# DEMS WORKING PAPER SERIES

# Preferences and strategic behavior in public goods games

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No. 395 – December 2018

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http://dems.unimib.it/

# Preferences and strategic behavior in public goods games

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December 19, 2018

**Abstract**

We analyze experimentally behavior in a finitely repeated public goods game. One of the main results of the literature is that contributions are initially high, and gradually decrease over time. Two explanations of this pattern have been developed: (i) the population is composed of free-riders, who never contribute, and conditional cooperators, who contribute if others do so as well; (ii) strategic players contribute to sustain mutually beneficial future cooperation, but reduce their contributions as the end of the game approaches. This paper contributes to bridging the gap between these views. We analyze preferences and strategic ability in one design by manipulating group composition to form homogeneous groups on both dimensions. Our results highlight the interaction between the two: groups that sustain high levels of cooperation are composed of members who share a common inclination toward cooperation and have the strategic abilities to recognize and reap the benefits of enduring cooperation.

**Keywords:** Voluntary contribution, conditional cooperation, free riding, strategic sophistication.
**JEL codes:** H41, C73, C92.

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**Acknowledgements**: the authors would like to thank Ennio Bilancini, Francesco Fallucchi, Aldo Rustichini, Sasha Vostroknutov as well as participants to presentations in Brussels, Luxembourg, Milan and Nice for valuable comments and suggestions to improve the paper. They are especially grateful to Roberto Burlando and Francescco Guala for making their data available to us. The authors gratefully acknowledge financial support by the project "IDex Attractivité" funded through the the University of Strasbourg IDEX Unistra.

# 1 Introduction

In a finitely repeated public goods game, players do not contribute to the public good at the only subgame perfect equilibrium. However, highly replicable experimental evidence shows that contributions are initially high, and gradually decrease over rounds [Chaudhuri, 2011; Ledyard, 1995]. Research on the topic has typically focused on one of two families of explanations: the first one based on (non-standard) preferences, the second on strategic motivations. According to the 'preference-based' explanation, these empirical patterns are due to the interaction of conditional cooperators and free riders. Conditional cooperators are willing to contribute to the public good only if the other group members also contribute. Free-riders do not contribute to the public good. Contributions would decrease over rounds because conditional cooperators reduce their contributions when they interact with free riders.[1] According to the 'strategy-based' explanation, subjects contribute larger amounts in the initial periods because current contributions may sustain mutually beneficial future cooperation. These incentives are higher when the future is long and vanish as the game comes close to its end [Kreps et al., 1982].[2]

This paper contributes to bridging the gap between these views by studying both preferences and strategic ability in a finitely repeated public goods game. We categorize subjects by preference types as free-riders, unconditional cooperators and conditional cooperators, based on their choices in a one-shot public goods game, using the so-called Strategy Method [Fischbacher et al., 2001]. We order subjects by strategic ability according to their average score in a cognitive

[1]Among the papers that established the presence of these heterogeneous types in one-shot public goods games, see Brandts and Schram [2001] and Fischbacher et al. [2001]. For the analysis of their role in explaining patterns in finitely repeated public goods games, see Ambrus and Pathak [2011] – who show theoretically and empirically how those patterns can be seen as an equilibrium of the game with heterogeneous players – and Fischbacher and Gachter [2010] – who show that a self-serving bias in the contributions of conditional cooperators may be sufficient to generate those patterns, even in the absence of free riders. A number of papers manipulate group formation to study the effects of group composition in terms of free-riders and conditional cooperators [Burlando and Guala, 2005; Gächter and Thöni, 2005; Gunnthorsdottir et al., 2007]. We refer more thoroughly to those papers in the main text.

[2]There is evidence that forward-looking strategic considerations are relevant in finitely repeated social dilemmas. Sonnemans et al. [1999] study a finitely repeated public goods game with partial re-matching at known stages. They show that participants strategically reduce their contributions when approaching a rematch of the group. Muller et al. [2008] investigate a finitely repeated public goods game with strategy method in all rounds. They find that contributions decline also after controlling for one's partners contributions, and that a longer horizon is sufficient to slow down this decline. Evidence of strategically-motivated cooperation can be also found in the literature on partners-versus-strangers protocols (e.g. Keser and van Winden [2000]). Baader and Vostroknutov [2017] interpret part of observed cooperative choices in the traveler's dilemma as a strategic response to the presence of participants with maximin preferences.

reflection test [Frederick, 2005], a race game [Dufwenberg et al., 2010; Gneezy et al., 2010] and a beauty contest [Nagel, 1995]. We then manipulate group formation and analyze behavior in groups that are homogenous either in terms of preferences or in terms of strategic ability.

Results are as follows. Overall, total contributions are the highest in the treatment where groups are homogenous with respect to the strategic ability of the subjects, because groups of high-ability subjects can sustain high contribution levels for nearly all periods. The role of strategic ability is confirmed by the comparison of contributions in the first period of the repeated public goods game with that in the one-shot version that we use to classify them. High-ability subjects respond to the incentives of repeated interaction by increasing their contributions more than low-ability ones. Consistent with previous studies, both conditional cooperators and groups of conditional cooperators contribute more than the average. Higher contribution rates by groups of conditional cooperators and by groups of high-ability subjects appear to be driven by homogeneous groups of high-ability conditional cooperators. The data suggest that both a shared inclination toward cooperation and the strategic ability to recognize and reap the benefits of enduring cooperation are necessary for a group to sustain high levels of cooperation in finitely repeated public goods games. We see these results as a step towards a more accurate explanation of behavior in public goods games, highlighting the interaction between preferences and strategic ability.

Previous research that manipulates group composition in finitely repeated public goods games has focused on the preference dimension. Burlando and Guala [2005] is the closest to our paper. They classify subjects according to their preference profile and compare their contributions in homogenous groups to those of the same subjects in randomly matched groups. They find that conditional cooperators contribute more when matched with other conditional cooperators, and that total contributions are higher when subjects are matched according to their preference profile than when they are matched randomly. Gächter and Thöni [2005] find similar results by forming homogenous groups based on choices in a one-shot public goods game, when subjects are informed about the matching protocol. Contrary to Burlando and Guala [2005], conditional cooperators do not contribute more when they are matched with other conditional cooperators in our study. We argue that this difference may arise from different classification procedures, as their conditional cooperators have stronger cooperative attitudes than ours.[3]

[3]See also Gunnthorsdottir et al. [2007] – who rematch groups period-by-period according to their current contribution level, also not informing subjects of the procedure – and Ones and Putterman [2007] – who classify subjects according to both their attitudes toward cooperation

Bosch-Rosa et al. [2018] perform the closest exercise to ours in terms of measuring strategic ability: they use the same tasks and form groups according to the resulting strategic-ability ranking. They show that homogeneous groups of high-ability subjects do not generate bubbles in asset markets. To the best of our knowledge, Rustichini et al. [2018] is the only paper matching subjects according to (cognitive) ability in a social dilemma.[4] They show that homogeneous groups of high-ability subjects play more cooperatively in an indefinitely repeated prisoner's dilemma.

The role of strategic motivations is, however, different when a game is indefinitely, rather than finitely repeated. Under standard assumptions, mutual cooperation is part of a Pareto superior equilibrium in the former case, but not in the latter.[5] One may expect that more strategic groups would play closer to equilibrium and, therefore, less cooperatively in the finitely repeated case. However, this deduction may be too naïve, since minimal departures from common knowledge of rationality and preferences can induce rational cooperation until the last rounds of the game [Kreps et al., 1982]. Our paper is the first to investigate empirically the role of strategic ability in a finitely repeated social dilemma. We show strategic ability is crucial to sustain cooperation over time even in a context where cooperation cannot be sustained under standard equilibrium notions.

The rest of the paper proceeds as follows. Section 2 provides the details of the experimental design. Section 3 reports our results. Section 4 compare our findings with those of Burlando and Guala [2005]. Section 5 concludes.

# 2 Experimental design

## 2.1 Main task

The main task of the experiment is a finitely-repeated linear Public Goods Game (PGG).[6] The PGG is played in fixed groups of three subjects (i.e. 'partners matching') for 15 periods. At the start of each period, each subject receives an endowment of 20 tokens and decides how many tokens to invest into a public account. Decisions are individual and simultaneous. Each token invested in the public account yields 0.6 token to each member of the group. Subjects keep for themselves

and their attitudes toward punishment.

[4]For the relation between cognitive and strategic ability, see, e.g., Gill and Prowse [2016], Basteck and Mantovani [2018].

[5]Reuben and Suetens [2012], Dreber et al. [2014] and Cabral et al. [2014] all conclude that cooperation is mainly explained by instrumental motives in indefinitely repeated games.

[6]See Appendix A for a complete transcript of the instructions.

tokens they do not invest. Therefore, in each period, the earnings of individual $i$ in a group with $j$ and $k$, given the contribution decisions to the public account $c_i$, $c_j$ and $c_k$ are given by:

$$\pi_i = 20 - c_i + .6(c_i + c_j + c_k)$$

We obtain different treatments by manipulating group composition through the matching procedure. In order to manipulate group composition, we classify subjects according to their preferences for contributions and strategic ability. The classification is based on their behavior in four independent tasks that are played before the repeated PGG.

## 2.2 Classification: preferences

To classify subjects according to their preferences, we use a one-shot PGG in Strategy Method [Fischbacher et al., 2001]. The framing of the problem is in all respects similar to the one described above for the finitely-repeated PGG, except it is made clear this would be a one-shot game. Subjects are asked to make two decisions. First, they choose a contribution level in a one-shot PGG – the 'unconditional contribution'. Then, they fill in a contribution table: they select a contribution level for every possible average contribution of the other group members.[7] In each group, earnings are computed using the unconditional contributions of two randomly-selected subjects and the contribution table of the third one.

We classify subjects into 'preference types' according to their contribution table. If a subject's average entry in the contribution table is below 10 percent of the initial endowment, she is labeled as a 'free rider'. If the average entry is higher and the standard deviation of the entries in the contribution table is below 5 percent of the endowment, the subject is labeled as an 'unconditional cooperator'. If a subject is not a free-rider, nor an unconditional cooperator, and the correlation between his entries in the contribution table and the corresponding average contribution of others is above .7, the subject is labeled as a 'conditional cooperator'. If none of these criteria is met, she is assigned to a residual category.[8]

[7] The earnings of individual i in a group with j and k given the contribution decisions to the public account $c_i$, $c_j$ and $c_k$ are given by: $\pi_i = 200 - c_i + .6(c_i + c_j + c_k)$. The rescaling of incentives with respect to the repeated PGG was used to ensure appropriate incentives in all tasks while maintaining payments within the experimental standard. See also Burlando and Guala [2005] who adopt a similar strategy.

[8] Figure 8, 9 and 10 in Appendix C report the contribution tables of all subjects. While the chosen thresholds are arbitrary, they appear to identify clearly distinct types.

## 2.3 Classification: strategic ability

To classify subjects according to their strategic ability, we use three different tasks.[9]

A **Cognitive reflection test (CRT)** [Frederick, 2005], which measures the ability to switch reasoning mode from the routine system to the reflexive system. The CRT is a three-item task of an algebraic nature. Each item has an intuitive incorrect answer and a non-intuitive correct one. The score of a subject in the CRT is the percentage of correct answers.[10]

A **Race to 26 game** [Dufwenberg et al., 2010; Gneezy et al., 2010], which measures the subject's ability to plan strategic decisions ahead and perform backward induction. The subject and the computer sequentially choose numbers between 1 and 5. Those are added up, until the target of 26 is reached. The subject wins if she reaches 26. By picking correct numbers, the subject can secure the victory from the first move. By backward induction, the dominant strategy of a subject is a number for every possible sum, such that the addition of the number to the sum is an element in the set of 'losing positions' $\{2, 8, 14, 20\}$, whenever possible. The computer never leads the subject to a losing position, but picks the winning number in case it has to make a choice between 21 and 25. We observe the moment where a subject switches to her dominant strategy. The percentage of consecutive losing positions a subject reaches, starting from the last, represents her score in the task.

A **Beauty contest** [Nagel, 1995], which measures the ability to perform iterative reasoning in a strategic environment. It is commonly used to classify subjects into levels of reasoning in normal form games, and to understand how sophisticated and accurate is a subject's model of others' behavior. Subjects are asked to choose a number between 0 and 100. The subject whose choice is closest to 2/3 of the average of all the numbers chosen receives a prize. The score of a subject in this game is the normalized distance between her choice and 2/3 of the average in the session (as done in Bosch-Rosa et al. [2018]). Formally, let a subject's entry be $b_i$, and the average entry in the session be $\mu$. The score of subject i in the beauty contest, $p_i$, is given by:

$$p_i = 100 \cdot \max\left\{0, 1 - \left[\frac{|b_i - 2/3\mu|}{66 - 2/3\mu}\right]\right\}$$

[9]Our classification of the strategic ability of subjects follows closely Bosch-Rosa et al. [2018]. They aggregate performances in the same three tasks that we use, although with slightly different procedures.

[10]See Appendix B for a transcript of the cognitive reflection test.

Subjects with strictly dominated entries are assigned a score of zero. A score of 100 is assigned to subjects for whom $b_i = (2/3) \cdot \mu$.

The strategic ability score of a subject is obtained by averaging her score in the CRT, the race game and the beauty contest. It is therefore a number between 0 and 100, and higher numbers correspond to a higher strategic ability. We label subjects with a score above the median in the whole sample as 'high-ability subjects' and we label other subjects as 'low-ability subjects'.

## 2.4 Treatments

The experiment has three treatments that differ with respect to the procedure adopted to form groups. In a baseline treatment, groups are matched at random (treatment RAND). In two other treatments, we manipulate the composition of groups to obtain groups that are homogeneous in terms of preferences for contributions (treatment PREF), and groups that are homogeneous in terms of strategic ability (treatment STRAT). In treatment PREF, the matching procedure maximizes the number of homogeneous groups. Within each preference type, groups are formed at random. All subjects that are not assigned to a homogeneous group are randomly matched. In treatment STRAT, the three subjects with the highest strategic ability score form one group, the three subjects with the highest score among the remaining form another group, and so on.[11] Treatments are ex-ante identical from the point of view of subjects: they are only told that they are matched with two other subjects in the session and that they will play in the same group for fifteen rounds.

## 2.5 Procedures

The experiment was conducted in spring 2016 in the Experimental Economics Lab at the University of Strasbourg. It was programmed using Z-tree [Fischbacher, 2007]. 192 subjects were recruited through ORSEE [Greiner, 2015], distributed over 8 experimental sessions. Each subject participated only in one session.

All sessions followed an identical procedure. After their arrival, subjects were randomly assigned to cubicles in the laboratory. Instructions were read aloud before each task. To ensure everybody understood the tasks, participants had to answer a set of control questions before the one-shot PGG, the Race to 26 game, the Beauty Contest and the repeated PGG. These tasks would start only after all had

[11] Ties are broken at random.

cleared the control questions.[12] In every session, participants faced the classification tasks first and then played the 15 repetitions of the PGG. Finally, they filled in a questionnaire which included qualitative information about their strategies and self-reported quantitative measures of risk preferences extracted from the SOEP German panel.[13] At the end of the repeated PGG, the computer selected at random one of the four classification tasks for the whole session. The monetary payment of the subjects was based on the tokens earned in this task and in the repeated PGG. The tokens were paid according to the exchange rate: 40tokens = 1€. Subjects could earn between 7.5 and 16.5€ from the repeated PGG, and between 0 and 11€ from the other tasks.[14] Participants earned 13.60€ on average and sessions lasted around 60 minutes.

# 3 Results

## 3.1 Classification

We analyze in this section the results obtained in the classification tasks. We find that (i) the proportion of preference types is consistent with previous studies, (ii) the types of subjects are evenly distributed between treatments, (iii) there is no correlation between measured strategic ability and preferences.

Table 1 reports a set of summary statistics on the classification tasks. Overall, 30 percent of the subjects are classified as free riders and 50 percent as conditional cooperators. These percentages are in line with previous studies [e.g., Fischbacher et al., 2001]. The proportion of free riders and conditional cooperators does not differ significantly in any two treatments.[15] In addition, the unconditional and average conditional contributions of the subjects are not statistically different in the different treatments.[16] The average strategic ability of subjects in

[12]Subjects played two trial versions of the race game before playing the one which was relevant for classification and payment. Trials featured a slightly different game, to avoid mechanical learning of losing positions. See Appendix A.

[13]For the use of the risk questions to measure risk preferences, see Dohmen et al. [2011] and Vieider et al. [2015]

[14]In particular: 0€, 2.5€, 5€ or 7.5€ from the CRT, 0€ or 5€ from the race game, 0€ or 5€ from the beauty contest and between 0€ and 11€ from the one-shot PGG.

[15]Two-sample proportion tests, conditional cooperators: RAND vs PREF, $z = .821$, $P$-val $= .41$; RAND vs STRAT, $z = -.224$, $P$-val $= .82$; PREF vs STRAT, $z = -1.167$, $P$-val $= .24$; free riders: RAND vs PREF, $z = -1.186$, $P$-val $= .24$; RAND vs STRAT, $z = .430$, $P$-val $= .67$; PREF vs STRAT, $z = 1.637$, $P$-val $= .13$.

[16]Wilcoxon rank-sum tests, unconditional contribution: RAND vs PREF, $z = 1.017$, $P$-val $=$ .31; RAND vs STRAT, $z = 0.065$, $P$-val $= .95$; PREF vs STRAT, $z = -1.035$, $P$-val $= .30$; average conditional contribution: RAND vs PREF, $z = 1.549$, $P$-val $= .12$; RAND vs STRAT, $z = 0.784$, $P$-val $= .43$; PREF vs STRAT, $z = -1.357$, $P$-val $= .18$.

Table 1: Summary variables

| | RAND | PREF | STRAT | Overall |
|---|---|---|---|---|
| N | 48 | 72 | 72 | 192 |
| FR | 13 (27%) | 27 (37%) | 17 (24%) | 57 (30%) |
| CC | 25 (52%) | 32 (44%) | 39 (54%) | 96 (50%) |
| | | | | |
| Unconditional | 85.73 (43%) | 71.81 (36%) | 84.18 (42%) | 79.93 (40%) |
| Av. cond. contrib. | 63.54 (32%) | 46.70 (23%) | 54.49 (27%) | 53.83 (27%) |
| | | | | |
| CRT | 34.67 | 42.67 | 46.33 | 42.0 |
| Race game | 36.2 | 50.2 | 42.8 | 44.0 |
| Beauty | 49.8 | 48.5 | 50.00 | 49.4 |
| Av. ability | 40.27 | 47.11 | 45.37 | 44.75 |
| # of High | 23 (48%) | 37 (52%) | 36 (50%) | 96 (50%) |

*Notes*: N/FR/CC are the numbers of subjects/free riders/conditional cooperators in each treatment. 'Unconditional' is the average unconditional contribution (endowment = 200). 'Av. cond. contrib.' is the average entry in the contribution table. 'CRT', 'Race game' and 'Beauty' report the average normalized (i.e., on a 0-100 scale) performance in the three strategic-ability tasks. 'Av. ability' is the average score obtained in the three ability tasks, between 0 and 100. The last rows report the number of subjects above the median strategic ability ('# High').

the whole sample is 44.7. In the different treatments, the average ability of subjects ranges from 40.3 to 47.1 and the proportion of high-ability subjects (those with an ability higher than the median, i.e., 43.4) ranges from 48% to 52%. These differences are not statistically significant.[17]

Table 2 reports statistics on strategic ability for each preference type. On average our measure of strategic ability is stable across types (Wilcoxon rank-sum test: conditional cooperators vs free riders, $z = .068$, $P$-val $= .95$). There are slightly more high-ability subjects among free riders (56%) than among conditional cooperators (47%) but the difference is not significant (Proportion test: conditional cooperators vs free riders, $z = .773$, $P$-val $= .44$). In addition, there is no correlation between the strategic ability of subjects and either one-shot contributions, or average contributions in the contribution table.[18] Finally, scores in the

[17] Strategic ability, Wilcoxon rank-sum test: RAND vs PREF, $z = -1.291$, $P$-val $= .20$; RAND vs STRAT, $z = -1.114$, $P$-val $= .27$; PREF vs STRAT, $z = .226$, $P$-val $= .82$; Number of high-ability subjects, proportion test: RAND vs PREF, $z = -.373$, $P$-val $= .71$; RAND vs STRAT, $z = -.224$, $P$-val $= .82$; PREF vs STRAT, $z = .167$, $P$-val $= .87$.

[18] On aggregate, we do not find evidence of a clear relation between strategic ability and preferences. Even looking at ability tasks individually, the only correlation that is significant at the .05 level regards subjects who perform well in the race game, who tend to choose lower numbers in the contribution table. These findings are consistent with the literature on cognitive ability and preferences. There, results typically depend on how ability and preferences are measured, and

Table 2: Abilities by preference type

| | Abilities by preference type | | | |
|---|---|---|---|---|
| | FR | CC | Others | |
| Ability | 45.62 | 44.90 | 43.12 | |
| High | 32 (56%) | 45 (47%) | 19 (49%) | |
| | Correlations across classification tasks | | | |
| | Race game | Beauty | Uncond. contrib. | Cond. contrib. |
| CRT | .32*** | .03 | .13* | .06 |
| Race game | | −.03 | −.11 | −.20*** |
| Beauty | | | .01 | .08 |
| Unconditional | | | | .46*** |

*Notes*: ***, ** and * stand for significant at the 1%, 5% and 10% level, respectively. FR/CC/Others are respectively the free riders, the conditional cooperators and those that are not free riders or conditional cooperators. Ability is the score obtained in the ability tasks. # of High is the number of subjects with a strategic-ability score above the median in the sample. CRT / Race game / Beauty refers to the score obtained in these tasks. Uncond. (cond.) contrib. is the unconditional (average conditional) contribution in the strategy method.

the CRT and in the Race to 26 are significantly correlated, while their correlation with the score in the beauty contest is not significant.[19]

## 3.2 Behavior in the repeated public goods game

We present in this section our findings about the contribution of subjects by treatment, by preference type and by ability type. We first compare average contributions across treatments and describe dynamic behavior of the different types. Then we compare first period choices to the unconditional contribution in the one-shot PGG used for the preference classification. Finally, we test for the interaction between treatments and types.

Table 3 shows the average contributions for each type of subject in each treatment. The average contribution of subjects in the treatment STRAT (7.8 tokens) is significantly higher than in the treatments PREF (7.1 tokens) or RAND (6.7 tokens), while the difference between the treatments PREF and RAND is not significant (see table 5 for these tests). The higher level of contributions in the treat-

fail at establishing a clear relation between the two [see Ben-Ner and Halldorsson, 2010; Burks et al., 2009; Chen et al., 2013; Lohse, 2016; van den Bos et al., 2010].

[19]Contrary to the score, the numbers chosen in the beauty contest are correlated with the score in the CRT. Therefore, those who perform better in the CRT choose lower numbers in beauty contest [see also Brañas-Garza et al., 2012; Burnham et al., 2009; Gill and Prowse, 2016], but are not better at guessing the others' choices.

Table 3: Average contributions by preferences and ability (top); non-parametric tests (bottom)

| | RAND | PREF | STRAT | Overall |
|---|---|---|---|---|
| All subjects | 6.7 | 7.1 | 7.8 | 7.3 |
| Free Riders | 3.6 | 4.9 | 6.3 | 4.9 |
| Cond. cooperators | 8.7 | 8.4 | 8.9 | 8.7 |
| High ability | 6.0 | 7.3 | 9.4 | 7.8 |
| Low ability | 7.3 | 6.9 | 6.2 | 6.7 |

| | | Tretament diff. (Kruskal-Wallis) | RAND vs PREF (Wilkoxon) | RAND vs STRAT (Wilkoxon) | PREF vs STRAT (Wilkoxon) |
|---|---|---|---|---|---|
| Contribution | Z | **6.29** | -0.09 | **-2.20** | **-2.10** |
| (All periods) | P-val | **.04** | .93 | **.03** | **.04** |

| | | Low vs High (Wilkoxon) | FR vs CC (Wilkoxon) | Preference type (Kruskal-Wallis) |
|---|---|---|---|---|
| Contr. period 1 - | Z | **-1.97** | **2.55** | 2.76 |
| Uncond. cont | P-val | **.05** | **.01** | .43 |

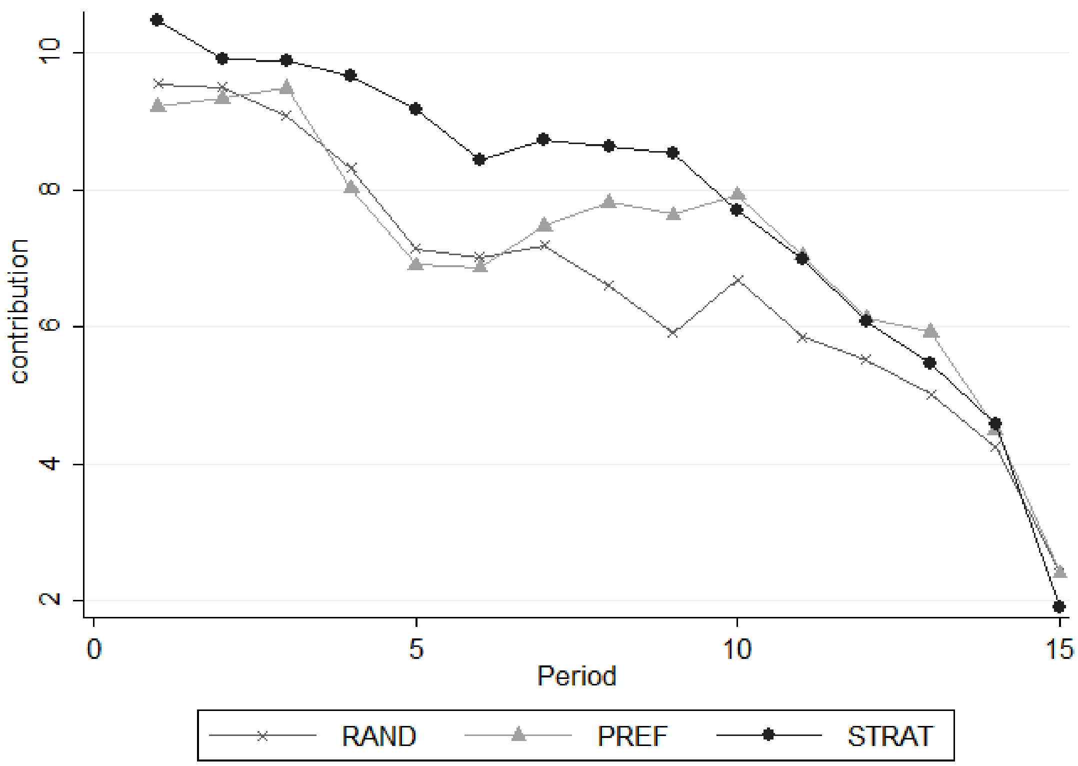
*Notes*: the first panel reports average contributions in the repeated PGG over all periods. The second panel reports tests on difference in contributions. The first column contains the Kruskal-Wallis test for differences across the three treatments. The other columns report pairwise comparisons (Wilcoxon rank-sum test). A positive statistic means higher contribution in the first listed treatment (and vice-versa). Tests are based on one independent observation per group. The third panel reports tests on differences in the gap between the contributions in the first-period of the repeated PGG and the unconditional contribution in the one-shot PGG. The first column compares subjects of low and high ability, the second compares free riders (FR) and conditional cooperators (CC), the third tests for differences across subjects with different preferences. Tests are based on one independent observation per subject. Bold indicates significance at the .05 level.

ment STRAT is driven by the higher average contribution of high-ability subjects in that treatment (9.4 tokens) relative to their average contribution in treatments PREF (7.3 tokens) or RAND (6.0 tokens). Conditional cooperators contribute on average more than free riders in every treatment. However, their contribution is stable across treatments.

Figure 1 displays the average contributions in each period. Figure 2 presents these results by preference types and Figure 3 by ability types. Overall, the behavior of the subjects is consistent with previous studies: subjects contribute on average 50 percent of their tokens in the first period, contributions are declining over time and approach zero in the last period. We observe in Figure 1 that the higher contributions observed in the treatment STRAT compared to the other treatments over the 15 periods come from higher contributions during the ten first periods. In particular, contributions in the treatment STRAT do not shrink as fast as in other treatments. We observe in Figure 3 that this result comes from the absence of decay among (groups of) high-ability subjects in this treatment over the first ten periods.

In a repeated game, past choices may influence future ones. First-period contributions are therefore crucial as they may influence the entire stream of future contributions. We compare them to the unconditional contributions in the one-

Figure 1: Average contributions by treatment




shot PGG used for the preference classification, to identify the effect of repetition on choices. Overall, subjects contribute 23 percent more in the first period of the repeated PGG than in the one-shot PGG: subjects are more inclined to contribute when their current behavior may be rewarded in the future.[20]

This increase in contributions is not uniform across types. For instance, low-ability free riders reduce their contribution by 1 percent in the first period of the repeated relative to the one-shot game. low-ability conditional cooperators increase their contributions by 12 percent, on average, while the same figure for high-ability conditional cooperators is 25 percent. Finally, high-ability free riders see the largest increase both in absolute and in relative terms (+93 percent). In line with these figures, statistical tests confirm that the difference between the contribution in period 1 of the repeated PGG and the contribution in the one-shot PGG is significantly larger for high-ability subjects (+33 percent) than for low-ability ones (+14 percent), suggesting that more able subjects are better at identifying the connections between current and future contributions. The differ-

[20]We do not differentiate across treatments when talking of first-period contributions, because treatments are identical until receiving the first feedback about one's group contributions.

Figure 2: Average contributions by preference type and treatment

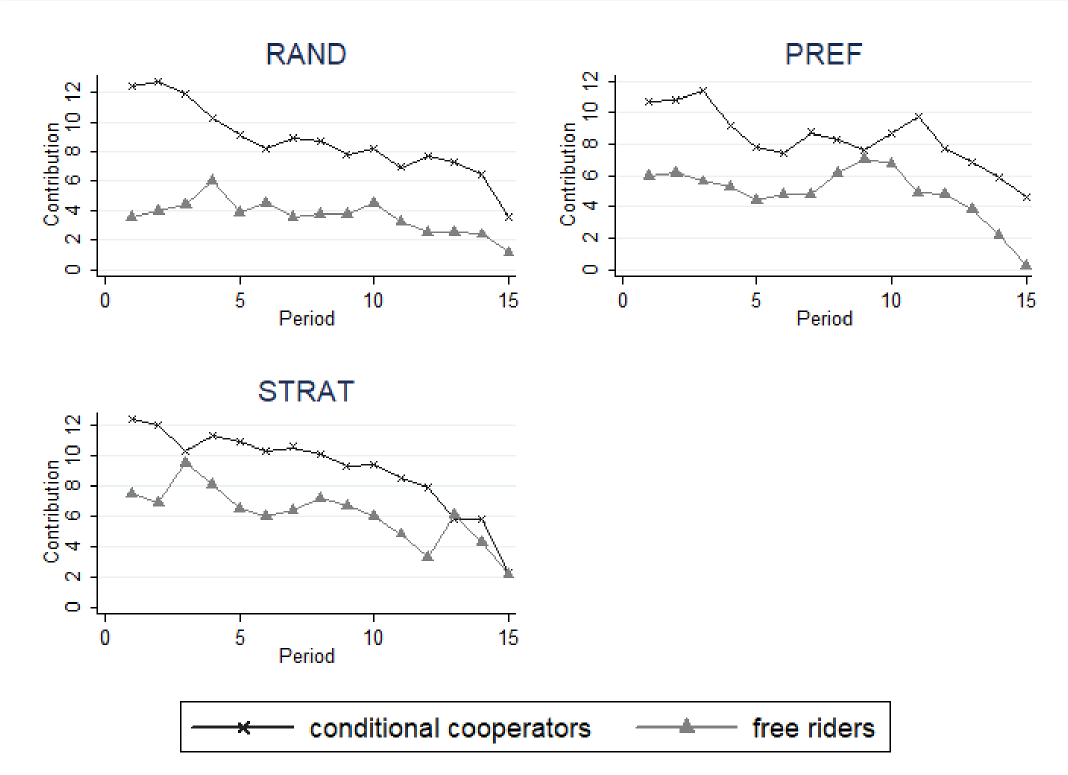



Figure 3: Average contributions by strategic ability and treatment

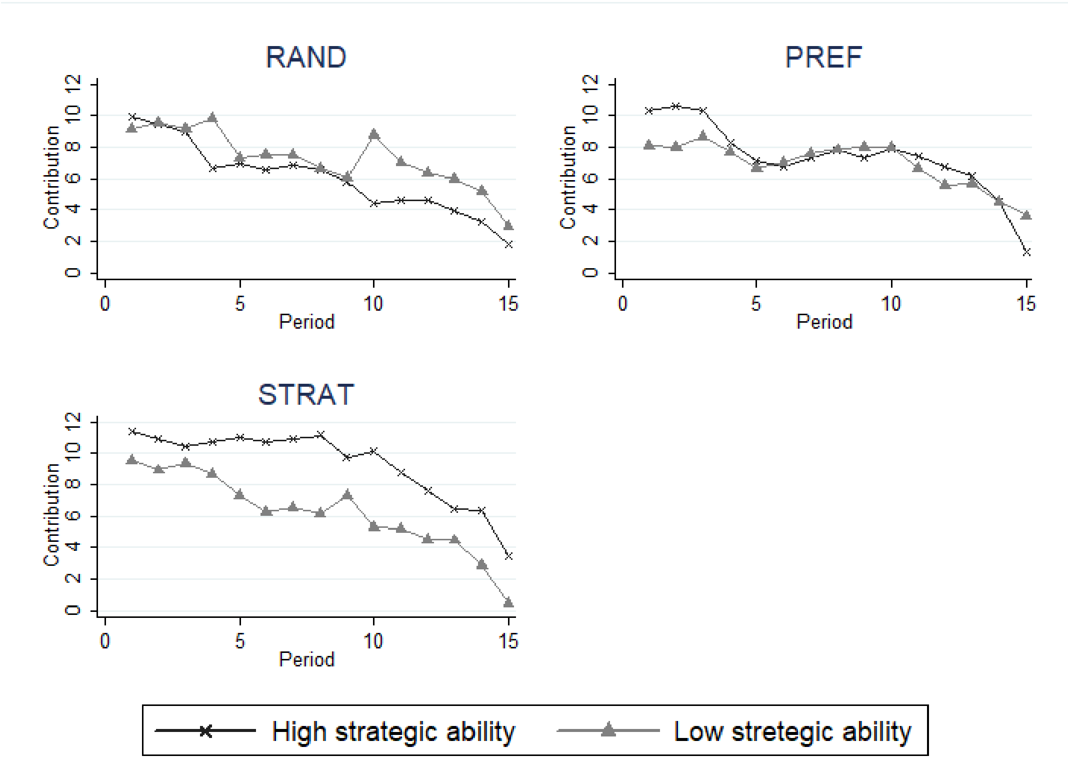


Table 4: Individual contributions

| Dependent variable: individual contribution | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| period | -0.425*** | -0.425*** | -0.425*** | -0.425*** | -0.425*** |
| | (0.0448) | (0.0448) | (0.0448) | (0.0448) | (0.0449) |
| High | 1.155 | | -1.243 | -0.774 | -0.311 |
| | (0.786) | | (1.112) | (0.952) | (1.097) |
| CC | 3.028*** | 4.215*** | | 2.843*** | 2.759*** |
| | (0.951) | (1.327) | | (0.940) | (0.983) |
| PREF | 0.635 | 1.648 | -0.358 | -0.114 | 0.262 |
| | (1.531) | (2.066) | (1.799) | (1.669) | (1.656) |
| STRAT | 1.021 | 1.733 | -1.078 | -0.715 | -0.640 |
| | (1.356) | (1.651) | (1.615) | (1.595) | (1.577) |
| CC*PREF | | -1.984 | | | |
| | | (2.596) | | | |
| CC*STRAT | | -1.316 | | | |
| | | (1.557) | | | |
| High*PREF | | | 1.645 | 1.561 | 1.027 |
| | | | (1.775) | (1.545) | (1.690) |
| High*STRAT | | | 4.423** | 3.559** | 3.478** |
| | | | (1.948) | (1.818) | (1.842) |
| _cons | 7.937*** | 7.872*** | 10.66*** | 8.958*** | 3.859 |
| | (1.322) | (1.365) | (1.237) | (1.372) | (7.461) |
| *N* | 2880 | 2880 | 2880 | 2880 | 2880 |
| Controls | NO | NO | NO | NO | YES |

*Notes*: In parentheses we report robust standard errors, clustered at the group level. 'High' is a dummy for high ability subjects. 'CC' is a dummy for conditional cooperators. Control variables include gender, age, field of study and self-reported risk preferences. **,***: statistically significant at the 5% and 1% level, respectively.

ence is also greater for free riders (+73 percent) than for conditional cooperators (+18 percent) (see the lower panel of Table 3 for the test statistics).[21]

To better understand the interaction between preferences, strategic ability and group composition we report in Table 4 a series of random effects OLS re-

[21]This is in line with the idea that free riders are more responsive to the monetary incentives of the repeated interaction.

gressions with robust standard errors clustered at the group level.[22] The dependent variable is the individual contribution in each period. Model (1) summarizes what we have observed in the descriptive results, i.e. contributions are positive and declining and conditional cooperators contribute more than others. According to this regression, treatment differences are not significant on aggregate. However, our treatments are expected to interact with preference types and strategic ability. In model (2) we interact a dummy for conditional cooperators with treatment dummies. In model (3), we interact the dummy for high ability with treatment dummies. The contributions of conditional cooperators are stable over treatments. High-ability subjects, instead, contribute significantly more in treatment STRAT than they do in treatment RAND,[23] and contribute significantly more than low-ability subjects only in treatment STRAT, where they are matched with other high-ability subjects.[24] This effect survives to controlling for subject's preferences, in model (4), where we include a dummy for conditional cooperators, and for other individual characteristics, as age, gender, field of study, and risk preferences, in model (5).[25]

Each of our treatments PREF and STRAT generates groups that are homogeneous along one single dimension. However, on the one hand, we would like to control for group composition on both dimensions at once. On the other hand, our measure of the effect of group composition through treatment differences may be biased, because homogenous groups of subjects with similar strategic ability and preferences are formed in all treatments.

In the regressions of Table 5, we explicitly compare groups of different compositions, independently of the matching procedure that led to their formation. Model (1) shows that homogeneous groups of conditional cooperators contribute more than the groups that are not composed only of conditional cooperators or of high-ability subjects, while the coefficient for homogeneous groups of high-ability subjects is not statistically significant. In model (2) we consider the interaction between preferences and ability. We analyze the behavior of subjects in groups of (i) conditional cooperators that include at least one subject with a low ability, (ii) high-ability subjects where at least one subject is not a conditional cooperator, (iii) high-ability conditional cooperators, and compare them to the behavior of subjects in all the other groups (baseline). Groups that are homo-

[22] We obtain similar results by estimating all models with 2-limit Tobit regressions. See Table 7 in Appendix C

[23] Chi-squared test: $z = 3.95$, $P$-val= .046.

[24] Chi-squared test: $z = 3.95$, $P$-val= .046.

[25] The results are robust to using, rather than the dummy for high-ability sibjects, the (continuous) ability score or the deciles of the distribution of the ability score. They are also robust to restricting to the first ten periods. Results are available upon request.

Table 5: Group contributions

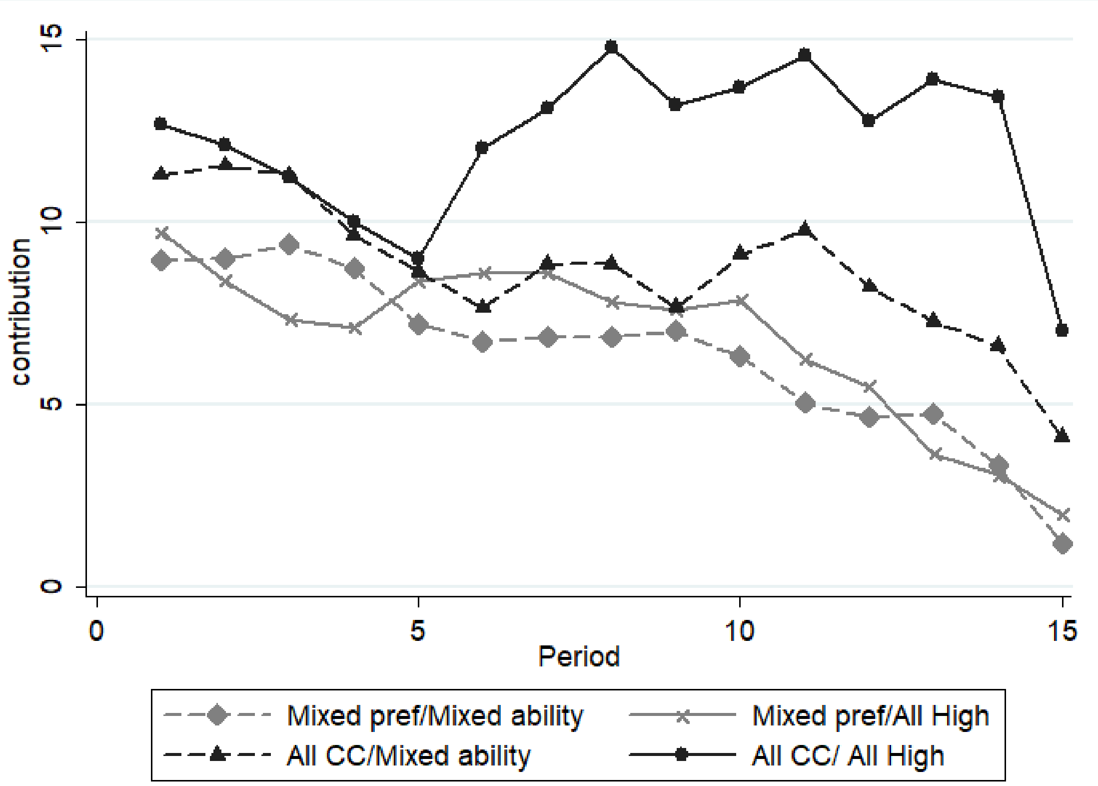
| Dependent variable: group average contribution | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| period | -0.425*** | -0.425*** | -0.134*** | -0.455*** |
| | (0.045) | (0.045) | (0.021) | (0.060) |
| allCC | 2.904** | | | |
| | (1.319) | | | |
| allHigh | 1.137 | | | |
| | (1.486) | | | |
| NOTallCC & allHigh | | 0.409 | 0.066 | 0.962 |
| | | (1.795) | (0.286) | (2.150) |
| allCC & NOTallHigh | | 2.295 | 0.355 | 1.489 |
| | | (1.517) | (0.230) | (1.932) |
| allCC & allHigh | | 5.915*** | 1.046*** | 5.103*** |
| | | (1.627) | (0.327) | (1.799) |
| past_groupcont | | | 0.860*** | |
| | | | (0.022) | |
| _cons | 9.629*** | 9.800*** | 1.536*** | 10.855*** |
| | (0.882) | (0.901) | (0.252) | (1.194) |
| *N* | 960 | 960 | 896 | 645 |

*Notes*: In parentheses we report robust standard errors, clustered at the group level. 'allHigh' is a dummy for groups composed by three high ability subjects. 'allCC' is a dummy for groups composed by three conditional cooperators. Control variables include gender, age, field of study and self-reported risk preferences. **,***: statistically significant at the 5% and 1% level, respectively.

geneous only in one dimension do not contribute significantly more than the baseline. However, the contributions in groups composed of high-ability conditional cooperators are significantly higher than the baseline. This result is robust to the inclusion of the average contribution in the group in the previous period (model (3)).

The baseline also includes groups that are homogeneous in terms of preferences and/or ability. In particular, homogeneous groups of free riders and low-ability subjects. To check that their presence does not bias our estimates, we exclude those groups in model (4), and obtain similar results. Indeed, Figure 4 shows that, between period 6 and 14, groups of high-ability conditional cooperators contribute on average 64 percent more than other groups of conditional

Figure 4: Average contributions in homogenous and heterogeneous groups




*Notes*: 'all CC' refers to groups composed only by conditional cooperators; 'all High' refers to groups composed only by subjects of high strategic ability.

cooperators, and more than twice as much as the other groups.

# 4 Discussion: a comparison with Burlando and Guala (2005)

One striking result of our analysis is that, contrary to Burlando and Guala [2005] (hereafter BG), we do not find that conditional cooperators contribute significantly more in homogenous groups of conditional cooperators than in groups formed randomly. We argue in this section that these differences come from the different definitions of conditional cooperation used in the two papers. BG classify subjects according to 4 tasks: a one-shot public goods game in strategy method, a finitely repeated public goods game, a decomposed game and a questionnaire. They classify subjects within each task and attribute weights to the different tasks (20, 20, 40, and 20 percent, respectively). A subject is a conditional cooperator if she is classified as such in tasks that account for at least 50 percent of the weights. In the one-shot public goods game, subjects are classified as conditional cooperators if their conditional contribution pattern lies within a bandwidth of ±10% from the average contribution of their partners. In the finitely repeated public goods game, subjects are classified as conditional cooperators if their average contribution over rounds is within a bandwidth of ±5% of the endowment from the average group contribution. We classify subjects according to a one-shot public goods game in strategy method. Subjects are classified as conditional cooperators if the correlation between their contribution and that of their partners is above 0.7, if they contribute on average more than 10% (otherwise they are classified as free-riders) and if the standard deviation of their contribution pattern is greater than 5% of their endowment (otherwise they are classified as unconditional cooperators).

We argue that their classification selects subjects with a stronger cooperative attitude than ours. Furthermore, if we restrict our attention to groups composed of the conditional cooperators with the highest cooperative attitude in our sample, we do in fact have results that are consistent with theirs.

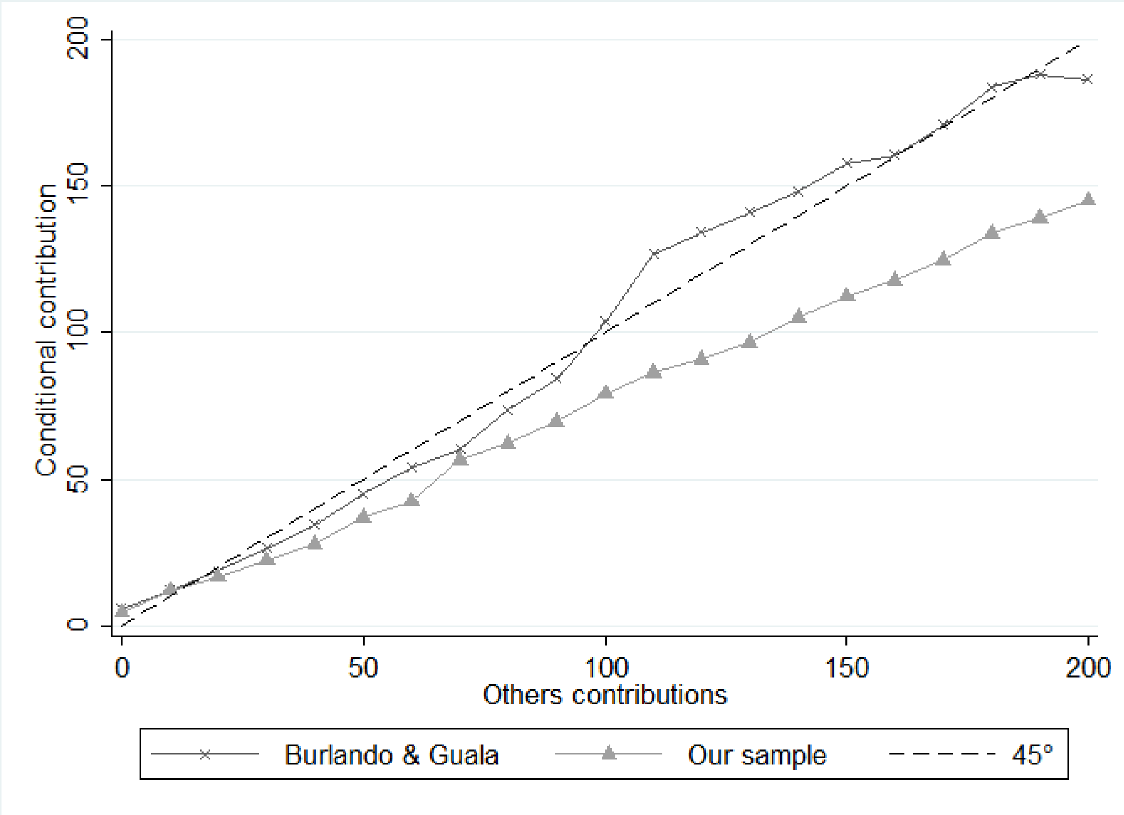
Their classification selects subjects with a stronger cooperative attitude than ours for two main reasons. First, they select subjects that are willing to match closely others' contributions in the repeated public goods game – that is, in the same game where the homogeneous matching is then applied. Second, they are likely to select subjects who show a low self-serving bias in the strategy method. Figure 5 shows the average contribution in the strategy method of subjects classified as conditional cooperators in the two samples.[26] The difference in the self-serving bias of the two groups is apparent, and the difference between the two slopes is significant, as documented in Table 6 (column (1)). A Wilcoxon rank-sum tests also shows that individual average entry in the contribution table of conditional cooperators in BG is significantly higher than in our sample ($z = -3.87$, $P$-val$< 0.01$). The median average contribution of a conditional cooperator is significantly higher in BG than it is in our study. These observations confirm that conditional cooperators in BG are more cooperative than in our study.[27]

Finally, we show that homogenous partnerships increase the contributions of conditional cooperators also in our sample, provided that other members of

[26]We are grateful to Roberto Burlando and Francesco Guala who have made their data available to us to run this analysis.

[27]Our design differs from BG on many aspects, other than the classification method highlighted in the text: we adopt a 'between' design, they adopt a 'within' design; we have groups of three subjects, they have groups of four subjects; the public goods technology is not identical; they have 20 repetitions plus three trial periods, we have 15 repetitions with no trial. While each of these differences could in principle contribute to the difference in results, we believe that the different nature of conditional cooperators in the two experiments is the main explanation of the differences that we observe.

Figure 5: Conditional contributions of conditional cooperators in Burlando and Guala [2005] and in our study




the group have sufficiently strong cooperative attitudes. To do so, we split our sample of conditional cooperators in two categories: the strong and the weak conditional cooperators. *Strong* conditional cooperators are the conditional cooperators whose average entry in the conditional contribution table is above the median average contribution of the whole set of conditional cooperators.[28] Columns (2) and (3) of Table 6 show that both (at-large) conditional cooperators and strong conditional cooperators do not contribute more when matched in groups of (at-large) conditional cooperators. Since, we do not have homogeneous groups of strong conditional cooperators, we propose a measure of the cooperative attitude of subjects' group members. The group members of a subject are said to be *strongly cooperative* if the average of their mean entries in the conditional contribution table is above the individual median. In column (5) of Table 6, we see that strong conditional cooperators contribute significantly more when they are matched in strongly cooperative groups than when they are matched in

[28]The clustering analysis in Fallucchi et al. [forthcoming] detects the existence of two separate groups of conditional cooperators, the strong and the weak, which are distinguished by the strength of their self-serving bias.

Table 6: Behavior of conditional cooperators

| | (1) Cond. contrib. | (2) Ind. contrib. | (3) Ind. contrib. | (4) Ind. contrib. | (5) Ind. contrib. |
|---|---|---|---|---|---|
| others_cont | 0.731*** | | | | |
| | (0.009) | | | | |
| BG | -4.228 | | | | |
| | (7.013) | | | | |
| BG*other_cont | 0.284*** | | | | |
| | (0.020) | | | | |
| period | | -0.468*** | -0.583*** | -0.468*** | -0.583*** |
| | | (0.070) | (0.094) | (0.070) | (0.088) |
| others CC | | 1.257 | 1.594 | | |
| | | (1.413) | (1.653) | | |
| others_CC+ | | | | 0.697 | 4.214** |
| | | | | (1.663) | (1.985) |
| _cons | 3.404 | 11.825*** | 13.413*** | 10.467*** | 13.009*** |
| | (3.378) | (0.934) | (1.144) | (1.319) | (1.016) |
| Sample | CC's (BG + GLM) | CC's (GLM) | Strong CC's (GLM) | CC's (GLM) | Strong CC's (GLM) |
| *N* | 2625 | 1440 | 735 | 1440 | 735 |

*Notes*: the dependent variable is the conditional contribution in the strategy method in model (1). It is the individual contribution in the repeated PGG in models (2) – (5). 'others_cont' is the average contribution of the other group members in the contribution table. 'BG' is a dummy for observations from the Burlando and Guala [2005] dataset. 'others_CC' is a dummy that takes value 1 when one's group members are both conditional cooperators; 'others_CC+' also implies that their average conditional contribution is above the median of the averages of conditional cooperators. In the row 'Sample', 'BG' stands for Burlando and Guala [2005]; 'GLM' stands for our sample;'CC's' ('strong CC's') means we are restricting the analysis to subjects classified as conditional cooperators (strong conditional cooperators). In parentheses we report robust standard errors, clustered at the individual level in model (1), at the group level in models (2) – (5). **,***: statistically significant at the 5% and 1% level, respectively.

other groups, while we do not observe such difference for (at-large) conditional cooperators (column (4)). We believe that this qualification is relevant, since narrow variations of our definition of conditional cooperation are common in the literature [e.g., Fischbacher et al., 2001].

# 5 Conclusions

Previous studies have highlighted the relevance of matching together people sharing similar cooperative attitudes or preferences to sustain cooperation in finitely repeated interactions. In this paper, we extend these findings and show how like-mindedness of group members matters also in a deeper sense, related to the common understanding of the strategic features of the game. Our results indicate that both a high strategic ability and an attitude toward conditional cooperation by all its members are necessary for a group to sustain high levels of cooperation until the end of the game.

We believe our results represent an important step toward a better understanding of cooperation in finite dynamic interactions, one that incorporates forward-looking strategic thinking and anticipation of others' choices. They also pave the way to future research questions. First, what is the nature of the interaction between preferences and strategic ability? Our results suggest that cooperative attitudes may generate an 'intercept effect' – i.e., cooperators are needed as they contribute large amounts in the first round – while strategic ability may trigger a 'slope effect' – i.e., strategic players are needed because they are able to keep on cooperating over rounds, but a direct scrutiny of this hypothesis is needed. Second, our measure of strategic ability is based on cognitive ability, strategic sophistication and ability to plan ahead. Among those aspects of strategic ability, which are (more) relevant for sustaining cooperation in finitely repeated games, and why? Third, following the work of Rustichini et al. [2018], who show that (cognitive) ability helps sustaining efficient equilibria in infinitely repeated games, and our work highlighting the role of (strategic) ability in finitely repeated games, a more in-depth examination of the relation between the structure of a game and the characteristics of subjects also constitutes an interesting area for future research on the emergence of cooperation.

Cooperation in groups determines their performance. The organization of work is increasingly characterized by temporary teams rather than permanent structures [e.g., Sydow and De Filippi, 2004]. In this context, the incentives of workers change, which in turn matters for the recruitment decisions and for team formation choices. Job applicants are routinely screened according to personality traits, but their effectiveness to predict job performance has been called into question [Morgeson et al., 2007]. The topic we analyze, our findings, as well as the further investigations they invite will contribute to better understand these and related issues.

# References

Ambrus, A. and P. A. Pathak, "Cooperation over finite horizons: A theory and experiments," *Journal of Public Economics* 95 (2011), 500–512.

Baader, M. and A. Vostroknutov, "Interaction of reasoning ability and distributional preferences in a social dilemma," *Journal of Economic Behavior & Organization* 142 (2017), 79–91.

Basteck, C. and M. Mantovani, "Cognitive ability and games of school choice," *Games and Economic Behavior* 109 (2018), 156–183.

Ben-Ner, A. and F. Halldorsson, "Trusting and trusworthinesss: what are they, how to measure them, and what aaffect them," *Journal of Economic Psychology* 31 (February 2010), 64–79.

Bosch-Rosa, C., T. Meissner and A. Bosch-Domènech, "Cognitive bubbles," *Experimental Economics* 21 (2018), 132–153.

Brañas-Garza, P., T. García-Muñoz and R. H. González, "Cognitive effort in the beauty contest game," *Journal of Economic Behavior & Organization* 83 (2012), 254–260.

Brandts, J. and A. Schram, "Cooperation and noise in public goods experiments: applying the contribution function approach," *Journal of Public Economics* 79 (February 2001), 399–427.

Burks, S. V., J. P. Carpenter, L. Goette and A. Rustichini, "Cognitive skills affect economic preferences, strategic behavior, and job attachment," *Proceedings of the National Academy of Sciences* 106 (2009), 7745–7750.

Burlando, R. M. and F. Guala, "Heterogeneous agents in public goods experiments," *Experimental Economics* 8 (2005), 35–54.

Burnham, T. C., D. Cesarini, M. Johannesson, P. Lichtenstein and B. Wallace, "Higher cognitive ability is associated with lower entries in a< i> p</i>-beauty contest," *Journal of Economic Behavior & Organization* 72 (2009), 171–175.

Cabral, L., E. Y. Ozbay and A. Schotter, "Intrinsic and instrumental reciprocity: An experimental study," *Games and Economic Behavior* 87 (2014), 100–121.

Chaudhuri, A., "Sustaining cooperation in laboratory public goods experiments: a selective survey of the literature," *Experimental Economics* 14 (March 2011), 47–83.

Chen, C.-C., I. Chiu, J. Smith, T. Yamada et al., "Too smart to be selfish? Measures of cognitive ability, social preferences, and consistency," *Journal of Economic Behavior & Organization* 90 (2013), 112–122.

DOHMEN, T., A. FALK, D. HUFFMAN, U. SUNDE, J. SCHUPP AND G. G. WAGNER, "Individual risk attitudes: measurement, determinants, and behavioral consequences," *Journal of the European Economic Association* 9 (2011), 522–550.

DREBER, A., D. FUDENBERG AND D. G. RAND, "Who cooperates in repeated games: The role of altruism, inequity aversion, and demographics," *Journal of Economic Behavior & Organization* 98 (2014), 41–55.

DUFWENBERG, M., R. SUNDARAM AND D. J. BUTLER, "Epiphany in the Game of 21," *Journal of Economic Behavior & Organization* 75 (2010), 132–143.

FALLUCCHI, F., R. A. LUCCASEN III AND T. L. TUROCY, "Identifying discrete behavioural types: A re-analysis of public goods game contributions by hierarchical clustering," *Journal of the Economic Science Association* (forthcoming).

FISCHBACHER, U., "z-Tree: Zurich toolbox for ready-made economic experiments," *Experimental Economics* 10 (2007), 171–178.

FISCHBACHER, U. AND S. GACHTER, "Social Preferences, Beliefs, and the Dynamics of Free Riding in Public Goods Experiments," *American Economic Review* 100 (March 2010), 541–56.

FISCHBACHER, U., S. GACHTER AND E. FEHR, "Are people conditionally cooperative? Evidence from a public goods experiment," *Economics Letters* 71 (June 2001), 397–404.

FREDERICK, S., "Cognitive reflection and decision making," *The Journal of Economic Perspectives* 19 (2005), 25–42.

GÄCHTER, S. AND C. THÖNI, "Social learning and voluntary cooperation among like-minded people," *Journal of the European Economic Association* 3 (04/05 2005), 303–314.

GILL, D. AND V. PROWSE, "Cognitive ability, character skills, and learning to play equilibrium: A level-k analysis," *Journal of Political Economy* 124 (2016), 1619–1676.

GNEEZY, U., A. RUSTICHINI AND A. VOSTROKNUTOV, "Experience and insight in the Race game," *Journal of Economic Behavior & Organization* 75 (2010), 144–155.

GREINER, B., "Subject pool recruitment procedures: organizing experiments with ORSEE," *Journal of the Economic Science Association* 1 (2015), 114–125.

GUNNTHORSDOTTIR, A., D. HOUSER AND K. MCCABE, "Disposition, history and contributions in public goods experiments," *Journal of Economic Behavior & Organization* 62 (February 2007), 304–315.

KESER, C. AND F. VAN WINDEN, "Conditional cooperation and voluntary contributions to public goods," *Scandinavian Journal of Economics* 102 (March 2000), 23–39.

KREPS, D., P. MILGROM, J. ROBERTS AND R. WILSON, "Rational cooperation in the finitely repeated prisoners' dilemma," *Journal of Economic Theory* 27 (1982), 245–252.

LEDYARD, J., "Public goods: A survey of experimental research," in J. H. Kagel and A. E. Roth, eds., *Handbook of Experimental Economics* (Princeton University Press, Princeton, 1995), 111 – 194.

LOHSE, J., "Smart or selfish – When smart guys finish nice," *Journal of Behavioral and Experimental Economics* (2016), –.

MORGESON, F. P., M. A. CAMPION, R. L. DIPBOYE, J. R. HOLLENBECK, K. MURPHY AND N. SCHMITT, "Reconsidering the use of personality tests in personnel selection contexts," *Personnel psychology* 60 (2007), 683–729.

MULLER, L., M. SEFTON, R. STEINBERG AND L. VESTERLUND, "Strategic behavior and learning in repeated voluntary contribution experiments," *Journal of Economic Behavior & Organization* 67 (September 2008), 782–793.

NAGEL, R., "Unraveling in guessing games: An experimental study," *The American Economic Review* 85 (1995), 1313–1326.

ONES, U. AND L. PUTTERMAN, "The ecology of collective action: A public goods and sanctions experiment with controlled group formation," *Journal of Economic Behavior & Organization* 62 (2007), 495–521.

REUBEN, E. AND S. SUETENS, "Revisiting strategic versus non-strategic cooperation," *Experimental Economics* 15 (2012), 24–43.

RUSTICHINI, A., E. PROTO AND A. SOFIANOS, "Intelligence, Personality, and Gains from Cooperation in Repeated Interactions," *Journal of Political Economy* (2018).

SONNEMANS, J., A. SCHRAM AND T. OFFERMAN, "Strategic behavior in public good games: when partners drift apart," *Economics Letters* 62 (January 1999), 35–41.

SYDOW, L. L., JÖRG AND R. DE FILIPPI, "Project-based organizations, embeddedness and repositories of knowledge," *Organization Studies* 25 (2004), 1475 – 1489.

VAN DEN BOS, W., M. WESTENBERG, E. VAN DIJK AND E. A. CRONE, "Development of trust and reciprocity in adolescence," *Cognitive Development* 25 (2010), 90–102.

VIEIDER, F. M., M. LEFEBVRE, R. BOUCHOUICHA, T. CHMURA, R. HAKIMOV, M. KRAWCZYK AND P. MARTINSSON, "Common components of risk and uncertainty attitudes across contexts and domains: Evidence from 30 countries," *Journal of the European Economic Association* 13 (2015), 421–452.

# A Experimental instructions

We thank you for taking part in this experiment on decision-making. In the experiment, your earnings will depend **on your decisions as well as on other participants' decisions**. It is important that you carefully read these instructions. They will help you to understand the experiment. All your decisions are anonymous. You will never enter your name in the computer. During the experiment you are not allowed to communicate. If you have questions then please raise your hand. One of us will come to you to answer your question. If you do not respect this rule you will be excluded from the experiment and from any gains.

The experiment consist of five different tasks. These instructions present in details the five tasks and will be read to you. Before completing each task, you will answer to a series of comprehension question to make sure that you fully understand the task. During this experiment, your earnings are counted in tokens. Among the first four tasks, one will be randomly chosen and your gains in this task will be added to your total gains. Your gains in the fifth task will be automatically added to your total gains.

At the end of the experiment, your total payoffs in cash will be calculated according to the following conversion rate:

**40 tokens = 1 €**

Your payoffs will then be paid to you in cash.

**TASK 1**

During the first task, you have five minutes to answer correctly to three problems that will be displayed on the screen.

The problems are of various difficulty but for each right answer, you will earn 100 tokens. Therefore, if you can answer correctly to three problems, your payoffs will be 300 tokens for this task.

Your payoffs for this task will be communicated to you once the whole experiment is finished.

**TASK 2**

In this task, participants are divided in group of 3. You will play with two other participants randomly chosen. You will be a member of this group only for this task. You cannot know the identity of other members of your group. As no member can know your identity. You do not know the constitution of other groups

At the beginning, you receive 200 tokens and you must decide how to use this endowment. More precisely, you must decide how many tokens you want to contribute in a common project to the group to which you belong and how many tokens you want to keep for you. Choosing your contribution in the project automatically determines the number of tokens you keep for yourself (200 minus your contribution). Each member of your group makes the decision and the total contribution to the common project entitles you to an income. Each token contributed to the project gives 0.6 token to each member of the group.

> *For example, if the total amount contributed by the three members of the group is 600 tokens, each group member receives an income of* $0.6 * 600 = 360$ *tokens. If the total contributions are is 150 tokens, each group member receives an income of* $0.6 * 150 = 90$ *tokens from the project.*

Your gains are then the sum of two amounts:

1. The tokens you keep from your endowment.
2. The tokens you earn from the common project.

**Your payoff = (200 - contribution to the project) + 0.6 * (total contributions)**

When you make your decision, a calculator is available on the screen. It may help you to calculate the potential gains for a given your contribution to the project and the others' contributions.

In this task, you are asked to make two types of decisions with regards of your contribution to the project:

A) You have to decide how many of the 200 tokens you want to contribute to the common project.

B) You have to fill out a contribution table. In the table you have to indicate how many tokens you want to contribute to the project for each possible average contribution of the other group members (rounded to the next ten). You must enter a number between 0 and 200 that is your contribution to the project if the others contribute 0 token, 10 tokens, 20 tokens, etc.

After all participants have made their decisions A and B, in each group a member will be randomly selected. For the randomly chosen subject only, the contribution table in B will be payoff-relevant. For the other group members, their payoffs will be determined according to decision in A. Since you do not know whether you are going to be selected, please be careful when making your decision in both A and B. Both types of decisions can become relevant for your payoffs.

The following example should make it clear:

| Average others' contribution | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Your contribution | | | | | | | | | | | |
| Average others' contribution | 110 | 120 | 130 | 140 | 150 | 160 | 170 | 180 | 190 | 200 | |
| Your contribution | | | | | | | | | | | |

*Example: If you have been selected by the computer, your payoffs will be determined by the contribution table. For the other two group members, the decision in A is relevant. Assume that they have contributed 30 and 90 tokens respectively. The average contribution of these two subjects therefore is 60 tokens= (30+90)/2. If you have indicated in your contribution table that you will contribute 130 tokens if the others contribute 60 tokens on average, then the total contribution to the project is 30 + 90 + 130 = 250 tokens. All group members therefore earn 0.6*250=150 tokens plus the tokens (off the initial endowment of 200 tokens) that they have not contributed to the project. The total payoff for the first member is 200-30+150=320 tokens. The second member earns 200-90+150=260 tokens. And your payoff is 200-130+150=220 tokens. If instead of 130 tokens, you have indicated in the contribution table that you will contribute 180 tokens if the others contribute 60 tokens on average, then the total contribution to the project is 30 + 90 + 180 = 300 tokens. All group members therefore earn 0.6*300=180 tokens from the project. The total payoff for the first member is 200-30+180=350 tokens. The second member earns 200-90+150=260 tokens. And your payoff is 200-130+180=250 tokens.*

The random choice between A and B as well as the payoff will be determined at the end of the experiment.

**TASK 3**

In this task, you will be playing a game against a computer opponent. The computer is programmed to play in response to your decision.

The figure hereafter shows the situation in which you are going to play in this task. The cross indicates the initial position. In this game, you and your opponent start at position 1 (the cross in the grid). You will move first. You have to choose a number between 0 and 5 included. This number adds to your current position to determine a new position for both of you. Then the computer choses a number between 0 and 5 included. This number adds to your current position to determine a new position for both of you. It is then your turn and the game continues with each player incrementing the position.

> *Example: You start in position 1. You chose the number 4 such that you reach the position 5. If the computer in turn selects the number 2, you both are now in position 7 (5+2) and it is you turn to decide, etc.*

The game continues until one player (you or the computer) reaches position 26. If you reach position 26 first, you earn 200 tokens. If the computer reaches first the final position, you earn nothing.

Before the game starts, you have 90 second to think about your choice. You can use the grid below to help you.

| Position | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | X | | | | | | | | | | | | |
| Position | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 |
| | | | | | | | | | | | | | |

**TASK 4**

In this task you are randomly assigned to a group with two other participants. You will be a member of this group only for this task. You cannot know the identity of other members of your group. As no member can know your identity.

Each group member, as well as you, has to choose a number between 0 and 100. The winner is the group member whose number is closest to 2/3 times the average of all chosen numbers by the group members. The winner earns 200 tokens.

If there are more than one winner, the 200 tokens are equally split among the winners.

**TASK 5**

You now participate to the last task. This task includes 15 periods and you are sorted in group of 3 players. It means you are randomly assigned to a group with two other participants. You cannot know the identity of other members of your group. As no member can know your identity. The composition of the group stays the same throughout the 15 periods. You are a member of this group only for this task.

The rules of the game are similar to task 2; the only change is the value of your endowment in each period. At the beginning of each period you get 20 tokens and you must decide how many tokens you want to contribute to a common project to the group to which you belong and how many tokens you want to keep for you.

Each member of your group makes the decision and the total contribution to the common project entitles you to an income. Each token contributed to the project gives 0.6 token to each member of the group.

After each member of your group has made its investment choices, you are informed of the total amount invested in the project (that is your contribution and the others' ones). You are also informed of your earnings for that period. Your payoff for this period are the sum of two amounts:

1. The number of tokens you have not invested in the joint project and you have kept for you.

2. The income obtained through your investment in the joint project.

**Your payoff = (200 - contribution to the project) + 0.6 * (total contributions)**

When you make your decision, a calculator is available on the screen. It may help you to calculate the potential gains for a given your contribution to the project and the others' contributions.

At the end of the period, your earnings for the period will be announced and another period will begin.

Your total earnings for this task are the sum of the accumulated tokens throughout the 15 periods.

# B Cognitive reflection test questions

1. A bat and a ball cost 1.10 dollars in total. The bat costs 1.00 dollar more than the ball. How much does the ball cost?

2. If it takes 5 machines 5 minutes to make 5 widgets, how long would it take 100 machines to make 100 widgets?

3. In a lake, there is a patch of lily pads. Every day, the patch doubles in size. If it takes 48 days for the patch to cover the entire lake, how long would it take for the patch to cover half of the lake?

# C Additional tables and figures

Table 7: Tobit regressions

| Dependent variable: individual contribution | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| period | -0.882*** | -0.884*** | -0.882*** | -0.880*** | -0.881*** |
| | (0.102) | (0.102) | (0.103) | (0.082) | (0.102) |
| High | 1.615 | 8.307*** | -2.344 | -1.292 | -0.780 |
| | (1.431) | (2.847) | (2.093) | (2.465) | (2.070) |
| CC | 6.026*** | | | 5.710*** | 5.526*** |
| | (1.829) | | | (1.396) | (1.910) |
| PREF | 0.880 | 2.413 | -0.736 | -0.212 | 0.393 |
| | (2.911) | (4.463) | (3.416) | (2.426) | (3.130) |
| STRAT | 1.995 | 3.984 | -1.513 | -0.597 | -0.526 |
| | (2.502) | (3.529) | (2.952) | (2.247) | (2.921) |
| CC*PREF | | -2.708 | | | |
| | | (5.100) | | | |
| CC*STRAT | | -3.500 | | | |
| | | (3.203) | | | |
| High*PREF | | | 2.559 | 2.316 | 1.779 |
| | | | (3.439) | (3.582) | (3.224) |
| High*STRAT | | | 7.247** | 5.324* | 5.764* |
| | | | (3.486) | (3.197) | (3.361) |
| _cons | 7.069*** | 6.573** | 12.183*** | 8.612*** | -0.127 |
| | (2.425) | (2.896) | (2.183) | (2.001) | (14.332) |
| sigma | | | | | |
| _cons | 12.393*** | 12.418*** | 12.639*** | 12.328*** | 12.270*** |
| | (1.040) | (1.036) | (1.067) | (0.731) | (1.046) |
| *N* | 2880 | 2880 | 2880 | 2880 | 2880 |
| Controls | NO | NO | NO | NO | YES |

*Notes*: In parentheses we report robust standard errors, clustered at the group level. 'High' is a dummy for high ability subjects. 'CC' is a dummy for conditional cooperators. Control variables include gender, age, field of study and self-reported risk preferences. **,***: statistically significant at the 5% and 1% level, respectively.

Figure 6: Distribution of strategic ability

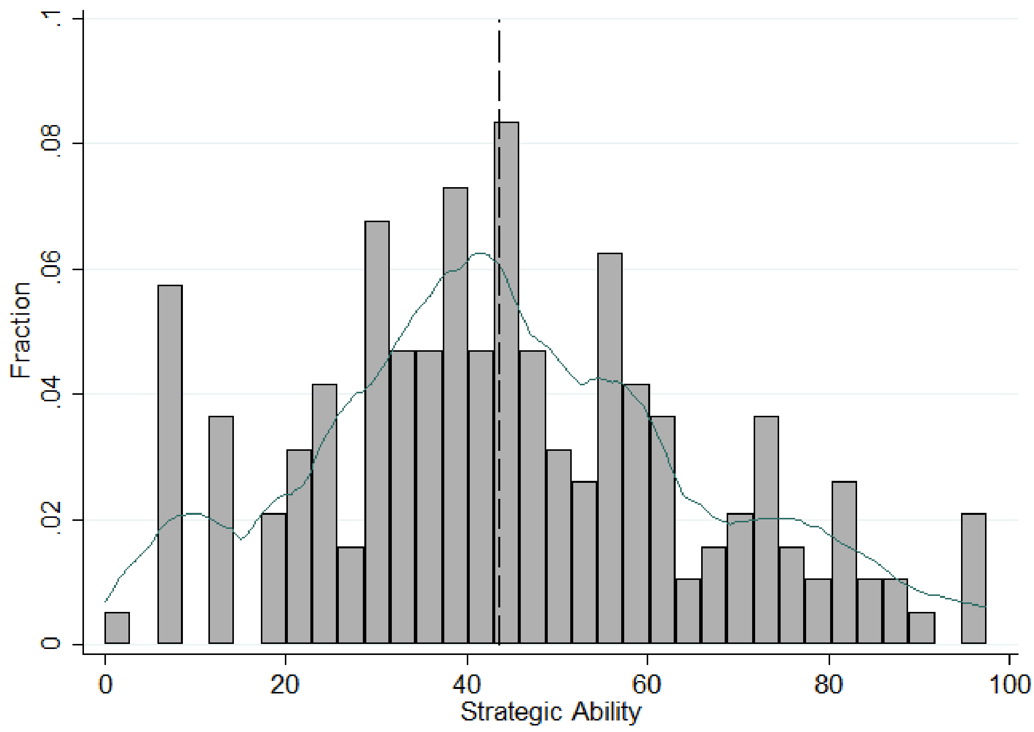



Figure 7: Average contribution tables of each preference type

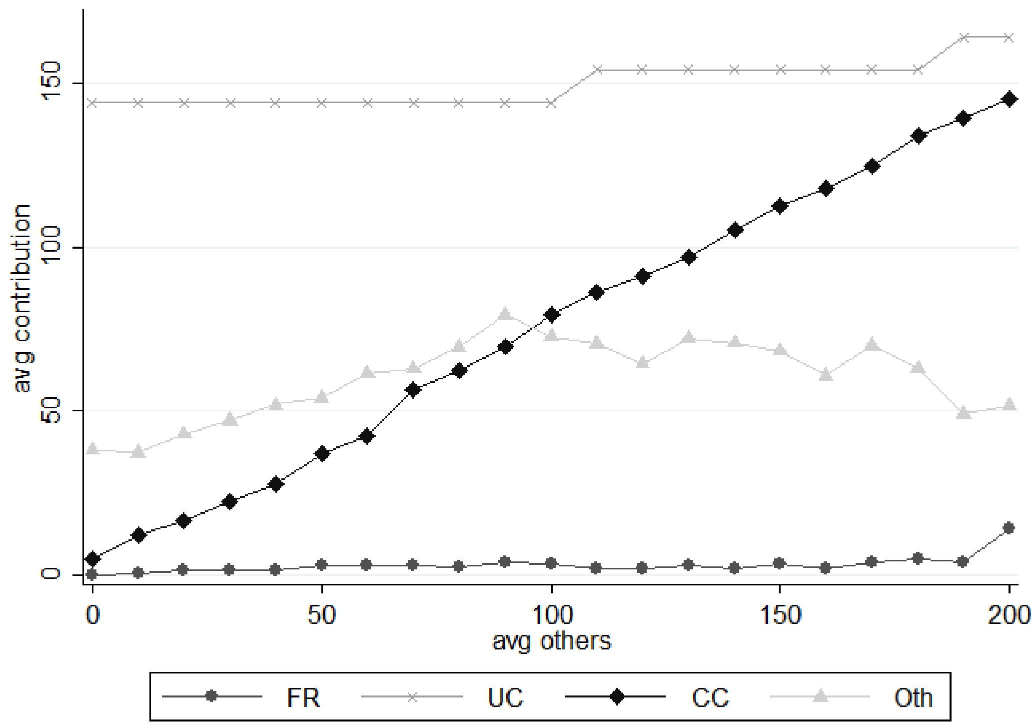


Figure 8: Contribution tables of FR

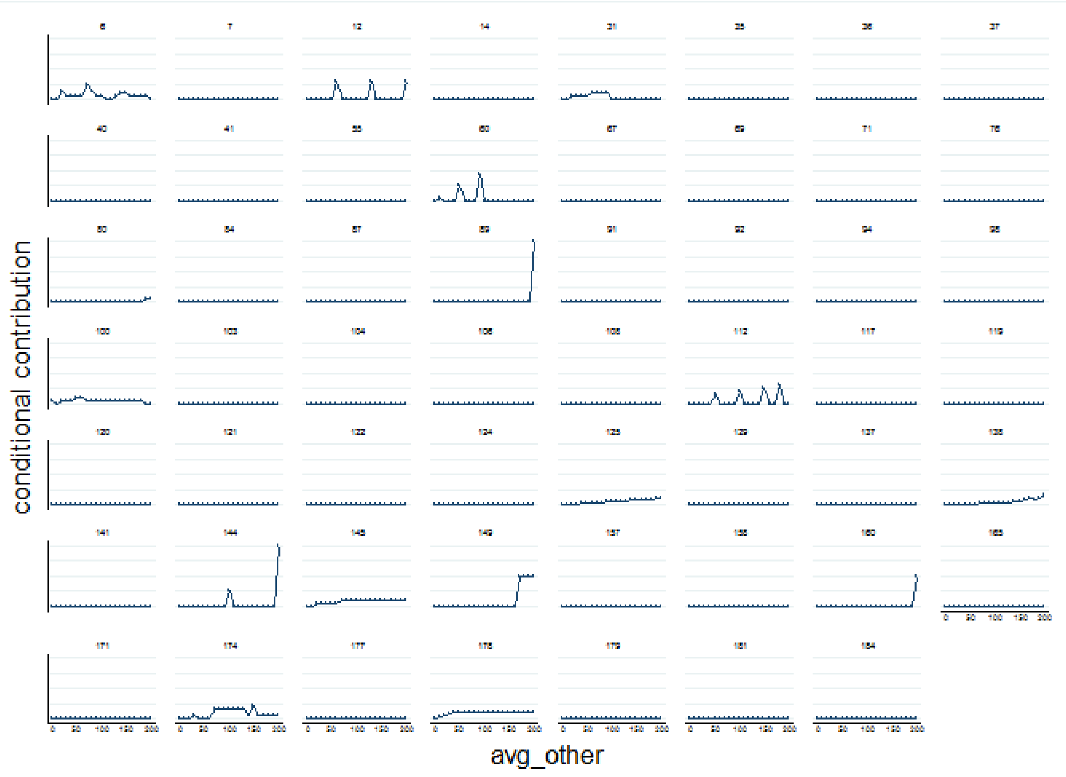



Figure 9: Contribution tables of CC

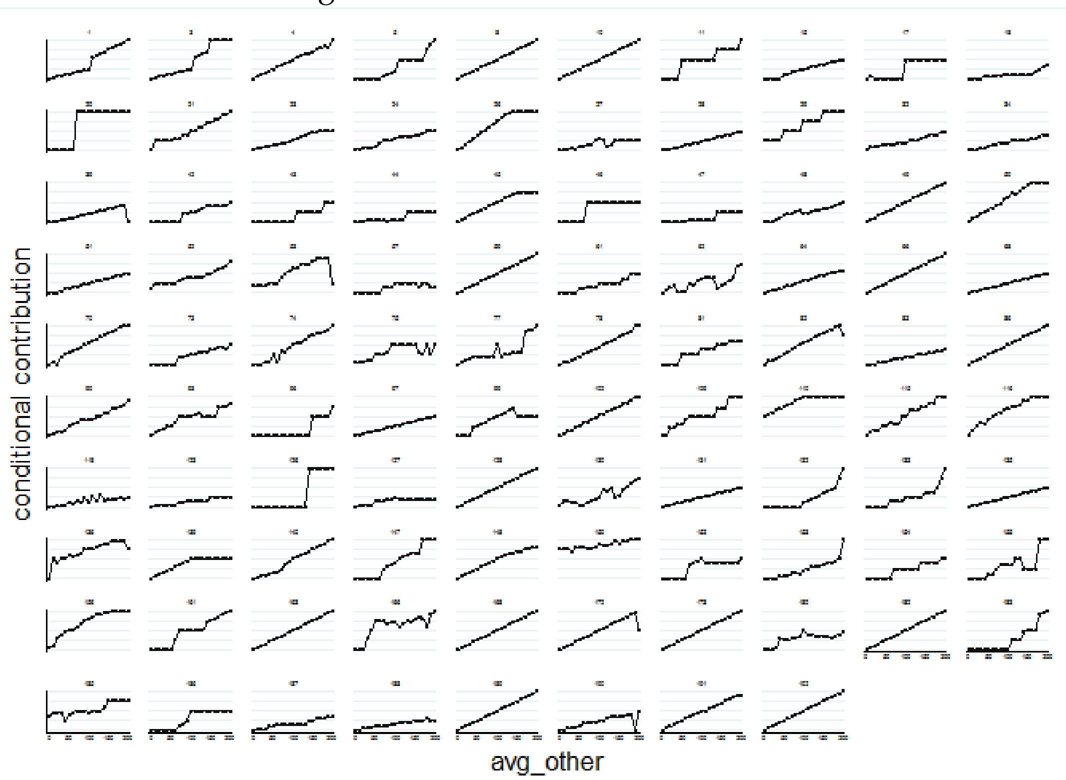


Figure 10: Contribution tables of residual category