Strategic Behavior in Public Good Games:

When Partners Really Become Strangers

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Abstract

We use a new design to (re)examine the occurrence of strategic behavior in voluntary contributions mechanism experiments. Subjects are in groups that remain constant for a number of periods before they change. The change is public knowledge and always consists of one member switching to another group. Moreover, everyone knows that this individual will not be grouped with any of the members again. In this sense 'partners' really become 'strangers'. We find considerable evidence of strategic behavior in these relatively simple games. Subjects who leave their group contribute less than in the previous period and less than in the next period in their new group. Contribution levels decline with the number of periods remaining for the group. The results can be explained by the occurrence of conditional cooperators, who are willing to contribute if and only if enough others do the same. The presence of these subjects elicits strategic (forward looking) behavior from others.

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1. Introduction

The experimental literature on the voluntary provision of public goods is booming. In laboratories all over the world, economists are using variants of the voluntary contribution mechanism (vcm) to test various theories about individual contributions to these goods. For a recent, but already partly outdated overview, see Ledyard (1995). In this literature, there appears to be consensus with respect to the conclusion that many subjects contribute to a public good, even when it is a dominant strategy not to do so. The reason why subjects do so is subject to debate, however. This note attempts to contribute to this debate by presenting an innovation to the typical vcm design, that allows one to study strategic behavior more explicitly than previous designs[1].

In vcm experiments subjects are allocated to groups and they typically have to divide an endowment between a private and a public (group) account. The money in the public account is multiplied by some factor and divided between all group members, irrespective of their contribution, while only the owner profits from the private account. If this game is played only once, the dominant strategy is to contribute nothing at all (free ride). All players free ride in the subgame perfect equilibrium of the finitely repeated game as well. However, a general conclusion in public good experiments is that free riding is not complete in one-shot trials or in early rounds of finitely repeated trials, and that contributions typically decay with repetition (Ledyard 1995, p 121).

Learning and strategic behavior may both play a role when the game is repeated (Andreoni 1988). Repetition may allow subjects to learn the incentives and the subgame perfect equilibrium. But repetition may also allow subjects to use multi-period, forward looking, strategies like trigger strategies (cf. tit for tat in a 2 person game) to promote cooperation. Andreoni (1988) used a clever design to examine both hypotheses. In his 'strangers' condition group composition randomly changes from period to period. In the 'partners' condition the group composition remains the same throughout the experiment. After the announced final (10th) period, Andreoni's experiment was restarted by surprise and a few additional periods were played. The rationale of this design is that learning is possible in both conditions, while strategic behavior is only possible in the partners condition. The results are surprising: strangers contributed more than partners, and the restart caused contributions to rise temporarily in strangers and more lasting in partners. The learning hypothesis predicts no difference between partners and strangers and no effect of the restart, and can therefore be rejected. Rational strategic behavior is expected to enhance cooperation, and the opposite is observed, so the strategic behavior hypothesis should be rejected as well. It has proven difficult to replicate Andreoni's results. Weimann (1994) for example, finds no difference in contributions between partners and strangers, nor does Offerman (1996) in an analysis of steplevel public goods. For an overview of this discussion see Keser and van Winden (1996).

[1] In this note, we focus on our design, a motivation for it, and the results of the experiment. For an extensive discussion of the relevant literature, we refer to other papers.

These inconsistent results suggest that the role of strategic behavior in public good games is still unresolved. To contribute to this discussion, we introduce a new design. The traditional strangers set-up has two specific features that may have a strong effect on the results. First of all, all subjects switch groups simultaneously. Therefore, it is not possible to establish whether effects are due to subjects themselves switching, or because others are leaving the group. Second, subjects are in the same group with some others, in various periods. It is possible that subjects in the strangers condition overestimate the possibility that they will meet former group members in the future and that they overestimate the effect of their behavior on the future behavior of others. They may see all participants in their session as one group, and try to influence the behavior of the whole group. If this is the case subjects may act strategically even in a strangers condition.

In our design we control for the possibility of strategic behavior more rigorously. In each session 4 groups of 4 members play 36 periods of a public good game with binary contributions. Group composition remains constant for a minimum of 3 and a maximum of 12 periods. Groups change only gradually, in the sense that at most one subject at the time may leave the group and be replaced by a new member. Group composition and changes thereof are public knowledge. A subject who leaves a group is sure that she will never meet her former group members in another group, so strategic behavior is impossible in the last period before leaving the group, while strategic behavior is still possible in other periods. Hence, this design is a combination of a partners and a ‘real’ strangers treatment. In addition, we (incentive compatibly) measure the expectations subjects form about the behavior of other group members.

This design, elaborated in section 2, has various advantages. It allows us to study into the occurrence of strategic behavior at the individual level. The design enables a comparison of behavior between subjects (e.g. contributions of subjects who leave a group versus subjects who stay) as well as within subjects (e.g. the last period before leaving a group and the first period in a new group). In addition, the measurement of expectations combined with the choices, gives us information about the individual motivations. The between and within subject comparison and the confrontation of expectations with choices are in contrast with traditional designs which can only focus on the group performance (e.g. decreasing contributions).

The organization of the remainder of this note is as follows. Section 2 discusses the design of the experiment. Section 3 presents the results, section 4 discusses the strategic behavior in this experiment and section 5 concludes.

2. Design

A total of 85 subjects participated in 5 sessions. Five subjects were randomly allocated the role of observer (to assure the participants that no deceit was taking place). Of the 80 active participants, 46 were students of economics and 33 were known to be students of other departments; 22 were female and 57 were male and the gender of 1 is unknown to us. The average age was 22.5 years old. An average of 61.80 guilders (US$ 37,50) was earned by the subjects in about 2 hours.

Subjects start with reading the instructions (see appendix 1). These are computerized. Subjects have to answer some questions testing understanding. After everybody finishes the instructions, two practice periods are conducted where the decisions of the others are simulated and no money is involved (as explained to the participants).

The experiment consists of 36 periods. In each period 4 groups of 4 participants are formed. Participants find an envelope with a number between 1 and 16 on their table, and a scheme with the group composition in each period (the scheme is given in the appendix, in the form it is handed out to our subjects). Subjects can read in which group they will be in a period, how many periods the group will remain unchanged, and when, if ever, they will switch to another group. Group composition remains constant for at least 3 periods. When somebody leaves the group, (s)he will never meet former group members again.

In each period, a subject has to make two decisions, A and B. When making decision A, players have to chose between either 'buying a marker' at a cost of 60 cents, or not. Subjects receive a public payoff ('group revenue') depending on how many markers are bought in their group (see table 1). Buying a marker is equivalent to investing 60 cents in the public good, and gives a return of 40 cents to each member. Therefore, the marginal per capita return is .667.

	number of markers bought in the group				
	0	1	2	3	4
group revenue	60	100	140	180	220

A marker costs 60 cents.

Table 1: The payoff structure of the experiment, in cents.

The reason the payoff function is presented in this way, is that it makes it relatively easy to elicit beliefs. Before any information about the aggregate decisions of other group members is given, each subject is asked to report probabilities about how many of the others in her or his group will buy a marker (decision B). Subjects have to estimate the probabilities that exactly 0, exactly 1, exactly 2 and exactly 3 others will buy a marker. A quadratic scoring rule is used to encourage subjects to report their beliefs truthfully (Murphy and Winkler 1970). This incentive compatible method of eliciting probabilities was successfully used before in Offerman et al. (1996), which also includes an exhaustive discussion of its merits. If an individual reports $p(i)$ $0 \leq i \leq 3$ as the probability that exactly i of the others will buy a marker, and in reality j of the others buy a marker, then the payoff generated by this rule is be equal to:

$$Q(j) = a + 2 * b * p(j) - b * \sum_{i=0}^{3} [p(i)]^2$$

In the experiment, the parameters a and b are both set equal to 48. The scoring rule is given on a handout. It is stressed that subjects do not need mathematical understanding of the formula and that it is in the interest of the subject to report beliefs truthfully.

It is explained in the instructions that the payoff structure is the same for everybody and remains constant during the experiment. Choices are made simultaneously and anonymously and communication is prohibited.

3. Results

The results are summarized in 4 observations.

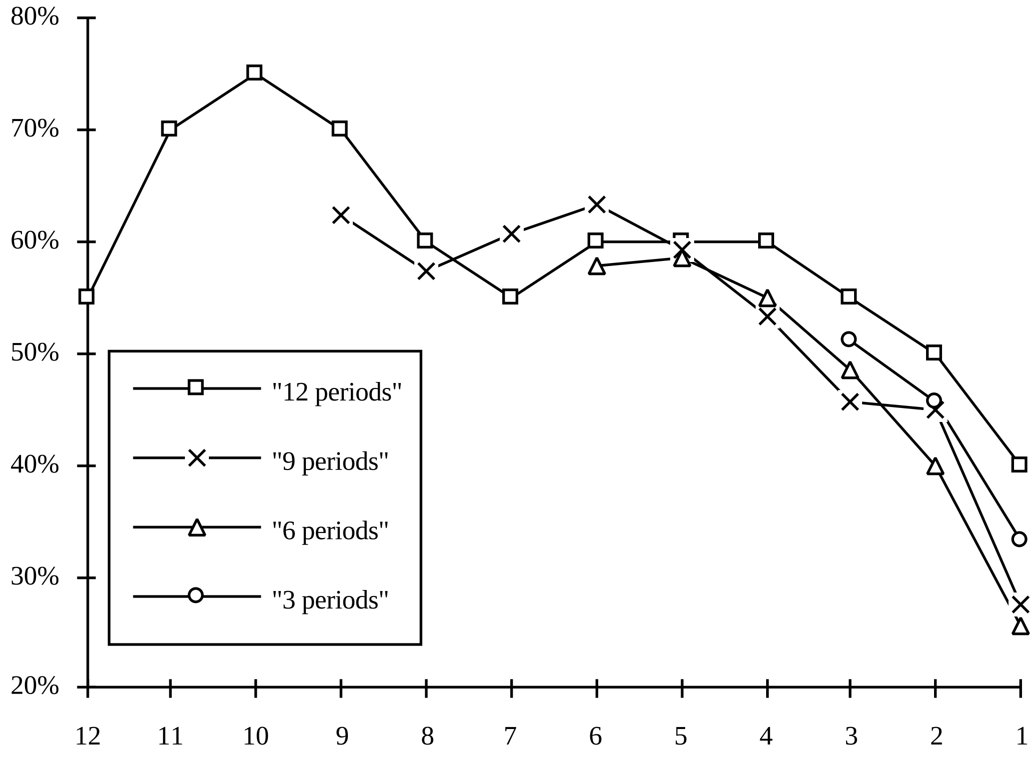

Figure 1: Proportion of contributions (Y-axis) by the number of periods to go before the group composition changes

Observation 1. *The number of contributions declines when approaching a change in group composition.*

Figure 1 shows the proportion of contributions for the various groups (see appendix 2 for the data). We distinguish the groups for which the composition stays constant for 3, 6, 9 or 12 periods. It is clear that the number of contributions declines with the number of remaining periods for the group. Contributions do not seem to be influenced by the history (how long have we been together) but by the future (how long will we stay together). This follows from the remarkable way in which the four series coincide. This indicates that subjects are (at least to some extent) forward looking.

Note that the pattern observed is similar to the decay generally observed in partner conditions (see Ledyard 1995, for a discussion). The interesting thing here is that it occurs even when only one of the four members will leave the group. Moreover, the contribution level at the start of a spell of partners (of 3, 6, 9 or 12 periods) seem to be mainly determined by the duration of the spell. To the best of our knowledge, this has not been observed before.

Observation 2a (between subjects): *Subjects who leave a group contribute less than subjects who stay.*
Observation 2b (within subjects): *In the last period before changing groups subjects contribute less than in the previous period and less than in the next period (in the new group).*
Table 2 displays the proportion of contributions in the different situations. Subjects who will leave their group contribute in 25% of the cases, and the members who will stay behind in 35% of the cases, a statistically significant difference (Wilcoxon test with sessions as observations, $p<0.05$).

Subjects who leave their group contribute in 25% of the cases, much less than in the previous period (47%; this number is not in the table) or in the next period (56%). These three numbers differ significantly (Wilcoxon test with sessions as observations, $p<0.05$).

Observation 3: *Subjects contribute more when they expect more contributions by others.*
Using the reported expectations, we find that, over all periods, subjects who contribute expect 2.00 others to contribute on average, and subjects who do not contribute expect 1.15 others to contribute on average (see table 3). The difference is statistically significant (Wilcoxon test with sessions as observations, $p<0.05$).

The reported expectations may be based on the outcome(s) in the previous period(s). Table 3 shows that the reported expectations are a better predictor of behavior than the outcome in the previous period (because $2.00-1.15>1.83-1.21$).

It turns out that the higher level of contribution after changes in group composition are expected by the subjects. Even though reported expectations and the observed outcome of the previous period are highly correlated ($R=.74$), one systematic deviation of expectation from previous observation occurs, to wit in the first period after a change of group composition. On average, subjects expect more contributions than they observed in the previous period if they themselves just changed groups (+.59) or if there is a new member in their group (+.48). The subjects are right in their expectations that contributions will be higher in those cases (the correct numbers are +.55 and +.68 respectively). This suggests that subjects anticipate strategic behavior.

	session					
	1	**2**	**3**	**4**	**5**	**total**
first period in group						
first period in new group	.55	.68	.64	.50	.45	.56
period 1	.63	.81	.63	.69	.56	.66
subtotal	.58	.74	.63	.58	.50	.61
last period in group						
last period in group before leaving	.32	.23	.27	.27	.18	.25
period 36	.25	.19	.25	.06	.19	.19
subtotal	.29	.21	.26	.18	.18	.23
composition of group changes						
last period before somebody else leaves	.36	.29	.38	.32	.38	.35
first period with new member	.44	.53	.56	.55	.58	.53
all other situations	.49	.49	.61	.53	.54	.53
total	.46	.47	.55	.49	.50	.49

Table 2: Proportion of contributions

	average number of contributions by others in the previous period	average expected number of contributions by others in the present period
no contribution	1.21	1.15
contribution	1.83	2.00
For Entire Population	1.51	1.57

Table 3: The first column shows the average contributions by others in the previous period, the second column the expected number of contributions by others in the present period.

Observation 4: *At least some subjects stop contributing if insufficient others contributed in the previous period.*

Table 4 shows indications that at least some subjects stop contributing if insufficient others contributed in the previous period. Note the clear correlation between the contribution rate and the previous contribution level of others. This correlation is only observed for those who contributed in the previous period, however. Subjects who contributed to the public good are more likely to switch to non-contribution the next period if only few others contributed. Note that if enough subjects use strategies of this kind, it may be rational for individualists to contribute. By doing so, they can 'lure' those subjects into maintaining their contributions. For example, if one expects that 3 others will contribute, and the group composition will remain the same for at least one more period, not contributing will save 20 cent this period (60 cents cost minus 40 cents return), but will cost on average 3*.15*40 cents= 18 cents the next period (the probability of contributing of each of the 3 others decreases by 97%-82%=15% cf. table 4). If the group composition will remain the same for more periods, contributing can be profitable if 3 or 2 others contribute.

	Previous own decision		
	no contribution	**contribution**	**total**
first period after group composition changed			
0 other contributed prev. per.	.46	.51	.47
1 other contributed prev. per.	.45	.71	.54
2 others contributed prev. per.	.50	.79	.60
3 others contributed prev. per.	.36	1.00	.70
last period before group composition changed, or period 36			
0 other contributed prev. per.	.13	.41	.19
1 other contributed prev. per.	.16	.42	.27
2 others contributed prev. per.	.15	.50	.32
3 others contributed prev. per.	.25	.58	.51
other periods			
0 other contributed prev. per.	.13	.39	.21
1 other contributed prev. per.	.20	.63	.42
2 others contributed prev. per.	.25	.82	.57
3 others contributed prev. per.	.18	.97	.78
Total			
0 other contributed prev. per.	.23	.42	.28
1 other contributed prev. per.	.25	.61	.42
2 others contributed prev. per.	.27	.77	.53
3 others contributed prev. per.	.20	.91	.73

Table 4: The proportion of cooperative decisions by the outcome of the previous period (own decision and the number of contributions by others).

4. Strategic behavior: the categorization of individuals

A few remarks about the nature of strategic behavior will be made and before we discuss the experimental evidence. Rational individuals may act strategically in a finitely repeated game because of incomplete information. One possible source of incomplete information is the value orientation of the other players (Offerman et al. 1996). Value orientation is a psychological concept which captures the individual attitude towards others. Individuals can be categorized as 'individualists', who want to do best for themselves, 'cooperators' who pursue the best for both themselves and others and 'altruists', who care for others irrespective of the consequences for themselves. The group of altruists is not observed very often (see Brandts and Schram 1996 or Palfrey and Prisbey 1995).

In a recent study Brandts and Schram (1996) argue that the cooperative motivation is of a specific type, which they call cooperative gain seeking. Cooperative gain seekers are willing to forgo the benefits from individual deviation if there are enough others doing the same. 'Enough others' in this case means that the cooperative gain seekers are making more money than they would if none of them contributed. For the relationship between this notion and various similar notions in the psychological and economic literature (including reciprocity), see Brandts and Schram (1996). In the present study, we also assume that cooperators are willing to forgo the gains from individual deviation if enough others do the same. We do not need to specify 'enough' however. By only assuming that cooperation is conditional on the contributions by others, we allow for the possibility that cooperative gains are in terms of utility instead of money earnings[2]. To stress this, we will refer to them as 'Conditional Cooperators' (CC) in this note. In a repeated game the expectations of the CC's are likely to be influenced by results in previous periods. In the extreme case, this backward lookingness yields strategies of the form "contribute if at least x others contributed in the previous period".

Next, consider the group of individualists. In case of complete information, they will not contribute. However; if a rational individualist assumes that some others in her group are CC's using the strategy described above, it may be optimal to contribute in early periods in order to induce these CC's to cooperate. Rational individualists will only contribute if they expect enough CC's in their group, and if that expectation is based on the outcomes of previous periods (Offerman et al 1995), they will start with a strategy of the same kind as the CC's do. Only in the last period before they leave the group, rational individualists will show themselves in their true colors and will not contribute.

The observations in the previous section show the occurrence of strategic behavior. The question arises whether this behavior can be explained by the presence of conditional cooperators, and the reactions of individualists to this presence. In other words, can we classify our subjects, based upon their behavior in the experiment, as individualists, conditional cooperators and altruists? In order to do this, we have to examine the decisions in the last period before leaving a group (including the last period of the experiment) because in other periods individualists may use strategies that disguise them as conditional cooperators. Note that it is our specific design that allows us to conduct the analysis that follows. It is not possible with traditional designs.

No subjects contributed in all periods, so no subjects can be labelled altruists. Somebody who contributes at least once in one of the last periods before leaving a group (or the last period of the experiment) cannot be an individualist and is therefore categorized as conditional cooperator. Somebody who never contributes in these last periods, can be either an individualist, or a

[2] Weimann 1994 uses the term 'exploitation aversion' in this context.

conditional cooperator who expects too few contributions of the others. Of the 80 subjects, 20 never changed groups during the experiment and have to be classified based upon only one decision (period 36). The other subjects changed groups 1, 2, or 3 times. Table 5 displays the categorization of the subjects. According to table 5 at least 31 subjects (39%) are conditional cooperators. The classification of the subjects on basis of their choices is supported by their answers in a post-experiment questionnaire: CC report a cooperative goal more often than other subjects do[3].

Conditional cooperators (CC) contribute if and only if they expect enough others to contribute, so we can check the correctness of the categorization by comparing the expectations of the CC in the last periods before leaving a group. The 26 subjects who sometimes contributed expected 1.27 others to contribute when they themselves did not contribute, versus 1.87 when they themselves did contribute. This difference is statistically significant (Wilcoxon test, 26 subjects as observations, p=0.01). These results imply that CC do exist in our subject population.

Contributions	**only period 36**	**more group changes**	**total**
(1) Never contributed	17	32	49
(2) Sometimes contributed	--	26	26
(3) Always contributed	3	2	5
total	20	60	80

Table 5: Number of subjects who never, sometimes, or always contributed in the last period before leaving a group. Category (1) contains individualists and conditional cooperators, categories (2) and (3) contain only conditional cooperators

5. Conclusions

In this study we used a new design to study strategic behavior in a public good game. In previous studies group compositions were either constant or randomly changed after each interaction. In life outside the laboratory, groups like communities, university faculties or families do not change after each interaction, nor do they stay constant forever: colleagues move to other jobs, family members are murdered and neighbors (or co-authors) go insane and have to be removed. In this sense the slowly changing groups of the present study are more realistic. Besides being more realistic, this design enables us to study strategic behavior in a very clear way because subjects who leave a group are completely sure they will never meet former group members again, and because we simultaneously have a partners and strangers design.

We found evidence of strategic behavior: (1) contribution levels decrease when approaching a change in group composition; (2) subjects who will change groups in the next period, contribute less than those who will stay, and also less than they themselves did in the previous period or in

[3] Subjects were asked to (dis)agree with the statement: "My goal in this experiment was to earn as much as possible together with the other participants", using a 7-point scale. The mean score of CC was 5.43, of other subjects it was 4.47, significant Mann Whitney p<.05.

the next one. However, we also observed evidence of more adaptive behavior; (3) subjects contribute more often if they expect more contributions by others; (4) some subjects seem to stop contributing if insufficient others contributed in the previous period. This combination of strategic and adaptive behavior may seem paradoxical at first sight. We have explained the observations by the heterogeneity of the population: some people act more strategically than others do.

It seems likely that the level of strategic reasoning is a function of the perceived difficulty of the game. The present public good game is fairly easy in the sense that a unique subgame perfect equilibrium exists in case of complete information. In case of incomplete information, subjects may believe that their own contributions may elicit future contributions by fellow group members. Strategic reasoning seems less likely in a more difficult game. In Offerman et al. (1995) subjects played a step level public good game. No dominant strategy exists in a such game and a difficult coordination problem arises. We found that subjects play this game unstrategically, as if they are playing a game against nature.

Nobody ever contributes in the subgame perfect equilibrium of the finitely repeated public good game with complete information. However, strategic contributions may be rational in case of incomplete information about the rationality or value orientation of other subjects. We found that especially value orientation may play an important role. The existence of conditional cooperators, who only contribute if they think others will do so as well, may cause rational individualists to contribute. In more or less stable situations cooperators have an influence on total contributions that go beyond their own contributions.

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Appendix 1: summary of the instructions

This experiment will last 36 periods.

Group composition

For each period you can read your group number on the group composition sheet. Group composition is constant for 3, 6, 9 or 12 periods. It will never happen that more than 1 person at a time will leave the group. Someone who leaves the group, will NEVER be in another group with one of his or her former group members.

In each period you will be asked to make two decisions. First, you will be asked whether you want to buy a marker or not (decision A). Then, you will be asked to estimate the probabilities of how many of the others in your group will buy a marker (decision B).

DECISION A: You will make the decision whether or not to buy a marker. The COSTS of buying a marker will be equal to 60 cents. The COSTS of buying a marker are equal for everybody and will not change in the 36 periods. You will get a revenue which depends on the number of members of your group that buy a marker. This revenue will be called the GROUP-REVENUE, because it is equal for everyone in a group.

number of markers	0	1	2	3	4
group revenue	60	100	140	180	220

Cost per marker: 60 cents

Your payoff in this part of the experiment, your MARKER-PAYOFF, will be equal to the GROUP-REVENUE, if you decide not to buy a marker, and will be equal to the GROUP-REVENUE minus the COSTS if you decide to buy a marker.

DECISION B: You will fill in the percentages which you assign to how many of the other participants in your group (excluding yourself!) choose to buy a marker. You will get a payoff depending on the number of markers bought by the others in your group and on the percentages you report: the PROBABILITY-PAYOFF. For the remainder of the experiment it is not important that you have mathematical understanding of the formula which is used to calculate the probability-payoff.

In principle it is sufficient to know that your expected PROBABILITY-PAYOFF is maximized if you report probabilities truthfully (the proof of this statement is available on request after the experiment has ended). So, it is advantageous for you to report probabilities as honestly as possible!

Here is the formula for those who are interested: call the reported percentages P_i for $0 \leq i \leq 3$, where P_i denotes the reported percentage that i of the other group-members choose to buy a marker. Calculate $p_i = P_i/100$ for all i between 0 and 3. If j of the other group-members choose to buy a marker, with $0 \leq j \leq 3$, you will receive a PROBABILITY-PAYOFF (referred to as PP) equal to:

$$48 + 96 * p_j - 48 * \sum_{i=0}^{3} [p_i]^2$$

Again, for the remainder of the experiment it is not important that you have mathematical understanding of this formula: when you have reported your probabilities and when everybody in your group has decided whether or not to buy a marker, you will automatically be told how much your PROBABILITY-PAYOFF is.

The group compositions

The group composition is given for each period. Participants who switch groups are printed in bold.
A border is printed around the periods in which the group does NOT change.

Period	Group 1				Group 2				Group 3				Group 4			
1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
2	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
3	1	2	3	4	5	6	**7**	8	9	10	11	12	13	**14**	15	16
4	1	2	3	4	5	6	**14**	8	9	10	11	12	13	**7**	15	16
5	1	2	3	4	5	6	14	8	9	10	11	12	13	7	15	16
6	**1**	2	3	4	5	**6**	14	8	9	10	11	12	13	7	15	16
7	**6**	2	3	4	5	**1**	14	8	9	10	11	12	13	7	15	16
8	6	2	3	4	5	1	14	8	9	10	11	12	13	7	15	16
9	6	2	3	4	5	1	14	**8**	9	10	11	**12**	13	7	15	16
10	6	2	3	4	5	1	14	**12**	9	10	11	**8**	13	7	15	16
11	6	2	3	4	5	1	14	12	9	10	11	8	13	7	15	16
12	6	2	3	4	5	1	14	12	9	**10**	11	8	13	7	15	**16**
13	6	2	3	4	5	1	14	12	9	**16**	11	8	13	7	15	**10**
14	6	2	3	4	5	1	14	12	9	16	11	8	13	7	15	10
15	6	2	**3**	4	5	1	14	12	9	16	11	8	13	7	**15**	10
16	6	2	**15**	4	5	1	14	12	9	16	11	8	13	7	**3**	10
17	6	2	15	4	5	1	14	12	9	16	11	8	13	7	3	10
18	6	**2**	15	4	5	1	14	12	9	16	**11**	8	13	7	3	10
19	6	**11**	15	4	5	1	14	12	9	16	**2**	8	13	7	3	10
20	6	11	15	4	5	1	14	12	9	16	2	8	13	7	3	10
21	6	11	15	4	5	**1**	14	12	9	16	2	8	13	7	**3**	10
22	6	11	15	4	5	**3**	14	12	9	16	2	8	13	7	**1**	10
23	6	11	15	4	5	3	14	12	9	16	2	8	13	7	1	10
24	6	**11**	15	4	5	3	14	**12**	9	16	2	8	13	7	1	10
25	6	**12**	15	4	5	3	14	**11**	9	16	2	8	13	7	1	10
26	6	12	15	4	5	3	14	11	9	16	2	8	13	7	1	10
27	6	12	15	4	5	**3**	14	11	9	16	**2**	8	13	7	1	10
28	6	12	15	4	5	**2**	14	11	9	16	**3**	8	13	7	1	10
29	6	12	15	4	5	2	14	11	9	16	3	8	13	7	1	10
30	6	12	15	4	5	2	14	**11**	9	16	3	8	13	7	1	**10**
31	6	12	15	4	5	2	14	**10**	9	16	3	8	13	7	1	**11**
32	6	12	15	4	5	2	14	10	9	16	3	8	13	7	1	11
33	6	12	**15**	4	5	2	14	10	9	**16**	3	8	13	7	1	11
34	6	12	**16**	4	5	2	14	10	9	**15**	3	8	13	7	1	11
35	6	12	16	4	5	2	14	10	9	15	3	8	13	7	1	11
36	6	12	16	4	5	2	14	10	9	15	3	8	13	7	1	11

Appendix 2: Summary of the data: mean contributions per group and period aggregated over all sessions.
--- means that there is a change in group composition (see instructions in appendix 1).

period	group1	group2	group3	group4
1	.60	.80	.75	.50
2	.45	.65	.70	.55
3	.35	.45	.55	.35
		---		---
4	.35	.30	.65	.55
5	.20	.30	.70	.35
6	.30	.35	.75	.50
	---	---		
7	.65	.35	.65	.60
8	.55	.35	.65	.55
9	.60	.35	.35	.30
		---	---	
10	.55	.55	.70	.30
11	.30	.70	.70	.35
12	.30	.75	.55	.20
			---	---
13	.25	.70	.55	.50
14	.25	.60	.55	.40
15	.15	.55	.60	.40
	---			---
16	.35	.60	.60	.60
17	.25	.60	.55	.60
18	.40	.60	.40	.60
	---		---	
19	.65	.55	.60	.50
20	.55	.50	.55	.45
21	.35	.40	.65	.25
		---		---
22	.30	.60	.65	.65
23	.25	.55	.75	.70
24	.05	.25	.70	.80
	---	---		
25	.55	.55	.65	.75
26	.60	.60	.65	.75
27	.55	.35	.45	.65
		---	---	
28	.60	.50	.55	.65
29	.50	.40	.70	.55
30	.50	.25	.60	.35
		---		---
31	.25	.55	.65	.55
32	.25	.60	.65	.65
33	.15	.65	.35	.70
	---		---	
34	.45	.50	.55	.50
35	.35	.50	.40	.20
36	.15	.30	.15	.15