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Do Overconfident Workers Cooperate Less? The Relationship between Overconfidence and Cooperation in Team Production

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Do Overconfident Workers Cooperate Less?

The Relationship between Overconfidence and Cooperation in Team Production

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Abstract

The tendency to underestimate others' relative performance compared to one's own is widespread among individuals in all work environments. We examine the relationship between, and the driving forces behind, individual overconfidence and voluntary cooperation in team production. Our experimental data suggest an indirect and gender-specific link: Overconfident men hold more optimistic beliefs about coworkers' cooperativeness than men who lack confidence, and are accordingly significantly more cooperative, whereas overconfidence, beliefs, and cooperativeness are not correlated in women.

Keywords: team production, public good, experiment, real effort, cooperation, gender, overconfidence, belief

JEL classification: M52, J33, J16, J24, C91

1. INTRODUCTION

As cooperation is indisputably important in the workplace and society as a whole, tremendous research efforts have been put into identifying variables determining individuals' willingness to voluntarily contribute to public goods, such as socio-demographic (Andersen *et al.*, 2008; Burlando and Hey, 1997; Herrmann and Thöni, 2009), personality (Kurzban and Houser, 2001), and even genetic factors (Cesarini *et al.*, 2008; Mertins *et al.*, 2011). Despite the recently observed far-reaching implications of people's tendency to overestimate their own ability relative to their social environment (Dohmen and Falk, 2006; Gervais and Goldstein, 2007), the link between overconfidence and cooperation is poorly understood.

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Addressing this obvious research gap is the aim of the present paper. We study the effects of overconfidence, that is, the tendency to underestimate others' performance relative to one's own, in a setting of team production. Team production is characterized by the incentive problems that arise when individual actions affecting the well-being of others are not subject to enforceable contracts. Thus, individual welfare in cooperative work environments depends not only on coworkers' abilities and efforts but also on coworkers' voluntary cooperativeness.

Rational, selfish workers should not cooperate at all. However, individuals often do. This has been proved in field (Hamilton *et al.*, 2003) and laboratory studies (van Dijk *et al.*, 2001; Vandegrift and Yavas, 2011). The question arises whether people with certain characteristics are more inclined to cooperate than others. The present study empirically explores the relationship between, and the driving forces behind, individuals' overconfidence and their willingness to contribute to a joint project.

Robust empirical evidence shows that overconfidence is a common trait among the public and important economic agents (e.g., investors, managers, politicians, or employees). Thus, a relationship between overconfidence and cooperation is potentially of high practical relevance. Are those who overestimate their own performance relative to others' willing to mobilize their individual abilities to benefit the team? This may be the case if overconfident workers feel that they may help other, less able coworkers if they contribute relatively more to the team project. An alternative explanation suggests that overconfidence is associated with a lower level of rationality in self-evaluation and behavior. Consequently, overconfident people might deviate more from the predictions of the rational homo economicus than those with a less pronounced evaluation bias. Or are overconfident people worse team players, for example, because they have an innate tendency to compete rather than to cooperate?

Standard behavioral assumptions do not predict a relationship between overconfidence and cooperation, unlike various theories of social preferences and bounded rationality. In fact, various complementary mechanisms predict a *direct link.* A *positive relationship* is, first, suggested by inequity aversion (Fehr and Schmidt, 1999); that is, overconfident agents contribute relatively more to the team output to decrease inequity among team members in that they compensate for others' expected lower performance. Second, a positive relationship between overconfidence and cooperation follows from a bounded rationality approach. If cooperation is partly

the result of errors or confusion (Andreoni, 1995), agents with more accurate (rational) expectations about their own relative ability are more likely to follow the dominant strategy of free-riding in team production. Thus, less biased agents produce less for the team and more for themselves than highly overconfident workers and workers who lack confidence. It also seems plausible to suggest a *negative relationship* between overconfidence and cooperativeness in team production, because overconfident individuals tend to be more competitive (Bartling *et al.*, 2009; Dohmen and Falk, 2006) and competitive subjects tend to be less cooperative (Savikhin and Sheremeta, 2012). In contrast, the theory of conditional cooperation—which posits that the more individuals contribute to a public good, the more they expect others to contribute (Fischbacher *et al.*, 2001; Neugebauer *et al.*, 2009)—suggests a potential *indirect link* between overconfidence and cooperativeness. If conditional cooperation motivates workplace behavior in a team production setting, then we should expect an agent's decision to exert effort toward the team output to depend on his beliefs about others' willingness to cooperate.

As field data usually lacks information on individuals' preferences and expectations, we used a specifically designed controlled laboratory experiment. Public good experiments are appropriate tools frequently used for studying individual determinants of the willingness to cooperate. However, these experiments cannot study individuals' task-related abilities and their unwarranted levels of confidence regarding the individuals' willingness to contribute voluntarily to a joint project. Furthermore, in standard public goods experiments, subjects' endowments are fixed and "fall like manna from heaven." We therefore designed a specific real effort public goods experiment that closely resembles a typical workplace interaction. Workers in team production settings have the freedom to decide how to allocate their working time. Consequently, they face the permanent internal conflict between cooperation (i.e., investing effort toward the team product) and shirking (i.e., putting effort toward alternative activities such as private leisure activities or organizational tasks that yield utility for the respective individual only). In the experiment, workers repeatedly had a choice of exerting effort toward a team task or toward a private task. The tasks differed only in the payment amount. The marginal per-capita return from investing in the team product was specified to be low enough so that it was individually optimal to exert effort only toward the private task, but

high enough so that it was socially optimal to direct any effort toward the team task. Therefore, free-riding is a dominant strategy.

Given the lack of empirical evidence, it is *a priori* unclear how, if at all, overconfidence affects workers' willingness to cooperate. We test our assertions by grouping workers according to gender as recent evidence suggests that (1) men are usually more overconfident than women (Bengtsson *et al.*, 2005; Hardies *et al.*, 2013) and (2) women tend to be more cooperative than men (Croson and Gneezy, 2009; Kuhn and Villeval, 2011).

2. EXPERIMENTAL METHOD

To measure performance heterogeneity and respective self-evaluations, in addition to the willingness to contribute to team production and expectations about coworkers' cooperativeness, we designed a specific real effort public goods game.[3] According to the standard version of the game, subjects can choose whether to contribute to providing a public good (i.e., team output) in a situation where it is individually optimal not to contribute at all but socially optimal to fully contribute. Unlike standard public good games, the subjects' endowments are not fixed and do not "fall like manna from heaven." Instead, the subjects need to exert real effort. We used a commonly applied (Eriksson *et al.*, 2009; Niederle and Vesterlund, 2007; Sloof and van Praag, 2010) work task that involved repeatedly adding three two-digit numbers. After a participant entered the correct answer, a new addition problem was generated from randomized numbers. The arithmetic task resembles real work (Ivanova-Stenzel and Kübler, 2011) and facilitates observation of a sufficient degree of performance heterogeneity (Dohmen and Falk, 2011).

The experimental setup is intended to resemble the permanent internal conflict of workers in settings of team production between cooperation (i.e., putting effort toward the team product) and shirking (i.e., putting effort toward alternative activities such as private leisure activities or organizational tasks that yield utility for the respective individual only). Thus, the setting represents work environments in which individuals have a sufficient degree of freedom to decide how to allocate their

[3] With the exception of Cooper and Saral (2013) and van Dijk *et al.* (2001) who use a similar framework, virtually all economic experiments on team production compare incentive or selection effects between team-based and individual-based compensation schemes (e.g., Vandegrift and Yavas, 2011; Bäker and Mertins, 2013).

work time. Subjects were simultaneously presented with two tasks, the *team task* and the *private task*. The tasks did not differ in the level of difficulty or in any other characteristic. Critically, for a setting based on team production, the tasks differed only in the payment amount. The private task paid 20 points per correct answer to the individual, whereas the team task paid 8 points to each team member irrespective of who provided the answer. Individuals maximized their payoffs by allocating their full work time to the private task, while team output was maximized by investing effort solely in the team task. There were no joint decisions; all questions were answered privately and individually. Participants were asked to enter the answer to an addition problem in the corresponding box and then confirm the answer by pressing the OK button. If a participant entered the correct number, he/she was credited with the equivalent earnings, and the computer immediately generated a new addition problem from randomized numbers. If the number entered was incorrect, the answer box was deleted, and the participant could attempt the task again.

The game was played over ten two-minute periods. At the beginning of each period, participants were randomly and anonymously assigned to groups of four. By carefully explaining that the groups would be randomly reshuffled in each period, we excluded the possibility of noise due to reputation formation, peer pressure, peer learning, or utility through social interaction. Using this procedure, we measured pure cooperation preferences and behavioral adjustments over time. Because all interactions were completely anonymous, we can rule out that individual willingness to cooperate may depend on the interaction partners' characteristics (such as gender). At the end of a work period, subjects indicated their expectations for their group members' average number of correct answers in the private and team tasks. In particular, participants estimated how many private tasks and team tasks the other three group members in this period solved on average. Thus, the participants estimated the average number of correct entries in both tasks. Participants were additionally rewarded for the accuracy of their estimates. If the estimate corresponded exactly to the average number of entries of the other three group members, the participant received 60 extra points. If an estimate deviated in one entry from the correct result, the participants received 40 additional points, and a deviation of two entries resulted in 20 additional points.

Afterwards, subjects received feedback about the average number of correct answers for each task across their team members, their individual payoff from each

task, and a report showing the accuracy of their beliefs in team performance. Using this procedure, participants steadily updated their estimates about their own relative ability and their coworkers' cooperativeness.

Individual performance is measured by the number of correct answers for the private task and the team task. The number of problems solved for the team task divided by the overall performance (team task + private task) measures subjects' *relative team contribution*. This measure is our main variable of interest as it indicates individuals' willingness to cooperate. If, for example, a person solved five team tasks and ten individual tasks, then this person's relative team contribution would be given by 5/15≈33.33%. We evaluate individuals' relative self-assessment with the ratio of actual individual performance and the individual's expectation of others' performance. We measure *overconfidence* with the difference between relative self-assessment and actual relative performance.

The estimated average number of solved problems in the team task divided by the estimated average sum of solved problems in the team task and coworkers' individual tasks provides us with a measure of the individual's *belief* about others' relative team contribution. An initial non-incentivized test period familiarized subjects with the task, persuaded them that the tasks did not differ in terms of difficulty and provided a *productivity* indicator. Furthermore, subjects completed a post-experimental questionnaire on socio-demographic and personality variables.

After the experiment, subjects completed a post-experimental questionnaire on socio-demographic variables (e.g., gender, age, major), a 15-item (German language) version (Gerlitz and Schupp, 2005) of the well-established NEO Five-Factor Inventory (NEO FFI) by Costa and McCrae (1989), a personality questionnaire indicating the individuals' five main personality dimensions (the so-called Big Five: conscientiousness, neuroticism, openness to experience, agreeableness, and extroversion), and a 20-item version of Machiavellianism (Christi and Geis, 1970) using the German version (see Shajek, 2007). Furthermore, we measure self-monitoring (Snyder, 1974) using a German version of the questionnaire (Graf, 2004). We gained self-reported data on a wide range of individual characteristics such as subjects' risk attitudes, patience, and impulsivity on an 11-point scale. We used the same wording for the questions as in the 2004 wave of the German Socio-Economic Panel Study.

The experiment took place in the Trier Experimental Laboratory (TrEx) at the University of Trier, Germany. We conducted four identical sessions with 24 subjects each, which gave us 96 participants. Participants, all students from various disciplines, were recruited by ORSEE (Greiner, 2004). After arriving at the laboratory, subjects were seated in cubicles. Instructions were read aloud. The experiment was computerized using z-Tree (Fischbacher, 2007). Earnings in points were converted to Euros at an exchange rate of 1 point equals 0.25 Eurocent. The experiment took less than 40 minutes, and subjects earned on average €12.10 (including a show-up fee of €5).

3. RESULTS

Our empirical analysis starts with a summary of the descriptive results. Table 1 shows the averages of the tasks solved, the beliefs about tasks solved by others, and other sample characteristics, differentiated by male and female subjects. The results show that men solve more tasks in total than women, but the amount solved for the team is smaller in absolute as well as in relative terms. The total higher number of tasks solved is reflected by a higher average ability of men compared to women. Regarding beliefs, no substantial difference is observable in the beliefs about others' relative contributions. However, in absolute terms, men expect a lower number of tasks solved (public and private tasks) by the other team members. This is reflected in the degree of overconfidence, which is significantly higher for men than for women. Regarding other sample characteristics, our subjects are on average about 25 years old, and more than one quarter of the female subjects and more than a third of the male subjects are economics or business studies students. In terms of personality, the two groups significantly differ in some of the measured dimensions, but these differences are generally small.

Table 1. Descriptive Statistics

	Female subjects n=60		Male subjects n=36		Differences	
Variable	Mean	SD	Mean	SD		p-value (t-test)
# team tasks	2.093	2.894	1.553	2.833	0.541	.005**
# private tasks	8.482	4.507	10.281	4.381	-1.799	.000***
Sum all tasks	10.575	3.507	11.833	3.351	-1.258	.000***
Expected # team tasks by others	3.367	3.052	2.764	2.355	0.603	.001***
Expected # private tasks by others	6.857	4.281	6.556	3.133	0.301	.246
Productivity	0.413	0.192	0.498	0.214	-0.085	.048*
Relative team contribution	0.223	0.289	0.137	0.245	0.086	.000***
Belief	0.335	0.225	0.314	0.241	0.022	.162
Age	24.65	3.569	25.14	2.696	-0.489	.480
Major in economics	0.267	0.446	0.361	0.487	-0.094	.334
Overconfidence	0.140	0.404	0.382	1.194	-0.242	.000***
Openness to experience	4.911	1.121	5.056	1.306	-0.144	.070
Conscientiousness	5.167	1.018	4.667	0.980	0.500	.000***
Neuroticism	4.550	1.116	3.907	1.263	0.078	.000***
Extraversion	4.794	1.265	4.657	1.384	0.137	.117
Agreeableness	4.878	0.951	5.074	1.146	-0.196	.004**
Machiavellianism	53.833	11.267	54.639	13.425	-0.806	.319
Self-monitoring	8.200	3.067	9.639	3.006	-1.439	.000***
Risk preferences	5.067	2.066	5.111	2.261	-0.044	.756
Patience	4.700	2.656	5.361	2.853	-0.661	.000***
Impulsiveness	4.767	2.094	4.250	2.317	0.517	.000***

Note: In Column 6, we report differences between women and men. In Column 7, we provide p-values (two-sided) resulting from t-tests. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

To test for a correlation between individuals' unwarranted levels of confidence in their own relative performance and cooperativeness, we use a linear regression model. The proportion of answers contributed to the team in period *t* (*relative team contribution*) is the dependent variable, and *overconfidence* is the main independent variable. We also test for gender differences. Our models comprise several additional control variables: individuals' productivity, age, an economics major dummy, session dummies, the Big Five personality traits, and measures for Machiavellianism,

self-monitoring, patience, impulsiveness, and risk preferences. Furthermore, period dummies are included to capture the well-known dynamics of repeated linear public goods experiments.

We observe that men show a significantly higher ($p < 0.001$) average level of overconfidence (*mean* = 0.382) than women (*mean* = 0.139) using a two-sided t-test.[4] Our base model (Model 1) in Column 1 of Table 2 shows the OLS estimates, suggesting that the higher the level of overconfidence in personal ability, the higher the relative contribution to the team output. Further regressions (not reported) splitting overconfidence into two variables for positive and negative deviations prove that only overconfidence, and not a lack of confidence, has an effect on the subjects' behavior. These results point to a positive relationship between overconfidence and cooperativeness, indicating that overconfidence, and not irrationality per se, drives the results.

Because significant gender differences in overconfidence have been identified in the past, we extend our analysis through the interaction of the variable *overconfidence* with the gender variable. The corresponding estimates offer interesting insights: We observe a negative and statistically significant interaction effect of *gender* and overconfidence, indicating a gender-specific relationship between *overconfidence* and cooperativeness. More specifically, we observe a positive relationship between overconfidence and cooperativeness for men and a relative negative relationship for women. The magnitude of this negative relationship indicates a negative absolute gender-effect, although the difference is not statistically significant, as the recoding of the gender variable and re-estimation of Model 2 reveals (not reported).

The results regarding our control variables are in line with previously reported findings. The significant negative coefficient for the *period* variable reflects the well-known decreasing path in repeated public goods experiments (Fischbacher and Gächter, 2010). Furthermore, we observe the lower cooperativeness of individuals with higher productivity (Cooper and Saral, 2013) and the higher cooperativeness of women compared with men (Croson and Gneezy, 2009).

[4] Interestingly, the level of inaccuracy in relative self-assessment or overconfidence does not decrease as feedback increases. Thus, the subjects did not adjust their expectations over time, suggesting that overconfidence is a relatively stable trait for men and women.

Table 2. Explaining the Willingness to Cooperate

	Model 1	Model 2	Model 3	Model 4
Overconfidence	0.0404***	0.0541***	-0.000731	0.00683
	(0.0146)	(0.0153)	(0.0162)	(0.0181)
Gender [female=1]	0.111***	0.122***	0.0826***	0.0887***
	(0.0186)	(0.0195)	(0.0171)	(0.0182)
Gender*Overconfidence		-0.0770***		-0.0406
		(0.0296)		(0.0289)
Belief			0.614***	0.609***
			(0.0473)	(0.0472)
Productivity	-0.104**	-0.123***	-0.00545	-0.0166
	(0.0436)	(0.0435)	(0.0388)	(0.0389)
Period	-0.0160***	-0.0159***	-0.00370	-0.00376
	(0.00291)	(0.00289)	(0.00269)	(0.00269)
Constant	0.232	0.246*	-0.144	-0.133
	(0.147)	(0.145)	(0.127)	(0.127)
Controls included	Yes	Yes	Yes	Yes
Observations	960	960	960	960
R-squared	0.232	0.238	0.409	0.410

Legend: Dependent variable: relative team contribution (# team tasks / (# team tasks + # private tasks). *** denotes significance at 1%. ** denotes significance at 5%. * denotes significance at 10%. Robust standard errors are in parentheses.

Thus far, our results point to gender-specific cooperation preferences dependent on the individuals' degree of overconfidence. We now consider whether the positive correlation between overconfidence and cooperativeness is caused by *different cooperation preferences* among overconfident and less confident individuals. Therefore, we test the alternative hypothesis that conditional cooperation drives the results. If this is true, *beliefs* about others' behavior would substantially influence individual behavior. In a world with no differences in pure cooperation preferences and where conditional cooperation is the prevalent social norm, one would expect differences in contribution solely depending on differing beliefs about others' contributions. Following the norm of conditional cooperation, individuals would cooperate if they expect others to cooperate, too, and to defect if they expect others to defect. Thus, if the norm of conditional cooperation holds, one would expect a

statistically significant positive coefficient of the newly added belief variable in the corresponding regression models. Furthermore, individual beliefs about others' behavior might act as a mediator between overconfidence and cooperativeness. Statistically, mediation is indicated when the relationship between overconfidence and relative team contribution turns insignificant after controlling for beliefs. Models 3 and 4 show that neither overconfidence nor the interaction term is statistically significantly different from zero after the belief variable is added. The formerly identified relationship is now captured in the belief coefficient, which is highly significant in both models and increases the explanatory power of the models in terms of R-squared significantly by approximately 17 percentage points. Even regarding the control variable *productivity*, we no longer observe a significant relationship. Only the pure *gender* coefficient remains significant—indicating the truly higher (unconditional) cooperativeness of women in a setting of team production. This is completely in line with recent meta-analytical evidence provided by Croson and Gneezy (2009).

Finally, we study the individual belief formation process (Table 3). Thus, we test whether overconfidence can partly explain individuals' expectations of others' relative team contributions. We take the variable *belief* as the new dependent variable in our econometric models. We then examine the effects of the same set of variables as in the former analysis plus a variable *contribution of others (t-1)* capturing the average contributions of the other players in the preceding period (cf. Fischbacher and Gächter, 2010). We observe a similar coefficient structure in models 5 and 6 as in our previous models. In both specifications, we observe a positive and significant gender coefficient indicating the higher expectations of women regarding the cooperativeness of others. In Model 6, we observe higher expectations by men with higher degrees of overconfidence as well as a negative gender-interaction effect. Although the latter coefficient is only weakly significant, this result provides an indication of gender-specific belief formation regarding the degree of overconfidence. More specifically, the data suggest that overconfidence has a positive effect for men on their beliefs, whereas for women, we observe a relative negative effect. In line with the insignificant result on women's team contributions, further testing reveals no statistically significant overconfidence effect for women.

Table 3. Belief Formation		
	Model 5	Model 6
Overconfidence	0.0708***	0.0793***
	(0.00994)	(0.0119)
Gender [female=1]	0.0481***	0.0549***
	(0.0139)	(0.0141)
Gender*Overconfidence		-0.0486*
		(0.0249)
Contributions of others (t-1)	0.288***	0.282***
	(0.0412)	(0.0410)
Productivity	-0.155***	-0.167***
	(0.0353)	(0.0358)
Period	-0.0133***	-0.0133***
	(0.00238)	(0.00237)
Constant	0.507***	0.518***
	(0.0988)	(0.0978)
Controls included	Yes	Yes
Observations	960	960
R-squared	0.367	0.370

Note: Dependent variable: belief about others' relative team contributions (# expected team tasks by others / (# expected team tasks by others + # expected private tasks by others). *** denotes significance at 1%. ** denotes significance at 5%. * denotes significance at 10%. Robust standard errors are in parentheses.

4. DISCUSSION

As teamwork is integral to many jobs, a comprehensive understanding of the determinants is clearly necessary. Our key results for the relationship between individuals' willingness to cooperate and overconfidence are as follows: First, in line with recent experimental evidence (Cooper and Saral, 2013), we observe no direct link. Thus, overconfident people do not cooperate more or less than others due to different social preferences or a higher level of confusion. Second, our study provides initial evidence that the prevalent social norm of team production is conditional cooperation: The higher the beliefs about coworkers' relative team contribution, the higher the individuals' relative team contribution. Considered a

robust result in standard public goods games (e.g., Herrmann and Thöni, 2009; Kocher *et al.*, 2008), we are the first to show that the driving force behind workers' motivation to cooperate in a setting of real effort team production is their expectation that coworkers will cooperate, too. Third, our data suggest an *indirect* and *gender-specific link* between overconfidence and team contributions: Overconfident men hold more optimistic beliefs than those who lack confidence and are accordingly significantly more cooperative, whereas overconfidence, beliefs about others' relative team contribution, and cooperativeness are not correlated in women. Taken together, our empirical evidence points to the tendency of men to overestimate the probability of favorable events in the context of team production. Men overestimate their own relative performance and their coworkers' cooperativeness. Furthermore, our findings suggest that men not only hold overconfident beliefs but also act on them.

Our study is intended to contribute to a more comprehensive understanding of the effect of overconfidence on workplace behavior. The findings add to recent evidence concerning the welfare consequences of this behavioral bias. Dohmen and Falk (2006), for example, have shown that a positive relationship between overconfidence and competitiveness exists. Overconfidence can even partially explain the gender gap in tournament entry because men's higher levels of competitiveness are driven by them being more overconfident than women (Niederle and Vesterlund, 2007). Furthermore, group output by overconfident agents has been shown to be higher as overconfidence reduces the moral hazard problem in tournaments (Santos-Pinto, 2011) and improves workers' performance in contests (Ludwig *et al.*, 2011). Given these findings, firms seem to be well advised to have a preference for overconfident workers. The present study also suggests that hiring overconfident individuals pays, at least among men: Overconfident men free-ride relatively less as they expect coworkers to be highly cooperative. This behavioral bias somewhat points to men being "ideal" team players. However, our results from the laboratory must be carefully interpreted for managerial decision making. This is still true while we added important realism to the study of team production in that subjects exerted real rather than chosen effort. Using a stranger's design in a highly controlled laboratory setting naturally limits the transferability of our results to real-world work settings where social relationships play a vital role in team tasks, for example. Thus, the

external validity of our findings (e.g., by using large-scale survey data or natural field experiments) must be established in future research.

Our findings point to a potentially interesting avenue of research. Admittedly, at this point we can only speculate about possible explanations for the differing gender effects. Various studies have shown that people tend to exhibit behavioral biases that encourage optimism (i.e., positive illusions), which may work as a kind of self-fulfilling prophecy by promoting personal performance, health, or creativity (Gillham, 2000; Taylor and Brown, 1988). This may explain the positive relationship between optimism in one's own relative ability and optimism in others' cooperativeness. Furthermore, as groups with more positive expectations about others' cooperativeness are more successful overall, hunter-gatherer groups in ancient times would have benefited from unrealistic optimism. Accordingly, there might be an evolutionary selection pressure for this behavioral bias especially among men (Tiger, 1979). Since we use data from a carefully controlled laboratory experiment, we can exclude various potential reasons for the gender-specific belief formation process (e.g., divergent feedback, different perceptions of environmental cues, different costs of effort, gender-specific group composition). However, the specific mechanisms that drive the results must still be established.

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Appendix

Instructions

You are participating in an economic experiment. Once you have carefully read the following instructions, you can earn a sum of money in addition to the €5.00 that you received for showing up on time. At the end of the experiment, you will be paid in cash the full amounts that you have earned. The instructions are identical for all participants. During the experiment, you may not communicate with any of the participants. If you have any questions during the experiment, raise your hand, and we will come to you and answer them in private. The computer may be used only for the experiment. If you violate these rules, you will be excluded from the experiment and will receive no payment.

During the experiment, we will speak in terms of points rather than Euros. Your total earnings will initially be calculated in points. At the end of the experiment, the points will be converted to Euros according to the following exchange rate:

1 point = 0.25 cents.

All participants will be divided into groups of four. Only we, the experimenters, know who is in which group. After every period, which will last **2 minutes**, the composition of the groups will be randomly changed. **Therefore, your group will consist of different people in each period.** The experiment will end after **10 periods**.

Your task consists of adding three two-digit numbers and communicating the answer. After 2 minutes (the duration of a period), the composition of your work group will change. Between each period will be a 20-second break.

In each period, we provide two tasks simultaneously, task A and task B. **You can alternate between the tasks or choose only one. With both tasks, you can earn money. During the process, you can choose your own work pace: You can work quickly, slowly, or not at all.** In doing so, you may not use a calculator or a cell phone, and the computer may be used only in line with the experiment. Additionally, you may not communicate with the other participants.

The following is a picture of the screen that you will be using:

Enter the answer to the addition problem in the corresponding box. Confirm your entry afterward with OK. If you entered the correct number, you will be credited with the equivalent earnings, and the computer will immediately generate a new addition problem from randomized numbers. If the number entered is incorrect, the answer box will be deleted, and you can attempt the task again. After you have entered the correct answer, a new addition problem will be generated from randomized numbers.

Tasks A and B **do not differ in the level of difficulty or in any other respect. The only difference is in the payment. <u>The only difference between task A and task B is their payoff.</u>**

<u>Payoff in task A:</u>

In each period, you will be randomly assigned to a group with three other participants. You—as well as all the other participants—will not find out with whom you are grouped. Your earnings will depend not only on your own results but also on the results of the other three participants. Likewise, the earnings of the other participants will depend on your results. **For every correctly answered task, every group member receives 8 points irrespective of who correctly answered the task.** For example, if you solve one task and the other three group members each solve two tasks, then a total of seven addition problems of type A are correctly answered, and each group member will receive 56 points. If you answer 0 tasks correctly and the

other three together answer 10 tasks, then every group member will receive 80 points.

Payoff in task B:

In this variant, only your **own results will determine how much you earn. For every correctly answered addition problem, you will receive 20 points.** For example, if you correctly answer three task B types, you will receive 3 x 20 points=60 points. If you correctly answer 0 tasks, you will receive 0 points in task B.

Total Earnings

Your total earnings are the sum of your payoffs for task A and task B:

Number of correctly answered task A problems x 8 points

+ Number of correctly answered task B problems x 20 points

= total earnings

Every period lasts **2 minutes.** The time remaining will be shown in the upper-right corner of your screen. After every period, you will be informed **about the number of addition problems that you correctly solved in task A and task B. Additionally, you will find out how many points you earned in this period.**

Afterward, you should **estimate how many task A and task B addition problems the other three group members in this period on average solved.** Thus, you should estimate the **average number of correct entries** in task A and task B for the other three group members**.** You will be rewarded for the accuracy of your estimate.

- If your estimate is **exactly** correct (that is, if your estimate corresponds exactly to the average number of entries of the other three group members in this period), you will receive **60 points** in addition to your earnings for the experiment.
- If your estimate deviates 1 entry from the correct result, you will receive 40 additional points.
- A deviation of 2 entries means you will receive 20 additional points.
- If your estimate deviates 3 or more from the correct result, you will receive no additional points.

At the end of each period, you will receive a report stating the average number of task A and task B addition problems the other group members solved in this period. In addition, you will receive your earnings for task A, task B, and your estimations.

Test Period

When all the participants have read the instructions and there are no more questions, the 2-minute test period will start. The purpose of the test run is to familiarize you with the task. During the test phase, you cannot earn any money.

After the 10 work periods, the experiment is complete, and you will receive:

Earnings from the experiment

+ Earnings from correct estimates

= Total earnings from the experiment

+ €5.00 for showing up on time.

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