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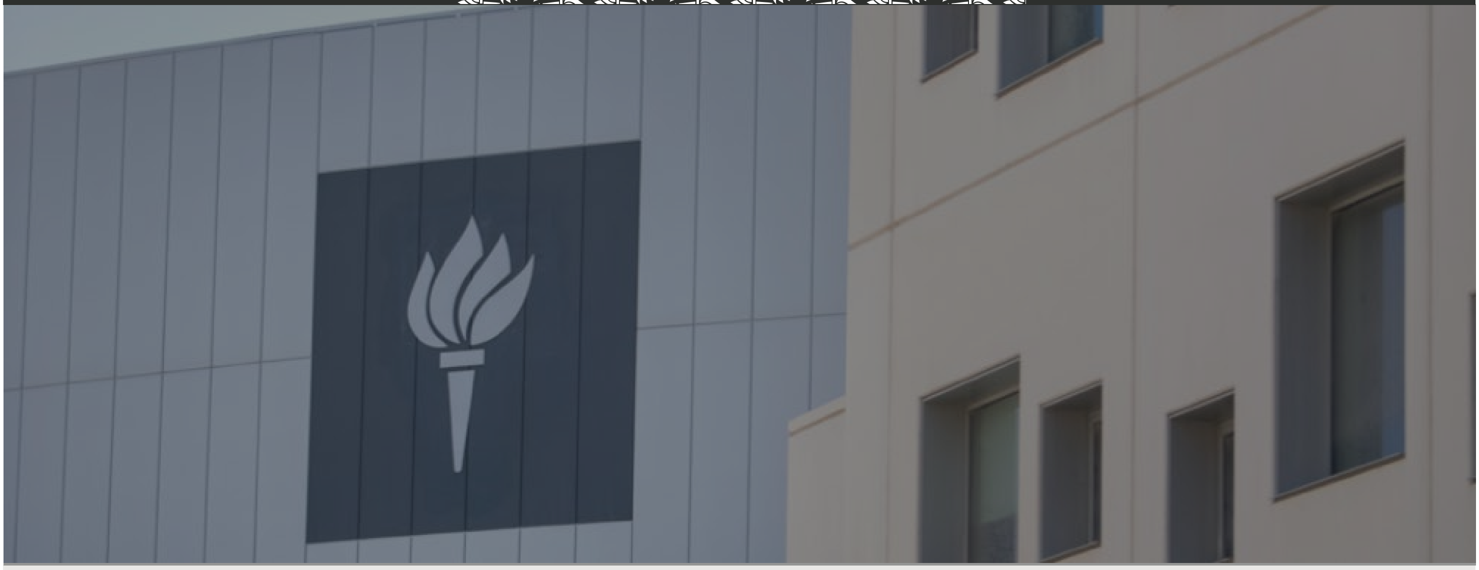

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Measuring Preferences for Competition

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Abstract

Recent research has found that competitive behavior measured in experiments strongly predicts individual differences in educational and labor market outcomes. However, there is no consensus on the underlying factors behind competitive behavior in these experiments. Are participants who compete more capable, more confident, and more tolerant of risk, or are they competing because they enjoy competition *per se*? In this study, we present an experiment designed to measure individuals' preferences for competition. Compared to previous work, our experiment rules out risk preferences by design, measures beliefs more precisely, and allows us to measure the magnitude of preferences for competition. In addition, we collect multiple decisions per participant, which lets us evaluate the impact of noisy decision-making. We find strong evidence that many individuals possess preferences for competition. Most participants are either reliably competition-seeking or competition-averse, and their choices are highly consistent with expected utility maximization. We also find that preferences for competition depend on the number of competitors but not on the participants' gender.

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1 Introduction

In recent decades, economists have started to pay attention to non-cognitive factors as important determinants of economic behavior. After reviewing the economic literature, Heckman et al. (2019) conclude that factors such as psychological traits and preferences explain and cause important life outcomes, like wages and health. More recently, the literature in experimental economics has started to focus on one of these traits, preferences for competition. Competition is present in most aspects of our lives, for instance, in the workplace, our education systems, markets, and many more. Recently, Therefore it is perhaps unsurprising that several studies have found that competing in laboratory experiments predicts important labor market and educational outcomes (Buser et al., 2014; Berge et al., 2015; Buser et al., 2017; Reuben et al., 2017; Kamas and Preston, 2018; Reuben et al., 2019; Zhang, 2019; Buser et al., 2020, 2021).

Since the seminal paper by Niederle and Vesterlund (2007), many experimental studies have documented individual heterogeneity in the decision to compete (for reviews see, e.g., Niederle, 2017; Dariel et al., 2017). However, it is yet unclear what underlying factors drive competitive behavior (Gillen et al., 2019; van Veldhuizen, 2022). Is it due to individual differences in the ability to perform, beliefs about relative performance, and risk attitudes, or is it due to individual differences in a taste for competition? Given the importance of competition in determining economic outcomes, it is important to uncover whether decisions to engage in competitive behavior are influenced by a desire or dislike to perform in competitive environments.

Typically, preferences for competition are measured by asking experimental participants to choose how they wish to be paid for an adding task they will subsequently perform. Participants are given two options, which we call *individual pay* and *competitive pay*. Under individual pay, participants are paid a fixed amount per correct answer. Under competitive pay, they are paid a larger amount per correct answer but only if they have the highest performance in a randomly selected group (for details, see Niederle and Vesterlund, 2007). Afterward, preferences for competition are identified as the residual of regressing the compensation scheme choice on controls for confounding traits such as risk preferences, beliefs, and performance. We advance the traditional experimental design by measuring preferences for competition in a setting that rules out risk preferences by design, measures beliefs more precisely, and allows us to measure the magnitude of preferences for competition. In addition, we collect multiple decisions per individual, which helps us evaluate the impact of decision errors.

To remove the role of risk preferences on the decision to compete, we adjust the compensation schemes participants choose from. As in Niederle and Vesterlund (2007), participants who choose competitive pay earn a large amount per correct answer if they are the best performer in their group and a low amount otherwise. Unlike the traditional design, in our experiment, participants who choose individual pay take part in a lottery. If they win the lottery, participants earn the same large amount per correct answer as those who choose to compete and win and the same low amount otherwise. By using identical outcomes for both compensation schemes, we ensure that risk preferences do not affect the participants' choices. This feature removes the need to statistically control for risk preferences and allows us to measure preferences for competition without making assumptions about the correlation between these two traits.

A crucial variable to identify preferences for competition is the participants' belief in their relative performance and, more precisely, their belief that they will be the best performer in their group. To measure this belief accurately, we incentivize the belief elicitation using a binarized scoring rule (Hossain and Okui, 2013). The advantage of this method is that it is unconfounded by varying levels of risk preferences and has been shown to outperform other belief elicitation methods (e.g., see Trautmann and van de Kuilen, 2015). In addition, we reduce noise in the elicitation of beliefs in two ways. First, we implement an interactive graphical interface that automatically calculates the applicable incentives (see, Danz et al., 2022). Second, we help participants calculate how their expected percentile ranking in the performance distribution translates into the probability of being the best performer in a randomly-formed group.

Another feature of our experimental design is that participants choose between competitive and individual pay using a multiple price list (MPL), where the probability of winning the lottery in individual pay gradually increases. For a given belief of being their group's winner, the point where participants switch from competitive to individual pay allows us to calculate the precise monetary amount participants are willing to pay to avoid or engage in competition. For instance, competition-neutral participants will switch from competitive pay to individual pay as soon as the probability of winning the lottery exceeds their expected probability of winning the competition. Participants who switch before this point accept a lower expected utility to avoid competition, which makes them competition averse. Analogously, participants who switch after this point accept a lower expected utility to keep competing, making them competition-seeking. In addition, the pattern of choices in the MPL allows us to identify whether a participant's competition-entry choices are consistent with expected utility maximization, which is a necessary condition for the measurement of preferences for competition to be meaningful.

A common drawback of most studies that measure preferences for competition is that they rely on one competition-entry decision. Therefore, they do not observe how noisy individuals' decisions are. In our experiment, we elicit choices in five different settings, where each setting implies an MPL with ten different choices between competitive and individual pay. Thus, we have much more data to determine the role of decision error.

Finally, while the literature studying preferences for competition has increased considerably, there is yet little knowledge of how these preferences depend on the degree of competition individuals face. We contribute to this question by studying the impact of group size on preferences for competition by implementing competition in groups of three and six.

We find strong evidence that many individuals have a preference for competition. Specifically, 75% of the participants in our sample switch from competitive to individual pay at points that imply they are willing to pay a positive amount of money to either seek competition (45% of participants) or avoid it (30% of participants). We also find that most participants are either reliably competition seeking or reliably competition averse across decisions and that these decisions are highly consistent with expected utility maximization. Our findings also reveal two other intriguing patterns. First, individuals become more competition-seeking when they compete in groups of six compared to groups of three. Second, we do not find that men have more competition-seeking preferences than women. This suggests that, while preferences for competition do exist, the commonly reported gender difference in competitiveness (Dariel et al., 2017) might be the result of gender differences in preferences for risk and beliefs.

This paper contributes to the literature on competitive behavior and how to measure it. Starting with the seminal paper of Niederle and Vesterlund (2007), there have been many papers measuring preferences for competition, especially in the context of gender differences (for reviews see, e.g., Niederle, 2017; Dariel et al., 2017). Most of these studies are based on slight variations of the original Niederle and Vesterlund (2007) experiment. The three most related papers to ours are Gillen et al. (2019), van Veldhuizen (2022), and Geraldes (2020). In the context of identifying gender differences in preferences for competition, Gillen et al. (2019) develop a statistical technique to correct for noise in the measurement of confounding variables in the Niederle (2017) design. Their findings suggest that the gender gap in choosing competitive pay is fully accounted for by gender differences in risk preferences and beliefs. van Veldhuizen (2022) introduces new treatments that remove the role of competition and overconfidence from the decision to compete. He then compares gender gaps in these treatments to that in the Niederle (2017) design to identify under what conditions the gender gap in the decision to compete disappears. As Gillen et al. (2019), van Veldhuizen (2022) concludes that the gender gap in competition is mainly captured by gender differences in risk preferences and beliefs. Another similar approach to ours is Geraldes (2020). Like us, Geraldes (2020) uses a lottery as individual pay. However, he does not use a MPL to find a precise indifference point and does not elicit beliefs with a proper scoring rule. Conceptually, our work differs from these papers in that we do not focus on identifying the sources of the gender difference in decisions to compete. Instead, we focus on measuring individuals' preferences for competition directly. Also, our experiment is designed to create a richer dataset that allows us to observe the consistency of choices within individuals and with expected utility maximization.

2 Experimental design

We propose a variation of the experimental task developed by Niederle and Vesterlund (2007) to measure preferences for competition. As in their design, participants are randomly assigned to groups and perform an adding task. The participant who correctly solves the highest number of sums in their group is the group's winner (tie are broken randomly). The elicitation of preferences for competition is based on the following two tasks.

2.1 Belief elicitation task

In this part, participants report their belief of being their group's winner. We incentivize the belief elicitation using a robust scoring rule (Karni, 2009). Specifically, participants take part in a lottery for a prize of €20 in which the probability of getting the prize depends on their stated belief and whether or not they turn out to be their group's winner. Given a stated belief of being the winner b_i, participant i has a probability $1 - (1 - b_i)^2$ of getting the prize if i is indeed the winner, and a probability $1 - b_i^2$ if i is one of the losers. This framework has the advantage that it is easy to implement, is incentive compatible for a wide range of risk preferences and has been shown to outperform other belief elicitation methods (Gächter and Renner, 2010; Wang, 2011; Hossain and Okui, 2013; Harrison and Phillips, 2014; Trautmann and van de Kuilen, 2015). To facilitate the understanding of the elicitation method, we gave participants a detailed instructions, including examples that illustrate why it is optimal to report truthfully. In addition, we use an interactive graphical interface that automatically calculates these probabilities and the associated expected earnings for any selected belief (see the instructions in Appendix A.8 for a screenshot of the interface).

Another feature of our belief elicitation task is that participants can answer the belief elicitation question by indicating their expected percentile ranking in the performance distribution. Upon selecting a percentile the participants are shown the probability of being a winner in a randomly formed group. The advantage of this feature is that participants that struggle calculating compound probabilities can answer in terms of ranking. We also provide participants with a table displaying the probability of being their group's winner for every percentile (see the instructions in Appendix A.8).

2.2 Payment-scheme choice and adding task

Before performing the adding task, participants choose how they want to be paid per correct sum. Specifically, they choose between *competitive pay* and *individual pay* in five independent decision sets. Each decision set is a MPL that contains ten rows, each row is a choice between competitive pay (left) and individual pay (right). Participants make a choice in each row of each decision set, thus making fifty choices. After making their choices, one row and decision

Table 1. Example of a decision set

Note: Example of a decision set with a high amount $\pi^H = 4$, a low amount $\pi^L = 1$, and a range of probabilities for individual pay between 0.17 to o.44.

	Competitive pay		Individual pay			
Row	**Win (€)**	**Lose (€)**	**Win (€)**	**P(Win)**	**Lose (€)**	**P(Lose)**
1	4	1	4	0.17	1	0.83
2	4	1	4	0.20	1	0.80
3	4	1	4	0.23	1	0.77
4	4	1	4	0.26	1	0.74
5	4	1	4	0.29	1	0.71
6	4	1	4	0.32	1	0.68
7	4	1	4	0.35	1	0.65
8	4	1	4	0.38	1	0.62
9	4	1	4	0.41	1	0.59
10	4	1	4	0.44	1	0.56

set is randomly chosen and implemented.

Under competitive pay, participants earn a high amount π^H per correct sum if they are their group's winner and a low amount π^L per correct sum otherwise. Under individual pay, participants earn π^H per correct sum with some probability p and π^L per correct sum with probability $1-p$. Within a decision set, the probability of earning π^H in individual pay increases as one goes from the first to the tenth row. The values of π^H and π^L were constant within each decision set but varied across decision sets. Table 1 displays an example of a decision set where $\pi^H = 4$, $\pi^L = 1$, and p ranged from 0.17 to o.44.

After the selection of the payment-scheme in the five decision sets, participants perform the adding task knowing the decision set and row that was randomly chosen. The adding task consists in performing sums of four two-digit numbers for four minutes. The integers are randomly drawn from a uniform distribution with support 10 to 99. Participants are not allowed to use a calculator, but they are provided with scratch paper. Every time they submit an answer, they can see whether their answer was correct or incorrect.

2.3 Treatment variations

We use a 2×2 treatment design. The first treatment variation consists of varying the timing of the belief elicitation task. In treatment *Belief-first*, participants first do the belief elicitation task, followed by the payment-scheme choice, and ending with the adding task. In treatment *Choice-first*, participants first do the payment-scheme choice, followed by the adding task, and ending with the belief elicitation task. This treatment variation serves as a robustness check to see whether our proposed method to elicit preferences for competition is sensitive to the sequence in which beliefs and choices are elicited. This treatment variation was implemented between-subjects.

The order of the tasks also affects how we construct the MPLs of the belief elicitation task. In all treatments, the range of probabilities in the decision sets was a function of the participants' previous choices to ensure MPLs with a reasonable degree of accuracy (i.e., the steps between rows are not too large) and that the participants' belief is contained within the MPL. In treatment *Belief-first*, the range of probabilities is simply centered around the participants' belief of being their group's winner. In treatment *Choice-first*, we narrow down the range of probabilities by giving participants two additional decision sets in which they chose between competitive and individual pay. In the first additional decision set, the probabilities for individual pay range from 0.05 to 0.95 in steps of 0.10. Based on the number of times a participant chooses competitive pay in that first set, the probabilities for individual pay in the second additional set range from either 0.05 to 0.50, 0.30 to 0.70, or 0.50 to 0.95 in steps of 0.05. The five decision sets used to measure preferences for competition are centered around the probability at which participants switch from competitive pay to individual pay in this second additional set.[1] Appendix A.1 contains a more detailed description of the procedure used to determine the probabilities in individual pay and the high and low amounts used in each decision set.

The second treatment variation consists of varying the size of the group in which participants compete. We implemented groups of three and six participants. This treatment variation allows us to evaluate the role of the number of competitors in shaping individual preferences for competition. This treatment variation was implemented between-subjects. In other words, all participants did the belief elicitation task, payment-scheme choice, and adding task twice, once for a group of three and once for a group of six. The order of the group size was counter-balanced across sessions.[2]

2.4 Experimental procedures

The study was conducted at the Behavioral and Experimental Economics Laboratory (BEElab) at Maastricht University. The experiment consisted of 11 sessions of 22 participants on average. We recruited in total 224 participants, 133 women and 91 men, through the online recruitment system ORSEE (Greiner, 2015). The experiment was programmed and executed with the software z-Tree (Fischbacher, 2007).

All participants signed an informed consent form before participating in the experiment. The experiment consisted of five tasks: two belief elicitation tasks, two payment-schemes choices with addition tasks, and a final task that consisted of a risk-elicitation task. Instructions for each

[1]We randomized the position of the belief or switching probability from two rows above to two rows below the fifth row so that participants faced a different range of probabilities across decision sets. As Chapman et al. (2019), participants were not explained how their previous choice would affect future decision sets.

[2]Note that participants do not receive feedback on their relative performance until the end of the experiment.

task were provided at the beginning of the respective task. At the end of the experiment, one of these tasks was randomly selected for payment and this was known by the participants from the beginning. In addition, participants had an unincentivized practice round of three minutes to familiarize themselves with the adding task and completed a demographics questionnaire that included gender, age, number of siblings and position among them, nationality, and level of education. Participants received €25 on average (including a €10 show-up fee). The instructions for experiment can be found in Appendix A.8.

3 Measuring preferences for competition

In this section, we describe the conceptual framework used to measure preferences for competition. We assume that participants' preferences can be represented by a utility function $U(\pi_i, C)$ that depends on the monetary payoffs π and whether a participant is performing under competitive ($C = 1$) or individual ($C = 0$) pay. More specifically, We assume the following utility function for participant i:

$$U(\pi_i, C) = u(\pi_i) + C\theta_i,$$

where π_i is the monetary value of performing the task (i.e., i's number of correct sums multiplied by either π^H or π^L) and θ_i is the parameter that captures i's non-pecuniary utility of performing under competition. As usual, we assume $u'(\pi_i) > 0$ and individual risk preferences are represented by the curvature of the utility function, $u''(\pi_i)$. Hence, we assume separability between preferences for competition and risk.

Under these assumptions, i is indifferent between competitive and individual pay if

$$\begin{aligned} b_i u\big(x_i \cdot \pi^H\big) + (1 - b_i)u\big(x_i \cdot \pi^L\big) + \theta_i &= pu\big(x_i \cdot \pi^H\big) + (1 - p)u\big(x_i \cdot \pi_i^L\big) \\ \theta_i &= (p - b_i)\big[u\big(x_i \cdot \pi^H\big) - u\big(x_i \cdot \pi^L\big)\big], \end{aligned}$$

where b_i is i's belief of being the winner of their group in the competitive pay, p is the probability of obtaining π^H in individual pay, and x_i is i's the expected number of correct sums in the addition task. Note that by using the same π^H and π^L for both payment schemes ensures that we can identify $theta_i$ irrespective of i's risk preferences. This feature of our design accounts for some of the concerns raised by Gillen et al. (2019) and van Veldhuizen (2022) as our setting does not rely on the assumption that risk and competitive preferences are orthogonal.

We measure preferences for competition by finding this indifference point using a precise estimate of participants' beliefs and locating the probability at which they switch from competitive to individual pay. In other words, our experimental design allows us to calculate i's monetary equivalent of θ_i. More specifically, for a participant i in decision set t we calculate

$$\omega_{it} = (p_{it} - b_i)\big(\pi^H - \pi^L\big)\hat{x}_i.$$

where ω_{it} as i's willingness to pay to perform under competitive pay, p_{it} is the midpoint between the probability of the row at which i switched from competitive pay to individual pay and the probability of the preceding row, b_i is i's reported belief of being their group's winner, and $\hat{x}_i$ is i's number of correct sums in the adding task. An $\omega_{it} < 0$ implies i is competition seeking whereas $\omega_{it} > 0$ implies i is competition averse.

4 Results

This section is divided into three parts. First, we study the participants' switching behavior in the five decision sets. Second, we analyze the participants willingness to pay to compete. Lastly, we link our findings with the literature on gender differences in competition by testing for gender differences in switching behavior and and our measure of preferences for competition. Descriptive statistics of the participants performance in the adding task and beliefs of being their group's winner are presented in Appendix A.2 .

Throughout this section, we separate our analysis by group size (i.e., by groups of three or six). The order in which participants faced the different group sizes is counter-balanced. Hence, in the main analysis we pool together both orders. However, since we observe a significant difference in beliefs across orders (OLS regression, $p < 0.001$),[3] in Appendix A.4, we report the results for each order. Since we do not observe significant differences in behavior between the *Belief-first* and *Choice-first* treatments,[4], we pool the data from both treatments.

4.1 Switching behavior

In this subsection, we analyze switching behavior within decision sets in the payment-scheme choice. Since we did not impose a single-switch restriction in the decision sets, we can test whether behavior within sets is consistent with utility maximization by looking at the number of times participants switch within a decision set. Specifically, we categorize behavior within decision sets as *inconsistent* if there is more than one switch (multiple switches) or there is a unique switch from the payment-scheme with the higher expected value to the one with the lower expected value (non-monotonic switch). In other words a switch from individual to competitive pay. Similarly, we categorize behavior within decision sets as *consistent* if there is one switch from competitive to individual pay (single switch) or if all choices correspond to either competitive or individual pay (no switch).

Table 2 displays the fraction of consistent and inconsistent decision sets for the two group

[3]There are no significant differences in performance or the selection of competitive pay (OLS regressions, $p = 0.276$)

[4]There are no significant differences between treatments in either reported beliefs, performance, or the selection of competitive pay (OLS regressions, $p = 0.337$ and $p = 0.128$, respectively)

Table 2. Consistency in switching behavior within decision sets

Note: Percentage of decision sets with switching behavior that is consistent or inconsistent with utility maximization. Decision sets with inconsistent behavior have either *multiple switches* or a single *non-monotonic switch* from individual to competitive pay. Decision sets with consistent behavior have either a *single switch* from competitive to individual pay or *no switch* at all. For each group size, the total number of decision sets is 1120.

	Group Size	
	Three	Six
Inconsistent behavior		
Multiple switches	2.2%	2.5%
Non-monotonic switch	1.9%	2.1%
Consistent behavior		
Single switch	77.0%	76.0%
No switch	18.9%	19.4%

sizes. When participants compete in groups of three, we observe around 96% of the decision sets display consistent switching behavior, with 77% of sets having a single switch and 19% no switch. A similar pattern is present in groups of six. Namely, 95% of decision sets exhibit consistent behavior, with 76% having a single switch and 19% no switch. There are no significant differences in consistency across group sizes (t-test, $p = 0.651$).

Next we look at consistency with utility maximization within individuals. The top section of Table 3 shows the percentage of participants who exhibited at least one inconsistent decision set. We can see that this is a small minority of 9% when competing in groups of three and 12% when competing in groups of six. This leaves the vast majority of participants are consistent with utility maximization in all five sets: 91% when competing in groups of three and 88% when competing in groups of six. We do not observe a significant difference between group's sizes in the fraction of participants with at least one inconsistent set (t-test, $p = 0.351$).

We continue by looking at the number of sets with one switch among participants who exhibited consistent behavior in all five sets. The reason is that to identify a precise value for participants' willingness to pay to compete, ω_{it}, we need to observe a switch from competitive to individual pay. The bottom section of Table 3 shows the percentage of participants who switched in all five sets as well as the percentage who switched in at least three out of five sets. In groups of three, we observe that 76% of all participants have five consistent sets with a single switch in at least three sets and 55% switch from competitive to individual pay in all five sets. Similarly, in groups of six, 75% have a single switch in at least three sets and 46% switch from competitive to individual pay in all five sets.

These results show that, overall, most participants exhibit behavior consistent with utility maximization. However, since our interest is in measuring participants' willingness to pay to compete, ω_{it}, in the rest of our analysis we concentrate solely on participants who switched once

Table 3. Consistency in switching behavior within individuals

Note: Percentage of participants with inconsistent behavior in least one decision set. For the participants with consistent behavior in all five decision sets, the table also displays the percentage of participants with a single switch in three or more decision sets and the percentage with a single switch in all five decision sets. For each group size, the total number of participants is 240.

	Group Size	
	Three	Six
Inconsistent behavior		
At least one set with inconsistent behavior	8.9%	11.6%
Consistent behavior		
All sets with consistent behavior	91.1%	88.4%
All sets with consistent behavior and a single switch in three or more sets	75.9%	75.0%
All sets with consistent behavior and a single switch in all five sets	54.5%	45.5%

from competitive to individual pay in the majority of decision sets (i.e., in three or more sets) and had no inconsistent behavior in any set. That is, 76% of participants when competing in groups of three (170 out 224) and 75% of participants when competing in groups of six (168 out 224).[5]

To sum up, we conclude that choices to compete are highly consistent with utility maximization at the individual level for both group sizes. Furthermore, for the purpose of measuring participants willingness to pay to compete, we observe that most participants switch once from competitive to individual pay in a majority of decision sets.

4.2 Willingness to pay to compete

In this subsection, we look at the location of the switching point for the participants who have consistent behavior in any five sets and a single switch from competitive to individual pay in at least three sets.

We summarize a participant's willingness to pay to perform under competitive pay by calculating the median value of the five ω_{it}s, which we denote as $\bar{\omega}_i$.[6] If participants derive non-pecuniary utility from performing under competitive pay, we should observe values of $\bar{\omega}_i$ that are noticeably different from zero.

Figure 1 displays the distribution of $\bar{\omega}_i$ for the two different group sizes. The figure shows that most participants have a nonzero $\bar{\omega}_i$ (65% when competing in groups of three and 82% when

[5]We test the sensitivity of our results to this restriction in the Appendix. Appendix A.5 presents the main results including all 224 participants. Appendix A.5 presents the main results including all participants who had five sets with consistent behavior (204 in groups of tree and 198 in groups of six). The results are quantitatively similar to those presented in the following subsection.

[6]Similar results are obtained if we use the mean (see Appendix A.3). However, we think that the median makes more sense since it guarantees that the summary measure is based on a decision set that contains a switch from competitive to individual pay.

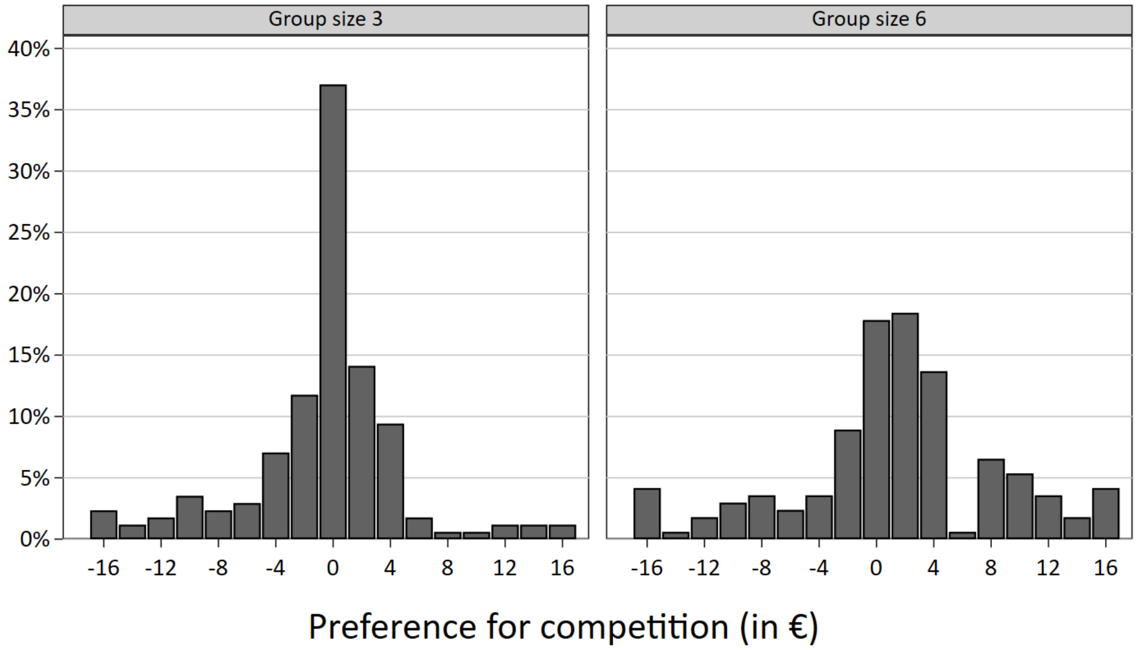

Figure 1. Distribution of $\bar{\omega}_i$ by group size

competing in groups of six). In other words, they switch from competitive pay to individual pay at a row where their belief of being the group's winner does not coincide with the probability of winning the prize in individual pay.[7] A test for equality of matched pairs reveals that the median subject is slightly competitive in groups of six ($p < 0.001$), but not in groups of three ($p = 0.938$). Lastly, we also observe that the distributions of $\bar{\omega}_i$ are significantly different depending on group size (Mann-Whitney-Wilcoxon test, $p < 0.001$), suggesting that increasing the number of competitors in the tournament makes participants more competitive.

Robustness checks

Next, we take a closer look at our data to determine whether the distribution of $\bar{\omega}_i$ in Figure 1 reflect the participants' preferences for competition or whether they are the result of decision error. To do so, we use the fact that our experimental design gives us more than one measure of willingness to pay to compete per participant. In other words, we analyze the variation in the ω_{it}s within participants.

As a first step, we compare variation in the values of ω_{it} within participants to variation in ω_{it} between participants. As argued by (Falk et al., 2018), if the values of ω_{it} are mostly due to decision errors, then we should expect that variation within participants will exceed variation between participants. A total variance decomposition analysis shows that within-participant

[7] For groups of three, these are the summary statistics of $\bar{\omega}_i$: mean=-0.62, median=-0.08, s.d.=6.08. For groups of six, the summary statistics of $\bar{\omega}_i$ are: mean= 1.71, median=2.27, s.d.=15.53. For visual ease, Figure 1 censors the values of $\bar{\omega}_i$ at -16 and 16.

variation is smaller than the between-participants variation. Specifically, around 74% of the total variation in the values of ω_{it} is due to between-participant variation in groups of three and 78% in groups of six.[8]

As a next step, we analyze variation in ω_{it}s by looking at whether participants are consistently competition seeking or competition averse. The idea is that if nonzero values of ω_{it} are due to decision error, then we should find that it is equally likely for a participant to err on a positive or negative value of ω_{it}.

Figure 2 displays the percentage of participants that have either competition seeking ($\omega_{i,t} > 0$) or competition averse ($\omega_{i,t} < 0$) behavior in four or five decision sets. The remaining participants are classified as not having a defined willingness to pay to compete.[9] The figure's left panel reveals that among participants competing in groups of three, 71% have consistently positive or negative values of ω_{it} and only 29% are classified as not having a defined willingness to pay to compete. The figure's right panel shows a similar pattern for groups of six where 74% have consistently positive or negative values of ω_{it}. As a benchmark, it is illustrative to compare these percentages to those obtained in a hypothetical scenario where participants choose positive or negative values of $\omega_{i,t}$ with equal probability in five decision sets. In that hypothetical scenario, one obtains around 19% consistently positive, 19% consistently negative, and 62% as not having a defined willingness to pay to compete (the observed and hypothetical distributions are significantly different, χ^2 test, $p < 0.001$). Figure 2 also reveals that, while the fraction of participants classified as "not defined" is similar across group sizes, participants are more consistently competition seeking in groups of six compared to groups of three (Mann-Whitney-Wilcoxon test, $p < 0.001$).

Overall, the results from this section suggest that participants do possess preferences for competition.

4.3 Gender differences

Since our findings might be informative for the literature in gender differences in competitiveness, we also test whether there are gender differences in the variables analyzed above.

Before comparing the willingness to pay to compete between men and women, we first ensure that there are no gender differences in the consistency of competitive choices with expected utility maximization. We find no statistically significant difference in the percentage of decision sets with behavior consistent with utility maximization between men and women (98.2% vs. 97.8%, t-test, $p = 0.476$). Similarly, we do not find a statistically significant difference in the

[8] The fraction of the total variance accounted for by variance between participants corresponds to the R^2 of an OLS regression of all values of ω_{it} on a set of individual dummies.

[9] The "not defined" category in Figure 2 refers to participants who have consistent switching behavior in all sets but do not display consistent competition seeking or averse switching points in at least four decision sets.

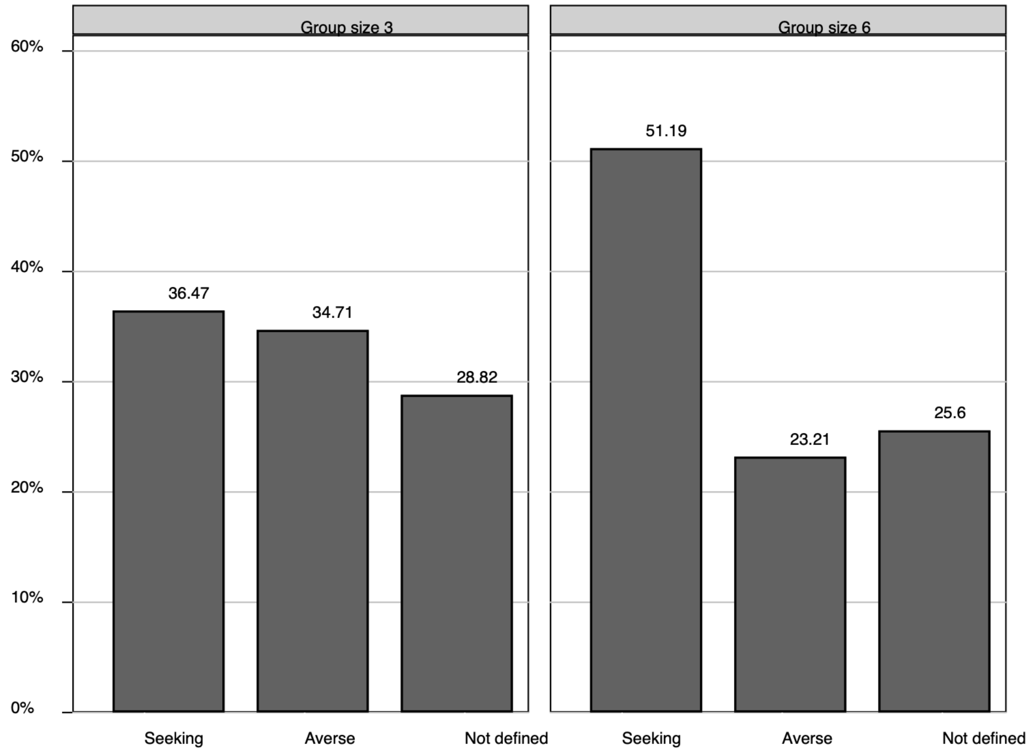

Figure 2. Fraction of participants with consistently positive (competition seeking) or negative (competition averse) values of ω_{it}

percentage of participants exhibiting consistent behavior in all five sets between men and women (91.7% vs. 88.3%; t-test, $p = 0.244$). See Appendix A.7 for details.

When considering gender differences in willingness to pay to compete, we consider only the men and women with a majority of decision sets with a single switch from competitive to individual pay (74% of men and 77% of women when competing in groups of three and 76% of men and 74% of women when competing in groups of six).

Figure 3 displays the distribution of $\bar{\omega}_i$ by gender. We do not observe gender differences in the distribution of $\bar{\omega}_i$ (Mann-Whitney-Wilcoxon test, $p = 0.203$). Lastly, we also do not find significant differences in the fraction of men and women who are consistently competition seeking, competition averse, or do not have a defined willingness to pay to compete (Mann-Whitney-Wilcoxon test, $p = 0.112$; see Appendix A.7 for more details).[10] In conclusion, we do not find evidence of gender differences in preferences for competition in our setting.

[10]A total variance decomposition analysis for each gender shows that the percentage of total variation in the values of ω_{it} that is due to variation between individuals is 72% for men and 77% for women when competing in groups of three and 79% for men and 77% for women when competing in groups of six.

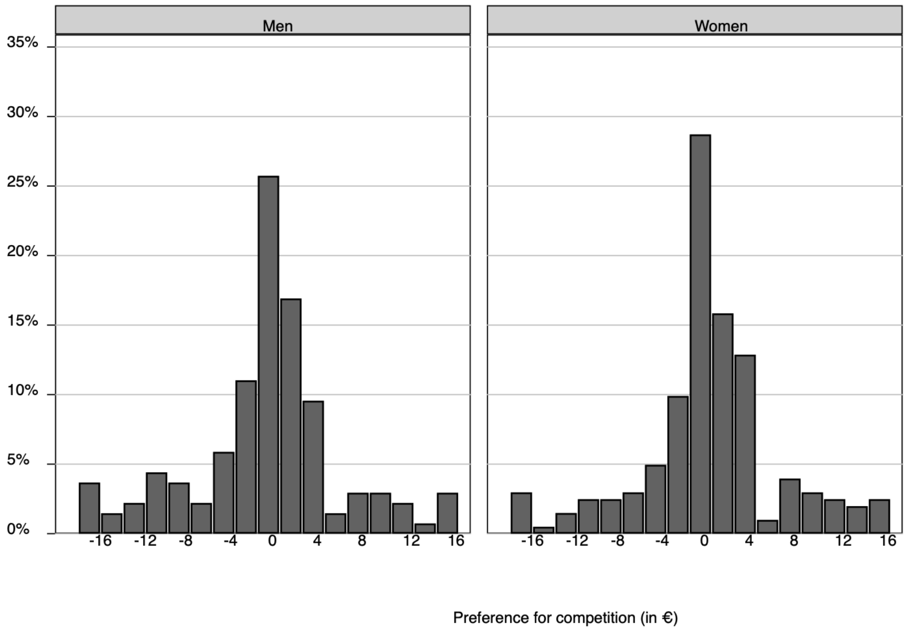

Figure 3. Distribution of $\bar{\omega}_i$ by gender

5 Discussion and conclusions

This study uses an experimental design to measure preferences for competition at the individual level. We modify the experimental task developed by Niederle and Vesterlund (2007) to control for risk preferences by design, obtain precise measures of beliefs, and obtain multiple measures of individuals' willingness to compete. Our results reveal the existence of a nonzero preference for competition for most participants.

To test for consistency of individual's choices in competition, we look at the switching behavior during the selection of the payment-scheme. Our results reveal that competitive behavior is highly consistent with utility maximization. We find that choices in 95% of the decision sets are consistent with utility maximization and 89% of participants make consistent choices in all five decision sets. We also observe that most of the consistent decision sets contain a switch from competitive to individual pay (76% of the all participants). These are the participants for whom we calculate the monetary value of their non-pecuniary utility of performing under competitive pay.

We measure the participants' preferences for competition by looking at when they switch from competitive to individual pay in each decision set. Our findings suggest that most of the participants either like or dislike competing since 75% of our sample switches when their belief of winning the competition is not equal to the probability of winning the same prize under individual pay. Looking deeper within decision sets demonstrates that most participants are either consistently competition seeking or competition average, which is in line with competition choices being affected by a preference for competition.

A caveat to our design is that it considers only preferences for competition that are independent of individuals utility over monetary outcomes. We believe that this is a good start to understand preferences for competition. However, future work could consider other functional forms of the utility function.

Recently, the existence of preferences for competition has been questioned given the limitations of the most common approach to measure this trait (see for instance Gillen et al., 2019; van Veldhuizen, 2022). However, extensive literature in experimental economics has pointed out the relevance of competitive behavior in explaining differences in educational and labor market outcomes (Buser et al., 2014; Berge et al., 2015; Buser et al., 2017; Reuben et al., 2017; Kamas and Preston, 2018; Zhang, 2019; Reuben et al., 2019; Buser et al., 2020; Fallucchi et al., 2020; Buser et al., 2021). Our findings contribute to this discussion as they suggest that preferences for competition are distinct from preferences for risk and do exist for a large portion of individuals.

Our results also reveal that 75% of participants have competition seeking (45%) or competition averse preferences (30%). This profile of preference suggests a high heterogeneity of preferences for competition. Given that competition is present in every aspect of our lives, for instance in markets, education, and social status, it seems crucial to acknowledge that a high share of the population dislikes competition. Also, a possible venue for future research will be to understand how this individual heterogeneity interacts with other individual traits or cultural aspects of our lives.

Our study suggests that the median participant is more competitive when competing in groups of six compared to groups of three. Moreover, bigger groups also display a higher variance of preferences at the individual level. Unfortunately, our design cannot bring light on the driving factors of these results. Although it does make intuitive sense that a more competitive setting increases the importance of preferences for competition. To our knowledge, there are few attempts to test the role of the group size on competitors' behavior. Overall, the literature in psychology suggests that competitors' motivation decreases when the number of competitors increases, and that this effect is mediated by social comparison (Garcia and Tor, 2009; Hanek et al., 2016). However, these studies do not account for participants' overconfidence or risk attitudes, which makes it difficult to compare them with our setting. Regarding contests, the literature in economics suggests that increasing the number of competitors decreases the chances of any competitor to win, and therefore, reduces incentives to exert effort (Che and Gale, 2003). In addition, it is also suggested that higher uncertainty reduces the negative effect of added competitors on incentives (Boudreau et al., 2011). We believe further research is needed to precisely address the role of the number of competitors on preferences for competition, and also to target the role that risk preferences can play in it.

An important point to consider is whether our results are due to measurement error in beliefs.

Although we cannot ensure that our belief elicitation method is completely free of measurement error, we consider there are some reasons why we can trust the beliefs provided by participants in our study. First, we use a robust scoring rule which offers incentives for truth-telling for a wide range of risk preferences and outperforms other scoring rules and unincentivized elicitation mechanisms (Gächter and Renner, 2010; Wang, 2011; Hossain and Okui, 2013; Harrison and Phillips, 2014; Trautmann and van de Kuilen, 2015). Second, we help participants provide accurate beliefs by giving them information about how their ranking in the performance distribution affects their probability of winning. Third, we give participants a simple graphical interface that is easy to understand and shows the incentives of the scoring rule without the need for participants to fully understand the payoff function.[11] Lastly, variance in beliefs does not seem to explain variance in our measure of preferences for competition. More specifically, in our experimental design, participants report their belief of winning the tournament twice, once when competing in groups of three and once when competing in six. Although participants could use information on their own performance to update their beliefs, another interpretation of reporting different percentile rankings is measurement error. Under this interpretation, participants who exhibit higher measurement error in beliefs should also show larger deviations from zero in their values of ω_{it}. To test this conjecture, we first calculate the absolute difference between the two reported percentile rankings for each participant. Then, we test whether the variance of ω_{it} differs between participants who have an above-average difference in beliefs to those with a below-average difference in beliefs. We do not find a significant difference in the variance of ω_{it} across these two groups ($p = 0.132$ and $p = 0.898$). This finding suggests that noise in beliefs is not driving variation in the participants' willingness to pay to compete.

We also test for gender differences in consistency with utility maximization and preferences for competition in our experimental setting. Contrary to most of the literature in gender differences in competition (Gneezy et al., 2003; Booth and Nolen, 2012; Dariel et al., 2017; Saccardo et al., 2018), our findings suggest that men and women do not differ in preferences for competition. Our results suggest that the common finding that women are less likely to select into competition (Niederle, 2017; Dariel et al., 2017) vanishes once one controls for risk preferences and accounts for beliefs. This result is in line with Gillen et al. (2019) and van Veldhuizen (2022) who also observe that gender differences for competition can be fully accounted for by risk preferences and beliefs. Unlike these papers, we show that the lack of gender difference is not due to preferences for competition being nonexistent.

[11] Recent evidence suggests that providing precise information on the BSR quantitative incentives can alter belief reporting (Danz et al., 2022). However, Danz et al. (2022) also shows that a graphical interface like the one we use performs relatively well.

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Appendix

A.1 Additional details of the experimental design

In this first section of the appendix we provide additional details for our experimental design.

High and low payments in Part 2

In Table A1, we list the high π^H and low π^L amounts for the five decision sets in Part 2 of the experiment.

Table A1. High and low values of the lotteries in the five decision sets (in euros)

Decision set	1	2	3	4	5
π^H	4	6	1.5	4	2
π^L	0	0	0	1	0.5

Probabilities used in the multiple price lists

In this subsection, we explain how we obtain the probabilities used in the MPLs of the decision sets. We use the procedures described below to have MPLs with a reasonable degree of accuracy (i.e., the steps between items are not too large) and ensure that the subjects belief of winning the tournament is contained within the MPL.

More specifically, each multiple price list consists of ten rows $r \in [1, 10]$. Each row has a probability of winning in individual pay $p_r \in [0, 100]$. As one goes down the list, the probability of winning in individual pay increases by z percentage points (i.e., $p_{r+1} = p_r + z$). Hence, in a given MPL, the probabilities range from $p_1 = p_L$ to $p_{10} = p_L + 9z$. For a participant i, we use a reference probability $b_i \in [0, 100]$ to set the starting probability, p_L for i's MPLs in the following way:

- If $b_i \leq 9z$ then $p_L = 0$.

- If $b_i \geq 1 - 9z$ then $p_L = 1 - 9z$.
- If $9z < b_i < 1 - 9z$ then $p_L = b_i - 5z + \epsilon$, where ϵ is a random number drawn from a uniform distribution with support $[-0.025, 0.025]$.

The values of z varied across the various decision sets as follows: $z = 2$ in decision set 1, $z = 1$ in decision set 2, $z = 3$ in decision set 3, $z = 2$ ($z = 3$) in decision set 4 for group sizes of three (six), and $z = 4$ in decision set 5, We varied the values of z and introduced the random component ϵ so that participants would not see the same probability range in every decision set.

The reference probability b_i depends on when participants' beliefs are elicited. In treatments where the beliefs of winning the tournament are elicited before the payment scheme choice, b_i equaled the participants' submitted belief. In treatments where beliefs of winning are elicited after the payment scheme choice, b_i is obtained by giving participants two additional MPLs designed to narrow down the range of probabilities where a participant switches from competitive to individual pay. In the first additional MPL $p_L = 0.05$ and $z = 0.10$. We construct the second additional MPL based on the answers to the first additional MPL. Specifically, participants who switch from competitive pay to individual pay at a probability $p_r \leq 0.35$ get $p_L = 0.05$, those who switch at a probability $0.35 < p_r < 0.65$ get $p_L = 0.30$, and those who switch at a probability $p_r \geq 0.65$ get $p_L = 0.50$. In all cases $z = 0.05$. We then set b_i as the probability at which the participant switches from competitive to individual pay in the second additional MPL.[12]

A.2 Descriptive statistics of the adding task

Table A2 displays the mean number of correct sums in the adding task and the mean reported belief of being the group's winner depending on group size and gender. Participants solve on average 11.4 sums correctly for both group sizes and report a mean belief of being the group's winner of 53% in groups of three and 41% in groups of six. We find are no statistically significant differences in performance by group size (Mann-Whitney-Wilcoxon test, $p = 0.792$), but a significant difference in the reported beliefs between the two group sizes (Mann-Whitney-Wilcoxon test, $p < 0.001$). Hence, participants (correctly) believe that they have lower chances of winning the tournament in groups of six than in groups of three. In addition, we observe that there are significant differences in performance between men and women (Mann-Whitney-Wilcoxon tests, $p = 0.051$ for groups of three and $p = 0.027$ for groups of six). Lastly, we find a significant difference in beliefs between men and women in groups of six (Mann-Whitney-Wilcoxon test, $p = 0.046$) but not in groups of three (Mann-Whitney-Wilcoxon test, $p = 0.307$).

[12]For participants that switch multiple times or switch from individual to competitive pay, the switching probabilities equaled the number of competitive pay choices multiplied by z plus p_L.

Table A2. Summary behavior in the experimental tasks

Note: values represent the average performance in the adding task or average reported belief for each category, i.e., different group sizes, gender, and all participants.

	Group size	**Women** (n=133)	**Men** (n=91)	**All** (n=224)
Adding task performance	3	10.87	12.27	11.44
	6	10.72	12.07	11.27
	Average	10.80	12.17	11.35
Average reported belief of being the winner	3	52.49	54.80	53.43
	6	37.90	44.72	40.67
	Average	45.19	49.76	47.05

A.3 Supplementary analysis: Mean willingness to pay to compete

In this subsection, we show the distribution of the participants' Willingness to pay to compete when it is calculated using the mean value of the five ω_{it}s instead of the median. We denote this mean value as $\hat{\omega}_i$ and graph its distribution in Figure A1.

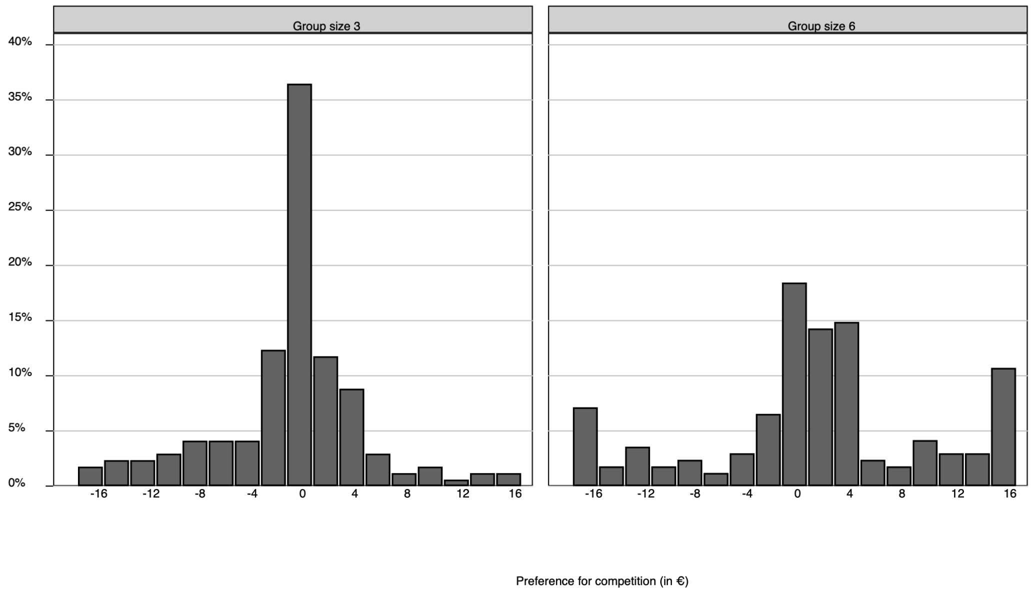


Figure A1. Distribution of $\hat{\omega}_i$ by group size

A.4 Supplementary analysis: Order of play

In this subsection we present the results by the order in which participants played the experimental tasks. Some participants played first in groups of three and then in groups of six while others played first in groups of six and then in groups of three.

Table A3 displays consistency of switching behavior with expected utility maximization within decision sets depending on the order of play. Table A4 shows consistency of switching behavior with expected utility maximization at the participant level by the order of play.

Table A3. Consistency in switching behavior within decision sets by order of play

Note: Percentage of decision sets with switching behavior that is consistent or inconsistent with utility maximization. Decision sets with inconsistent behavior have either *multiple switches* or a single *non-monotonic switch* from individual to competitive pay. Decision sets with consistent behavior have either a *single switch* from competitive to individual pay or *no switch* at all. The total number of decision sets is 550 for those who played first in groups of three and 570 for those who played first with groups of six.

	Played 1st		**Played 2nd**	
	Size 3	Size 6	Size 3	Size 6
Inconsistent behavior				
Multiple switches	3.6%	2.6%	0.9%	2.4%
Non-monotonic switch	2.7%	2.1%	1.1%	2.2%
Consistent behavior				
Single switch	76.9%	78.1%	77.0%	73.8%
No switch	16.7%	17.2%	21.1%	21.6%

Table A4. Consistency in switching behavior within individuals by order of play

Note: Percentage of participants with inconsistent behavior in least one decision set. For the participants with consistent behavior in all five decision sets, the table also displays the percentage of participants with a single switch in three or more decision sets and the percentage with a single switch in all five decision sets. The total number of participants is 110 who played first in groups of three and 114 who played first in groups of six.

	Order 1		**Order 2**	
	Size 3	Size 6	Size 3	Size 6
Inconsistent behavior				
1+ set with inconsistent behavior	11.8%	11.4%	6.1%	11.8%
Consistent behavior				
5 sets with consistent behavior	88.2%	88.6%	93.9%	88.2%
5 sets with consistent behavior and a single switch in 3+ sets	79.1%	78.1%	72.8%	71.8%
5 sets with consistent behavior and a single switch	52.7%	49.1%	56.1%	41.8%

For the results of of measurement of preferences for competition, the figures below display the distribution of $\bar{\omega}_i$ for the two different group sizes for participants who played first in groups of three (A2) and those of played first in groups of six (A3).

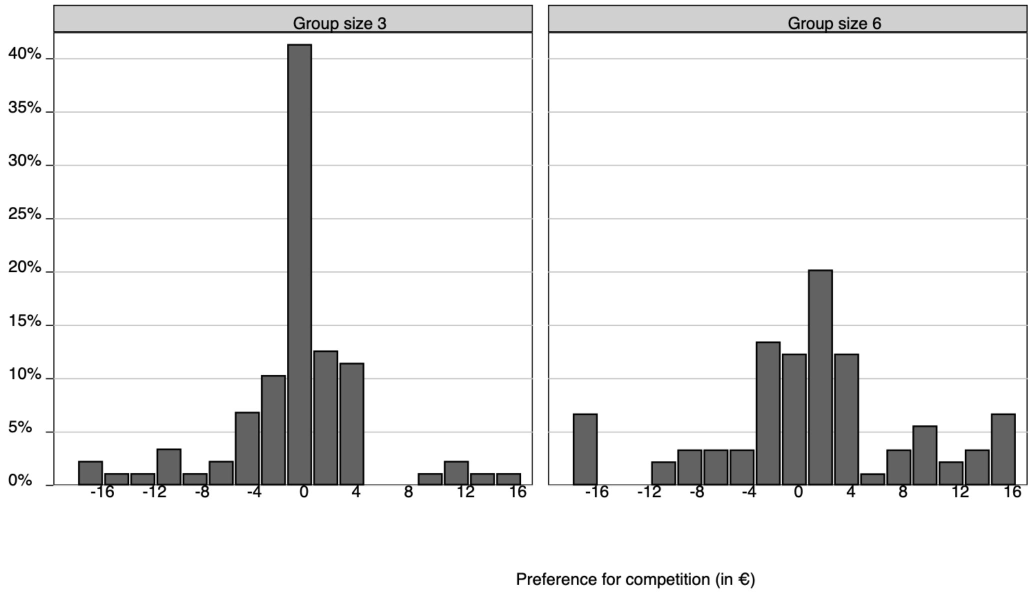


Figure A2. Distribution of $\bar{\omega}_i$ by group size for participants who played first in groups of three and then in groups of six

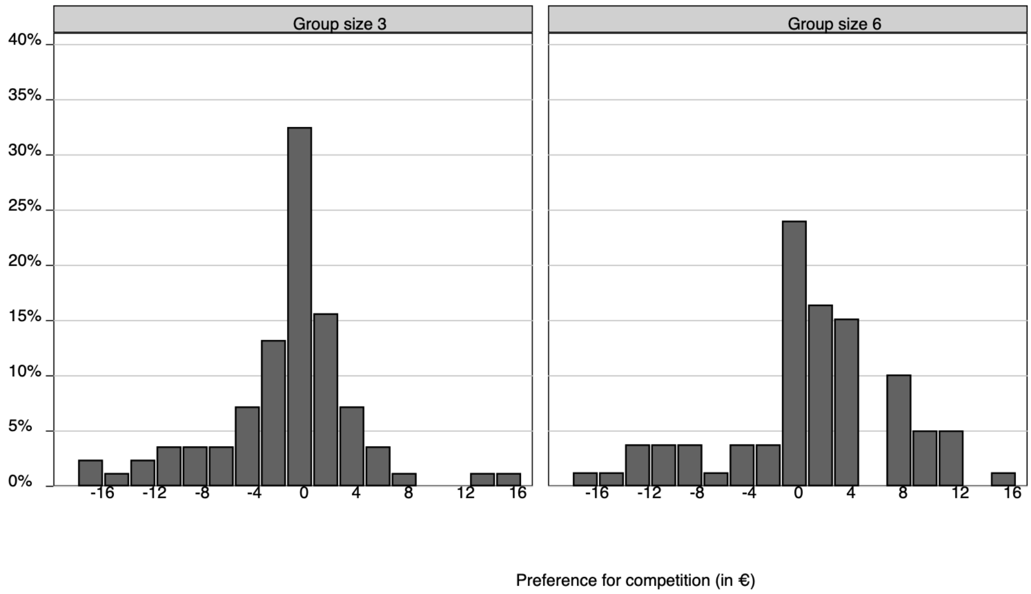


Figure A3. Distribution of $\bar{\omega}_i$ by group size for participants who played first in groups of six and then in groups of three

The figures below display the percentage of participants that have either competition seeking ($\omega_{i,t} > 0$) or competition averse ($\omega_{i,t} < 0$) behavior in four or five decision sets. The remaining participants are classified as not having a defined willingness to pay to compete. Figure A4 corresponds to participants who played first in groups of three and Figure A5 to those of played first in groups of six (A3)

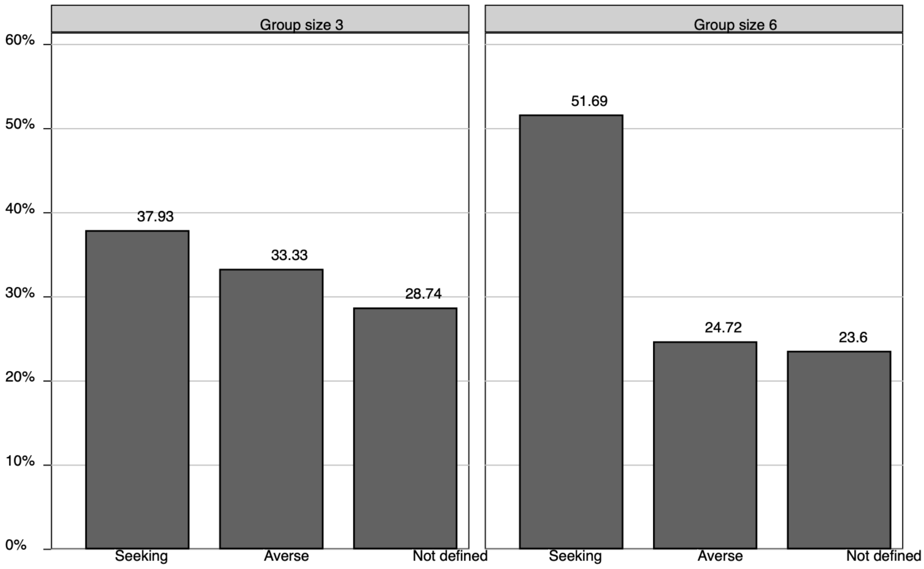


Figure A4. Fraction of participants with consistently positive (competition seeking) or negative (competition averse) values of ω_{it} for participants who played first in groups of three and then in groups of six

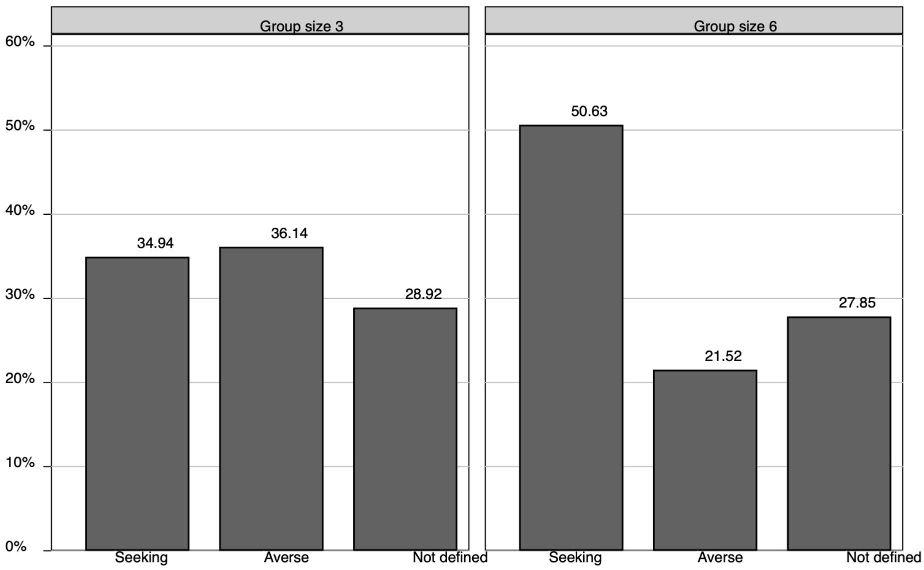


Figure A5. Fraction of participants with consistently positive (competition seeking) or negative (competition averse) values of ω_{it} for participants who played first in groups of six and then in groups of three

A.5 Supplementary analysis: Using the whole sample, including inconsistent sets

In this subsection we present the results for our measure of preferences for competition without removing the participants who have decision sets with switching behavior that is inconsistent with utility maximization or who have less than three decision sets with a single switch from competitive to individual pay. In sets with multiple switches, the value of ω_{it} is calculated based on the first switch from competitive to individual pay. In sets with no switches from competitive to individual pay, the value of ω_{it} is the smallest in the set if the participants' first choice is individual pay and the largest in the set if the participants' first choice is competitive pay.

Figure A6 displays the distribution of $\bar{\omega}_i$ for the two different group sizes when using all participants, including those with inconsistent switching behavior in some decision sets.

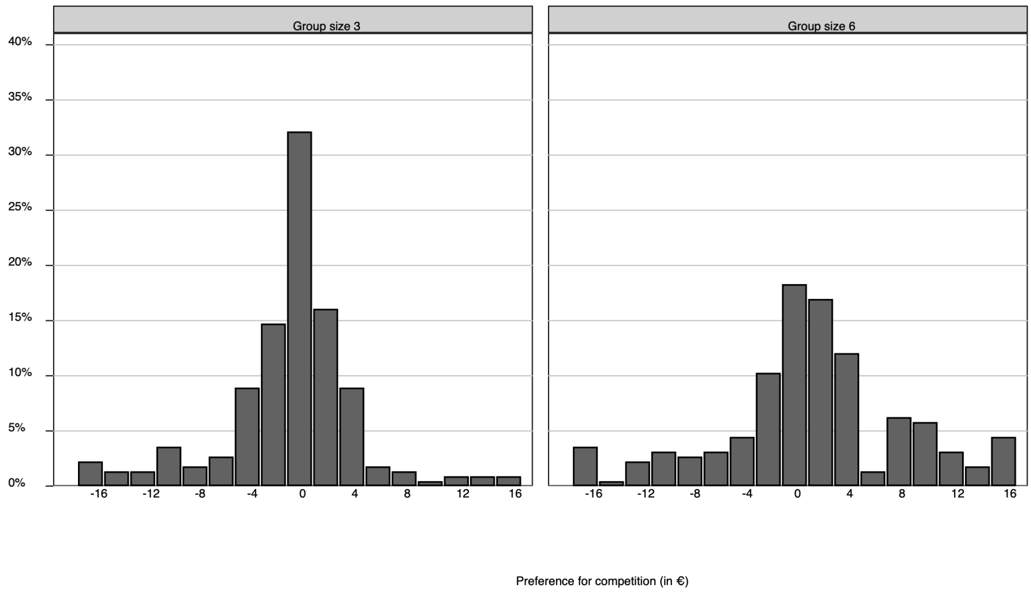


Figure A6. Distribution of $\bar{\omega}_i$ by group size for all participants, including those with inconsistent switching behavior in some decision sets

Figure A7 displays the percentage of participants that have either competition seeking ($\omega_{i,t} > 0$) or competition averse ($\omega_{i,t} < 0$) behavior in four or five decision sets. The remaining participants are classified as not having a defined willingness to pay to compete. It is based on data from all participants, including those with inconsistent switching behavior in some decision sets.

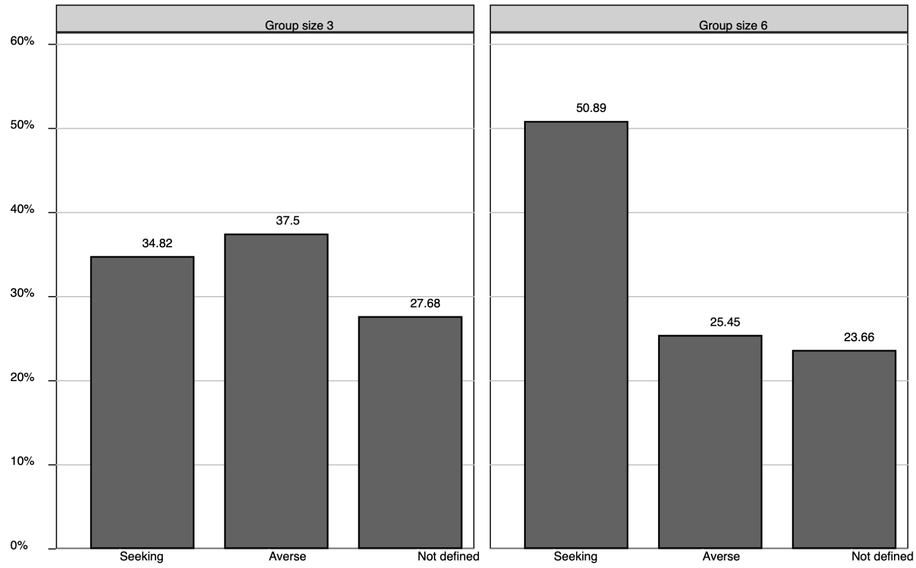


Figure A7. Fraction of participants with consistently positive (competition seeking) or negative (competition averse) values of ω_{it} for all participants, including those with inconsistent switching behavior in some decision sets

A.6 Supplementary analysis: Including sets without switching

In this subsection we present the results for our measure of preferences for competition without removing participants who have five decision sets with switching behavior that is consistent with utility maximization but have less than three decision sets with a single switch from competitive to individual pay. In sets with no switches from competitive to individual pay, the value of ω_{it} is the smallest in the set if the participants' first choice is individual pay and the largest in the set if the participants' first choice is competitive pay.

Figure A8 displays the distribution of $\bar{\omega}_i$ for the two different group sizes when using all participants with consistent switching behavior in all five decision sets.

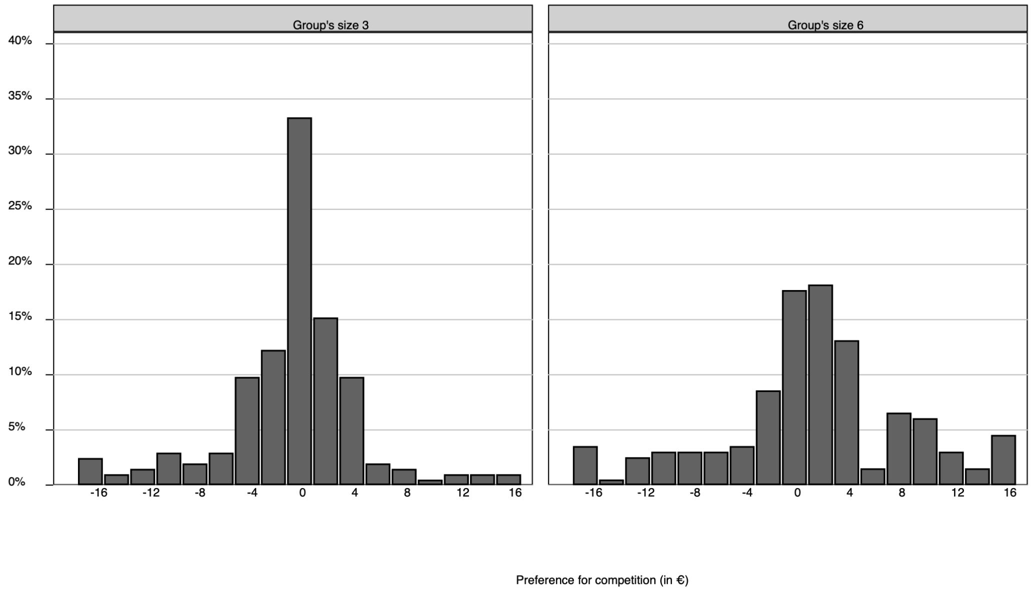


Figure A8. Distribution of $\bar{\omega}_i$ by group size for all participants with consistent switching behavior in all five decision sets

Figure A9 displays the percentage of participants that have either competition seeking ($\omega_{i,t} > 0$) or competition averse ($\omega_{i,t} < 0$) behavior in four or five decision sets. The remaining participants are classified as not having a defined willingness to pay to compete. It includes data from all participants with consistent switching behavior in all five decision sets.

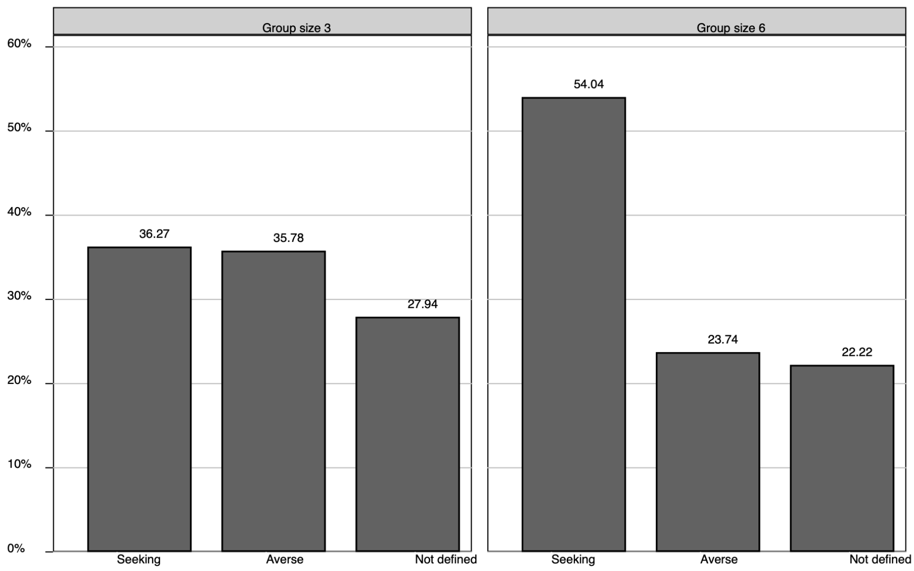


Figure A9. Fraction of participants with consistently positive (competition seeking) or negative (competition averse) values of ω_{it} for all participants with consistent switching behavior in all five decision sets

A.7 Supplementary analysis: By gender

In this subsection we present the results for consistency of behavior with utility maximization and our measure of preferences for competition separately for men and women.

Table A5 displays consistency of switching behavior with expected utility maximization within decision sets depending on the participants' gender. Table A6 shows consistency of switching behavior with expected utility maximization at the participant level by the participants' gender.

Table A5. Consistency in switching behavior within decision sets by gender

Note: Percentage of decision sets with switching behavior that is consistent or inconsistent with utility maximization. Decision sets with inconsistent behavior have either *multiple switches* or a single *non-monotonic switch* from individual to competitive pay. Decision sets with consistent behavior have either a *single switch* from competitive to individual pay or *no switch* at all. The total number of decision sets is 455 for men and 655 for women.

	Men		Women	
	Size 3	Size 6	Size 3	Size 6
Inconsistent behavior				
Multiple switches	1.3%	1.8%	2.9%	3.0%
Non-monotonic switch	1.3%	2.2%	2.3%	2.1%
Consistent behavior				
Single switch	74.7%	75.2%	78.5%	76.5%
No switch	22.6%	20.9%	16.4%	18.4%

Table A6. Consistency in switching behavior within individuals by gender

Note: Percentage of participants with inconsistent behavior in least one decision set. For the participants with consistent behavior in all five decision sets, the table also displays the percentage of participants with a single switch in three or more decision sets and the percentage with a single switch in all five decision sets. The total number of participants is 91 men and 133 women.

	Men		Women	
	Size 3	Size 6	Size 3	Size 6
Inconsistent behavior				
1+ set with inconsistent behavior	6.6%	9.9%	10.5%	12.8%
Consistent behavior				
5 sets with consistent behavior	93.4%	90.1%	89.5%	87.2%
5 sets with consistent behavior and a single switch in 3+ sets	73.6%	75.8%	77.4%	74.4%
5 sets with consistent behavior and a single switch	49.5%	46.2%	57.9%	45.2%

For each gender, Figure A10 displays the percentage of participants that have either competition seeking ($\omega_{i,t} > 0$) or competition averse ($\omega_{i,t} < 0$) behavior in four or five decision sets. The remaining participants are classified as not having a defined willingness to pay to compete.

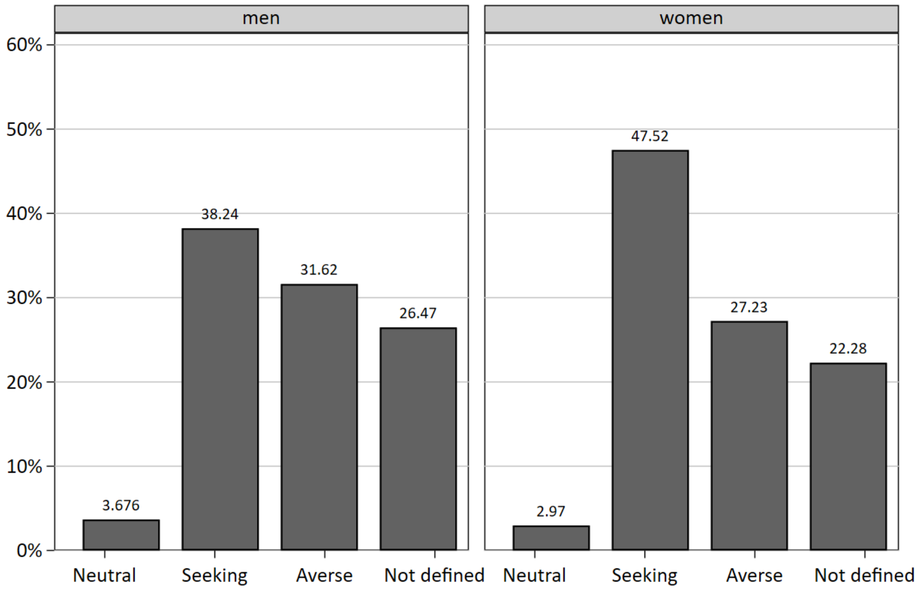


Figure A10. Fraction of participants with consistently positive (competition seeking) or negative (competition averse) values of ω_{it} depending on the participants' gender

A.8 Instructions

Below are the instructions for the *before* treatment with first a group size of three followed by a group size of six. Instructions for the other treatments are very similar and available upon request.

General Instructions

Welcome to the experiment. In the experiment today, you will be asked to complete five tasks. Before each task, you will receive detailed instructions and description of how your earnings in that task are determined.

Your total earnings at the end of the experiment are the sum of the following two components:

1. A €10 show-up fee.
2. Your earnings in one of the five tasks. Specifically, at the end of the experiment, one of the five tasks you will complete during the experiment will be randomly chosen for payment purposes.

During the experiment, the use of cell phones is prohibited. All your information, decisions, and performance during this experiment are anonymous.

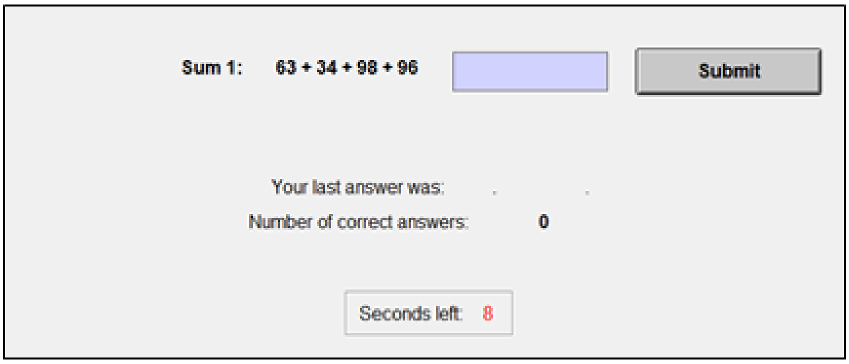
If you have a question, please raise your hand. An experimenter will come and answer your question in private.

Now you will start Task 1, please read the instructions of Task 1 carefully.

Task 1

In Task 1, you will be randomly assigned to a group of three participants. In other words, you will be matched with two other participants in the room.

In Task 1 you will be given four minutes to calculate a series of sums of four two-digit numbers (see the screenshot below). You cannot use a calculator, but you are welcome to use the provided scratch paper. You submit an answer by clicking the button "Next". When you submit an answer, the computer will immediately tell you whether the answer is correct or incorrect and a new sum is generated.



Your earnings in Task 1 depend on your number of correct sums. Specifically, you can earn either a high amount or a low amount per correct sum. The high amount will vary between €1.5 and €6 per correct sum, and the low amount will vary between €0 and €1. You will be given the precise values before you perform the task. Whether you are paid a high amount or a low amount depends on your choices. Before you perform the task, you will choose between **individual pay** and **competitive pay**. The two payments schemes are as follows:

- **Individual pay:** if you choose individual pay, whether you receive a high or low amount per correct sum depends on chance. With individual pay your earnings do NOT depend on the performance of others in your group.

- **Competitive pay:** if you choose competitive pay, whether you receive a high or low amount per correct sum depends on your performance and the performance of the other two members of your group. Specifically, you will be your group's winner if you solve more sums in Task 1 than all others in your group in Task 1. If there are ties, the winner will be randomly determined among the tied group members. If you are your group's winner, you will receive the high amount per correct sum. If you are NOT your group's winner, then you are one of the two losers in the group. If you are one of the group's losers, you will receive the low amount per correct sum.

Practice round: Before Task 1 starts, you will have two minutes to get familiar with the screen and to practice the calculation of series of sums of four two-digit numbers. Please notice that your answers in this practice round will not be considered for your earnings in this experiment.

Once you are done reading, click on the "NEXT" button on your screen.

Task 2

In this task, you can earn money by answering the following question:

"How likely do you think it is that you are the winner of your group in Task 1?"

Your answer can go from 0 (meaning you are completely certain that you are not the winner of your group) to 100 (meaning you are completely certain that you are the winner of your group).

Your earnings in Task 2 can be either **€0 or €20**. The probability of earning €20 depends on two things:

1. The actual outcome (whether you are the winner or a loser in your group)

2. The likelihood you selected as the answer to the question above.

The closer the likelihood you choose is to your actual outcome in Task 1, the higher the probability you have of earning €20. This probability is based on the formulas you see in the footnote.[13] It is not necessary for you to understand precisely the formulas, but it's important that you know that these formulas have been designed so that **your expected earnings are higher the closer your answer is to your actual likelihood of being your group's winner**.

To help you to think about your likelihood of being your group's winner, it is useful to think **how your performance in Task 1 ranks compared to the performance of all participants.** The table provided in the next page displays this information. In the table you can see for each possible rank (from being on the top 0% to being on the top 100%) the likelihood that someone with that rank is the winner of a group of three. The numbers on the table are calculated based on you being randomly assigned to groups of three. For example, imagine that your performance in Task 1 puts you in the Top 10%. This means that you performed better than 90% of all participants in the study and you performed worse than around 10% of all participants in the study. Then for you to be the winner it must be the case that **all two** of the other members of your group have a worse rank than you. In other words,

- You have been randomly matched **only** with participants who **all** come from the 90% of participants who performed worse than you, and

- You have **not** been randomly matched with **any** of the 10% of participants who performed better than you.

[13]Probability of earning €20 if you are the winner = $1 - (1 - \text{Your selected likelihood}/100)^2$. Probability of earning €20 if you are one of the losers = $1 - (\text{Your selected likelihood}/100)^2$.

The table shows that, for someone in the Top 10%, the likelihood that this happens is 81.00%.

Group size 3

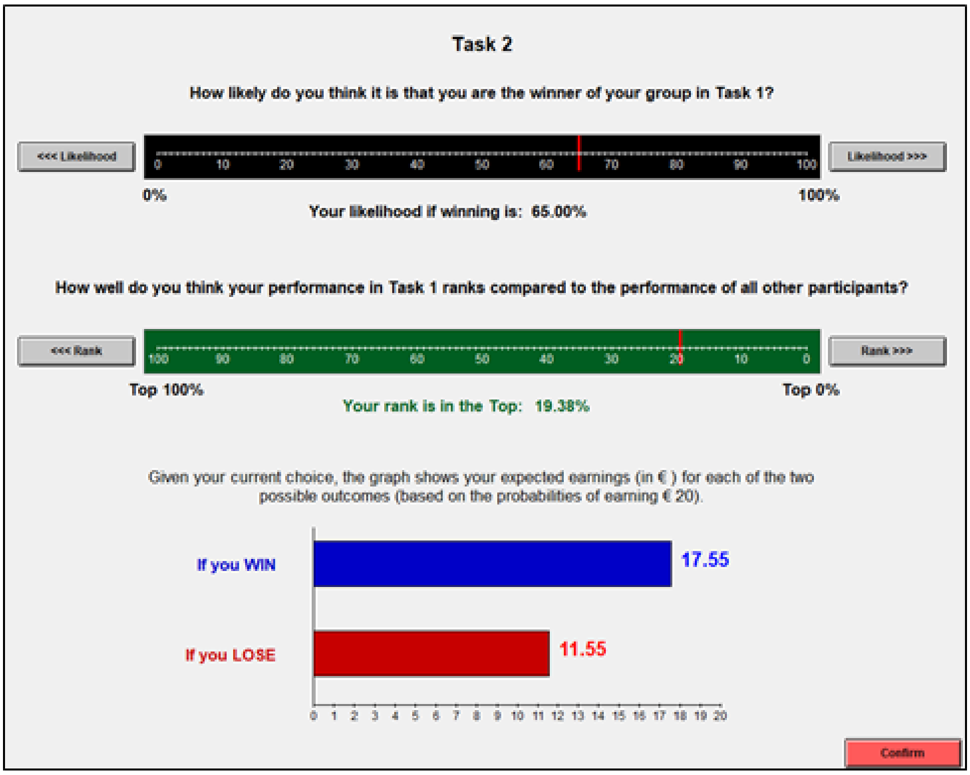
Your performance is in the Top ...	The likelihood that you are your group's winner is...	Your performance is in the Top ...	The likelihood that you are your group's winner is...
0%	100.00%	50%	25.00%
1%	98.01%	51%	24.01%
2%	96.04%	52%	23.04%
3%	94.09%	53%	22.09%
4%	92.16%	54%	21.16%
5%	90.25%	55%	20.25%
6%	88.36%	56%	19.36%
7%	86.49%	57%	18.49%
8%	84.64%	58%	17.64%
9%	82.81%	59%	16.81%
10%	81.00%	60%	16.00%
11%	79.21%	61%	15.21%
12%	77.44%	62%	14.44%
13%	75.69%	63%	13.69%
14%	73.96%	64%	12.96%
15%	72.25%	65%	12.25%
16%	70.56%	66%	11.56%
17%	68.89%	67%	10.89%
18%	67.24%	68%	10.24%
19%	65.61%	69%	9.61%
20%	64.00%	70%	9.00%
21%	62.41%	71%	8.41%
22%	60.84%	72%	7.84%
23%	59.29%	73%	7.29%
24%	57.76%	74%	6.76%
25%	56.25%	75%	6.25%
26%	54.76%	76%	5.76%
27%	53.29%	77%	5.29%
28%	51.84%	78%	4.84%
29%	50.41%	79%	4.41%
30%	49.00%	80%	4.00%
31%	47.61%	81%	3.61%
32%	46.24%	82%	3.24%
33%	44.89%	83%	2.89%
34%	43.56%	84%	2.56%
35%	42.25%	85%	2.25%
36%	40.96%	86%	1.96%
37%	39.69%	87%	1.69%
38%	38.44%	88%	1.44%
39%	37.21%	89%	1.21%
40%	36.00%	90%	1.00%
41%	34.81%	91%	0.81%
42%	33.64%	92%	0.64%
43%	32.49%	93%	0.49%
44%	31.36%	94%	0.36%
45%	30.25%	95%	0.25%
46%	29.16%	96%	0.16%
47%	28.09%	97%	0.09%
48%	27.04%	98%	0.04%
49%	26.01%	99%	0.01%
	continues →	100%	0.00%

You will indicate your likelihood of being your group's winner in a screen like the one below. As you can see, there are two sliders in the top part of the screen. You can select your answer by moving the cursors in these two different sliders:

- **In the black slider**, you can select your likelihood of being the winner of your group. Your answer can go from 0% (meaning you are completely certain that you are not the winner of your group) to 100% (meaning you are completely certain that you are the winner of your group).
- **In the green slider**, you can select how your performance in task 1 ranks compared to the performance of all participants. Your answer can go from Top 100% (you performed worse than **all** other participants of the study) to Top 0% (you performed better than ALL other participants in the study).

Please notice that the information displayed in both sliders is always consistent with each other. In other words, when you select a likelihood on the black slider, the cursor on the green slider will automatically mark the rank associated with your selected likelihood. Similarly, when you select a rank on the green slider, the cursor on the black slider will automatically mark the likelihood associated with your selected rank. The values of the sliders are based on the numbers you can see in the table of the previous page.

The cursors will appear on the sliders only after you have clicked on one of the sliders for the first time.



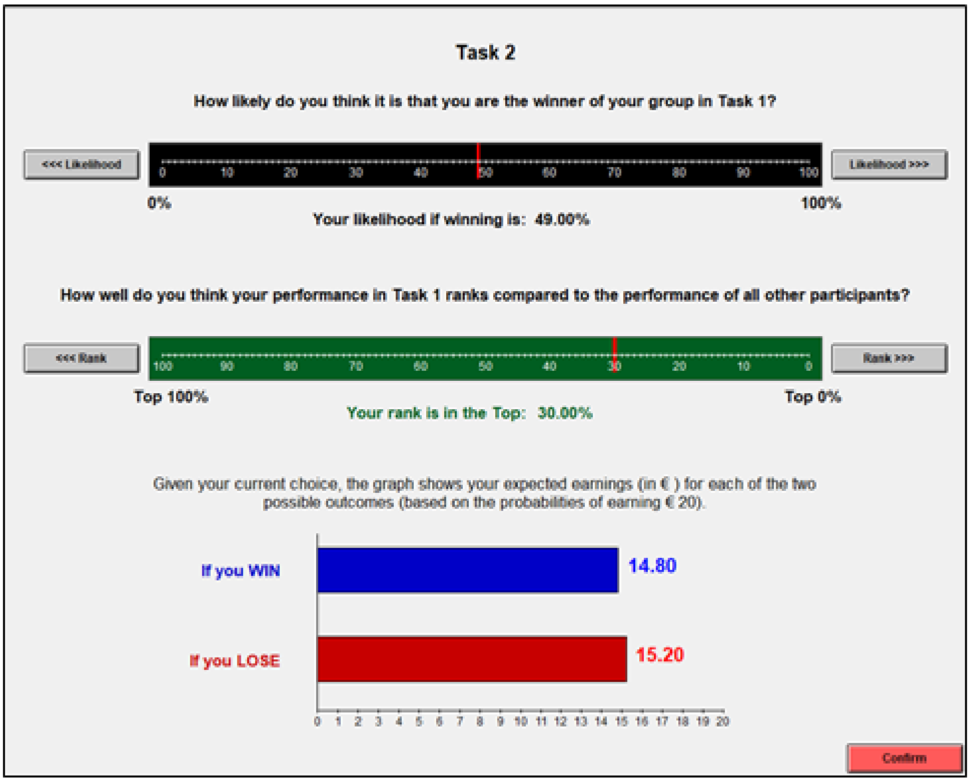
To help you to understand the consequences of your choice, below the sliders, you will also see the **expected earnings** associated to your choice in the two possible outcomes: in case **you are the winner**, and in case **you are one of the losers** of your group. You will obtain the highest expected earnings if **your answer equals the actual likelihood of you being the winner**.

Please remember that your earnings in Task 2 are either **€0 or €20**, therefore, your expected earnings are equal to €20 multiplied by the probability of earning the €20 (which is calculated with the formulas in footnote 1).

We provide an example below to illustrate how your earnings depend on your answers (note that the numbers used in this example are not indicative of what constitutes a good or bad answer in this task).

Example: Imagine that among the students taking part in this study, your performance in Task 1 puts you in the **Top 30%**. In other words, 70% of the study participants performed worse than you did and 30% performed better than you did. Recall that, for you to be the group's winner, it must be the case that **all two** of the other members of your group come from the 70% of participants who performed worse than you did. In this example, the probability that this occurs is 49.00% (see the table).

Suppose that your answer is 49.00% in the black slider and Top 30% in the green slider, as shown in the screen below.

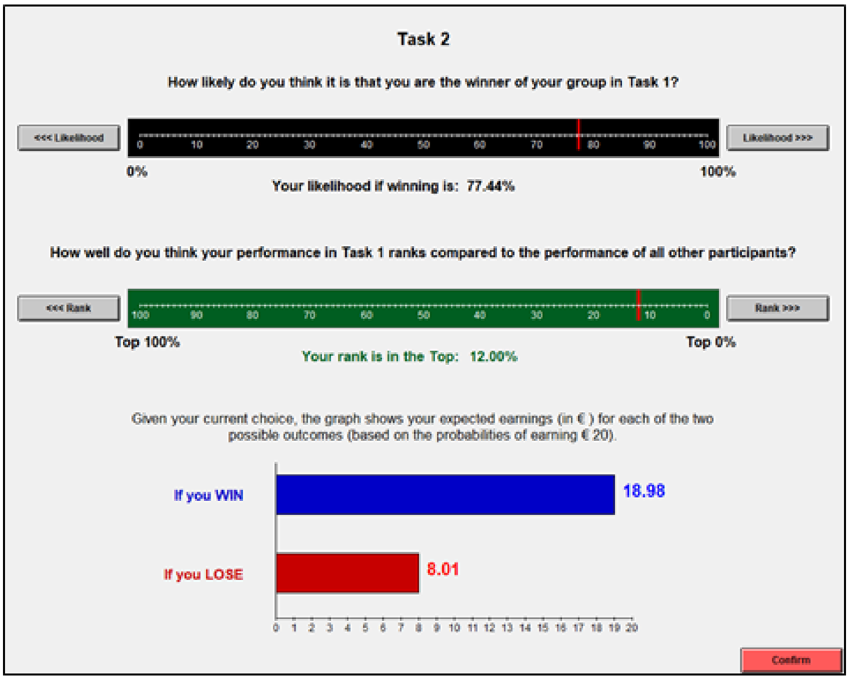


Then, as you can see with the bar graph in the screenshot:

- If you turn out to be the winner of your group, you can expect to earn in Task 2 **€14.80** on average (= €20 × probability of earning €20 if you are the winner).
- If you turn out to be one of the losers of your group, you can expect to earn in Task 2 **€15.20** on average (= €20 × probability of earning €20 if you are one of the losers).

Since the actual likelihood that you are the winner of your group is **49.00%**, this means that **49.00%** of the time you are the group's winner and **51.00%** of the time you are one of the losers. Overall, this means that you can expect to earn in Task 2 **€15.00 on average** (€15.00 = 0.49 × €14.80 + 0.51 × €15.20).

Now let's see what happens if you answer differently. Continue to suppose that your performance places you in the **Top 30%**. However, imagine that this time your answer is 77.44% in the black slider and Top 12% in the green slider, as shown in the screen below.



Then, as you can see with the bar graph in the screenshot:

- If you turn out to be the winner of your group, you can expect to earn in Task 2 **€18.98** on average (€20 × probability of earning €20 if you are the winner).
- If you turn out to be one of the losers of your group, you can expect to earn in Task 2 **€8.01** on average (€20 × probability of earning €20 if you are one of the losers).

Since the actual likelihood that you are the winner of your group is still 49.00% (remember that you actually are in the Top 30%), this means you can expect to earn in Task 2 **€13.39 on average** (€13.39 = **0.49** × **€18.98** + **0.51** × **€8.01**).

Note that **€13.39** is lower than **€15.00**, which are the expected earnings from reporting 49.00% in the black slider and Top 30% in the green slider.

In conclusion and to reiterate, you will obtain the highest expected earnings in Task 2 if **your answer equals your actual likelihood of being the group's winner in Task 1**.

Once you are done reading, click on the "Next" button on your screen.

Your payment choice in task 1

Next you are going to perform Task 1, but before performing the task, you must choose how you want to be paid for each correct sum in Task 1. Recall that you can choose between **individual pay** and **competitive pay**.

You will be asked to make choices in 5 **different decision sets**. All these decision sets are completely independent of each other. An example of one decision set is displayed in the screenshot below.

	Competitive Pay		Individual Pay
1.	€ 4.00 if you win and € 1.00 if you lose		€ 4.00 with **17%** chance and € 1.00 with **83%** chance
2.	€ 4.00 if you win and € 1.00 if you lose		€ 4.00 with **20%** chance and € 1.00 with **80%** chance
3.	€ 4.00 if you win and € 1.00 if you lose		€ 4.00 with **23%** chance and € 1.00 with **77%** chance
4.	€ 4.00 if you win and € 1.00 if you lose		€ 4.00 with **26%** chance and € 1.00 with **74%** chance
5.	€ 4.00 if you win and € 1.00 if you lose		€ 4.00 with **29%** chance and € 1.00 with **71%** chance
6.	€ 4.00 if you win and € 1.00 if you lose		€ 4.00 with **32%** chance and € 1.00 with **68%** chance
7.	€ 4.00 if you win and € 1.00 if you lose		€ 4.00 with **35%** chance and € 1.00 with **65%** chance
8.	€ 4.00 if you win and € 1.00 if you lose		€ 4.00 with **38%** chance and € 1.00 with **62%** chance
9.	€ 4.00 if you win and € 1.00 if you lose		€ 4.00 with **41%** chance and € 1.00 with **59%** chance
10.	€ 4.00 if you win and € 1.00 if you lose		€ 4.00 with **44%** chance and € 1.00 with **56%** chance

Each decision set consists of a table with a series of choices:

- The left-choices correspond to **competitive pay**. Under competitive pay your earnings in Task 1 depend on your performance and the performance of others in your group. Specifically, if are the winner of your group then you earn the high amount per correct sum, otherwise you earn the low amount per correct sum.

- The right choices correspond to **individual pay**. Under individual pay your earnings in Task 1 depend on your performance and on chance. Specifically, you earn the high amount per correct sum with some probability X [a number between 1 and 100]. To determine your earnings, you will throw two ten-sided dice to randomly generate a number between 1 and 100. If the number you generate is lower than the probability X then you earn the high amount per correct sum, otherwise you earn the low amount per correct sum.

You must decide in every row whether you prefer **individual pay** or **competitive pay**.

Notice that in a decision set, the high and low amounts for competitive pay are the same in all rows. In some decision sets, what varies from row to row is the probability of getting the high amount in individual pay. In other decision sets, what varies from row to row is the high amount in individual pay.

At the end of the experiment, one of the 8 decision sets will be randomly selected. Within the selected decision set, one of the 10 rows will be randomly selected. The type of payment you chose in the selected row will be used to determine how much you will receive per correct sum in Task 1.

Example: Take a look at the choices in the screenshot below. Now, imagine that this decision set is randomly selected for payment and within this decision set, row number 4 is randomly selected. Given that **individual pay** was chosen instead of a **competitive pay** in this row, then:

- With 27% of chance, you will earn €5 per correct sum in Task 1 [the high amount].
- With 73% of chance, you will earn €0 per correct sum in Task 1 [the low amount].

	Competitive Pay	Individual Pay
1.	€ 6.00 if you win and € 0.00 if you lose	€ 6.00 with 21% chance and € 0.00 with 79% chance
2.	€ 6.00 if you win and € 0.00 if you lose	€ 6.00 with 23% chance and € 0.00 with 77% chance
3.	€ 6.00 if you win and € 0.00 if you lose	€ 6.00 with 25% chance and € 0.00 with 75% chance
4.	€ 6.00 if you win and € 0.00 if you lose	€ 6.00 with 27% chance and € 0.00 with 73% chance
5.	€ 6.00 if you win and € 0.00 if you lose	€ 6.00 with 29% chance and € 0.00 with 71% chance
6.	€ 6.00 if you win and € 0.00 if you lose	€ 6.00 with 31% chance and € 0.00 with 69% chance
7.	€ 6.00 if you win and € 0.00 if you lose	€ 6.00 with 33% chance and € 0.00 with 67% chance
8.	€ 6.00 if you win and € 0.00 if you lose	€ 6.00 with 35% chance and € 0.00 with 65% chance
9.	€ 6.00 if you win and € 0.00 if you lose	€ 6.00 with 37% chance and € 0.00 with 63% chance
10.	€ 6.00 if you win and € 0.00 if you lose	€ 6.00 with 39% chance and € 0.00 with 61% chance

Now, imagine that instead of row number 4, the row randomly selected for payment is row number 2. Given that **competitive pay** was chosen instead of **individual pay** in this row, then:

- If you are the group's winner in Task 1, you earn €6 per correct sum [the high amount].
- If you are one of the group's losers in Task 1, you earn €0 per correct sum [the low amount].

Task 3

In Task 3 you will be perform again the same summation task you performed in Task 1. The main difference is that you will be randomly assigned to a **group of six participants** instead of three.

Task 4

Task 4 is like Task 2. In Task 4 you can earn money by answering the following question:

"How likely do you think it is that you are the winner of your group in Task 3?"

Again, your will be able to select your answer by moving the cursors in two different sliders:

- In the black slider, you can select your likelihood of being the winner of your group. Your answer can go from 0% (meaning you are completely certain that you are not the winner of your group) to 100% (meaning you are completely certain that you are the winner of your group).
- In the green slider, you can select how your performance in task 3 ranks compared to the performance of all participants. Your answer can go from Top 100% (you performed worse than ALL other participants of the study) to Top 0% (you performed better than **all** other participants in the study).

Your earnings in Task 4 will be calculated using the same formulas as in Task 2. Recall that you will obtain the highest expected earnings if your answer equals the actual likelihood of you being the winner in Task 3.

One important consideration for Task 4, is that to be the winner in Task 3, you need to be the best in a group of **six**. The table provided in the next page displays the likelihood of being your group's winner in Task 3 depending on each possible rank. Logically, it is harder to be the winner in a group of six than in a group of three. This is why the percentages in the table for Task 4 are lower than the percentages in the table for Task 2.

Group of 6

Your performance is in the Top ...	The likelihood that you are your group's winner is...
0%	100.00%
1%	95.10%
2%	90.39%
3%	85.87%
4%	81.54%
5%	77.38%
6%	73.39%
7%	69.57%
8%	65.91%
9%	62.40%
10%	59.05%
11%	55.84%
12%	52.77%
13%	49.84%
14%	47.04%
15%	44.37%
16%	41.82%
17%	39.39%
18%	37.07%
19%	34.87%
20%	32.77%
21%	30.77%
22%	28.87%
23%	27.07%
24%	25.36%
25%	23.73%
26%	22.19%
27%	20.73%
28%	19.35%
29%	18.04%
30%	16.81%
31%	15.64%
32%	14.54%
33%	13.50%
34%	12.52%
35%	11.60%
36%	10.74%
37%	9.92%
38%	9.16%
39%	8.45%
40%	7.78%
41%	7.15%
42%	6.56%
43%	6.02%
44%	5.51%
45%	5.03%
46%	4.59%
47%	4.18%
48%	3.80%
49%	3.45%
	continues →
50%	3.13%
51%	2.82%
52%	2.55%
53%	2.29%
54%	2.06%
55%	1.85%
56%	1.65%
57%	1.47%
58%	1.31%
59%	1.16%
60%	1.02%
61%	0.90%
62%	0.79%
63%	0.69%
64%	0.60%
65%	0.53%
66%	0.45%
67%	0.39%
68%	0.34%
69%	0.29%
70%	0.24%
71%	0.21%
72%	0.17%
73%	0.14%
74%	0.12%
75%	0.10%
76%	0.08%
77%	0.06%
78%	0.05%
79%	0.04%
80%	0.03%
81%	0.02%
82%	0.02%
83%	0.01%
84%	0.01%
85%	0.01%
86%	0.01%
87%	0.00%
88%	0.00%
89%	0.00%
90%	0.00%
91%	0.00%
92%	0.00%
93%	0.00%
94%	0.00%
95%	0.00%
96%	0.00%
97%	0.00%
98%	0.00%
99%	0.00%
100%	0.00%

Task 5

This is Task 5 of the experiment. The earnings from this part of the experiment are completely independent from the other tasks. The amount you earn depends **solely on your decisions and on chance**. Moreover, you will not perform further summation tasks.

You will be asked to make choices in **4 different decision tables**. All these decision tables are completely independent of each other. An example of one decision table is displayed in the screenshot below.

	Option A	Option B
1.	€ 28.80 with certainty	€ 72.00 with 50% chance and € 0.00 with 50% chance
2.	€ 30.24 with certainty	€ 72.00 with 50% chance and € 0.00 with 50% chance
3.	€ 31.68 with certainty	€ 72.00 with 50% chance and € 0.00 with 50% chance
4.	€ 33.12 with certainty	€ 72.00 with 50% chance and € 0.00 with 50% chance
5.	€ 34.56 with certainty	€ 72.00 with 50% chance and € 0.00 with 50% chance
6.	€ 36.00 with certainty	€ 72.00 with 50% chance and € 0.00 with 50% chance
7.	€ 37.44 with certainty	€ 72.00 with 50% chance and € 0.00 with 50% chance
8.	€ 38.88 with certainty	€ 72.00 with 50% chance and € 0.00 with 50% chance
9.	€ 40.32 with certainty	€ 72.00 with 50% chance and € 0.00 with 50% chance
10.	€ 41.76 with certainty	€ 72.00 with 50% chance and € 0.00 with 50% chance

Each table has 10 different decisions, each in a different row. Each decision has two options:

- **Option A**, where you can earn a different certain amount in each of the 8 rows.
- **Option B**, where you can earn a high amount with some probability and a low amount with some other probability. Specifically, you earn the high amount with some probability X [a number between 1 and 100]. To determine your earnings, you will throw two ten-sided dice to randomly generate a number between 1 and 100. If the number you generate is lower than the probability X then you earn the high amount, otherwise you earn the low amount.

You can decide for every row whether you prefer **Option A** or **option B**. Option A is the same for every row, while option B takes 8 different amounts, one for each row.

At the end of the experiment, one of the 4 decision tables will be randomly selected. Within the selected table, one of the 10 rows will be randomly selected. The choice you made in that row will determine your earnings of Task 5.