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Are People Conditionally Cooperative? Evidence from a Public Goods Experiment

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Fischbacher, U; Gächter, S; Fehr, E

Fischbacher, U; Gächter, S; Fehr, E (2001). Are people conditionally cooperative? Evidence from a public goods experiment. *Economics Letters*, 71(3):397-404.

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Originally published at:
Economics Letters 2001, 71(3):397-404.

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Institute for Empirical Research in Economics
University of Zurich

Working Paper Series
ISSN 1424-0459

forthcoming: Economics Letters

Working Paper No. 16

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July 2000

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Evidence from a Public Goods Experiment

Urs Fischbacher*, Simon Gächter[†] and Ernst Fehr[‡]

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Abstract

We study the importance of conditional cooperation in a one-shot public goods game by using a variant of the strategy-method. We find that a third of the subjects can be classified as free riders, whereas 50 percent are conditional cooperators.

JEL-Classification: H41, C91.

Keywords: voluntary contributions, conditional cooperation, free riding, strategy-method, experiments.

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1 Introduction

In public goods experiments one observes that people cooperate much more than predicted by standard economic theory assuming rational and selfish individuals. However, observed cooperation is heterogeneous and declining over time. One possible explanation, which is investigated in this paper, is the assumption that there are “*conditional cooperators*”, i.e., people who are willing to contribute the more to a public good the more others contribute. Conditional cooperation can be considered as a motivation in its own or be a consequence of some fairness preferences like “altruism”, “warm-glow”, “inequity aversion” or “reciprocity”. In the recent literature, such “non-standard” motivations have received a lot of attention as explanations for the observed contribution behavior in public goods-type situations.¹ In this paper, we report the results of an experiment that *directly* elicits subjects’ willingness for conditional cooperation.² Our examination of the importance of conditional cooperation is based on a novel experimental design described in detail in Section 2. The central feature of our design is that we apply a variant of the so-called “strategy method” (Selten 1967) to elicit subjects’ preferences. Put differently, the subjects’ main task in the experiment is to indicate *for each average contribution level of other group members* how much they want to contribute to the public good.

In Section 3 we present the main results of our investigation. According

¹See, for example, Sugden (1984), Andreoni (1995), Palfrey and Prisbrey (1997), Anderson, Goeree and Holt (1998), Croson (1998), Sonnemans, Schram and Offerman (1999), Keser and van Winden (2000) and Brandts and Schram (forthcoming).

²The above-mentioned papers by Croson (1998), Sonnemans, Schram and Offerman (1999), Keser and van Winden (2000) and Brandts and Schram (forthcoming) also investigate “conditional cooperation”. However, in contrast to our experiment the approaches in these papers are much more indirect. The evidence on conditional cooperation found in these papers is inferred from particular data patterns.

to our data, roughly 50 percent of the subjects show conditional behavior such that the own contribution increases in the other group members' average contribution. A third of the subjects can be characterized as free riders. The conditional contribution patterns of about 14 percent are “hump-shaped”.

Given the observed pattern of conditional cooperation, the often observed decay of cooperation in a repeated public goods game can be explained as a reaction to the other players' contributions. In the concluding section we discuss this in more detail.

2 Experimental Design and Procedures

The decision situation in which the experiment was embedded is a standard linear public goods game (see Ledyard 1995). Each of four individuals decides how to spend twenty tokens. A subject can either keep these tokens for herself or invest them into a so-called ‘project’. The pecuniary payoff function that was explained to the subjects was the following:

$$\pi_i = 20 - g_i + 0.4 \sum_{j=1}^4 g_j \quad (1)$$

For simplicity, the size of the project, i.e., the public good, is just given by the sum of all contributions g_j to it. The marginal payoff of a contribution to the public good is 0.4 tokens. Hence, under standard assumptions the prediction is complete free riding by all subjects.

The above public good problem was explained to the subjects in the instructions. After subjects had read the instructions they had to answer ten control questions that tested their understanding of this public goods problem. All subjects successfully solved all ten control questions. This indicates that the subjects understood the mechanics and the implications

of the above payoff function.

After all participants had finished the control questions the subjects were introduced to the actual decision situation. Specifically, subjects were asked to make two types of contribution decisions. The first type of contribution decision was called “*unconditional contribution*” and the second type of decision was called “*contribution table*”. Subjects had to make both types of decisions without knowing the others’ decisions. To ensure thoughtful decisions, we gave subjects plenty of time to make their decisions (i.e., we did not impose a time limit).

The “unconditional contribution” was just a *single* decision about how many of the 20 tokens to invest into the “project”, i.e., into the public good. After subjects had made their unconditional contribution decision, a new screen appeared where they now had to fill out a “contribution table”, i.e., we applied a variant of the “strategy method” (Selten 1967). Subjects were told that they have to indicate for *each* of the 21 possible average contribution levels of the other group members (rounded to integers) how much they are willing to contribute to the public good. Whereas the unconditional contribution decision just asked for the “usual” type of decision, the contribution table elicits a contribution *schedule* (i.e., a vector of contributions).

To give subjects a monetary incentive to take both types of decisions seriously and to ensure that potentially all decisions can become contributions to a public good, we employed the following procedure. Subjects were told that, after they have made *both* types of decisions, a random mechanism will determine which of the two decisions will become relevant for the determination of actual payoffs.³ In each group, for *one* randomly chosen

³The random mechanism worked as follows. In each group, each group member was given a ‘member number’ between 1 and 4. At the very beginning of the experiment, when subjects were randomly allocated to the computers, one participant was randomly selected to employ the random mechanism at this stage of the experiment. Subjects were

subject the contribution table became this subject's relevant decision. For the other three group members their unconditional contribution was their relevant contribution decision. For each subject, the probability that the contribution schedule will be the payoff-relevant decision was $1/4$. This procedure ensures that both, all entries in the contribution table, as well as the unconditional contributions, are potentially payoff relevant for *all* subjects.⁴

Our experiment can be considered as the following extensive form game played with the strategy-method: First, nature chooses three players who simultaneously have to make their contribution decisions. The fourth player learns the (rounded) average contribution of the other players and then decides how much to contribute. All players learn whether they are the fourth player or not. If they are not chosen to be the fourth player, they do not learn *who* is chosen. For rational and selfish players, we get the following prediction: For the fourth player it is optimal to contribute zero - independent of the contributions of the other players. Hence, with the strategy method rational and selfish players should have only "0" entries in their contribution schedules. Assuming common knowledge of rationality

told that this participant will - *after* all decisions have been made - throw a 4-sided die to determine for which group member 1 to 4 the contribution table is the relevant decision.

⁴An example illustrates the point. Assume that the four group members make an unconditional contribution of 4, 6, 8, and 10 tokens, respectively. Assume that the random mechanism determines that for the fourth subject, whose unconditional contribution is 10 tokens, the contribution table becomes the payoff-relevant decision, while for the other three group members their unconditional contributions are payoff-relevant. The average of their unconditional contributions is, therefore, 6 tokens. Assume the contribution table of the fourth subject says that she will contribute 5 tokens in case the others contribute 6 tokens, then her contribution to the public good was taken to be 5 tokens. In this example the sum of all contributions is, therefore, 23 tokens. Individual payoffs can now be calculated according to payoff function (1). To render this method for the calculation of payoffs transparent, the instructions contained several examples like this.

and selfishness, also the players who have to make simultaneous contribution decisions will contribute zero to the public good.⁵

Contrary to many other experiments, this one was only played *once*, i.e., there were no repetitions and this was known to the subjects. The reason for this is that we are interested in eliciting *preferences* and therefore did not want to complicate matters by “intertemporal” considerations of strategy choices. For example, if a subject chooses a contribution table that is increasing in the average contribution of others, this cannot be due to reputation formation or any kind of repeated game consideration. Instead, it can be taken as an unambiguous measure of the subject’s willingness to be conditionally cooperative.

The experiments were conducted in the computerized experimental lab of the University of Zurich. We used the experimental software “z-Tree” developed by Fischbacher (1999). Subjects were first and second-semester undergraduates from various fields (except economics). We conducted two experimental sessions in which 44 subjects participated. These subjects formed a total of eleven groups of four subjects. Since all subjects played only once, all 44 decisions are independent observations. To give subjects an incentive to take the experiment seriously we chose a relatively high stake level. On average subjects earned 27.6 Swiss Francs (about \$ 21).

⁵If we lift the assumption of *common knowledge* of rationality, the latter prediction does not necessarily hold anymore. If players assume that a ‘fourth player’ is a “conditional cooperator” who displays an pattern of increasing contributions in her schedule then it may be optimal to make “non-zero” *unconditional* contributions. However, for the prediction of the *conditional* contribution, only rationality and selfishness is assumed. In this paper, we are mainly interested in the contribution schedule and not in the unconditional contribution.

3 Results

Our main interest concerns subjects' contribution decisions in the "contribution table", i.e., their elicited willingness to contribute given the average contribution level of others. Figure 1 contains our main result.

Although it was common knowledge that this game will be played only once, the average contribution vector is not characterized by complete free riding. The mean contribution (the bold line in figure 1) is clearly increasing in the average contribution of other group members. Thus, on average, subjects display conditional cooperation.

However, an inspection of the data at the individual level shows that subjects are *heterogenous*. Figure 2 contains the individual schedules of all 44 subjects. Basically, subjects' contribution decisions fall into three distinct categories.

FIGURE 1

FIGURE 2

Conditional cooperation. The contribution schedules of 22 subjects (i.e., 50 percent) fall into this category. Sixteen of them are both increasing and (weakly) monotonic. Four of these sixteen subjects are perfectly conditionally cooperative, i.e., their contribution table is exactly on the diagonal. In other words, these subjects always want to exactly match the contributions of others. Five contribution schedules show an increasing trend but display sometimes (slight) negative deviations from the trend. These are strategies that are not monotonic in a strict sense but they all have a highly significant (at the 1-percent level) and positive Spearman rank correlation coefficient (between own and others' contribution). It is also noteworthy that only 11.9 percent of all entries of the conditionally cooperative subjects' contribution schedules are strictly above the diagonal. In other words, the bulk of all con-

ditionally cooperative contribution decisions lies at or below the diagonal. Most subjects who are conditionally cooperative deviate from the diagonal in the selfish direction. The observed average behavior in this category can thus be shortly described as “conditional cooperation with a self-serving bias”.

Free riding. Thirteen subjects (i.e., about 30 percent) can be classified as purely selfish or as insufficiently motivated by altruism or warm glow. They all submitted a contribution schedule that contained “0” in all 21 entries.

“Hump-shaped” contributions. Six subjects (or 14 percent) display such a contribution behavior. As can be seen from the figure, they are - on average - close to perfect conditional cooperation for contribution levels of up to ten tokens of the other group members. Beyond this level they steadily *reduce* their contributions.

“Other patterns”. One subject was willing to contribute 1 token for all contributions of other group members. The contribution vectors of two subjects do not show a readily interpretable pattern - except, perhaps, randomness.⁶

Remember that in our design we also asked subjects to make an “unconditional contribution”, primarily to render the contribution schedules payoff-relevant. We find that the total average over all 44 unconditional decisions is 6.7 tokens which corresponds to 33.5 percent of the endowment.⁷

⁶For clarity, they are not separately included in figure 1. They are, however, present in the total average over all subjects.

⁷A breakdown of the “unconditional contribution” made by the types summarized in figure 1 shows that the unconditional contributions are largely consistent with the observations of figure 1. Specifically, the mean (with standard deviations in parentheses) of the unconditional contributions of the different types of subjects are as follows. “Conditional cooperators”: 8.4 (6.3); “free riders”: 2.0 (5.3); “contributors with ‘hump-shaped’ schedules”: 9.0 (5.9); and “other patterns”: 12.7 (5.0).

4 Concluding Discussion: The Decline of Cooperation

Our results allow for a new, tentative, interpretation why we observe declining contributions in almost all public goods experiments. The key is given in figure 1. First, a non-negligible fraction of subjects free rides regardless of others' contribution. Second, even those who are conditionally cooperative display a bias in the self-serving direction in that they contribute less than the others do on average.⁸ Under the assumption that the elicited preferences are stable (i.e., the assumption that these schedules do not change with experience)⁹ contributions in repeated interactions are expected to “spiral downwards” over time. Since subjects react on average conditionally cooperatively on other subjects' contributions (but with bias in the selfish direction) positive, but deteriorating contributions to the public good are observed. The speed of convergence depends on the actual composition of the group. Positive *and stable* contributions to the public good are very unlikely. Put differently, despite a majority of conditional cooperators, free riding will be pervasive under conditions of anonymous interactions.

Acknowledgments. This paper is part of the EU-TMR Research Network ENDEAR (FMRX-CT98-0238). Support from the Swiss National Science Foundation under the project no. 1214-051000.97 and from the MacArthur Foundation Network on Economic Environments and the Evolution of Individual Preferences and Social Norms is also gratefully acknowledged. We thank Armin Falk, Claudia Keser, Axel Ockenfels, Arthur Schram and seminar participants at the University of Amsterdam, the GEW workshop in Meissen and the European Economic Association Meeting in Santiago de

⁸Ockenfels (1999), in a comparable design, gets results similar to ours.

⁹To test this stability, we asked the subjects in a *post*-experimental questionnaire again to fill out a hypothetical “contribution table”. It turned out that the results are almost identical to the schedules submitted in the actual experiment.

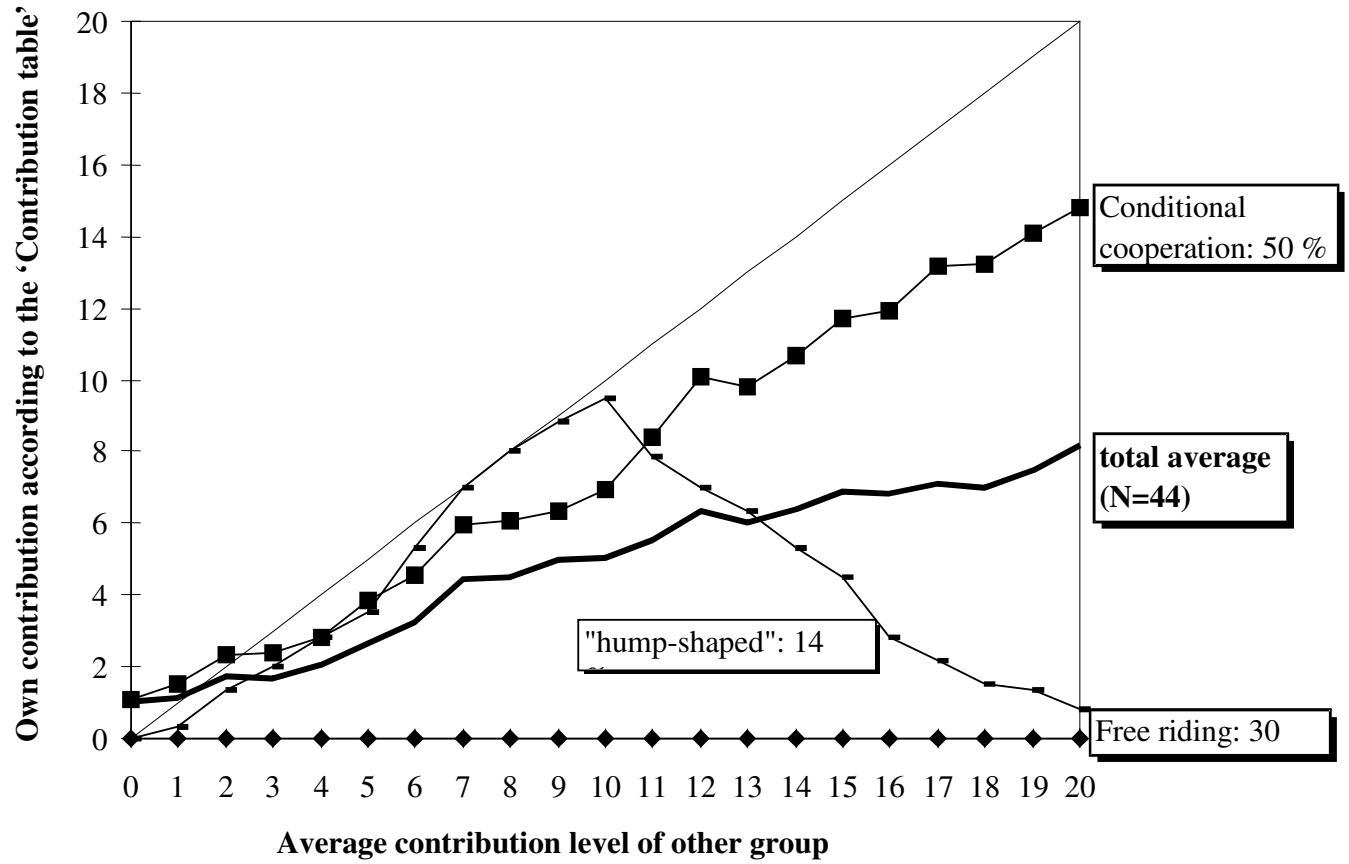
Compostela for their helpful comments.

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Figure 1: Average own contribution level for each average contribution level of other members (Diagonal= perfect conditional)



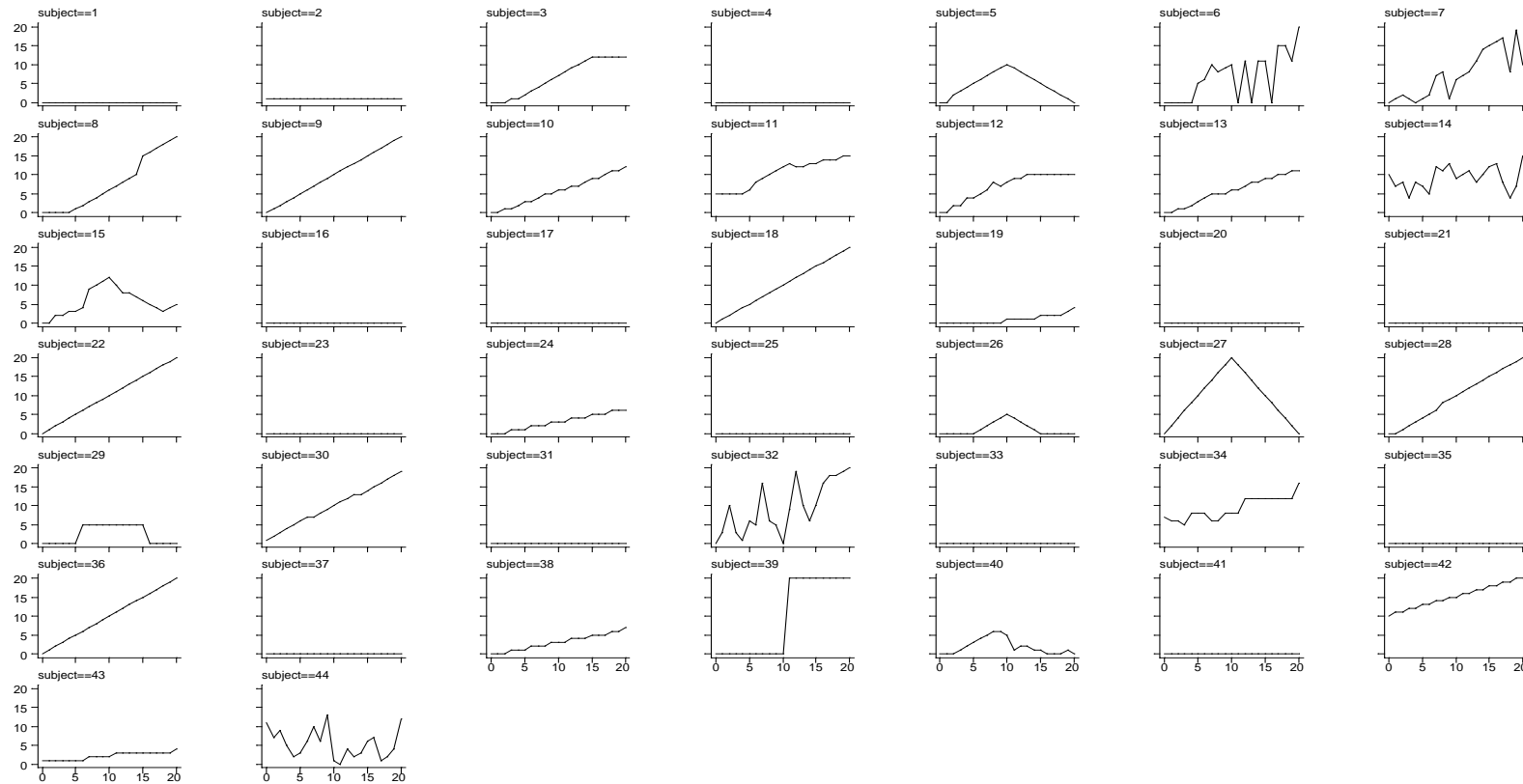


Figure 2: The contribution schedules of all subjects

Contribution other group members Contribution schedules per subject

Note: Subjects were classified as follows: *Free-riders*: Subjects no. 1, 4, 16, 17, 20, 21, 23, 25, 31, 33, 35, 37, 41;

Conditional Cooperators (Spearman's $\rho > 0$ at p-value < 0.001): Subjects no. 3, 6, 7, 8, 9, 10, 11, 12, 13, 18, 19, 22, 24, 28, 30, 32, 34, 36, 38, 39, 42, 43;

"Hump-Shaped": Subjects no. 5, 15, 26, 27, 29, 40;

Other patterns: Subjects no. 2 (unconditional cooperation of 1 token), 14, 44 (random patterns).

Experimental Instructions (originally in German)

You are now taking part in an economic experiment which has been financed by various foundations for research promotion. If you read the following instructions carefully, you can, depending on your decisions, earn a considerable amount of money. It is therefore very important that you read these instructions with care.

The instructions which we have distributed to you, are solely for your private information. It is prohibited to communicate with the other participants during the experiment. Should you have any questions please ask us. If you violate this rule, we shall have to exclude you from the experiment and from all payments.

During the experiment we will not speak of Francs but rather of points. During the experiment your entire earnings will be calculated in points. At the end of the experiment the total amount of points you have earned will be converted to Francs at the following rate:

$$1 \text{ point} = 35 \text{ Rappen}$$

All participants will be divided in groups of four members. Except us, the experimenters, nobody knows who is in which group.

The decision situation

You will learn later on how the experiment will be conducted. We first introduce you to the basic decision situation. At the end of the description of the decision you will find control questions that help you to gain an understanding of the decision situation.

You will be a member of a group of 4 people. Each member has to decide on the division of 20 tokens. You can put these 20 tokens on a private account or you can invest them fully or partially into a project. Each token you do not invest into the project will automatically be transferred to your private account.

Your income from the private account:

For each token you put on your private account you will earn exactly one point. For example, if you put twenty tokens on your private account (which implies that you do not invest anything into the project) you will earn exactly twenty tokens from the private account. If you put 6 tokens into the private account, you will receive an income of 6 tokens from the private account. Nobody except you earns something from your private account.

Your income from the project

From the token amount you invest into the project each group member will get the same payoff. Of course, you will also get a payoff from the tokens the other group members invest into the project. For each group member the income from the project will be determined as follows:

$$\text{Income from the project} = \text{sum of contributions to the project} \times 0.4.$$

For example, if the sum of all contributions to the project is 60 tokens, then you and all other group members will get a payoff of $60 \times .4 = 24$ points from the project. If the four group members together contribute 10 tokens to the project, you and all others will get a payoff of $10 \times .4 = 4$ points from the project.

Your total income

Your total income results from the summation of your income from the private account and your income from the project.

$$\text{Income from the private account} (= 20 - \text{contribution to the project}) + \text{Income from the project} (= .4 \times \text{Sum of contributions to the project}) = \text{total income}.$$

Control questions

Please answer the following control questions. Their purpose is to make you familiar with the calculation of incomes that accrue from different decisions about the allocation of 20 tokens.

1. Each group member has 20 tokens at his or her disposal. Assume that none of the four group members (including you) contributes anything to the project. What will your total income be? What is the total income of the other group members?

2. Each group member has 20 tokens at his or her disposal. Assume that you invest 20 tokens into the project and each of the other group members also invests 20 tokens. What will be your total income? What is the total income of the other group members?

3. Each group member has 20 tokens at his or her disposal. Assume that the other three group members together contribute 30 tokens to the project.

What is your total income if you - in addition to the 30 tokens - contribute 0 tokens to the project?

What is your income if you - in addition to the 30 tokens - contribute 8 tokens to the project?

What is your income if you - in addition to the 30 tokens - contribute 15 tokens to the project?

4. Each group member has 20 tokens at his or her disposal. Assume that you invest 8 tokens to the project.

What is your total income if the other group members - in addition to your 8 tokens - together contribute 7 tokens to the project?

What is your total income if the other group members - in addition to your 8 tokens - together contribute 12 tokens to the project?

What is your income if the other group members - in addition to your 8 tokens - contribute 22 tokens to the project?

If you finish these questions before the others, we advise you to think about additional examples to further familiarize yourself with the decision situation.

The Experiment

The experiment contains the decision situation that we have just described to you. At the end of the experiment you will get paid according to the decisions you make in this experiment. The experiment will only be conducted once.

As you know you will have 20 tokens at your disposal. You can put them into a private account or you can invest them into a project. In this experiment each subject has to make two types of decisions. In the following we will call them “unconditional contribution” and “contribution table”.

- With the unconditional contribution to the project you have to decide how many of the 20 tokens you want to invest into the project. You will enter this amount into the following computer screen:

Periode 1 von 1 Verbleibende Zeit [sec]: 22

Ihr unbedingter Beitrag zum Projekt

OK

Hilfe
Bitte geben Sie den unbedingten Beitrag zum Projekt ein. Drücken Sie "OK", wenn Sie fertig sind.

- After you have determined your unconditional contribution you press the "OK"-button.
- Your second task is to fill out a "contribution table". In the contribution table you have to indicate for each possible average contribution of the other group members (rounded to the next integer) how many tokens you want to contribute to the project. You can condition your contribution on the contribution of the other group members. This will be immediately clear to you if you take a look at the following screen. This screen will show up immediately after you have determined your unconditional contribution.

Periode 1 von 1 Verbleibende Zeit [sec]: 28

Ihr bedingter Beitrag zum Projekt (Beitragstabelle)

0	<input type="text"/>	7	<input type="text"/>	14	<input type="text"/>
1	<input type="text"/>	8	<input type="text"/>	15	<input type="text"/>
2	<input type="text"/>	9	<input type="text"/>	16	<input type="text"/>
3	<input type="text"/>	10	<input type="text"/>	17	<input type="text"/>
4	<input type="text"/>	11	<input type="text"/>	18	<input type="text"/>
5	<input type="text"/>	12	<input type="text"/>	19	<input type="text"/>
6	<input type="text"/>	13	<input type="text"/>	20	<input type="text"/>

OK

Hilfe
Geben Sie in den Feldern ein, welchen Beitrag zum Projekt Sie leisten, wenn die anderen im Durchschnitt den Beitrag zum Projekt geleistet haben, der links vom Eingabefeld steht. Wenn Sie alles eingegeben haben, drücken Sie "OK".

The numbers next to the input boxes are the possible (rounded) average contributions of the other group members to the project. You simply have to insert into each input box how many tokens you will contribute to the project - conditional on the indicated average contribution. You have to make an entry into each input box. For example, you will have to indicate how much you contribute to the project if the others contribute 0 tokens to the project, how much you contribute if the others contribute 1, 2, or 3 tokens etc. In each input box you can insert all integer numbers from 0 to 20. If you have made an entry in each input box, press the OK-button.

After all participants of the experiment have made an unconditional contribution and have filled out their contribution table, in each group a random mechanism will select a group member. For the randomly determined subject only the contribution table will be the payoff-relevant decision. For the other three group members that are not selected by the random mechanism, only the unconditional contribution will be the payoff-relevant decision. When you make your unconditional contribution and when you fill out the contribution table you of course do not know whether you will be selected by the random mechanism. You will therefore have to think carefully about both types of decisions because both can become relevant for you. Two examples should make that clear.

- EXAMPLE 1: Assume that you have been selected by the random mechanism. This implies that your relevant decision will be your contribution table. For the other three group members the unconditional contribution is the relevant decision. Assume they have made unconditional contributions of 0, 2, and 4 tokens. The average contribution of these three group members, therefore, is 2 tokens. If you have indicated in your contribution table that you will contribute 1 token if the others contribute 2 tokens on average, then the total contribution to the project is given by $0+2+4+1 = 7$ tokens. All group members, therefore, earn $.4 \times 7 = 2.8$ points from the project plus their respective income from the private account. If you have instead indicated in your contribution table that you will contribute 19 tokens if the others contribute two tokens on average, then the total contribution of the group to the project is given by $0 + 2 + 4 + 19 = 25$. All group members therefore earn $.4 \times 25 = 10$ points from the project plus their respective income from the private account.
- EXAMPLE 2: Assume that you have not been selected by the random mechanism which implies that for you and two other group members the unconditional contribution is taken as the payoff-relevant decision. Assume

your unconditional contribution is 16 tokens and those of the other two group members is 18 and 20 tokens. The average unconditional contribution of you and the two other group members, therefore, is 18 tokens. If the group member who has been selected by the random mechanism indicates in her contribution table that she will contribute 1 token if the other three group members contribute on average 18 tokens, then the total contribution of the group to the project is given by $16 + 18 + 20 + 1 = 55$ tokens. All group members will therefore earn $.4 \times 55 = 22$ points from the project plus their respective income from the private account. If instead the randomly selected group member indicates in her contribution table that she contributes 19 if the others contribute on average 18 tokens, then the total contribution of that group to the project is $16 + 18 + 20 + 19 = 73$ tokens. All group members will therefore earn $.4 \times 73 = 29.2$ points from the project plus their respective income from the private account.

The random selection of the participants will be implemented as follows. Each group member is assigned a number between 1 and 4. As you remember, at the very beginning a participant, namely B2, was randomly selected. This participant will, after all participants have made their unconditional contribution and have filled out their contribution table, throw a 4-sided die. The number that shows up will be entered into the computer. If B2 throws the membership number that has been assigned to you, then for you your contribution table will be relevant and for the other group members the unconditional contribution will be the payoff-relevant decision. Otherwise, your unconditional contribution is the relevant decision.

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