No. 121

THURGAU INSTITUTE OF ECONOMICS
at the University of Konstanz

Baiba Renerte
Jan Hausfeld
Torsten Twardawski

Gender, overconfidence, and optimal group composition for investment decisions

Research Paper Series
Thurgau Institute of Economics
and Department of Economics
at the University of Konstanz

Gender, overconfidence, and optimal group composition for investment decisions

Baiba Renerte[a,b] Jan Hausfeld[c,*] Torsten Twardawski[b]

a Thurgau Institute of Economics, Hauptstr. 90, 8280 Kreuzlingen, Switzerland
b Department of Economics, University of Konstanz, Universitaetsstr. 10, 78464 Konstanz, Germany
c CREED, Faculty of Economics and Business, University of Amsterdam, Roetersstraat 11, 1018 WB Amsterdam, Netherlands
* Corresponding author: j.hausfeld@uva.nl

How to compose boards of directors for optimal investment decision making? Depending on the group composition, each member's characteristics — like gender and motivated beliefs — can influence the final group decision, especially if the particular investment situation leaves room for decision biases. We design two types of investment situations in a laboratory experiment — one with fixed chances of success and one with performance-dependent chances of success. Our design entails the board members' perceived ability to "beat the odds" of the market and thus models real-life investment situations more accurately than standard lottery choices. We find support for mixed group composition in terms of both gender and overconfidence: Groups with more men and more overconfident group members overinvest when a possibility to "beat the odds" is present, while standard situations do not allow for such pronounced effects. We explore several channels for our results, including (i) risk perception, (ii) responsibility allocation and (iii) spillover effects from priming and communication.

JEL classification: C91, C92, G41.
Keywords: motivated beliefs, overconfidence, gender differences, risky decisions, laboratory experiment, experimental finance.

1. Introduction

Overconfidence is a commonly observed motivated belief that can have a range of real-life consequences — from positive psychological effects (Johnson and Fowler, 2011) and hiring advantages (Anderson et al., 2012; Reuben et al., 2014) to negative trading and investment outcomes (Barber & Odean, 2001; Malmendier & Tate, 2005; Trinugroho & Sembel, 2011). The focus in the literature has mostly been on individual overconfidence, although important economic decisions are often made by groups rather than individuals, e.g., boards of directors versus chief executives.[1] A parallel strand of research examines gender differences in economic decision making (Eckel & Füllbrunn, 2015; Gneezy & Croson, 2009; Powell & Ansic, 1997 among others). Again, more attention has been dedicated to individual decision making, although there is a growing literature on group composition and diversity (Bracha et al., 2019; Campbell & Mínguez-Vera, 2008; Charness & Rustichini, 2011; Hannagan & Larimer, 2010; Kim & Starks, 2016). We combine these two strands of literature in a laboratory experiment to investigate how collective decisions are affected by both overconfidence and gender of the group members. Our main focus in this respect is on modelling the mediating effects of risk perception on boards' investment decisions.

Previous research suggests that boards of directors discuss details of merger and acquisition (M&A) investment decisions in interactive board meetings (Fama & Jensen, 1983; Hillman & Dalziel, 2003; Schwartz-Ziv & Weisbach, 2013) and that various board characteristics affect the performance of the approved deals (Khorana et al., 2007; Kolasinski & Li, 2013, among others). A largely overlooked aspect in the investment decision literature is the board members' perceived ability to "beat the odds" of the market. Previous studies show that an experience-based proxy measure of board overconfidence can be negatively related to M&A success and positively related to overpricing, such that having more task-specific experience leads to poorer M&A decisions (Menkhoff et al., 2013; Twardawski & Kind, 2016). This could be a result of biased risk perception, e.g., due to a feeling of above-average knowledge of the market.

[1] Throughout this study, we define overconfidence as an excessive belief in one's own judgment or abilities, namely as a difference between one's confidence and actual performance (Klayman et al., 1999). See Moore & Healy (2008) for a detailed discussion on different definitions of overconfidence.

In this study, we investigate the perceived ability to "beat the odds" of investment decisions in a laboratory experiment that was particularly designed for this purpose. We examine two types of investment situations: (i) standard-modelled investment situations (lotteries) with objectively-given chances of success and (ii) ability-related investment situations with performance-dependent chances of success. As the latter situations entail possible biases in risk perception, we argue that these capture real-life investment situations more accurately than the standard situations. To illustrate, consider a standard lottery with a 50% chance of a positive outcome, zero otherwise. In comparison, consider now an equivalent lottery with a positive outcome if and only if one successfully solves a task that the general population is able to solve in 50% of cases. Would the subjective chances of success be evaluated as the same in both situations? Possibly, but not necessarily; for example, due to the "better-than-others" (overplacement) aspect of the overconfidence phenomenon, which is often linked to gender (Barber & Odean, 2001; Bengtsson et al., 2005; Reuben et al., 2012; Ring et al., 2016, among others).

We use these two types of investment situations to construct a randomized controlled experiment that models an interactive meeting of a board of directors (or any other group making an investment decision). We find that gender and overconfidence have a stronger effect on the investment levels in the performance-dependent situations than in the standard situations. Namely, groups with more men and more overconfident group members choose more above-optimum group investment levels when a possibility to "beat the odds" of success is present (while gender and overconfidence are not strongly related[2] in our sample). We further examine the potential reasons behind this finding, including risk perception biases, leadership preferences, and risk perception spillovers through priming and communication. We find that average investment levels are more above-optimum if the group members are first primed with performance-dependent investment situations. Thus, our results suggest that more diverse boards, in terms of both overconfidence and gender, improve group decision making — and so does perceiving the investment success chances as objective.

[2] Please see section 4.1 and Appendix C for further details on the relation between overconfidence and gender measures in our study, which allows us to examine the effects of overconfidence and gender on overinvestment both in parallel and jointly.

2. Related literature

We investigate how group investment decisions are influenced by the gender composition of the group and the overconfidence of the group members. In terms of the research question, the empirical studies on the decision making of boards of directors by Twardawski & Kind (2016) and Levi et al. (2014) are most closely related to our experimental study. Twardawski & Kind (2016) find that the directors' *overconfidence* is negatively related to M&A success. In a different setup, Levi et al. (2014) find that the directors' *gender* is related to the board's M&A success, in that female directors help create shareholder value.[3] In addition, Chen et al. (2019) conclude that male CEOs are less overconfident when female directors are on the board. Thus, the literature suggests that board members' overconfidence leads to overinvestment, while more gender-balanced boards make more optimal investment decisions. Yet, it remains unclear how pronounced are the effects of group composition for different types of investment situations (e.g., see the evidence on "betting on oneself"; Benoit et al., 2019; Blavatskyy, 2009).

A substantial body of research[4] in economics and finance find a link between overconfidence of individuals and faulty individual investment decision making. This phenomenon has been observed in chief executives (Billett & Qian, 2008; Huang & Kisgen, 2013; Malmendier & Tate, 2008, 2005; Roll, 1986) as well as private and institutional traders (Barber & Odean, 2001; Deaves et al., 2009), security analysts (Hilary & Menzly, 2006) and experiment participants (Biais et al., 2005; Camerer & Lovallo, 1999; Dittrich et al., 2005). Similarly, several studies have demonstrated gender differences in individual decision making. For example, risk preferences (Booth et al., 2014; Charness & Gneezy, 2010; Hardies et al., 2013), leadership preferences (Eagly & Karau, 2002; Ertac & Gurdal, 2012; Grossman et al., 2019; Melkas & Anker, 1997) and competitiveness (Datta et al., 2013; Gneezy et al., 2009; Niederle & Vesterlund, 2007; Reuben et al., 2012) often differ between men and women (see Gneezy & Croson, 2009 for an overview of gender differences in preferences). Although gender and overconfidence tend to be related (Barber

---

[3] In contrast, see also Adams & Ferreira (2009) who show that, under certain conditions, gender quotas for directors can actually reduce firm value.

[4] A long-established finding in the literature is that most individuals are overconfident about their own relative judgments and abilities (Lichtenstein & Fischhoff, 1977; Taylor & Brown, 1988; Weinstein, 1980). For example, early experimental studies show that almost 80% of respondents rate themselves in the top 50% of car drivers (Svenson, 1981), and more recent studies also demonstrate overconfidence in one's professional abilities (Meyer et al., 2013) and physical fitness (Obling et al., 2015), among others.

& Odean, 2001; Bengtsson et al., 2005; Lichtenstein & Fischhoff, 1977; Soll & Klayman, 2004), investment decision making can call for gender differences that go beyond overconfidence.

Last, it is not clear whether and to what extent these individual overconfidence and gender effects translate into group investment decisions.[5] There are several ways how overconfidence in a group environment can differ from individual overconfidence. On the one hand, the group could mitigate individual overconfidence due to, for example, countering or compromising in the negotiation process (Masclet et al., 2009; Shupp & Williams, 2008). On the other hand, several group decision-making phenomena, such as groupthink, irrational exuberance or risky shift could aggravate the effects of individual overconfidence (Bénabou, 2013, 2015). These effects can interact with gender too, e.g., Healy & Pate (2011) have showed that men are more confident in their own performance than their group's, while women are more confident in their group's performance than their own.

All these factors play a role in group investment decisions. In our laboratory study, we can further include important control variables, such as: (i) individual risk preferences that might be driving the overconfidence effects and gender differences (Johnson & Fowler, 2011) and (ii) various individual personality traits, such as optimism, that are known to correlate with overconfidence (Schaefer et al., 2004; Trevelyan, 2008). In an experimental study, we can also disentangle different components of overconfidence and must not take the types of investment situations as given. We can consider a crucial distinction — whether the investment decision at hand requires *judgment* about the optimal prospect or rather *abilities* to carry out the prospect. That is, we can distinguish (i) whether the overconfident experimental board members see themselves as overly able to choose the optimal investment in terms of its objective success odds, i.e., the intrapersonal overstatement component of overconfidence (with its directional effect implied by correlates of overconfidence such as the illusion of control, see Langer, 1975 among others) or (ii) whether they even see themselves as able to "beat the odds" of the investment , i.e.,

[5] While there have been a few studies investigating group decision making and overconfidence (Cheng et al., 2020; Healy & Pate, 2011; Kerr & Tindale, 2004; Sniezek, 1992; Zarnoth & Sniezek, 1997), these do not consider risky investment decisions. In contrast, Kocher & Sutter (2005) and Viscusi et al. (2011), among others, do consider risky group investment decisions while neglecting the respective overconfidence of the group members.

the interpersonal overplacement component of overconfidence (Moore & Healy, 2008).

3. Experimental design

In this study, we extend the previous empirical work on overconfidence and gender in group investment decisions by testing the proposed underlying mechanisms experimentally and including the respective controls. We construct a randomized controlled experiment that models the main elements of an interactive meeting of a board of directors. Importantly, we introduce investment situations with performance-dependent odds of success and compare them to the usually-used objective-odds investment situations.

The general structure of our experimental design is as follows: Each subject faces ten investment situations. Each situation is faced twice, first individually and then in a two-member group using the unanimity rule (i.e., renegotiation until a unanimous decision can be reached). Five of the investment situations are standard *Objective* situations (see sub-section 3.2.1) and the other five are performance-dependent *Ability* situations (see sub-section 3.2.2). Finally, in addition to these within-subject comparisons, we examine two possible channels for the effects by introducing two between-subjects comparisons (see sub-section 3.3): We vary whether subjects first face the standard or performance-dependent situations and whether they are allowed to communicate before each of the group decisions.

3.1. Definition and measurement of overconfidence

We define overconfidence as an excessive belief in one's own judgment or abilities, namely as a difference between confidence (in the said judgment or abilities) and actual performance (e.g., Klayman et al., 1999). To extract a bias score for each subject, we use an established multiple-choice general-knowledge task with 18 questions, which are adjusted for neutrality to hard-easy effects (Michailova & Katter, 2014; applied in a financial investment context by Michailova & Schmidt, 2016). As an example, one of the questions reads as follows: "Who is the author of the opera *Tosca*?" The subjects can provide one of the three possible answers to this question: G. Puccini, G. Verdi or A. Vivaldi. After choosing one of the answers, the subjects report their certainty that their answer was correct, between 33% (absolute guessing, chance level) and 100% (absolute certainty).

The bias score for each subject is calculated as the difference between the average confidence level across all questions and the proportion of the correct answers. A positive bias score represents overconfidence, a negative bias score represents underconfidence, and a bias score of zero indicates an accurately calibrated (neutral) subject.[6]

$$bias = mean\%confidence - mean\%correct \tag{1}$$

3.2. Definition and measurement of above-optimum investment levels

We construct an investment spectrum that allows to measure the closeness to a risk-neutral optimum of the chosen investment level in each investment situation.[7] The investment options in each situation are distributed non-linearly and the optimal choice in terms of the expected value lies either in the higher or lower middle sections of the spectrum or in one of the extremes of the spectrum. For each of the investment situations, the subjects receive an endowment of 50 monetary units (MU) and can decide how much of it to invest.

3.2.1. Standard *Objective* investment situations

Table 1 illustrates an exemplary investment situation. The left-hand side refers to the standard investment situations (denoted *Objective*). In these situations, the listed probabilities are fixed and correspond to the actual probabilities of success in an "objective" sense. The column (a) of Table 1 depicts a list of investment levels that a subject can choose from after receiving the 50 MU endowment. Each investment level corresponds to an investment in a lottery. For example, if a subject chooses the third row, she invests 10 MU of her endowment to play a lottery offering an 80% chance of winning 20 MU (final outcome: 50 – 10 + 20 = 60 MU), but also a 20% chance of winning nothing and only losing the invested 10 MU (final outcome: 50 – 10 = 40 MU).

[6] We measure individual overconfidence using the bias score and afterwards check the robustness of our measure using two questions that map to the two core properties of the overconfidence phenomenon: (i) overestimation of one's actual performance and (ii) overplacement of one's performance relative to others. Namely, we ask for the subjects' estimates of how many of the items they answered correctly (0 to 18 items) and their estimates of what performance rank they have in the session (1 to n, where n is the number of subjects in a given session).

[7] In this study, we mainly focus on examining the closeness to a risk-neutral optimum instead of a risk-preference adjusted optimum. We argue that this leads to a cleaner comparison between the investment situations, given that it is unclear whether risk preferences are expressed in the same way in the *Objective* situations as in the *Ability* situations.

Objective investment situations					*Ability* investment situations				
Invest	High	p(High)	Low	p(Low)	Invest	High	Low	p(Q)	EV
0			50		0		50		50
5	55	90%	45	10%	5	55	45	90%	54
10	60	80%	40	20%	10	60	40	80%	56
15	65	70%	35	30%	15	65	35	70%	56
20	70	60%	30	40%	20	70	30	60%	54
25	75	50%	25	50%	25	75	25	50%	50
30	80	40%	20	60%	30	80	20	40%	44
35	85	30%	15	70%	35	85	15	30%	36
40	90	20%	10	80%	40	90	10	20%	26
45	95	10%	5	90%	45	95	5	10%	14
(a)	(b)	(c)	(d)	(e)	(a)	(b)	(d)	(f)	(g)

Table 1: An example of comparable investment situations in *Objective* and *Ability* treatments, where the columns (a), (b), (d) and (g) are all measured in monetary units. Note that the columns (b) and (d) denote the respective High final outcomes and Low final outcomes. The information in column (g) was not visible to the subjects. The High final outcomes and Low final outcomes of the lotteries in columns (b) and (d) respectively are always distributed in a certain way. Namely, the Low outcome equals the endowment of 50 MU minus the investment level, and the High outcome equals the endowment of 50 MU plus some premium. The corresponding high probabilities *p*(High) and low probabilities *p*(Low) in columns (c) and (e) respectively are always distributed in a certain way: If the chosen investment level is positive, the subject receives the high final lottery outcome with a probability *p*(High) and the low final lottery outcome with a probability 1−*p*(High). If the chosen investment level is zero, the subject can keep the endowment of 50 MU with certainty. By keeping these distribution rules fixed but changing the outcomes and probabilities, we create the concave expected value functions.

In the example investment situation depicted in Table 1, the optimum investment in terms of the expected value (EV) in column (g) is 10 or 15 MU.[8] We compare how such investment decisions are made in groups with various gender and overconfidence compositions. We keep the group size of two and the (renegotiated) unanimity decision rule fixed. Based on the literature, we hypothesize that the group composition with respect to overconfidence and gender are positively linked to above-optimum investment levels, such that groups with more overconfident and more male group members decide in favor of more above-optimum investments.

[8] Note that the EV column in Table 1 was not visible to the subjects of the experiment. Appendix A includes a list of all investment situations. In addition, the Appendix G includes translated instructions with accompanying example screenshots from the experiment sessions.

Hypothesis 1. *Groups with more overconfident and more male members are linked to more above-optimum investment levels.*

3.2.2. Performance-dependent *Ability* investment situations

The subjects play half of the rounds with the described *Objective* type of investment situations with fixed (objective) odds of success. The other half of the rounds, however, are played with a second type of investment situations that differ in the way how the odds of success are portrayed. The performance-dependent investment situations (denoted *Ability*) are depicted on the right-hand side of Table 1. In these investment situations, we allow the subjects to potentially "beat the odds" of the lotteries. By doing so, we mimic the willingness and perceived ability of the board directors to "beat the market" in real-life investment decisions.

The *Ability* treatment with performance-dependent probabilities is a unique feature of our design and work as follows: We add a task to each of the investment levels, and the probabilities in column (f) indicate how easy or difficult the associated task will be. In other words, instead of receiving the High final outcome with the respective given probability as in the *Objective* investment situations, the subjects in the *Ability* situations receive the High final outcome if they successfully do a task for which we know from a large sample of general population what the task success chances in fact are.[9]

For example, the task associated with the 10 MU investment was successfully answered by 80% of the large general population sample, as indicated by the column (f) in Table 1. To receive the High final outcome associated with this investment level, the subjects need to answer the same question as well. If the subject answers correctly, she receives the High outcome (in total 60 MU). If not, she receives the Low outcome (in total 40 MU). The probabilities in the column (f) of the *Ability* treatment thus correspond to the probabilities in the column (c) of the *Objective* treatment, as it shows how often, on average, the High outcome is achieved.

[9] We use difficulty data from a popular TV show in Germany called QuizDuell, where everyone watching the show can vote on their preferred answers to the displayed multiple-choice questions in a mobile application to compete with the guest in the studio. After the vote, everyone can see how many percent of the viewers voted for each of the multiple-choice options, including the right answer. We compare the performance of our sample to the performance of this general population sample in sub-section 4.3.2.

After each subject first chooses the investment level and does the respective task on her own, an equivalent group decision follows. In the group decisions, one of the two group members (henceforth the "manager" of the task) steps forward to assume responsibility for the tasks.[10] The manager for each two-person group is chosen in a preference-consistent way before the first group decision (or any communication) of each group, in accordance with ranked self-reports of the willingness to become the manager.[11] Given the vast literature on preferences for taking on leadership roles (e.g., Eagly & Karau, 2002; Ertac & Gurdal, 2012), we expect that men and overconfident group members would be more willing to become the task manager. We can thus add a second hypothesis regarding the group dynamics.

Hypothesis 2. *Overconfident and male group members are more likely to take charge of the group tasks in the Ability treatment.*

In summary, the experimental design allows us to compare investment situations in the *Objective* and *Ability* treatments. The probabilities are equal for neutrally calibrated subjects who think that they are neither better nor worse than the general population. However, given the "better-than-others" (overplacement) property of overconfidence, the perceived probabilities in the *Objective* and *Ability* treatments might differ. We can thus add another within-subject hypothesis. While we anticipate overinvestment in groups with more overconfident and male group members in both *Objective* and *Ability* treatments, we expect the *Ability* treatment to show the effect more strongly. This follows, firstly, from the differences in the investment situations: While the *Objective* situations reveal the overstatement component of overconfidence, the *Ability* situations also trigger the overplacement component. Secondly, this also follows from the effects stated in Hypothesis 2.

---

[10] Note that all group decisions take place anonymously, with no communication before the task responsibility mechanism. Also, no details, such as gender, are revealed to other group members, in line with Eckel & Füllbrunn (2017) and in contrast to Eckel & Füllbrunn (2015).

[11] If both members of the group indicate the same willingness level, the manager is chosen randomly. More specifically, the four answer options were: 1-"Yes, I definitely want to answer for the group"; 2-"Yes, I want to answer for the group unless the other person chose option 1"; 3-"No, I do not want to answer for the group unless the other person chose option 4"; 4-"No, I definitely do not want to answer for the group". For the purposes of some analyses, we also split the responses in two, pooling the willing and very willing subjects together. We chose this approach to model real-life decision making in boards of directors, where task leadership roles, comparable to that of the task manager in our experimental design, are rarely assigned randomly.

Hypothesis 3. *The effect in Hypothesis 1 is more pronounced in the Ability treatment than in the Objective treatment.*

3.3. Selected spillover channels for above-optimum investment levels: Priming and communication

We examine two additional channels for how individual overconfidence might affect group decisions. Firstly, by changing the order of the *Objective* and *Ability* investment decision blocks (*Order* treatment), we consider the spillover effects of the subjects' mindsets associated with the respective investment types.[12] Secondly, and as a robustness check, we add a treatment with pre-decision communication in a free-text chat format (*Communication* treatment) to consider the "behavioral signature" of the overconfident group members.[13] These treatments allow us to add Hypothesis 4A about the described priming effects. In addition, if communication allows the overconfident group members to reveal their "behavioral signature" and exert more influence on the group decision-making process, we can expect the group investment levels to be higher after pre-decision communication and add Hypothesis 4B.

Hypothesis 4A. *Due to the priming effects from the "beat the odds" mindset, the average investment levels are higher if the group members first face Ability situations.*

Hypothesis 4B. *Due to the influence of the overconfident group members, the effects on the average investment levels are amplified by pre-decision communication.*

Figure 1 provides a summary of the experimental design with the counter-balanced between-subjects treatments *Order* and *Communication* underlined (see Appendix B for further details on the experimental design). Depending on the 2×2 treatment, the subjects begin either with the *Objective* or the *Ability* block and, depending on the treatment, the subjects either do or do not have a pre-decision communication stage before each group

[12] For example, if the subjects start with the *Ability* investment situations, they might continue with the perceived ability to beat the odds also in the *Objective* investment situations and invest higher above the optimum than otherwise, and vice versa. Spillovers are thus defined as a type of inertia in this context.

[13] For example, previous studies have shown that overconfident persons exhibit characteristics that appear like competence to others (Anderson et al., 2012). We thus give subjects a chance to exhibit such influence in a chat environment.

decision.

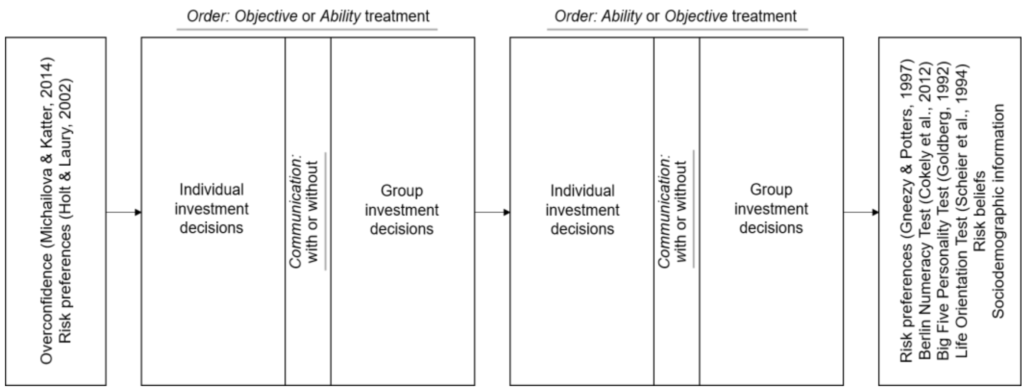


Figure 1: Summary of the experimental design, with the between-subject treatments (*Order* and *Communication*) underlined. In total, half of the investment decisions are with *Objective* probabilities and the other half with *Ability*-based probabilities (counter-balanced between sessions). Of these halves respectively, each investment decision is made twice, first individually and then in a two-member group using the unanimity rule.

3.5. Procedure

We used the z-Tree software (Fischbacher, 2007) and the ORSEE recruitment platform (Greiner, 2015) for the experiment with student subjects at the Lakelab in Konstanz, Germany. We gathered a balanced dataset on $n = 160$ subjects over six experiment sessions (40 subjects per treatment). 42.5% of the subjects were male, with an average age of 21.7 $\pm$ SD 2.5 years and an average payment of 16.5 $\pm$ SD 4.2 for an approximately 90-minute session. Unless indicated otherwise, we use pooled data on all 160 subjects for our analyses.

4. Main results

4.1. Confidence bias score

Figure 2 depicts the distribution of the overconfidence bias scores: A positive bias score represents overconfidence, and a negative bias score represents underconfidence. The mean and median scores among our subjects are larger than zero and in line with the previous literature: Most of the subjects are overconfident. In our sample, we find no significant differences between the bias score of male and female subjects and, therefore, can examine the effects of overconfidence and gender both in parallel and jointly.[14] We

[14]Please refer to Appendix C for further robustness results for the bias score.

divide the subjects at zero to create two categories: overconfident subjects (OC) and underconfident subjects (UC).

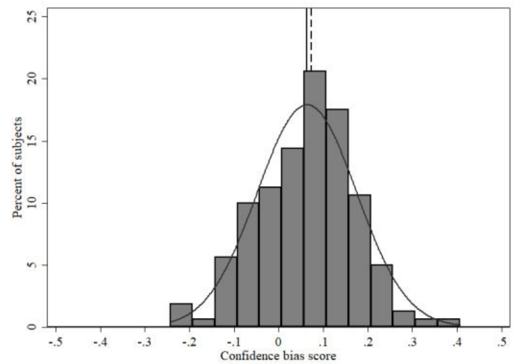


Figure 2: Distribution of the confidence bias scores. The solid and dashed lines denote the mean and median scores respectively, and the dotted line shows a normal distribution.

4.2. Group confidence, gender composition and group investments

We use the bias score measure of overconfidence to investigate how overconfidence shapes group decision making, juxtaposing these effects with gender effects. We find an upward trend in group decisions: The investment levels are somewhat related to the group compositions with respect to overconfidence, as depicted on the left-hand side of Figures 3a and 3b, and they are strongly related to group composition with respect to gender, as depicted on the right-hand side of Figures 3a and 3b. This effect appears to be stronger for gender than for overconfidence in the *Ability* investment situations (Figure 3b), while the effect is of similar magnitude in the *Objective* situations (Figure 3a). Considered jointly, groups with more overconfident members and more male members make higher investments in the *Ability* situations but not in the *Objective* situations. This is also depicted in Table 2 where we show the differences from the optimum investment levels for the nine possible group compositions.

(3a) Investment levels in *Objective* situations (3b) Investment levels in the *Ability* situations

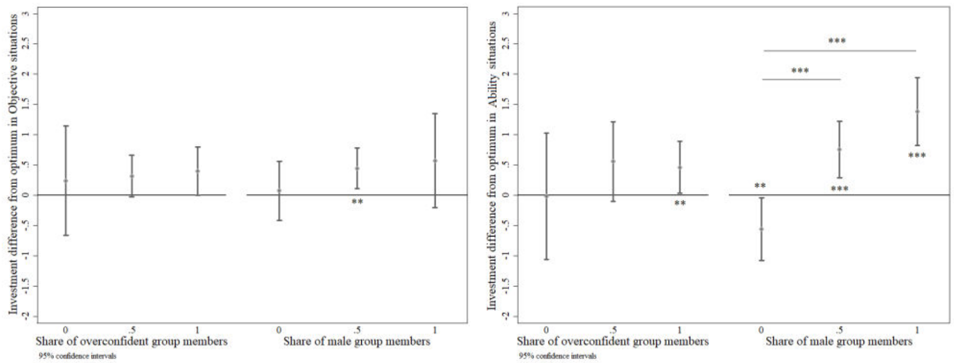


Figure 3: Group investment difference from the optimum in the *Objective* (3a left) and *Ability* (3b right) treatments, by group overconfidence bias score and group composition with respect to gender separately and compared to zero (solid line). The asterisks indicate Wilcoxon-Mann-Whitney rank sum tests for differences between the investment levels and Wilcoxon signed rank tests for differences from zero. $^{***}\ p < 0.01$, $^{**}\ p < 0.05$, $^{*}\ p < 0.1$.

	Objective situations			*Ability* situations		
	UC+UC	UC+OC	OC+OC	UC+UC	UC+OC	OC+OC
Female+Female	0.43	0.06	0.01	-0.30	-0.97*	-0.32
	3	5	15	2	9	13
Female+Male	0.10	0.29	0.63**	-0.10	0.99*	0.75**
	4	19	23	4	16	24
Male+Male	-	0.59	0.55	0.90	1.70**	1.10**
		7	4	1	6	5

Table 2: Group investment difference from the optimum and sub-sample size in *Objective* (left) and *Ability* (right) situations by group composition in terms of overconfidence and gender jointly. The asterisks indicate Wilcoxon signed rank tests for differences from zero. $^{***}\ p < 0.01$, $^{**}\ p < 0.05$, $^{*}\ p < 0.1$. Note that different shades are used for different average investment levels: the lightest shade for underinvestment (below 0), middle for moderate overinvestment (below 1) and the darkest for higher overinvestment (above 1).

Table 3 shows the combined effects of group overconfidence and gender group compositions using regression models with the deviation from the optimum investment levels as the dependent variable and confirms the above results. We use the average continuous overconfidence bias score per group as the independent variable for group overconfidence and the share of men per group as the independent variable for group gender composition. We run linear ordinary least squares (OLS) regressions and correct for experiment data dependencies using robust clustered errors at the matching-group level. Due to the specific construction of the investment situations, all models in Table 3 control for risk preferences (Holt and Laury, 2002). The models in columns 4 and 8 also control for additional factors and show that there still remains a significant upward trend with respect to both group overconfidence and group gender composition in the *Ability* treatment (columns 5 to 8) and a much weaker, barely significant trend in the *Objective* treatment (columns 1 to 4). We thus find *some* support for Hypothesis 1: The higher the group overconfidence and share of men in the group, the higher the average group investment levels. We also find support for Hypothesis 3 in that the *Ability* situations allow more pronounced overconfidence and gender effects than the *Objective* situations.[15]

Investment diff. from optimum	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Objective situations				*Ability* situations			
Male share	0.450		0.467	**0.292**	2.010***		2.103***	**2.135*****
	(0.36)		(0.36)	(0.46)	(0.37)		(0.39)	(0.64)
Overconfidence		2.734*	2.781*	**3.774**		3.428*	4.165***	**4.344****
		(1.52)	(1.45)	(2.43)		(2.01)	(1.47)	(1.62)
Risk aversion	-0.964***	-1.079***	-1.043***	-1.082***	-0.976**	-1.084**	-0.970**	-1.134***
	(0.32)	(0.35)	(0.35)	(0.36)	(0.40)	(0.45)	(0.39)	(0.30)
Order (*Ability* first)				**0.242**				**0.555****
				(0.25)				(0.27)
Communication				-0.207				-0.005
				(0.25)				(0.24)
Constant	0.706**	0.789***	0.567*	0.118	0.152	0.850***	-0.155	-1.408
	(0.27)	(0.22)	(0.29)	(2.07)	(0.35)	(0.29)	(0.34)	(1.94)
Controls	No	No	No	Yes	No	No	No	Yes
R^2	0.120	0.140	0.157	0.233	0.254	0.101	0.304	0.438
BIC	248.662	246.806	249.570	294.563	283.509	298.377	282.288	317.773
N	80	80	80	80	80	80	80	80

Table 3: Regressions of group overconfidence bias score and group gender composition on the average difference from the optimum in group investments as the dependent variable. Group gender variable ranges from 0 for all-female groups to 1 for all-male groups. Group overconfidence variable, expressed as an average bias score per group, ranges from -0.18 to 0.25. Group risk preference variable, expressed in terms of a constant relative risk aversion (CRRA) coefficient where higher values imply higher risk aversion and zero implies risk neutrality, ranges from -0.78 to 1.37. Columns 1-4 concern the *Objective* situations, while columns 5-8 concern the *Ability* situations. We consider four models for each. Columns 1, 2, 5 and 6 include the baseline model for gender and overconfidence separately, columns 3 and 7 include them jointly, and columns 4 and 8 additionally include the control variables and treatment dummies, namely: Big5 personality traits, numeracy test score, optimism test score, age, average school grade, lottery order, as well as Order and Communication treatment dummies. All variables are averages at the group level. Note: OLS regressions, robust standard errors in parentheses clustered at the matching-group level. $^{***}\ p < 0.01$, $^{**}\ p < 0.05$, $^{*}\ p < 0.1$.

[15] Appendix D includes full regression models. For comparison, see equivalent results for individual investment decisions in Appendix E. Note that we find less pronounced differences between *Objective* and *Ability* situations for individual decisions than for group decisions.

Result 1. *On average, group investments tend to increase with more overconfident and more male group members in the Ability treatment, while this tendency is less pronounced in the Objective treatment.*

4.3. Differences between *Objective* and *Ability* situations

4.3.1. Risk perception in *Ability* investment situations

One reason behind Result 1 could be related to the differences between how the probabilities in the *Objective* and *Ability* situations are viewed. Consider the following self-reports of perceived success chances that we gathered in the post-experiment questionnaire (adapted from Falk et al., 2017). We asked the subjects two questions about their individual decisions: "In your opinion, how successful will your 50%-success-chance investment be in (i) the *Objective* treatment and (ii) the *Ability* treatment?" The answers were provided on an 11-point Likert scale, where the middle point is the theoretical prediction in both cases.

We find significant differences in the results between the two treatments. In the *Objective* treatment, as depicted in Figure 4a, both overconfident and underconfident subjects provide answers that do not significantly differ from the expected 50% answer in all cases except the overconfident male subject sub-sample (Wilcoxon signed rank test, $p = 0.080$). In contrast, in the *Ability* treatment, as depicted in Figure 4b, all subjects except the underconfident female sub-sample provide answers that significantly differ (exceed) from the 50% answer (Wilcoxon signed rank tests, $p < 0.033$). On average, the perceived chances in the *Ability* situations answers are significantly higher than the perceived chances in the *Objective* situations (Wilcoxon-Mann-Whitney rank sum tests, all $p < 0.001$). We thus find further evidence in favor of Hypothesis 3.

(4a) Subjective 50% chance perception in *Objective* situations (4b) Subjective 50% chance perception in *Ability* situations

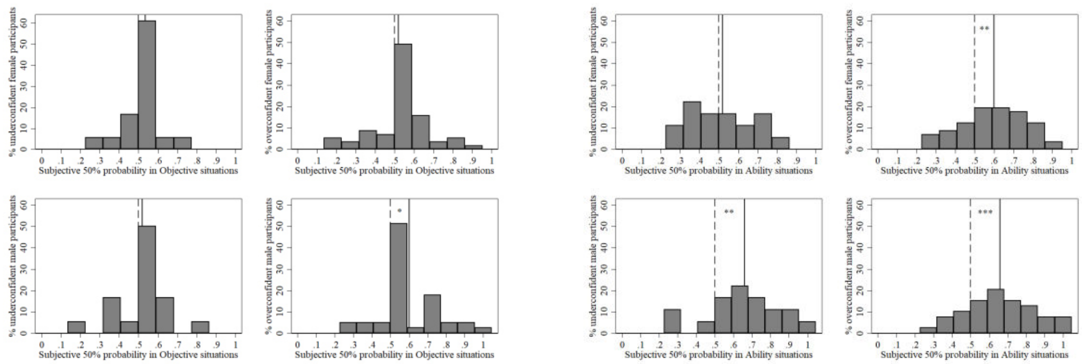


Figure 4: Perceived success chances in the *Objective* (4a left) and *Ability* (4b right) treatments, divided by gender (female top, men bottom) and overconfidence (underconfident left, overconfident right). The solid lines denote the mean perceived success chances, the dashed line denotes the theoretical prediction. The asterisks indicate Wilcoxon signed rank tests for differences from the theoretical prediction. $^{***}\ p < 0.01$, $^{**}\ p < 0.05$, $^{*}\ p < 0.1$.

Result 2. *The Ability investment situations lead to more upwards-biased perceived probabilities of success than the Objective situations.*

4.3.2. Task responsibility in group *Ability* investment situations

Another reason behind Result 1 could be related to the differences in group dynamics between *Objective* and *Ability* investment decisions. In *Ability* situations, one of the two group members steps forward to take charge of the tasks associated with the chosen group investment levels (i.e., provide answers to the question tasks). The task manager for each two-person group is chosen in a preference-consistent way, in accordance with ranked self-reports of the willingness to assume responsibility for group tasks. After each group member privately reports their willingness on a four-point scale, one of the two group members is assigned the role of the manager if she indicates higher willingness or, in case of both group members indicating the same willingness, on a random basis. In the following, we consolidate the four-point scale into a binary variable to indicate willingness (or high willingness) as opposed to unwillingness (or high unwillingness) to assume responsibility for the group tasks.

Willingness	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
to take charge of group tasks	Female subjects				Male subjects			
Overconfidence	-1.691	2.003	1.296	2.050	1.067	2.148	2.763	3.411
	(1.29)	(1.86)	(1.63)	(1.77)	(1.45)	(2.12)	(2.47)	(2.91)
Risk aversion		-0.312	-0.385	-0.647**		0.195	0.177	0.123
		(0.27)	(0.30)	(0.30)		(0.35)	(0.28)	(0.32)
Numeracy		1.435**	1.320**	1.641***		0.485	0.456	0.760
		(0.61)	(0.60)	(0.60)		(0.60)	(0.57)	(0.53)
Ex-ante ability		4.952***	4.910**	6.421***		1.475	1.727	3.148
		(1.92)	(1.94)	(1.99)		(2.20)	(2.63)	(2.83)
Optimism			-0.129	0.140			-1.749	-1.883
			(1.12)	(1.44)			(1.27)	(1.42)
Age			0.139**	0.164**			0.203**	0.220***
			(0.07)	(0.07)			(0.08)	(0.08)
Constant	-0.148	3.300***	6.016***	5.824***	0.576***	0.668	3.956*	7.026***
	(0.16)	(1.20)	(1.77)	(2.26)	(0.18)	(1.41)	(2.28)	(2.49)
Controls	No	No	No	Yes	No	No	No	Yes
BIC	134.772	134.874	139.867	157.815	86.488	97.454	98.305	120.506
N	92	92	92	92	68	68	68	68

Table 4: Regressions of individual overconfidence and competence on the willingness to assume responsibility for the group tasks. Columns 1-4 concern the female sub-sample, while columns 5-8 concern the male sub-sample. Additional controls include the Big5 personality traits and average school grade. Note: probit regressions with a binary dependent variable, robust standard errors in parentheses clustered at the matching group level. $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Our analysis shows that the willingness to assume responsibility for the group tasks is not related to individual overconfidence, but it is significantly related to gender. On average, the subjects who indicate willingness to become the task manager are more likely to be male (all Wilcoxon-Mann-Whitney rank sum tests, $p < 0.001$), older ($p = 0.016$) and more competent (in terms of the bias score[16] question correctness, $p = 0.018$). In particular, the more competent female subjects drive the link between competence and assuming task responsibility. For these female subjects the ex-ante bias score performance is on par with and not significantly different from male subjects (other Wilcoxon-Mann-Whitney rank sum tests between the unwilling female subjects and the other three sub-

[16] The bias score task correctness can be used as an ex-ante measure of expected performance in the *Ability* tasks. The experiment instructions point this out, too, stating: “The type of tasks is similar to [bias score tasks]: A task consists of a question with four possible answers.”

samples, $p < 0.001$).[17]

We have thus found some evidence in support of Hypothesis 2, in that the male group members are more likely to step forward and take charge of the group tasks than the female group members. Table 4 compares the various factors that influence the willingness to become a task manager using probit regressions with clustered standard errors at the matching group level. The factors seem to differ between gender: While only age appears to play a role for men, also competence and risk aversion matter for women.

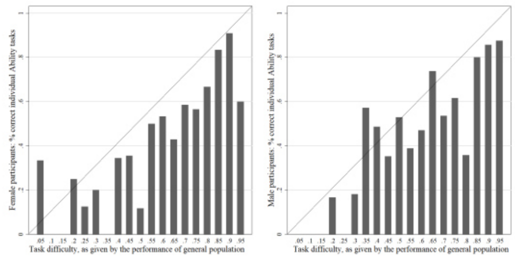
Result 3. *Male subjects are more willing to take charge of the group than female subjects.*

Meanwhile, the above-mentioned characteristics are not as strongly related to the subjects actually becoming task managers. This is likely due to the procedure to choose a task manager (as outlined above, this role allocation is random if both group members indicate the same willingness on a four-point scale). While there is a slight tendency for group managers to perform better than individuals and individual men to perform better than individual women, as depicted in Figure 5, we identify no significant differences in any of these comparisons. There is evidence, however, that individuals perform significantly worse than the general population (Wilcoxon signed rank test, $p < 0.001$, also for male and female subjects separately), while groups perform closer to the reference levels (Wilcoxon signed rank test, $p < 0.063$, insignificant for male and female task managers separately), hinting towards self-selection into assuming responsibility.[18] These effects could partly explain the higher *group* investment levels in *Ability* situations as compared to *Objective* situations. Yet, they cannot explain the similar levels of *individual* overinvestment in *Ability* situations (the results of individual investments are presented in detail in Appendix E).

[17] Comparing the differences between ex-ante expected performance and willingness to become the manager, we can conclude that male subjects are slightly over-willing and female subjects are under-willing to assume responsibility for the group tasks.

[18] One potential explanation for the differences is that the general population sample was likely older than our sample, and crystalized knowledge, which arguably is more needed in the trivia tasks, is known to increase with age.

(5a) *Ability* task performance by female and male individuals



(5b) *Ability* task performance by female and male managers

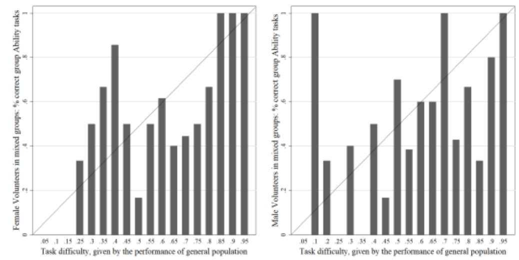


Figure 5: Individual *Ability* task performance for by gender (left) and group *Ability* task performance by manager gender in mixed groups (right). The 45-degree solid line indicates the approximate expected performance level for each difficulty level.

4.3.3. Priming and risk perception spillovers on *Ability* investment situations

A third reason behind Result 1 could be related to the priming that occurs through facing *Objective* investment decisions first in the session compared to facing *Ability* first. As outlined in sub-section 3.3, we check for differences in response to (i) the main variation which alternates whether the subjects start with the *Ability* or the *Objective* investment situations (*Order* treatment) and to (ii) pre-decision communication in a chat format (*Communication* treatment).

Order effects on group investments

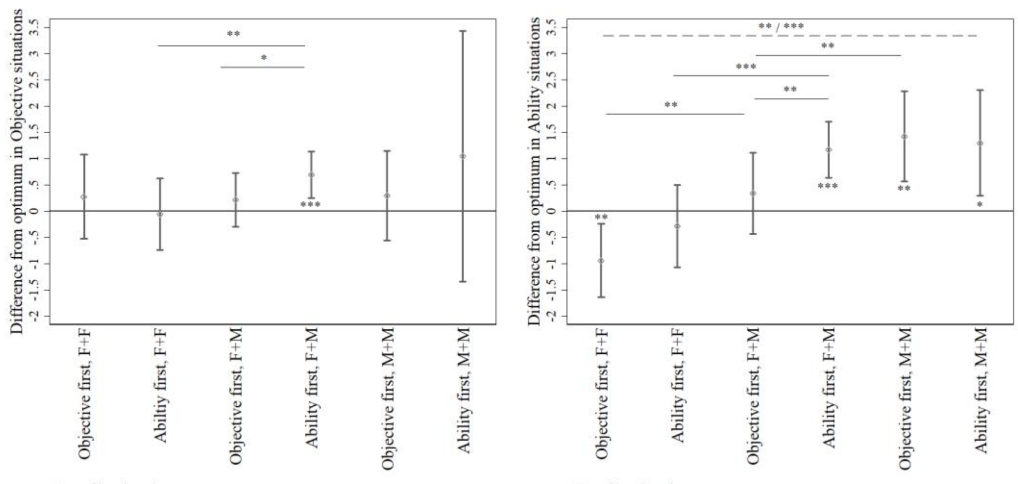


Figure 6: Group investment difference from optimum in the *Objective* (left) and *Ability* (right) treatments, divided by the *Order* treatment and group gender composition. For brevity, only the significance of all consecutive (one-step and two-step) comparisons between the investment levels in the *Ability* situations are depicted; the differences between further levels are significant at least at a 5% level (indicated by the dashed line). The asterisks indicate Wilcoxon-Mann-Whitney rank sum tests for differences between the investment levels and Wilcoxon signed rank tests for differences from zero. $^{***}\ p < 0.01$, $^{**}\ p < 0.05$, $^{*}\ p < 0.1$.

As illustrated in Figure 6, we find that investment levels throughout the session are on average higher whenever the *Ability* treatment is the first one in a session.[19] There is a strong upward shift in group *Ability* investments, as depicted also in the regressions with control variables in the Table 3. We thus find some support for Hypothesis 4A and conclude that we can identify spillover effects of the respective *Objective* or *Ability* mindset on the subsequent decisions.

Result 4. *Facing first the Ability investment situations creates spillovers that result in higher investment levels in the subsequent decisions.*

4.3.4. Communication content analysis

In contrast, if we divide the results in Figure 6 by pre-decision *Communication* instead of *Order*, we can conclude that the results are robust to communication and it does not exhibit a significant effect on group investment levels. The regression results in Table 3 support this conclusion; we thus reject Hypothesis 4B and further present the between-subject communication intervention effects in Appendix F.

And yet, the communication content[20] itself appears to lend an additional piece of information regarding the differences between *Objective* and *Ability* situations. As depicted in Figure 7, we find objective differences in how the communication stage is used—both between the overconfident and underconfident subjects and between the *Objective* and *Ability* treatments. The overconfident subjects are the first ones to talk significantly more often than the underconfident subjects in the pre-decision communication stages of the mixed UC+OC groups in the *Ability* situations (Wilcoxon-Mann-Whitney rank sum test, $p < 0.001$), while the underconfident subjects initiate the conversation more often in the *Objective* situations ($p < 0.001$). We can thus conclude that, depending on the situations, overconfident and underconfident subjects do indeed tend to have different "behavioral signatures".

[19] For the purposes of this comparison, we pull the *Communication* and *NoCommunication* data together. As we show in Appendix F, the *Communication* intervention alone does not lead to significant differences in the investment levels.

[20] Note that due to the concise nature of most of the observed pre-decision conversations, we mostly focus on objective measures of communication, e.g., we examine whether the overconfident or underconfident group members are the ones to initiate the conversation during pre-decision communication stage. Meanwhile, in the post-experiment questionnaire, when we asked the subjects directly to evaluate their peers' competence and likability on a Likert scale, the evaluations were consistently more positive in the *Communication* treatment than in the *NoCommunication* treatment (Wilcoxon-Mann-Whitney rank sum tests, $p < 0.001$); see details in Appendix F.

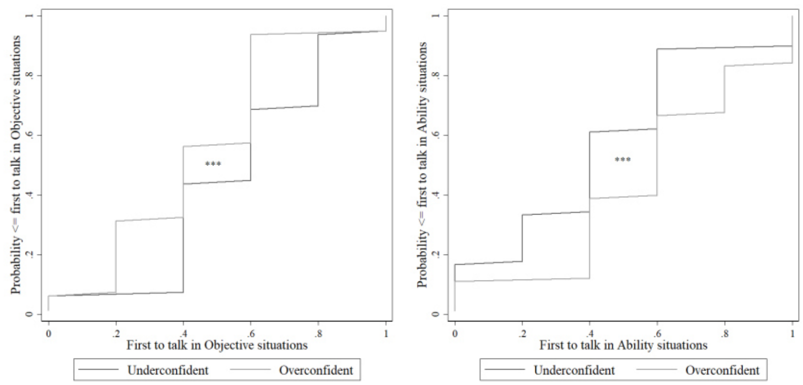


Figure 7: Likelihood of initiating the conversation during the pre-decision *Communication* intervention in the *Objective* (left) and *Ability* (right) group investment situations, by individual overconfidence. The asterisks indicate Wilcoxon-Mann-Whitney rank sum tests for differences between the probabilities. $^{***}\ p < 0.01$, $^{**}\ p < 0.05$, $^{*}\ p < 0.1$.

Result 5. *The overconfident subjects communicate more proactively about Ability investment situations than Objective situations.*

5. Discussion and conclusions

When evaluating the effects of gender and overconfidence on group investment decision making, many aspects of the decision situations—beyond their potential outcomes and objective probabilities—should be carefully considered. The way how success chances of an investment opportunity are perceived can play a significant role in group decisions. Although the *Objective* and *Ability* investment situations are by construction equivalent, the decision makers tend to treat them quite differently—both in terms of how overconfidence and gender manifests itself in the chosen investment levels and in how far from the optimum the chosen investment levels lie (as outlined in Results 1 to 3).

But the differences are not in the investment behavior alone. We find that the decision makers also learn from these situations differently and communicate about these situations differently. On average, all decision makers (both men and women and both overconfident and underconfident) learn to invest more "overconfidently" if first primed with the *Ability* investment situations (as outlined in Results 4 to 5).

We have found support for our main hypotheses. First, we show that groups decide less optimally when a possibility to "beat the odds" of success is given. This "beat the odds" mindset appears to manifest itself especially strongly if performance-dependent are faced first. One reason could be that facing the objective chances of success first "calibrates" the decision makers to think about the probabilities as objectively given. Second, we show that the investment levels do indeed depend on group composition with respect to gender and overconfidence, even after controlling for risk preferences and other characteristics: Groups overinvest in risky prospects when more men and more overconfident individuals are involved in the decisions.

Given that many important economic decisions are made by groups, not just individuals, our experimental results provide potential implications for board composition policies with respect to gender and overconfidence. One policy recommendation implies attempting to further increase the diversity in management teams and boards, echoing the empirical results by Levi et al. (2014) and Chen et al. (2019), among others. Indeed, as once expressed by Christine Lagarde, the former Head of the International Monetary Fund and the current President of the European Central Bank: "If Lehman Brothers had been 'Lehman Sisters,' today's economic crisis clearly would look quite different" (The New York Times, 2010).

Our results on the willingness to take charge of the group task also demonstrate gender differences and echo the empirical findings on women shying away from leadership roles. The mentioned reasons in former studies include, for example, ability differences, family-career balance and discrimination (Ertac & Gurdal, 2012). These results in combination with the result above emphasize the potential hazard of bias spillovers both between the decisions and within the groups themselves. One implication for better group decisions thus includes attempting to frame board investment decisions with objective odds of success as much as possible — to downplay the perception of being able to beat the odds.

Meanwhile, note that this study provides only partial insight into how individual overconfidence and gender can influence group decisions, and there remain many directions to add to this line of research. The design of this study itself could be expanded in several ways, for example, by varying the group size and the voting rule for the group decisions. Further extensions could also include different categories of tasks (e.g., requiring less crystalized and more lucid intelligence) that the subjects need to solve in the performance-dependent situations.

Acknowledgements

We would like to thank the research group at the Thurgau Institute of Economics (TWI) and the Department of Economics at the University of Konstanz for helpful comments along the way. We also thank the participants at the European Economic Association Meeting 2017 in Austria, the Thurgau Experimental Economics Meeting 2018 in Switzerland, as well as the Behavioral Decision-Making Workshop 2018 and the Organization Economics Workshop 2018 in Germany for fruitful discussions. We are grateful to the Graduate School of Decision Sciences at the University of Konstanz and the German Research Foundation (Deutsche Forschungsgemeinschaft, DFG) for financing the experiment. The authors also gratefully acknowledge support from the DFG through the research unit FOR 1882 "Psychoeconomics".

References

Adams, R.B., Ferreira, D., 2009. Women in the boardroom and their impact on governance and performance. J. Financ. Econ.

Anderson, C., Brion, S., Moore, D.A., Kennedy, J.A., 2012. A status-enhancement account of overconfidence. J. Pers. Soc. Psychol.

Barber, B., Odean, T., 2001. Boys will be boys: Gender, overconfidence, and common stock investment. Q. J. Econ.

Bénabou, R., 2015. The economics of motivated beliefs. Rev. Econ. Polit. 125, 665–685.

Bénabou, R., 2013. Groupthink: Collective delusions in organizations and markets. Rev. Econ. Stud.

Bengtsson, C., Persson, M., Willenhag, P., 2005. Gender and overconfidence. Econ. Lett.

Benoit, J.-P., Dubra, J., Romagnoli, G., 2020. Belief Elicitation When More Than Money Matters. Am. Econ. J. Microeconomics.

Biais, B., Hilton, D., Mazurier, K., Pouget, S., 2005. Judgemental overconfidence, self-monitoring, and trading performance in an experimental financial market. Rev. Econ. Stud.

Billett, M., Qian, Y., 2008. Are overconfident CEOs born or made? Evidence of self-attribution bias from frequent acquirers. Manage. Sci. 54, 1037–1051.

Blavatskyy, P.R., 2009. Betting on own knowledge: Experimental test of overconfidence. J. Risk Uncertain. 38, 39–49.

Booth, A., Cardona-Sosa, L., Nolen, P., 2014. Gender differences in risk aversion: Do single-sex environments affect their development? J. Econ. Behav. Organ.

Bracha, A., Cohen, A., Conell-Price, L., 2019. The heterogeneous effect of affirmative action on performance. J. Econ. Behav. Organ.

Camerer, C., Lovallo, D., 1999. Overconfidence and excess entry: An experimental approach. Am. Econ. Rev. 89, 306–318.

Campbell, K., Mínguez-Vera, A., 2008. Gender diversity in the boardroom and firm financial performance. J. Bus. Ethics.

Charness, G., Gneezy, U., 2010. Portfolio choice and risk attitudes: An experiment. Econ. Inq. 48, 133–146.

Charness, G., Rustichini, A., 2011. Gender differences in cooperation with group membership. Games Econ. Behav.

Chen, J., Leung, W.S., Song, W., Goergen, M., 2019. Why female board representation matters: The role of female directors in reducing male CEO overconfidence. J. Empir. Financ. 53, 70–90.

Cheng, J.T., Anderson, C., Tenney, E.R., Brion, S., Moore, D.A., Logg, J.M., 2020. The social transmission of overconfidence. J. Exp. Psychol. Gen.

Cokely, E., Galesic, M., Schulz, E., Ghazal, S., Garcia-Retamero, R., 2012. Measuring risk literacy: The Berlin numeracy test. Judgm. Decis. Mak. 7, 25.

Collins, B., Guetzkow, H., 1964. A social psychology of group processes for decision-making. New York: John Wiley & Sons.

Datta Gupta, N., Poulsen, A., Villeval, M.C., 2013. Gender matching and competitiveness: Experimental evidence. Econ. Inq.

Davis, J.H., 1992. Some compelling intuitions about group consensus decisions, theoretical and empirical research, and interpersonal aggregation phenomena: Selected examples 1950-1990. Organ. Behav. Hum. Decis. Process.

Deaves, R., Lueders, E., Luo, G., 2009. An experimental test of the impact of overconfidence and gender on trading activity. Rev. Financ. 13, 555–575.

Dittrich, D., Güth, W., Maciejovsky, B., 2005. Overconfidence in investment decisions: An experimental approach. Eur. J. Financ. 11, 471–491.

Eagly, A.H., Karau, S.J., 2002. Role congruity theory of prejudice toward female leaders. Psychol. Rev.

Eckel, C.C., Füllbrunn, S.C., 2017. Hidden vs. known gender effects in experimental asset markets. Econ. Lett.

Eckel, C.C., Füllbrunn, S.C., 2015. Thar she blows? Gender, competition, and bubbles in experimental asset markets. Am. Econ. Rev.

Ertac, S., Gurdal, M.Y., 2012. Deciding to decide: Gender, leadership and risk-taking in groups. J. Econ. Behav. Organ.

Falk, A., Dohmen, T., Quercia, S., Willrodt, J., 2017. Optimism, risk beliefs and risk preferences.

Fama, E., Jensen, M., 1983. Separation of ownership and control. J. Law Econ. 26, 301–325.

Fischbacher, U., 2007. Z-Tree: Zurich toolbox for ready-made economic experiments. Exp. Econ. 10, 171–178.

Gneezy, U., Croson, R., 2009. Gender differences in preferences. J. Econ. Lit.

Gneezy, U., Leonard, K., List, J., 2009. Gender differences in competition: Evidence from a matrilineal and a patriarchal society. Econometrica.

Gneezy, U., Potters, J., 1997. An experiment on risk taking and evaluation periods. Q. J. Econ. 112, 631–645.

Goldberg, L., 1992. The development of markers for the Big-Five factor structure. Psychol. Assess. 4, 26.

Gosling, S., Rentfrow, P., Swann, W., 2003. A very brief measure of the Big-Five personality domains. J. Res. Pers. 37, 504–528.

Greiner, B., 2015. Subject pool recruitment procedures: Organizing experiments with ORSEE. J. Econ. Sci. Assoc. 1, 114–125.

Grossman, P.J., Eckel, C., Komai, M., Zhan, W., 2019. It pays to be a man: Rewards for leaders in a coordination game. J. Econ. Behav. Organ.

Hannagan, R.J., Larimer, C.W., 2010. Does gender composition affect group decision outcomes? Evidence from a laboratory experiment. Polit. Behav. 32, 51–67.

Hardies, K., Breesch, D., Branson, J., 2013. Gender differences in overconfidence and risk taking: Do self-selection and socialization matter? Econ. Lett. 118, 442–444.

Healy, A.J., Pate, J.G., 2011. Overconfidence, social groups, and gender: Evidence from the lab and field. SSRN Electron. J.

Hilary, G., Menzly, L., 2006. Does past success lead analysts to become overconfident? Manage. Sci. 52, 489–500.

Hillman, A., Dalziel, T., 2003. Boards of directors and firm performance: Integrating agency and resource dependence perspectives. Acad. Manag. Rev. 28, 383–396.

Holt, C., Laury, S., 2002. Risk aversion and incentive effects. Am. Econ. Rev. 92, 1644–1655.

Huang, J., Kisgen, D.J., 2013. Gender and corporate finance: Are male executives overconfident relative to female executives? J. Financ. Econ.

Johnson, D., Fowler, J., 2011. The evolution of overconfidence. Nature 477, 317–320.

Kerr, N., Tindale, R., 2004. Group performance and decision making. Annu. Rev.

Psychol. 55, 623–655.

Khorana, A., Tufano, P., Wedge, L., 2007. Board structure, mergers, and shareholder wealth: A study of the mutual fund industry. J. financ. econ. 85, 571–598.

Kim, D., Starks, L.T., 2016. Gender diversity on corporate boards: Do women contribute unique skills?, in: American Economic Review.

Kind, A., Twardawski, T., 2016. Board overconfidence in mergers & acquisitions: A self-attribution bias. Acad. Manag. J.

Klayman, J., Soll, J., González-Vallejo, C., Barlas, S., 1999. Overconfidence: It depends on how, what, and whom you ask. Organ. Behav. Hum. Decis. Process. 79, 216–247.

Kocher, M., Sutter, M., 2005. The decision maker matters: Individual versus group behaviour in experimental beauty-contest games. Econ. J. 115, 200–223.

Kolasinski, A., Li, X., 2013. Can strong boards and trading their own firm's stock help CEOs make better decisions? Evidence from acquisitions by overconfident CEOs. J. Financ. Quant. Anal. 48, 1173–1206.

Langer, E.J., 1975. The illusion of control. J. Pers. Soc. Psychol.

Levi, M., Li, K., Zhang, F., 2014. Director gender and mergers and acquisitions. J. Corp. Financ.

Lichtenstein, S., Fischhoff, B., 1977. Do those who know more also know more about how much they know? Organ. Behav. Hum. Perform. 20, 159–183.

Malmendier, U., Tate, G., 2008. Who makes acquisitions? CEO overconfidence and the market's reaction. J. Financ. Econ. 89, 20–43.

Malmendier, U., Tate, G., 2005. CEO overconfidence and corporate investment. J. Finance 60, 2661–2700.

Masclet, D., Colombier, N., Denant-Boemont, L., Lohéac, Y., 2009. Group and individual risk preferences: A lottery-choice experiment with self-employed and salaried workers. J. Econ. Behav. Organ. 70, 470–484.

Melkas, H., Anker, R., 1997. Occupational segregation by sex in Nordic countries: An empirical investigation. Int. Labour Rev.

Menkhoff, L., Schmeling, M., Schmidt, U., 2013. Overconfidence, experience, and professionalism: An experimental study. J. Econ. Behav. Organ.

Meyer, A.N.D., Payne, V.L., Meeks, D.W., Rao, R., Singh, H., 2013. Physicians' diagnostic accuracy, confidence, and resource requests: A vignette study. JAMA Intern. Med.

Michailova, J., Katter, J., 2014. Quantifying overconfidence in experimental finance. Int. J. Behav. Account. Financ. 4, 351–367.

Michailova, J., Schmidt, U., 2016. Overconfidence and bubbles in experimental asset markets. J. Behav. Financ. 17, 280–292.

Moore, D., Healy, P., 2008. The trouble with overconfidence. Psychol. Rev. 115, 502.

Niederle, M., Vesterlund, L., 2007. Do women shy away from competition? Do men compete too much? Q. J. Econ.

Obling, K.H., Hansen, A.L.S., Overgaard, K., Normann, K., Sandbaek, A., Maindal, H.T., 2015. Association between self-reported and objectively measured physical fitness level in a middle-aged population in primary care. Prev. Med. Reports 2, 462–466.

Powell, M., Ansic, D., 1997. Gender differences in risk behaviour in financial decision-making: An experimental analysis. J. Econ. Psychol.

Reuben, E., Rey-Biel, P., Sapienza, P., Zingales, L., 2012. The emergence of male leadership in competitive environments. J. Econ. Behav. Organ.

Reuben, E., Sapienza, P., Zingales, L., 2014. How stereotypes impair women's careers in science. Proc. Natl. Acad. Sci. U. S. A.

Ring, P., Neyse, L., David-Barett, T., Schmidt, U., 2016. Gender differences in performance predictions: Evidence from the cognitive reflection test. Front. Psychol.

Roll, R., 1986. The hubris hypothesis of corporate takeovers. J. Bus. 197–216.

Schaefer, P., Williams, C., Goodie, A., Campbell, W., 2004. Overconfidence and the Big Five. J. Res. Pers. 38, 473–480.

Scheier, M., Carver, C., Bridges, M., 1994. Distinguishing optimism from neuroticism (and trait anxiety, self-mastery, and self-esteem): A reevaluation of the Life Orientation Test. J. Pers. Soc. Psychol. 67, 1063.

Schwartz-Ziv, M., Weisbach, M., 2013. What do boards really do? Evidence from minutes of board meetings. J. Financ. Econ. 108, 349–366.

Shupp, R.S., Williams, A.W., 2008. Risk preference differentials of small groups and

individuals. Econ. J.
Sniezek, J.A., 1992. Groups under uncertainty: An examination of confidence in group decision making. Organ. Behav. Hum. Decis. Process. 52, 124–155.
Soll, J.B., Klayman, J., 2004. Overconfidence in interval estimates. J. Exp. Psychol. Learn. Mem. Cogn.
Svenson, O., 1981. Are we all less risky and more skillful than our fellow drivers? Acta Psychol. (Amst). 47, 143–148.
Taylor, S.E., Brown, J.D., 1988. Illusion and well-being: A social psychological perspective on mental health. Psychol. Bull. 103, 193.
The New York Times, 2010. Lagarde: What If It Had Been Lehman Sisters? - The New York Times [WWW Document]. URL https://dealbook.nytimes.com/2010/05/11/lagarde-what-if-it-had-been-lehman-sisters/ (accessed 10.14.20).
Trevelyan, R., 2008. Optimism, overconfidence and entrepreneurial activity. Manag. Decis. 46, 986–1001.
Trinugroho, I., Sembel, R., 2011. Overconfidence and Excessive Trading Behavior: An Experimental Study. Int. J. Bus. Manag.
Viscusi, W., Phillips, O., Kroll, S., 2011. Risky investment decisions: How are individuals influenced by their groups? J. Risk Uncertain. 43, 81.
Weinstein, N., 1980. Unrealistic optimism about future life events. J. Pers. Soc. Psychol. 39, 806.
Zarnoth, P., Sniezek, J., 1997. The social influence of confidence in group decision making. J. Exp. Soc. Psychol. 33, 345–366.

Appendix

A. Investment situations

Invest	High	p(High)	Low	p(Low)	EV
0			50		50
5	55	90%	45	10%	54
10	60	80%	40	20%	56
15	65	70%	35	30%	56
20	70	60%	30	40%	54
25	75	50%	25	50%	50
30	80	40%	20	60%	44
35	85	30%	15	70%	36
40	90	20%	10	80%	26
45	95	10%	5	90%	14
0			50		50
5	55	45%	45	55%	50
10	60	40%	40	60%	48
15	65	35%	35	65%	46
20	70	30%	30	70%	42
25	75	25%	25	75%	38
30	80	20%	20	80%	32
35	85	15%	15	85%	26
40	90	10%	10	90%	18
45	95	5%	5	95%	10
0			50		50
5	55	95%	45	5%	55
10	60	90%	40	10%	58
15	65	85%	35	15%	61
20	70	80%	30	20%	62
25	75	75%	25	25%	63
30	80	70%	20	30%	62
35	85	65%	15	35%	61
40	90	60%	10	40%	58
45	95	55%	5	45%	55

Invest	High	p(High)	Low	p(Low)	EV
0			50		50
1	55	80%	49	20%	54
2	60	75%	48	25%	57
3	65	70%	47	30%	60
4	70	65%	46	35%	62
5	75	60%	45	40%	63
6	80	55%	44	45%	64
7	85	50%	43	50%	64
8	90	45%	42	55%	64
9	95	40%	41	60%	63
0			50		50
5	60	95%	45	5%	59
10	70	90%	40	10%	67
15	80	85%	35	15%	73
20	90	80%	30	20%	78
25	100	75%	25	25%	81
30	110	70%	20	30%	83
35	120	65%	15	35%	83
40	130	60%	10	40%	82
45	140	55%	5	45%	79

Table A1: All investment situations in the (equivalent) *Objective* and *Ability* treatments: low-optimum situations in the left sub-table, high-optimum situations in the right sub-table.

B. Further details on the experimental design

As summarized in Figure 1, we start each session by measuring the subjects' overconfidence (using the bias score as discussed in sub-section 3.1) and risk preferences using the multiple price list (Holt and Laury, 2002). Afterwards, the subjects go through the main experiment stages with the *Objective* and *Ability* investment tasks (as discussed in sub-section 3.2) in two separate treatment blocks. In the first block, each investment situation is faced first individually, then in a group, then the next again individually, then again in the same group, and so on. Afterwards, the same procedure follows in the second block, after random group rematching between the blocks. Note that the group changes between the *Objective* and *Ability* treatment blocks and the outcome values are jittered[21] in the second block. Depending on the treatment (as discussed in sub-section 3.3), the subjects begin either with the *Objective* or the *Ability* block and, depending on the treatment, the subjects either do or do not have a pre-decision communication stage before each group decision.

After the main stages, we again measure the subjects' risk preferences using a single-item investment game measure (Charness & Gneezy, 2010; Gneezy & Potters, 1997). In the post-experiment questionnaire, we consider the following tests for control purposes: the four-item Berlin Numeracy Test (Cokely et al., 2012) that we use in addition to the self-reported school grades to measure competence, the ten-item Life Orientation Test (Scheier et al., 1994) to measure optimism that is known to correlate with overconfidence and the ten-item Big Five Personality Test (Goldberg, 1992; Gosling et al., 2003) to measure other personality traits that could be related to overconfidence. In the post-experiment questionnaire, we also consider the subjects' self-reported perceived success chances and demographic variables.

The subjects are incentivized as follows. In the overconfidence measurement, they are paid 30 MU if they answered a randomly selected item correctly. In the investment decisions, the subjects can earn up to 140 MU for one randomly drawn investment decision, which can be drawn either from the *Objective* or *Ability* block and can be either an

[21] Namely, to avoid direct repetition between the blocks for the subjects, all values in the decision situations of the second block are jittered to be 1 to 2 MU higher or lower than in the first block, regardless whether the second block is constituted of Objective or Ability situations.

individual or group decision, thus avoiding hedging concerns. The drawn decision is then played out in accordance with the provided probabilities (if *Objective*) or the provided answers to the performance-dependent task (if *Ability*). In the two risk preference measurements, the subjects are paid up to 40 MU and 25 MU respectively for their chosen investments. Each MU is worth 0.12 such that 100 MU are equal to 12 EUR. The subjects are additionally paid a show-up fee of 5 EUR.

C. Further results on the overconfidence bias score

Our analysis shows that not only do the highly overconfident subjects report higher confidence, they also perform worse (Wilcoxon-Mann-Whitney rank sum tests, $p < 0.001$) such that their overconfidence is "unjustified", as depicted in Figure A1. Again, we identify no significant differences between male and female scores in this respect.

Furthermore, we also ask the subjects two robustness questions concerning their estimates of how many of the items they answered correctly and their estimates of what performance rank they have in their experimental session. As depicted in Figure A2, these overconfidence robustness measures encompass the two main properties of the overconfidence phenomenon—overestimation and overplacement— and strongly correlate with the bias score (Spearman's rank-order correlations > 0.57, both $p < 0.001$). We thus conclude that the bias score captures both of these properties similarly: The overconfident subjects report beliefs about significantly higher numbers of correct answers and place themselves in significantly higher ranks (Wilcoxon-Mann-Whitney rank sum tests, $p < 0.001$) than the underconfident subjects. In our sample, we do find no significant differences between the two robustness measures of male and female subjects.[22]

[22] Our analysis also shows that overconfident individuals are more optimistic (Life Orientation test, Wilcoxon-Mann-Whitney rank sum test, $p = 0.018$) and slightly more conscientious and less stable (Big Five Personality test, Wilcoxon-Mann-Whitney rank sum tests, $p < 0.029$). Other Big Five Personality traits do not appear to be significantly related to overconfidence in our sample. Note, however, that this study uses very concise test versions and can generally provide little insight in the underlying processes behind the decisions of overconfident and underconfident group members or behind the processing modes used in evaluating *Objective* and *Ability* investment situations. More extensive testing as well as complementary research approaches, such as eye-tracking or mouse-tracking analyses, could thus be beneficial for further research.

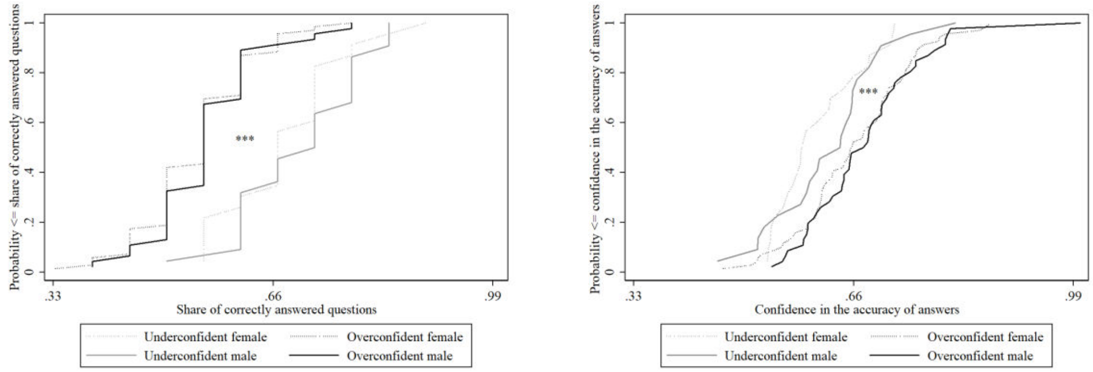


Figure A1: Actual share of correct answers in the overconfidence bias measure (left) and reported certainty about the answers in the overconfidence bias measure (right) divided by gender and overconfidence. The asterisks indicate Wilcoxon-Mann-Whitney rank sum tests between overconfident and underconfident male and female subjects. $^{***}\ p < 0.01,\ ^{**}\ p < 0.05,\ ^{*}\ p < 0.1$.

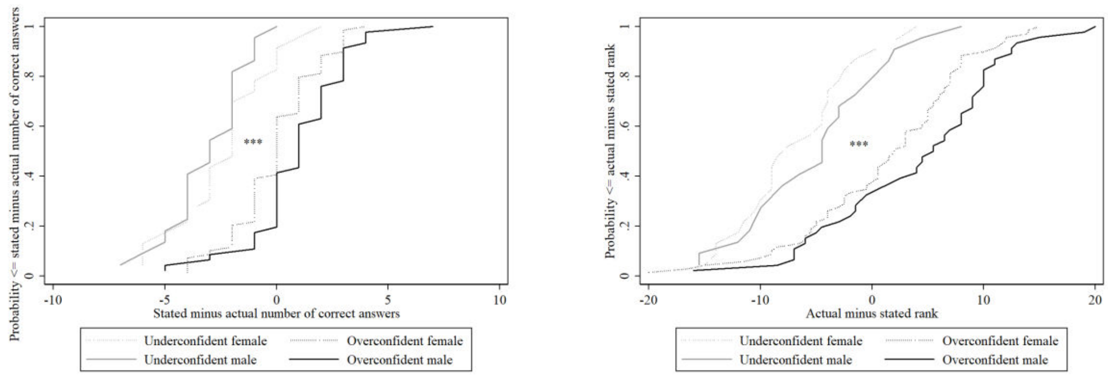


Figure A2: Overconfidence robustness questions that check the two main properties of the overconfidence phenomenon—overestimation (left) and overplacement (right)—divided by gender and overconfidence. The asterisks indicate Wilcoxon-Mann-Whitney rank sum tests between overconfident and underconfident male and female subjects. $^{***}\ p < 0.01,\ ^{**}\ p < 0.05,\ ^{*}\ p < 0.1$.

D. Extended group investment regressions

Investment diff.	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
from optimum	Objective situations				Ability situations			
Male group	0.450		0.467	**0.292**	2.010***		2.103***	**2.135*****
	(0.36)		(0.36)	(0.46)	(0.37)		(0.39)	(0.64)
Overconfidence		2.734*	2.781*	**3.774**		3.428*	4.165***	**4.344****
		(1.52)	(1.45)	(2.43)		(2.01)	(1.47)	(1.62)
Risk aversion	-0.964***	-1.079***	-1.043***	-1.082***	-0.976**	-1.084**	-0.970**	-1.134***
	(0.32)	(0.35)	(0.35)	(0.36)	(0.40)	(0.45)	(0.39)	(0.30)
Order (*Ability* first)				**0.242**				**0.555****
				(0.25)				(0.27)
Communication				-0.207				-0.005
				(0.25)				(0.24)
Numeracy score				0.519				0.803
				(0.81)				(0.70)
Optimism score				-1.137				-1.474
				(2.09)				(2.13)
Big5 Extravert.				-0.401				-1.695
				(1.06)				(1.01)
Big5 Agreeable.				0.468				-0.404
				(1.29)				(2.31)
Big5 Conscient.				-1.268				0.877
				(1.06)				(1.10)
Big5 Stability				2.008				2.063
				(1.33)				(1.24)
Big5 Openness				1.221				2.602**
				(1.14)				(1.21)
Age				-0.004				0.029
				(0.09)				(0.09)
Average grade				-0.642				-3.362
				(1.70)				(2.25)
Sequence				-0.134				-0.131
				(0.23)				(0.29)
Constant	0.706**	0.789***	0.567*	0.118	0.152	0.850***	-0.155	-1.408
	(0.27)	(0.22)	(0.29)	(2.07)	(0.35)	(0.29)	(0.34)	(1.94)
Controls	No	No	No	Yes	No	No	No	Yes
R^2	0.120	0.140	0.157	0.233	0.254	0.101	0.304	0.438
BIC	248.662	246.806	249.570	294.563	283.509	298.377	282.288	317.773
N	80	80	80	80	80	80	80	80

Table A2: Full regressions of group overconfidence and gender composition on the average difference from optimum in group investment levels. OLS regressions, robust standard errors in parentheses, clustered at the matching-group level. $^{***}\ p < 0.01$, $^{**}\ p < 0.05$, $^{*}\ p < 0.1$.

E. Individual investment results and extended regressions

Individual confidence, gender and individual investments

In order to obtain a more comprehensive view of how gender and overconfidence influence investment decision making, we now examine how *individual* overconfidence influences *individual* investment decisions, as depicted in Figure A3. We find that female subjects invest close to the optimum or even slightly below optimum in both *Objective* and *Ability* situations, while male subjects overinvest in both situations. Only the underconfident male subjects in *Objective* situations invest close to the optimum.

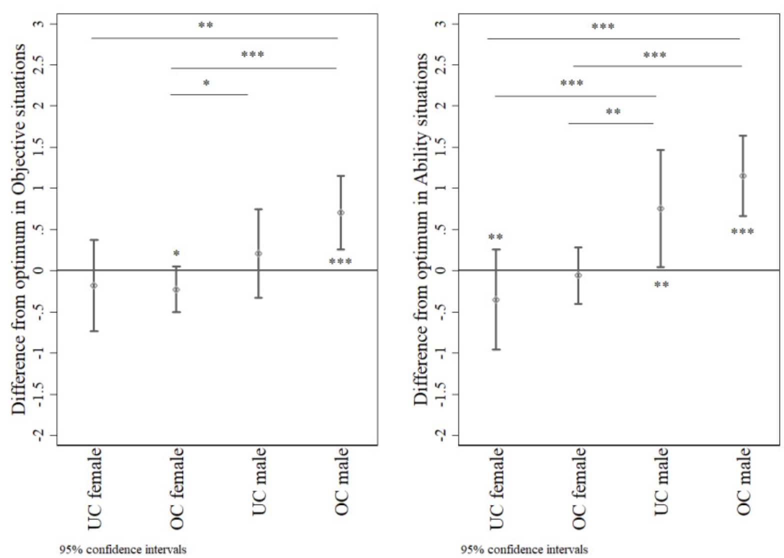


Figure A3: Individual investment difference from the optimum in the *Objective* (left) and *Ability* (right) treatments, by gender and overconfidence bias score and compared to zero (solid line). The asterisks indicate Wilcoxon-Mann-Whitney rank sum tests for differences between the investment levels and Wilcoxon signed rank tests for differences from zero. $^{***}\ p < 0.01$, $^{**}\ p < 0.05$, $^{*}\ p < 0.1$.

Investment diff.	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
from optimum	Objective situations				Ability situations			
Male individual	0.613***		0.635***	**0.818*****	1.097***		1.132***	**1.098*****
	(0.21)		(0.22)	(0.24)	(0.28)		(0.27)	(0.37)
Overconfidence		1.149	1.347	**1.391***		1.849	2.201**	**2.557****
		(0.88)	(0.81)	(0.77)		(1.16)	(0.97)	(0.98)
Risk aversion	-0.844***	-0.941***	-0.838***	-0.898***	-0.343	-0.517*	-0.332	-0.460**
	(0.23)	(0.26)	(0.24)	(0.25)	(0.24)	(0.27)	(0.23)	(0.21)
Order (*Ability* first)				**0.125**				**0.340***
				(0.22)				(0.18)
Communication				-0.269				-0.222
				(0.22)				(0.22)
Numeracy score				0.271				1.096*
				(0.35)				(0.56)
Optimism score				1.182				1.510
				(0.88)				(1.29)
Big5 Extravert.				0.068				-0.352
				(0.53)				(0.65)
Big5 Agreeable.				0.997				-0.619
				(0.66)				(0.97)
Big5 Conscient.				-0.358				-0.885
				(0.52)				(0.72)
Big5 Stability				-0.090				0.741
				(0.64)				(0.74)
Big5 Openness				1.220*				1.583**
				(0.61)				(0.77)
Age				-0.045				0.045
				(0.06)				(0.06)
Average grade				-1.089				-2.984**
				(0.85)				(1.13)
Sequence				-0.089				-0.019
				(0.21)				(0.24)
Constant	0.322*	0.564***	0.224	-0.405	0.086	0.532**	-0.075	-1.224
	(0.18)	(0.18)	(0.21)	(1.44)	(0.23)	(0.20)	(0.23)	(1.35)
Controls	No	No	No	Yes	No	No	No	Yes
R^2	0.181	0.140	0.193	0.276	0.137	0.043	0.160	0.321
BIC	529.538	537.356	532.152	575.717	598.493	614.986	599.272	626.154
N	160	160	160	160	160	160	160	160

Table A3: Full regressions of individual overconfidence bias score and gender on the average difference from the optimum in group investments as the dependent variable. Gender variable is 0 for women and 1 for men. Individual overconfidence variable ranges from -0.25 to 0.39. Group risk preference variable, expressed in terms of a constant relative risk aversion (CRRA) coefficient where higher values imply higher risk aversion and zero implies risk neutrality, ranges from -1.71 to 1.37. Columns 1-4 concern the *Objective* situations, while columns 5-8 concern the *Ability* situations. We consider four models for each. Columns 1, 2, 5 and 6 include the baseline model for gender and overconfidence separately, columns 3 and 7 include them jointly, and columns 4 and 8 additionally include the control variables and treatment dummies, namely: Big5 personality traits, numeracy test score, optimism test score, age, average school grade, lottery order, as well as Order and Communication treatment dummies Note: OLS regressions, robust standard errors in parentheses clustered at the matching-group level. $^{***}\ p < 0.01$, $^{**}\ p < 0.05$, $^{*}\ p < 0.1$.

In line with these observations, the regression results in Table A3 show that higher individual overconfidence and being male is associated with higher investment levels in both the *Objective* and *Ability* treatments. Note that we again run linear OLS regressions with the difference from optimum investment levels as the dependent variable and correct for experiment data dependencies using robust clustered errors at the matching-group level. We use the individual continuous bias score as the independent variable for individual overconfidence.

We thus find further evidence supporting Hypothesis 1, concluding that gender and overconfidence do indeed drive higher individual investments. In contrast to the group decisions where only *Ability* situations show a clear overconfidence effect, individual decisions show this effect in both *Objective* and *Ability* situations. We can thus also replicate some previous findings regarding biased individual decision making of, e.g., chief executives (Malmendier & Tate, 2005; Roll, 1986 among others).

Result A1. *On average, higher individual investments are associated with being overconfident and being male in both Objective and Ability treatments.*

Individual and group investments

We now compare the average individual and group investment levels, as depicted in Figure 10. We find "risky shift" differences in the *Objective* treatment (Wilcoxon signed rank tests, $p = 0.005$), in line with previous findings in the literature (for example, Collins and Guetzkow, 1964; Davis, 1992). The risky shift phenomenon is a tendency for people to make riskier decisions when they are in groups than when they are alone.

Interestingly, for the individual decisions in Figure A4, the average risky shift effect in *Objective* situations appears to be of equivalent magnitude to the individual *Ability*-versus-*Objective* treatment effect. Namely, there is no significant difference between average *group* investment levels in the *Objective* treatment and average *individual* investment levels in the *Ability* treatment. We thus find further evidence supporting Hypothesis 3. Note, however, that the magnitude of this relation could be driven by the sample composition, such that further research into this this question is still needed.

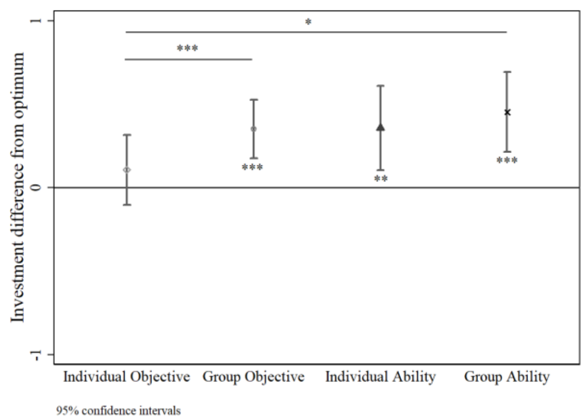


Figure A4: Average individual and group investment difference from the optimum in *Objective* and *Ability* treatments, compared to the average optimum investment level (solid line). The asterisks indicate Wilcoxon signed rank tests. $^{***}\ p < 0.01$, $^{**}\ p < 0.05$, $^{*}\ p < 0.1$.

Result A2. *The individual Ability investments are further away from the optimum than the individual Objective investments.*

Finally, in line with Result A1, also *Order* effects in the individual *Objective* situations are more pronounced than in the group *Objective* situations; see Figure A5.[23]

Order effects on individual investments

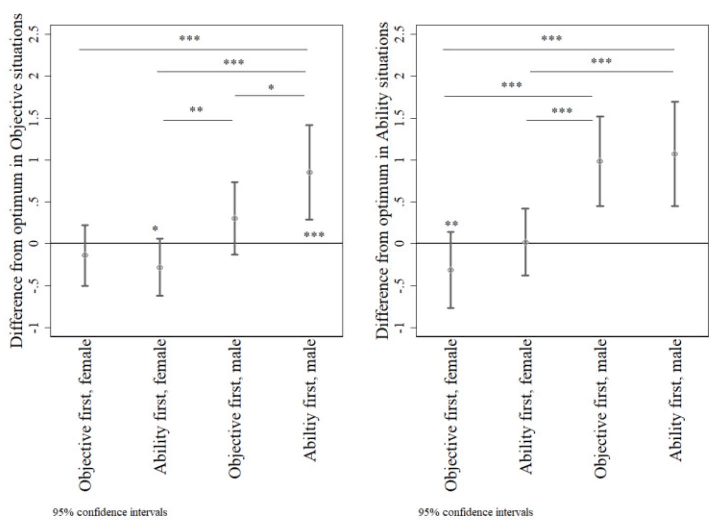


Figure A5: Individual investment difference from optimum in the *Objective* (left) and *Ability* (right) treatments, divided by the *Order* treatment and gender. The asterisks indicate Wilcoxon-Mann-Whitney rank sum tests for differences between the investment levels and Wilcoxon signed rank tests for differences from zero. $^{***}\ p < 0.01$, $^{**}\ p < 0.05$, $^{*}\ p < 0.1$.

[23] Notice also that the *Order* effects in the individual investments, as depicted in Figure A5, resemble the individual overconfidence effects, as depicted in Figure A3, remarkably closely. It could be that priming a well calibrated investment decision maker with a "beat the odds" mindset could lead to overinvestments that parallel those of overconfident decision makers, although further research into this question is still needed.

F. Further results on the communication effects

Firstly, we find no significant between-subject differences in investment levels between *Communication* and *NoCommunication* treatments, as depicted in Figure A6, except for all-male groups in the *Ability* treatment. Secondly, we find significant between-subject differences in how the other group members are evaluated in the *Communcation* and *NoCommunication* treatments. This is also why we combine the no-communication and communication treatments in the text to improve statistical power. Finally, in the post-experiment questionnaire, we asked the subjects directly to evaluate their peers' competence and likability on a Likert scale. In Figure A7, we show that the evaluations are consistently more positive in the *Communication* treatment than in the *NoCommunication* treatment (Wilcoxon-Mann-Whitney rank sum tests, $p < 0.001$).

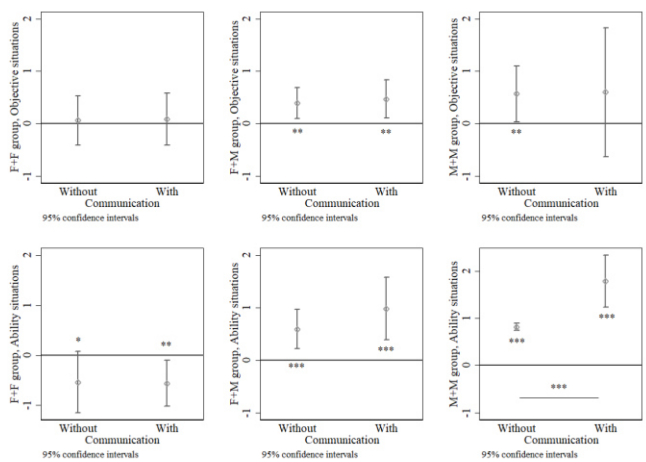


Figure A6 Group investment differences from optimum in the *Objective* (top) and *Ability* (bottom) treatments, divided by the *Communication* treatment (*NoCommunication* left, with *Communication* right) and group gender composition. The asterisks indicate Wilcoxon-Mann-Whitney rank sum tests for differences between the investment levels and Wilcoxon signed rank tests for differences from zero. $^{***}\ p < 0.01$, $^{**}\ p < 0.05$, $^{*}\ p < 0.1$.

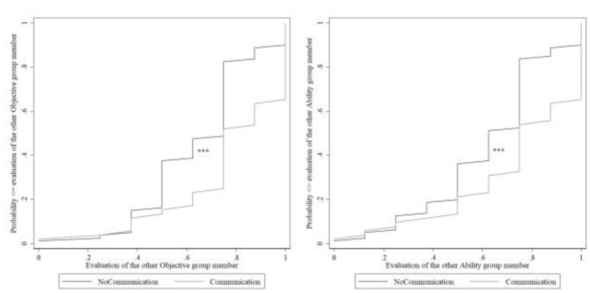


Figure A7 Evaluation of the other group member's competence and likability of the other *Objective* (left) and *Ability* (right) group member in the post-experiment questionnaire, by whether there were pre-decision communication stages in the given session. The asterisks indicate Wilcoxon-Mann-Whitney rank sum tests. $^{***}\ p < 0.01$, $^{**}\ p < 0.05$, $^{*}\ p < 0.1$.

G. Instructions

The following instructions (translated from German) correspond to the treatment that (i) includes pre-decision communication (as opposed to no communication) and (ii) presents the investment situations in an order that shows the *Objective* situations before the *Ability* situations (as opposed to vice versa).

Overview

Welcome to this experiment. Please do not speak with other participants during the experiment and turn off your mobile phones and other mobile electronic devices.

To participate in today's experiment, you will be paid in cash at the end. The amount of the payout depends partly on chance and partly on your decisions. It is therefore important that you carefully read and understand the instructions.

Today's experiment consists of four parts, each comprising several rounds. At the end, several randomly drawn rounds are paid out. From Part 1, two rounds (one round from Part 1a and one round from Part 1b) will be randomly drawn and paid out. From Parts 2 and 3, one round will be randomly drawn and paid out. From Part 4, one round will be randomly drawn and paid out.

Your payout will result from the earned points in the drawn rounds. These points will be converted into euro, and you will receive additional 5 euro to complete the subsequent questionnaire. The conversion of the points into euro is done as follows. Each point is worth 12 cents, so the following applies: 100 points = 12.00 euro. Each participant is paid privately so that other participants cannot see how many points you have earned.

Setup of the experiment

This experiment consists of four different parts. Part 1 consists of Part 1a and Part 1b. Part 1a consists of 18 identical rounds. In each round, you will answer questions with three choice options, with answers that can be right or wrong. Then, in Part 1b, you will make 10 decisions in a table.

The Parts 2 and 3 have 5 + 5 identical rounds each. An investment decision has to be made in every round. The tasks in these parts are similar in structure. In Part 2, individual investment decisions and group investment decisions are made five times, in an alternating manner. Similarly, in Part 3, five individual investment decisions and five group investment decisions are made alternately. That is, you first make a first individual investment decision on a first investment situation, then a two-member group investment decision on the same investment situation, then a second individual investment decision on a different investment situation, then a second two-member group investment decision on the same second investment situation, then a third etc.

Parts 2 and 3 differ in the following way. In Part 2, the mentioned probabilities will determine the chances of success of the investment. In Part 3, certain tasks with an appropriate level of ease (easiness of task) will determine the success of the investment. The detailed instructions for Part 2 will be shown after Part 1, and detailed instructions for Part 3 will be shown after Part 2. The instructions for Part 4 (4a and 4b) will be shown after Part 3.

In summary, the sequence of this experiment is as follows: 1a, 1b, five times alternating investment decisions and group decisions in Part 2, five times alternating individual investment decisions and group decisions in Part 3, and finally 4a, 4b.

Payout

From Part 1, two rounds will be randomly drawn (one round from Part 1a and one round from Part 1b). In Part 1a, you get 20 points if you answered the drawn round (1 out of 18 answers) correctly or 0 points if you answered the drawn round incorrectly. Also in Part 1b, you will be paid out the respective drawn round (1 out of 10 decisions). The exact number of points you get in Part 1b depends partly on your decisions and partly on chance.

From the Parts 2 and 3, a total of one round (1 of 20 decisions: either an individual decision or a group decision) will be randomly drawn and paid out. You can get up to 140 points in this round. The exact number of points you get depends partly on your decisions and partly on chance. Then, from Part 4, one round is randomly drawn and paid out. Each point is worth 12 cents, so the following applies: 100 points = 12.00 euro.

Questions?

Take your time to review the instructions thoroughly. If you have questions, please raise your hand. An experimenter will come to your place.

[Quiz]

Please answer the following understanding-question about the experiment. How many rounds are paid out of Parts 2 and 3 in total? You did [not] answer the question correctly. Your answer: [...] The correct answer: [...] If you wish, go back to the instructions, or ask an experimenter for explanations. Otherwise, click “Next".

Part 1a

Welcome to Part 1a of the experiment. It includes some general-knowledge questions. Imagine that you are involved in a game like “Trivial Pursuit" or “Who Wants to Be a Millionaire?" and you have to choose the right answer from the three alternatives.

1. Please click on one of the three given answers. Only one answer is correct. You will not receive any feedback as to which answer is correct.

2. Once you have made your choice and clicked on your answer, we would like to know how confident you are that your answer is correct. Since there are three alternative answers and only one of them is correct, you have a 33% chance to respond correctly. Thus, 33% means that you are guessing and do not know the right answer. Correspondingly, 100% means that you are absolutely sure which answer is correct.

You can use any number between 33% and 100% to indicate your confidence that your answer is correct. Fill in this confidence for each answer in the gap after each question: How sure are you that your answer is correct? (33% to 100%).

Note: Please answer all questions one by one in the order in which they appear in the questionnaire. If you do not know the answers, you can guess. Please do not jump back and forth between the questions and do not go back to questions that have already been answered to change your answers. We are interested in your first answer.

Please answer the questions below and assess how confident you are that your answer is correct. What is the name of an instant camera? a) Canon camera, b) Polaroid camera, c) Minolta camera. [...] How sure are you that your answer is correct? [...] (33% to 100%) [etc., 18 questions, see [35]]

Please estimate: In your opinion, how many questions, out of the total of 18 questions in Part 1a, did you answer correctly? Please enter a number between 0 and 18. [...] In this experiment, [n] participants are taking part. We ask you to estimate now how many questions you have answered correctly compared to the other participants. If you estimate that you have answered more questions correctly than any other participant, enter rank 1. If you estimate that you answered the least questions correctly, enter rank [n]. Please enter a number between 1 and [n]. [...] Thank you, you have completed Part 1a of the experiment. Now Part 1b follows.

Part 1b

Welcome to Part 1b of the experiment. You will see the instructions on the next screen. In this Part (1b), you will make a total of 10 decisions. In every decision, you have the option to choose either Option A or Option B. All 10 decisions are shown in a table below. Each row is one of the ten decisions. At the end of the experiment, we will randomly determine which of your 10 decisions is relevant for the payout.

Here is an example of a decision. If you choose option A in the first line, you can win 20.0 points with a 10% probability. With the remaining probability of 90%, you win 16.0 points. If you choose option B in the first line, you can win 38.5 points with a probability of 10%. With the remaining probability of 90%, you win 1.0 point. Note that you can only make one selection per line. You decide by either checking the box at A or B. [...] [10 lottery choices, see [24]]

Thank you, you have completed the entire Part 1 of the experiment. Now Part 2 follows. In Part 2 you will take five individual turns in making investment decisions and group decisions. Please wait until all participants have completed Part 1b. After that, you will receive the detailed instructions for Part 2.

Part 2

Welcome to Part 2 of the experiment.

Individual decisions

In Part 2, the shown probabilities will determine the chances of success of the investment. Your task is to select an investment. Each turn gives you 50 points of capital, and you can decide how much you want to invest.

Group decisions

Immediately after making the first individual decision, you make the same decision in a group that consists of you and one other participant. After that, you make the second individual decision and the same second decision in the same group, then the third, and so on. Before each group decision, you have 45 seconds to communicate with the other participant in your group in a chat. Both you and the other participant remain anonymous.

The result of each group decision will count for both participants in the group. You have to choose the investment in such a way that you and the other participant have selected the same option. You have a maximum of 90 seconds per round for the group decision. If you need more than 60 seconds, you will be penalized with 15 minus points from the total account. After 90 seconds, option A is selected for both participants, but with 15 minus points, and you automatically move to the next round. The timer on the top right will start at 90 seconds.

General notes

You can only select one investment option in each round. In the whole Part 2, you make individual decisions and group decisions five times in an alternating manner.

Part 2: Individual decisions

Option	Investition	Hohes Ergebnis	Hohe Wahrscheinlichkeit	Niedriges Ergebnis	Niedrige Wahrscheinlichkeit
A	0			50	
B	5	55	90%	45	10%
C	10	60	80%	40	20%
D	15	65	70%	35	30%
E	20	70	60%	30	40%
F	25	75	50%	25	50%
G	30	80	40%	20	60%
H	35	85	30%	15	70%
I	40	90	20%	10	80%
J	45	95	10%	5	90%

In this part, your task is to select an investment. Each turn gives you 50 points of capital, and you can decide how much you want to invest. In the situation shown above, you have received 50 points and can invest from 0 to 45 points (options A to J). If you decide not to make an investment (Option A, 0 points), you keep the capital endowment. For example, if you invest 45 points (Option J), you receive 95 points with 10% probability and keep only the remaining not-invested 5 points with 90% probability.

Part 2: Group decisions

Ihre Optionsauswahl	Investition	Vorherige Optionsauswahl des anderen Teilnehmers
A	0	
B	5	
C	10	
D	15	
E	20	E
F	25	
G	30	
H	35	
I	40	
J	45	

In each round, you will again have a capital of 50 points and decide how much you want to invest. You must choose in such a way that you and the other participant have selected the same option. In the situation shown above, the other participant in your group has selected option E. You have a maximum of 90 seconds per round for the group decision. If you need more than 60 seconds, you will be penalized with 15 minus points from the total account. After 90 seconds, option A is selected for both participants, but with 15 minus points, and you automatically move to the next round.

[Quiz]

Option	Investition	Hohes Ergebnis	Hohe Wahrscheinlichkeit	Niedriges Ergebnis	Niedrige Wahrscheinlichkeit
A	0			50	
B	5	55	90%	45	10%
C	10	60	80%	40	20%
D	15	65	70%	35	30%
E	20	70	60%	30	40%
F	25	75	50%	25	50%
G	30	80	40%	20	60%
H	35	85	30%	15	70%
I	40	90	20%	10	80%
J	45	95	10%	5	90%

Please answer the following understanding-questions about the experiment. 1. In the example shown above, what amount of investment (in points) corresponds to option E? [...] 2. If you chose option E, at most how many points could you get paid? [...] 3. How much time (in seconds) do you have in each group decision until you are penalized with 15 minus points from the total account? [...]

You have not answered all the questions correctly.

1. In the example shown above, which investment (in points) corresponds to the option E? Your answer: [...] The correct answer: 20.

2. If you chose option E, at most how many points could you get paid? Your answer: [...] The correct answer: 70.

3. How much time (in seconds) do you have in each group decision until you are penalized with 15 minus points from the total account? Your answer: [...] The correct answer: 60.

If you wish, go back to the instructions or ask an experimenter for explanations. Otherwise, click “Next”.

[First individual decision]

Capital for the [first] individual decision: 50 points. Please consider the following investment opportunity. How much do you want to invest? [...]

[First communication stage]

Before each group decision, you have 45 seconds to communicate with the other participant in your group. Now you can discuss the [first] group decision of Part 2. Please press “Enter" to send messages. [...]

[First group decision]

Capital for the [first] group decision: 50 points. Please note the following investment opportunity again. How much do you want to invest? [...]

[either] No agreement was found. Your suggestion: [...] Suggestion of the other participant: [...] You are entering a new round of negotiations.

[or] The proposal was accepted. Your suggestion: [...] Suggestion of the other participant: [...] [etc.]

Thank you, you've completed the entire Part 2 of the experiment. Now Part 3 of the experiment follows. Please note that new groups for the group decisions in Part 3 are created. That is, in Part 3, you make the group decisions in a group with a different second participant than in Part 2.

Part 3

Welcome to Part 3 of the experiment. The process in Part 3 is similar to Part 2. Overall, in Part 3, you make five individual investment decisions and group decisions in an alternating manner. In Part 2, the shown probabilities determined the chances of success of the investment. In the following Part 3, instead, certain tasks with a corresponding degree of ease (easiness of the task) will determine the success of the investment.

The easiness of the task indicates what percentage of a sample of German general population has answered the task correctly. The type of tasks is similar to Part 1: A task consists of a question with four possible answers. You will not receive any feedback as to which answer is correct.

Individual decisions

Your task is to select an investment. Each turn gives you 50 points of capital and you can decide how much you want to invest. After selecting the investment option, you will answer a task. If you answer the corresponding task correctly, you will receive the respective high result. If not, you will receive the respective low result. The tasks never repeat. The task should not take more than 10-15 seconds. After fifteen seconds, you automatically enter the next round.

Group decisions

Immediately after making the first individual decision, you make the same decision in a group that consists of you and one other participant. Then you make the second individual decision and the same second decision in a group, then the third, and so on. Before each group decision, you have 45 seconds to communicate with the other participant in your group in a chat. Both you and the other participant remain anonymous.

The result of each group decision will count for both participants in the group. You have to vote for a decision in such a way that you and the other participant have selected the same option. You have a maximum of 90 seconds per round for the group decision. If you need more than 60 seconds, you will be penalized with 15 minus points from the total account. After 90 seconds, option A (without a task) is selected for both participants, but with the 15 minus points, and you automatically move to the next round. The timer on the top right will start at 90 seconds.

Part 3: Individual decisions

Option	Investition	Hohes Ergebnis	Niedriges Ergebnis	Leichtigkeit der Aufgabe
A	0		50	
B	5	55	45	90%
C	10	60	40	80%
D	15	65	35	70%
E	20	70	30	60%
F	25	75	25	50%
G	30	80	20	40%
H	35	85	15	30%
I	40	90	10	20%
J	45	95	5	10%

In this part, your task is to select an investment. Each turn gives you 50 points of capital and you can decide how much you want to invest. In the situation shown above, you have received 50 points and can invest 0 to 45 (options A to J). For example, if you invest 45 points, you have to answer a task that has been correctly answered with a probability of 10% by a sample of general population. If you answer this task correctly, you receive the respective high result (95 points). If not, you receive the respective low result (5 points, meaning you will only retain the remaining not-invested points).

Part 3: Group decisions

In each round, you again have a capital of 50 points and can decide how much you want to invest. You must vote so that you and the other participant have selected the same option. In the shown situation, the other participant in your group has selected option E. You have a maximum of 90 seconds per round for the group decision. If you need more than 60 seconds, you will be penalized with 15 minus points from the total account. After 90 seconds, option A will be selected for both participants, but with the 15 minus points, and you will automatically move to the next round.

Ihre Optionsauswahl	Investition	Vorherige Optionsauswahl des anderen Teilnehmers
A	0	
B	5	
C	10	
D	15	
E	20	E
F	25	
G	30	
H	35	
I	40	
J	45	

Volunteers in group decisions

For individual decisions, you yourself answer the corresponding tasks. For the group decisions, a participant in the group (called the volunteer) answers the tasks. Before the first group decision, you will decide who of the two participants in your group will be the volunteer. Only the volunteer will answer all five tasks for the group. The result will count for both participants in the group. If the volunteer answers the task correctly, both group members receive the respective high result. If not, both receive the low result. Important note again: For Part 3, the groups for the group decisions are newly created. In Part 3, you make the group decisions in a group with a different second participant than in Part 2.

[Quiz]

Option	Investition	Hohes Ergebnis	Niedriges Ergebnis	Leichtigkeit der Aufgabe
A	0		50	
B	5	55	45	90%
C	10	60	40	80%
D	15	65	35	70%
E	20	70	30	60%
F	25	75	25	50%
G	30	80	20	40%
H	35	85	15	30%
I	40	90	10	20%
J	45	95	5	10%

Please answer the following understanding-questions about the experiment. 1. If you selected option E and answered the question correctly, how many points could you get paid (if this round was randomly drawn at the end?) [...] 2. How many tasks will the volunteer be answering for the group decisions in Part 3? [...]

You have [not] answered all the questions correctly.

1. If you selected option E and answered the question correctly, how many points could you get paid (if this round was randomly drawn at the end)? Your answer: [...] The correct answer: 70.

2. How many tasks will the volunteer be answering for the group decisions in Part 3? Your answer: [...] The correct answer: 5.

If you wish, go back to the instructions or ask an experimenter for explanations. Otherwise, click “Next”.

[First individual decision]

Capital for the [first] individual decision: 50 points. Please note the following investment opportunity. How much do you want to invest? [...]

After selecting the investment option, you will answer a task. If you answer the question correctly, you will get the high result. If not, you’ll get the low result. “Easiness of task" indicates the probability that the general population could answer this task correctly.

[e.g.] Easiness of task: 90%. What do you turn on when you press the “A/C" button in your car? a) Air conditioning, b) Fog lights, c) Windscreen wiper, d) Reverse gear. [...]

[Determining the volunteer]

You will now decide which of you in the newly created group will answer all five tasks for the following group decisions in Part 3. Please indicate if you would like to be the one to answer the tasks for your group (volunteer). If you and the other participant choose the same option, the roles (volunteer and not volunteer) will be randomly drawn.

1) Yes, I definitely want to answer the tasks for the group. 2) Yes, I want to answer the tasks for the group, unless the other participant in my group has selected option 1. 3) No, I do not want to answer the tasks for the group unless the other participant in my group has selected option 4. 4) No, I certainly do not want to answer the tasks for the group. [...]

Your role is: [volunteer / not volunteer]. The other participant in your group is: [not volunteer / volunteer].

[First communication stage]

Before each group decision, you have 45 seconds to communicate with the other participant in your group. Now you can discuss the [first] group decision of Part 3. Please press “Enter" to send messages. [...]

[First group decision]

Capital for the [first] group decision: 50 points. Please note the following investment opportunity. How much do you want to invest? [...]

After selecting the investment option, the volunteer will answer a task for the group. If the volunteer answers the question correctly, both participants in the group receive the respective high result. If not, both participants in the group receive the respective low result. “Easiness of task" indicates the probability that the general population could answer this task correctly.

[either] No agreement was found. Your suggestion: [...] Suggestion of the other participant: [...] You are entering a new round of negotiations.

[or] The proposal was accepted. Your suggestion: [...] Suggestion of the other participant: [...] Now the volunteer does the corresponding task. [etc.]

[e.g.] Easiness of task: 90%. Which catchphrase often comes up when it comes to recharging batteries? a) Monopoly dilemma, b) Mikado effect, c) Memory effect, d) Mau Mau syndrome.

Thank you, you have completed the entire Part 3 of the experiment. Before you learn the payout information, another decision-making situation in Part 4a and four questions in Part 4b follow. How many points you get in Part 4a is randomly drawn at the end of the experiment. The instructions for these parts can be seen after clicking “Next".

[Part 4a]

Welcome to Part 4a of the experiment. You will receive 10.0 points from us. You can use this money to invest an amount into a lottery. With the lottery you have a profit probability of 50%.

How is the payment made? It is randomly decided by chance whether your investment is successful or not. If your investment is successful, the amount you spend will be multiplied by 2.5 and paid out to you. If your investment is unsuccessful, you lose your stake. You can always keep the amount that you did not use.

Example 1: You invest 0.0 points. Thus, you will surely get 10.0 points. Example 2: You invest 1.25 points and your investment is successful. Thus you win and receive 8.75 + 1.25 * 2.5 = 11.88 points. Example 3: You invest 1.25 points and your investment is unsuccessful. Thus you lose and receive 10.0 – 1.25 = 8.75 points.

Click on the amount you want to place in the lottery (1 click). With your click on the points, you will get on to the next part immediately. [...] Thank you, you have completed Part 4a of the experiment.

[Part 4b]

Welcome to Part 4b of the experiment. The questions below are about decision making. You will face statistical and numerical questions. There are 4 questions with 4 answers each. You must work on the questions in the given order. You have a total of 4 minutes for this part. After 4 minutes you will automatically start the next part. If you need paper and pen for calculations, please approach us. Click “Next" to go to the questions.

Question 1: Imagine we throw a five-sided die 50 times. Of these 50 throws, how often would this five-sided die show an odd number (1, 3 or 5) on average? [...]

Question 2: Of 1000 people in a small town, 500 are members of the singing club. Of these 500 members of the singing club, 100 are men. Of the 500 inhabitants who are not in the singing club, 300 are men. What is the probability that a randomly selected man is a member of the singing club? Please specify the probability in percent. [...]

Question 3: Imagine throwing a marked die (6 sides). The probability that the die shows a 6 is twice the probability of each of the other numbers. Out of 70 throws, in how many of these 70 throws would this die show a 6, in expectation? [...]

Question 4: In a forest, 20% of the mushrooms are red, 50% are brown and 30% are white. A red mushroom is poisonous with a probability of 20%. A mushroom that is not red is toxic with a 5% chance. What is the probability that a poisonous mushroom in this forest is red? Please specify the probability in percent. [...]

Thank you, you have completed Part 4b of the experiment. Now comes the payout information and finally the questionnaire.

Payout: Parts 1a and 1b

The randomly drawn round in Part 1a: [...] Your payout in Part 1a (points): [...] Your payout in Part 1b can be found on the next page.

The randomly generated number in Part 1b: [...] Your payout in Part 1b (points): [...]

Payout: Parts 2 and 3

The randomly drawn round from Parts 2 and 3: [...] Your payout in this part (points): [...]

Payout: Parts 4a and 4b

Your payout in Part 4a (points): [...] Your payout in Part 4b (points): [...]

Payout: Summary

Part 1a: [...] Part 1b: [...] Parts 2 and 3: [...] Part 4a: [...] The total payout (points): [...] The total payout (euro): [...] The total payout, including questionnaire (euro): [...]

THURGAU INSTITUTE
OF ECONOMICS
at the University of Konstanz

Hauptstrasse 90
Postfach
CH-8280 Kreuzlingen 2

T +41 (0)71 677 05 10
F +41 (0)71 677 05 11

info@twi-kreuzlingen.ch
www.twi-kreuzlingen.ch