3. Among winners, the proportion of male subjects is statistically equal to that of women in CERTAIN (58.33%, p=0.56; one-sample test of proportions), but it is significantly different from 50% in UNCERTAIN (72%, p=0.03) and in AMBIGUOUS (69.44%, p=0.02).[11]

Result 3: The gender composition of winners gets more unbalanced in UNCERTAIN and AMBIGUOUS. This is a consequence of men improving their performance (while women do not) and the gender gap in the willingness to compete increasing in absolute terms in these two treatments. Hence, under more realistic conditions (with uncertainty and ambiguity), tournaments get skewed towards more male winners.

11 For completeness we note that in Stage 2 men win the tournament 58.3% of the time, which is not significantly different from 50% (p=0.20, one-sample test of proportions).

Before concluding the results section, we would like to briefly report on the risk and ambiguity measures for men and women reported in Table 3. We find that men are, on average, slightly risk seeking and have an average risk measure of r=0.47 (p=0.01, Wilcoxon sign-rank test, testing whether r is different than 0.5) while women are very close to risk neutrality (r=0.51, p=0.94 when testing whether r is different than 0.5). As a result, women are more risk averse than men on average (p=0.09). Subjects in our sample are significantly ambiguity averse, $a=0.07$ (p<0.01, sign-rank test when testing whether a is different than 0). However, there is no difference in ambiguity aversion between men and women (p=0.44).

Table 3. Risk and Ambiguity Measures

	Overall			CERTAIN		
	Pooled	Men	Women	Pooled	Men	Women
Risk	0.49	0.47	0.51	0.51	0.53	0.48
	(0.01)	(0.02)	(0.02)	(0.03)	(0.05)	(0.03)
Ambiguity	0.06	0.05	0.07	0.07	0.05	0.09
	(0.01)	(0.01)	(0.01)	(0.03)	(0.05)	(0.03)
	UNCERTAIN			AMBIGUOUS		
	Pooled	Men	Women	Pooled	Men	Women
Risk	0.48	0.43	0.53	0.49	0.48	0.50
	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.03)
Ambiguity	0.06	0.07	0.05	0.06	0.03	0.09
	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)

Standard errors in parenthesis.

The risk measure ranges from 0 (most risk seeking) to 1 (most risk averse), with 0.5 indicating risk neutrality. The ambiguity measure has positive values for ambiguity aversion, zero for ambiguity neutrality and negative values for ambiguity loving.

4. Discussion and Conclusion

Labor markets entail a considerable degree of uncertainty when workers compete for scarce jobs and higher pay. In many cases, the conditions of a tournament may not be fully known to competitors. While in some cases they may have accurate guesses about the potential number of winners and the likelihood of each number, in others the exact conditions may be ambiguous with unknown likelihoods. Since the labor market outcomes of men and women are still markedly different (Blau and Kahn, 2017), an ever growing body of literature has focused on gender differences in competitive behavior in order to explain (at least partly) the different labor market outcomes. This literature has emphasized potential gender differences both in competitive performance (starting with Gneezy et al., 2003) and in the willingness to compete (initiated by Niederle and Vesterlund, 2007), often finding that women shy away more often from competition and perform worse under competitive pressure than men. Interestingly, this literature has concentrated on settings where the tournament environment is perfectly known to competitors, meaning that they have perfect information about the number of competitors and the number of winners. Only a few field experiments (Flory et al., 2015; Gee, 2017) have had situations in which the competitors lacked perfect knowledge. However, contrary to our study, these field experiments did not measure *both* competitive performance and willingness to compete. Arguably, both dimensions are important when it comes to the ultimate question of which gender is more successful in tournaments, which is determined by a combination of tournament entry and performance in the tournament. Our experimental design has been able to study both dimensions in a unified framework.

We have found that men significantly increase their performance when the number of tournament winners becomes uncertain or ambiguous, while the performance of women decreases on average. Uncertainty and ambiguity cause both men and women to increase their likelihood to enter competition, with the effect being larger for men and significant in the case of the ambiguous tournament. On average, the gender gap in the willingness to compete increases with uncertainty and ambiguity, but not significantly so in comparison to the control treatment with certainty. In combination, the effects of uncertainty and ambiguity on performance and willingness to compete lead to the important finding that men win the tournament significantly more often than women whenever either uncertainty or ambiguity is involved. Seen from this perspective, the previous experimental studies with perfect information and certainty about the number of competitors and winners might have measured only a lower bound for the gender differences in competitive behavior and success under competitive environments.

Our results imply that competitive behavior of men and women seems to depend on the level of information available to potential competitors. The gender composition of winners (determined by tournament entry and performance in the competition of those who select into the tournament) seems to be better balanced when tournament conditions are perfectly known than when there is uncertainty or ambiguity involved. This suggests that companies can influence male and female competitive behavior by changing the available information to competitors. Such an approach might be a non-expensive and much less invasive alternative to institutionalized interventions such as affirmation action programs.

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Appendix (for online publication only):

Gender differences in their beliefs about relative performance.

Table A1 reports elicited beliefs about one's rank within a group in Stages 1 and 2. Men report significantly lower perceived ranks than women for their performance (i.e., they are more confident about having a good rank) in Stage 1 and in Stage 2 (p<0.01 for both stages, χ^2 tests).

Table A1. Elicited beliefs about ranks in Stages 1 and 2 (percentages)

	Stage 1		Stage 2	
	Men	Women	Men	Women
Rank 1 (best)	37.5%	16.7%	38.3%	10.0%
Rank 2	34.2%	39.2%	39.2%	50.8%
Rank 3	22.5%	33.3%	15.8%	30.8%
Rank 4 (worst)	5.8%	10.8%	6.7%	8.3%

Fraction of subjects stating the belief that their performance ranks as 1st, 2nd, 3rd, or last within their group. Sums may not add up to 100 due to rounding.

Sample Instructions (Treatment UNCERTAIN)

Welcome to an experiment on decision making. We thank you for your participation!

During the experiment, you and the other participants will be asked to make certain decisions. Your own decisions as well as the decisions of the other participants will determine your payment from the experiment, according to the rules that will be described in what follows. The experiment will be conducted on the computer. You make your decisions on the screen.

All decisions and answers will remain confidential and anonymous.

The experiment consists of 4 stages. You will be paid from one of the first three stages (chosen randomly at the end of the experiment) plus any earnings from Stage 4. Your total earnings from the experiment will be the sum of your payments from each of the two paid stages (Stage 4 plus one stage from Stages 1, 2, or 3). You will receive instructions for each of the four stages, one after the other.

We will read the instructions aloud and then give you time for questions. Please do not hesitate to ask questions if anything is not clear. Please do not talk to each other during the experiment. If you have any questions, please raise your hand.

Stage 1:

Your task in Stage 1 is to solve correctly as many addition exercises as possible. To be more precise, you will have 4 minutes time in order to solve as many additions of five randomly selected two-digit numbers as possible, by entering the sum of the five numbers. You are not allowed to use calculators but you can write down the numbers and use the provided scrap paper for your calculations. You enter an answer by clicking with the mouse on the "Confirm" button. When you enter an answer, you immediately find out on the screen whether it was correct or not.

If Stage 1 is the stage selected for payment (among Stages 1-3), then you will receive **€1.00 for each correct answer** that you entered within the 4 minutes. Your payment is not reduced when you enter a wrong answer.

Directly before the start of this stage you will be given one minute in order to familiarize yourselves with the screen: During this time you can solve addition exercises, which do not count for the experiment. Afterwards, Stage 1 will begin.

Stage 2:

As in stage 1, you will have 4 minutes time in order to solve correctly as many addition exercises as possible. However, your payment in this stage depends on your performance relative to the performance of a group of participants.

Group composition: Each group consists of **4 participants**, 2 of whom are men and 2 are women. Groups are randomly formed and each participant stays in the **same group** until the end of the experiment.

If Stage 2 is the stage selected for payment (amongst Stages 1-3), then your payment depends on how many additions you have solved correctly in comparison with the other three participants in your group. The group member who has entered the most correct answers is the winner of the tournament. The winner receives **€4.00 per correct answer** each, while the other three members **do not receive any payment**. In case of a tie, the ranking among the members with equal performances is determined randomly. You will not be informed about the outcome of the tournament until the end of the experiment.

Stage 3: Choice between Piece-rate payment and Tournament payment

As in Stages 1 and 2, you will have 4 minutes in order to solve correctly as many addition exercises as possible. However, you must now choose your preferred payment method for your performance in Stage 3. You can either choose a Piece-rate payment or the Tournament payment.

If you choose the **Piece-rate payment**, then you will receive **€1.00 per correct answer.**

If you choose the **Tournament payment**, then your performance in Stage 3 will be evaluated in comparison to the performance of the other three group members **in Stage 2**. As a reminder: That is the stage that you have just completed. **The number of Stage-2 performances of your group members that you need to beat in order to be a winner in this Stage is uncertain. In particular:**

Imagine there is a bag full of **blue**, **red**, or **green** marbles. There is an **equal number** of blue, red, and green marbles. Therefore, **each marble** has a **1/3 chance** of being chosen.

If a **blue** marble is drawn, then your performance must be better than all three of your group members' Stage 2 performances in order for you to win, and if you do win you will receive **€4.00 per correct answer.** In other words, no member of your group can have a Stage 2 performance which is higher than your Stage 3 performance; otherwise you receive **no payment** for this stage.

If a **red** marble is drawn, then your performance must be better than two of your group members' Stage 2 performances in order for you to win, and if you do win you will receive **€2.00 per correct answer.** In other words, only one member of your group can have a Stage 2 performance which is higher than your Stage 3 performance, otherwise you receive **no payment** for this stage.

If a **green** marble is drawn, then your performance must be better than one of your group members' Stage 2 performances in order for you to win, and if you do win you will receive

€1.33 per correct answer. In other words, only two members of your group can have a stage 2 performance which is higher than your Stage 3 performance, otherwise you receive **no payment** for this stage.

Stage 4 [risk task first]

In Stage 4 you will be presented with two different tasks privately. The two tasks are similar but differ in some critical aspects. Your choice will affect your payment for Stage 4.

This stage consists of two tasks. In total, you will have to make 40 decisions, 20 in Task 1 and 20 in Task 2. Two of these decisions will be paid for real; one decision from Task 1 and one decision from Task 2. For each task you have to make 20 choices between a sure amount of money and drawing a ball from the virtual bag. By drawing from the bag you may win €6.

The virtual bag has orange and white balls. When you decide to draw a ball from the virtual bag, a ball will randomly be chosen. If the drawn ball is orange, you receive €6. If the drawn ball is white, you get nothing.

In each task you have 20 decisions where each decision is one row on your computer screen. For each decision you must choose if you prefer a sure amount of money or drawing a ball from the virtual bag. These 20 decisions will look as follows on your screen:

[1]	draw form the bag	☐	**or**	☐	0.30 Euro for sure
[2]	draw form the bag	☐	**or**	☐	0.60 Euro for sure
[3]	draw form the bag	☐	**or**	☐	0.90 Euro for sure
[4]	draw form the bag	☐	**or**	☐	1.20 Euro for sure
[5]	draw form the bag	☐	**or**	☐	1.50 Euro for sure
[6]	draw form the bag	☐	**or**	☐	1.80 Euro for sure
[7]	draw form the bag	☐	**or**	☐	2.10 Euro for sure
[8]	draw form the bag	☐	**or**	☐	2.40 Euro for sure
[9]	draw form the bag	☐	**or**	☐	2.70 Euro for sure
[10]	draw form the bag	☐	**or**	☐	3.00 Euro for sure
[11]	draw form the bag	☐	**or**	☐	3.30 Euro for sure
[12]	draw form the bag	☐	**or**	☐	3.60 Euro for sure
[13]	draw form the bag	☐	**or**	☐	3.90 Euro for sure
[14]	draw form the bag	☐	**or**	☐	4.20 Euro for sure
[15]	draw form the bag	☐	**or**	☐	4.50 Euro for sure
[16]	draw form the bag	☐	**or**	☐	4.80 Euro for sure
[17]	draw form the bag	☐	**or**	☐	5.10 Euro for sure
[18]	draw form the bag	☐	**or**	☐	5.40 Euro for sure
[19]	draw form the bag	☐	**or**	☐	5.70 Euro for sure
[20]	draw form the bag	☐	**or**	☐	6.00 Euro for sure

For example, if line 7 is set as the payout-relevant line in the first task, you will receive € 6 if you have decided to draw the ball in this row and this ball is orange, but if the ball drawn is white then you receive € 0. If you have decided in this line for the secure amount (2.10 €), you will receive the respective safe amount indicated in line 7. You will find out the result from Stage 4 at the end of the experiment.

Task 1. (*risk*)

The virtual bag is full of 20 orange and white marbles. Half (10) of the marbles are orange and half (10) of the marbles are white. If you choose the virtual bag and an orange marble is chosen you receive €6. If a white marble is chosen you receive nothing. For the 20 choices on your screen, please select if you prefer to draw from the bag or take the sure amount of money instead.

Task 2. (*ambiguity*)

Now there is a different virtual bag full of 20 orange and white marbles. You do not know the number of orange and white marbles in this case, but each distribution of white and orange marbles is equally likely. If you choose the virtual bag and an orange marble is chosen you receive €6. If a white marble is chosen you receive nothing. For each of the 20 choices on your screen, please select if you prefer to draw from the bag or take sure amount of money instead.