

**CONDITIONAL PUNISHMENT AND COOPERATION:
A STRATEGY METHOD PUBLIC GOOD EXPERIMENT[†]**

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This version: 6 April 2010.

EXCEEDINGLY PRELIMINARY DRAFT

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Abstract

This paper reports the results of one-shot public good games with and without punishment, where both games are played in the strategy method. The study makes use of a within-groups design in which participants complete both one-shot games without receiving any feedback until the end of the session. Both games make use of a simplified three-person voluntary contribution mechanism in which it is possible to elicit the complete contribution or punishment strategy using only ten sets of contingent decisions. In the game without punishment, it is found that the selfish bias in conditional cooperation is significantly exacerbated when there is a mean-preserving spread in the contribution of the other players. This effect could not be detected in previous studies because they only elicited contributions conditional upon the average contributions of the other players. Contributions are found to be significantly higher when punishment is available, and half of the participants are willing to punish in at least one contingency. Punishment tends to be more severe the lower the contribution of the recipient – both in absolute terms and relative to that of the other player. However the strategy method also detects a surprising amount of antisocial punishment. One-third of those who ever punish are classified as strong antisocial punishers, and the punishment behaviour of these individuals is found to be essentially indiscriminate.

[†] I thank Bram Cadsby, Gary Charness, Glenn Harrison, Danielle Merrett, Charles Noussair, Stefan Palan, Robert Slonim and, especially, Simon Gächter for very valuable discussions regarding the design of this study. I also thank Tim Capon, Min-Taec Kim and Danielle Merrett for lab assistance, and the Faculty of Economics and Business at The University of Sydney for financial support.

INTRODUCTION

The capacity to punish free-riders in voluntary contribution experiments has attracted considerable interest as it has been found to sustain contribution at a level that is much higher than is typical when punishment is not available. Fehr and Gächter (2000, 2002) were the first to demonstrate experimentally that cooperators are willing to punish free-riders – even when doing so is costly and brings no prospect of any future benefit to the punisher – and that the availability of punishment can arrest the decay in contributions in repeated interactions.

This study aims to redress a significant limitation of the existing research on punishment in public good games. Previous research on punishment has relied on the traditional ‘direct-response’ mode of elicitation, in which participants are only asked to specify punishment decisions in response to some *actual specific contribution decisions* of the other group members. The problem is that this information is only ever sought, and thus revealed, for patterns of contribution that in fact arise in the course of play of the game. As a result, it is impossible to determine how punishment behaviour might have differed in the face of some alternative counterfactual pattern of contributions. In other words, the existing procedures only reveal *specific instances of punishment*, and not the full *underlying preference or willingness to engage in punishment*.

To redress this gap in previous research, this study extends the design of a voluntary contribution experiment with punishment to apply the ‘strategy method’ of elicitation, in which each participant is required to specify the punishment they would wish to assign in response to *every possible combination of contributions* of the other group members.

In the context of a public good game, the inherent difficulty of the strategy method arises because of the very large number of potential combinations of contributions. For the parameters used by Fehr and Gächter (2000, 2002), there are 21 possible integer levels of contribution from 0 to 20. With each participant assigned to a group with three other players, there are $21^3 = 9,261$ possible combinations of contributions, and thus $9,261 \times 3 = 27,783$ different punishments that need to be specified! Clearly, in order to make the strategy method operable, it will be necessary to simplify the strategy space of the game.

Fischbacher, Gächter and Fehr (2001) pioneer the application of the strategy method to a public good experiment *without* punishment. In their design, they reduce the number of responses that are elicited by asking each participant to specify their contributions conditional

upon each of 21 possible values of the *average* contribution of the other group members, rounded to the nearest integer. Using this procedure, they document a ‘selfish bias’ even among those who are classified as conditional cooperators, in the sense that these participants tend to fall somewhat short of matching the average contributions of others.

However, because Fischbacher, Gächter and Fehr (2001) only elicit conditional contributions as a function of the average of the other group members’ contributions, they cannot detect how contributions might vary with changes in the composition of that average. For a given average of the others’ contributions, it is quite possible that conditional contribution could be quite different in a scenario in which all contribute equally to one in which the same average is made up entirely of the contribution of a single individual. To address questions of this kind using the strategy method, it is necessary to elicit responses to *combinations of contributions* of the other group members, and not only to averages.

Accordingly, this study introduces the design of a simplified three-person voluntary contribution game with punishment, in which complete contribution or punishment strategies can be elicited using only ten sets of contingent decisions. This environment is then used as the basis to apply the strategy method in one-shot games both with and without punishment. A within-groups design is employed, and participants complete both one-shot games before they receive feedback on the outcomes of any of their decisions.

In the game without punishment, it is found that there are two sources of selfish bias in conditional contribution. Firstly, in cases where the other group members contribute equally, even those who are classified as conditional cooperators fall short of matching the others’ contributions. Secondly, conditional contribution declines even further in response to a mean-preserving spread in the others’ contributions.

Contributions are significantly higher when punishment is available than when it is not – even in a purely one-shot setting.¹ Half of the participants are willing to punish in at least one contingency, allaying the fear that the strategy method may fail to detect punishment because it takes away the emotional element from the interaction. In aggregate, those who contribute less tend to be punished more severely, but the severity of punishment is also responsive to the contribution of the recipient relative to that of the third player. Finally, the strategy

¹ Previous evidence on this point has been mixed: Walker and Halloran (2004) detect no effect, while Gächter and Herrmann (2009) find that there is an effect.

method also detects a surprising amount of antisocial punishment (Herrmann, Thöni and Gächter 2008), wherein punishment is directed toward someone whose contribution is greater than or equal to that of the punisher. However, contrary to the notion that such behaviour is an expression of disdain toward ‘do-gooders’, it is found that the punishment behaviour of strongly antisocial punishers is essentially indiscriminate.

DESIGN

Overview

In the experiments for this study, the basic decision environment is a linear public good game in which there are $n = 3$ players in each group, and the marginal per capital return is $a = 0.5$. Each player has an endowment of $y = 6$ ‘points’, and can choose one of four possible contribution levels: $c \in (0, 2, 4, 6)$. One can interpret these loosely as strong free-riding, weak free-riding, weak cooperation, and strong cooperation, respectively. For each player, there are thus ten possible combinations of the contributions of the other group members, namely $(0, 0)$, $(0, 2)$, $(0, 4)$, $(0, 6)$, $(2, 2)$, $(2, 4)$, $(2, 6)$, $(4, 4)$, $(4, 6)$, and $(6, 6)$. These are the ten cases to which each participant must respond under the strategy method.

Participants in each session complete two one-shot games: a game without punishment, and a game with punishment. Both games are played in the strategy method. The order in which the two games are played is counterbalanced across sessions, so as to allow the effect of either introducing or removing the punishment opportunity to be examined separately. Participants are paid for their decisions in both games, but they are not told anything about the second game until after they have completed the first one.

Importantly, participants do not receive any feedback on the results of their decisions in either of the games until after they have completed the second one. In particular, since they do not learn anything about the decisions of others in the first game until after they have made their decisions in the second one, each individual participant can be treated as an independent observation with respect to his or her decisions in both games. Nonetheless, for the purpose of computing their earnings, participants are told that they are never matched with any other participant twice in both games.

The use of a one-shot design makes it possible to isolate preferences toward cooperation and punishment in the absence of any strategic or reputational considerations. In such a setting,

there is no possible future gain that can ever accrue, either directly or indirectly, from contributing to the public good in the game without punishment, or from inflicting costly punishment in the game with punishment. Thus, following Gächter and Herrmann (2009), one can interpret contribution in the one-shot game without punishment as a measure of strong positive reciprocity, and punishment in the one-shot game with punishment as a measure of strong negative reciprocity.

The instructions for both games make use of a standard neutral framing, in which the public good is referred to as ‘contribution to a project’, and punishment is described as the assignment of ‘deduction points’. The instructions do not make any reference to public goods, punishment or sanctions.²

The game without punishment

The no-punishment game is an adaptation of the strategy method game as introduced by Fischbacher, Gächter and Fehr (2001) to study conditional cooperation in one-shot public good games without punishment. Each player makes two sets of decisions: an ‘unconditional’ contribution decision, and a ‘contribution table’ in which he or she can specify contributions conditional on the decisions of the other group members. Afterwards, one player from each group is randomly chosen to have his or her contribution determined by the contribution table, whereas for the other group members, the unconditional contribution is binding. Given these contributions, the earnings of each player are then given by:

$$\pi_i^{NP} = (y - c_i^{NP}) + a \cdot \sum_{j=1}^n c_j^{NP}$$

where the superscript *NP* denotes the game without punishment. In Fischbacher, Gächter and Fehr (2001), the entries in the contribution table correspond to each possible *average contribution* of the other group members (rounded to the nearest integer). However in this study, conditional contributions are elicited contingent upon every possible *combination of contributions* of the other group members. In this way, it is possible to examine the response in conditional contributions to a mean-preserving spread of the contributions of the other group members, for example from (4, 4) to (2, 6). Following Fischbacher, Gächter and Fehr (2001), each participant’s conditional contribution vector can also be inspected to classify

² Refer to the Appendix for the complete text of the instructions for the treatment order in which the no-punishment game is played first.

them either as a free-rider, a conditional cooperator, or as having some other contribution pattern (for example, a hump-shaped function).

The game with punishment

In the game with punishment, each player first makes an (unconditional) contribution decision, which need not be the same as in the game without punishment. Each player can then assign 0, 1, 2, or 3 punishment points to each of the other group members. Each punishment point costs one earnings point to the player who assigns it, and reduces the earnings of the recipient by $e = 3$ points. This is subject to the proviso that the punishment received from others cannot drive a player's earnings below zero. Nonetheless, it is possible for a player's earnings to become negative as a result of the cost of the punishment he or she assigns to others. In this event, the losses are deducted from a 'starting balance' of three points that was given to each participant at the very beginning of the session.³

In the game with punishment, each player only makes an unconditional contribution decision and there is no contribution table. At the time of making their punishment decisions, the participants do not know the actual contributions of the other group members. Instead, they are asked to make contingent punishment decisions for ten cases, corresponding to all ten possible combinations of the contributions of the other group members. Each case is presented on a separate screen, but there are 'Back' and 'Next' buttons provided to allow participants to review and revise their decisions in each of the cases prior to confirming them.

In each of the cases, the decision screen shows the participant's own contribution in the first column, the contributions of the other group members in the case under consideration, and the resulting (hypothetical) earnings of each group member from the contribution stage (before punishment). The contributions of the other group members are always presented in the order of lowest followed by highest, and each participant is only presented with the ten cases that are unique under this ordering convention. Thus, for example, it is not necessary to respond separately to the cases (0, 2) and (2, 0).⁴

³ There were 11 out of 123 participants for whom the value of the punishment received exceeded their earnings from the contribution stage. There were 12 out of 123 participants who went into a loss as a result of assigning punishment to others.

⁴ In the four cases in which the contributions of the other group members are equal, it is not necessary that the same amount of punishment be assigned to each of them.

At the end of the experiment, the computer looks up the actual contributions of the other group members to determine which case is applicable. Punishment points are only actually allocated for this case. To assign punishment to the other group members, the computer looks up the number of points that the participant elected to assign in that case. To determine the number of punishment points assigned to the participant, the same is done for the other group members. Given these punishment decisions, the earnings of each player are then given by:

$$\pi_i^P = \max \left\{ \left[(y - c_i^P) + a \cdot \sum_{j=1}^n c_j^P - e \cdot \sum_{j \neq i} p_{ji} \right], 0 \right\} - \sum_{j \neq i} p_{ij}$$

where the superscript P denotes the game with punishment, and p_{ij} is the number of punishment points assigned by i to j .

Elicitation of beliefs

In both games, participants' beliefs are elicited regarding the contributions of the other participants in the session. In previous studies, beliefs were elicited over the *average or total* contribution of the *other group members*.⁵ In this study, beliefs are elicited over the *entire distribution* of contributions of *all other participants in the session*. This is done by asking in how many cases out of 100 the participant expects the others to contribute 0, 2, 4, and 6 points. These beliefs are elicited using an incentive-compatible quadratic scoring rule.^{6,7}

In both the no-punishment and punishment games, each participant can earn up to two additional earnings points according to the accuracy of his or her estimates. The instructions explain carefully that a participant's earnings are higher the closer the reported estimates are to the actual contributions of the other participants in the session, and that it is not possible to lose points from making predictions.

In the game with punishment, participants' beliefs are also elicited regarding the number of deduction points they expect to receive from the other group members. This is again elicited

⁵ See Fischbacher and Gächter (2010), Gächter and Herrmann (2009), Gächter and Renner (2006), and Neugebauer, Perote, Schmidt and Loos (2009).

⁶ Refer to Rey-Biel (2009) and the references contained in Artinger, Exadaktylos, Koppel and Sääksvuori (2010) for related applications of the quadratic scoring rule from the literature on game theory.

⁷ Blanco, Engelmann, Koch and Normann (2010) note that the correlation between earnings from the game and earnings from beliefs is reduced when beliefs are elicited over the whole set of other players instead of just the matched players. This reduces the incentive to use stated beliefs as a hedge against adverse outcomes of decisions in the game, and may also make the possibility of hedging less prominent.

using an incentive-compatible quadratic scoring rule. Each participant can earn up to one additional earnings point according to the accuracy of his or her estimate.

In the context of a one-shot design with no feedback until the end of the session, there is no opportunity for participants to learn about the behaviour of others while the experiment is in progress. This means that the reported beliefs must derive from their own introspection based upon life experience outside of the laboratory.

Procedures

Given the one-shot nature of the design, it is essential to take care that participants have full understanding of the decision problem, so as to ensure that the results are not driven by confusion. To this end, participants were given ample time in which they could read the instructions carefully at their own pace and ask any questions privately to the experimenter. The experiment did not begin until all participants in the session correctly answered an extensive set of control questions. There were ten questions relating to earnings in the contribution stage without punishment, and an additional five questions regarding the punishment stage. There was no time limit for the completion of these questions. Before each game, the experimenter read aloud a summary of the instructions to ensure that all payoff-relevant information was common knowledge. Finally, there was no time limit for the participants to enter any of their decisions.

Participants and sessions

The experiments took place in the Behavioural Research Laboratory of the Faculty of Economics and Business at The University of Sydney in March 2010. A total of 60 participants took part in three ‘N-P’ sessions in which the no-punishment game was followed by the game with punishment. Another 63 participants took part in three ‘P-N’ sessions in which the treatment order was reversed. Each session involved between 18 and 24 participants.

Participants were drawn from a pool of nearly 2,000 undergraduate and postgraduate students from across all fields of study at The University of Sydney, who had expressed an interest in participating in experiments. For this study, it was decided to recruit only participants who had never previously participated in another experiment. A total of 13 of the 123 participants indicated that they knew one other participant in their session; no-one reported knowing more

than one. A total of 61 of the participants were female, and 62 were enrolled in the Faculty of Economics and Business. Of the latter, 14 indicated that their major was in Economics.

The average duration of each session was 90 minutes, and the average payment was AUD 28.3 (approximately USD 26.0 or EUR 19.4 at the time the experiments were conducted). The experiment was programmed using z-Tree (Fischbacher 2007) and the recruitment of participants was managed using ORSEE (Greiner 2004).

RESULTS

Unconditional contributions in the game without punishment

Figure 1 summarises the mean (unconditional) contributions to the public good in the two games separately by treatment order. In this Figure, the left-hand panel relates to the N-P sessions in which the game without punishment was played first, while the right-hand panel refers to the reverse P-N treatment order.

Before proceeding with the substance of the analysis, it is necessary to first test for the possibility of an order effect. In the case of the game without punishment, the mean unconditional contribution is 1.467 in the N-P treatment order, and 1.365 in the P-N order. The null hypothesis that these means are equal cannot be rejected in a two-sided independent-samples t -test ($p = 0.763$). Similarly, a Wilcoxon rank-sum test cannot reject the null hypothesis that the distribution is the same across the treatment orders ($p = 0.545$). Accordingly, the unconditional contribution data from the two treatment orders can be pooled for the purpose of the discussion that follows.

Result 1: In the game without punishment, the mean unconditional contribution to the public good is roughly one-quarter of the endowment. The modal allocation, chosen by over half of the participants, is to contribute nothing.

The mean contribution is 1.415 points or 24 percent of the endowment. This is somewhat lower than the figure of one-third obtained by Fischbacher, Gächter and Fehr (2001) in a Swiss subject pool using a similar design. The distribution of contributions is shown in Figure 2. A contribution of zero was chosen by 69 of the 123 participants (56 percent).

Conditional contributions in the game without punishment

Turning to the conditional contribution data, there is again no evidence of any order effect. There are ten entries in the contribution table, corresponding to the ten combinations of the contributions of the other group members. In all ten cases, the null hypothesis of no order effect cannot be rejected with $p \geq 0.325$ in a two-sided t -test, and $p \geq 0.265$ in a rank-sum test. Accordingly, the conditional contribution data from both treatment orders can be pooled for the purpose of the analysis that follows.

Result 2: In the conditional contribution table of the game without punishment, one-half of the participants always free ride, while one-third behave as conditional cooperators.

Figure 3 depicts the means of the conditional contribution data. ‘Player B’ refers to the lower contributor of the other group members, while the higher contributor is referred to as ‘Player C’. As one moves from front to back, the contribution of Player B increases from 0 through to 6. Similarly, the contribution of Player C increases from left to right.

As can be seen clearly in Figure 3, on average conditional contributions are increasing in the contributions of the other group members. However, the overall level of conditional contribution is rather low and, moreover, the averages conceal considerable heterogeneity in the data. Accordingly, it is instructive to extend the taxonomy in Fischbacher, Gächter and Fehr (2001) to classify the conditional contribution data into one of three categories.

In particular, a participant is classified as a free-rider if he or she enters zero in all ten entries of the contribution table. This was the case for 61 participants (50 percent). A participant is classified as a conditional cooperator if the ‘diagonal’ of his or her contribution table is weakly monotonically increasing: $c(0, 0) \leq c(2, 2)$, $c(2, 2) \leq c(4, 4)$ and $c(4, 4) \leq c(6, 6)$, with $c(0, 0) < c(6, 6)$. This was the case for 41 participants (33 percent). The remaining 21 participants (17 percent) did not meet either of these criteria, and are classified as ‘others’.

Figure 4 displays the mean conditional contributions of the conditional cooperators. Figure 5 shows the corresponding contributions of the ‘others’. It can be seen that this group conforms on average to the ‘hump-shaped’ pattern identified by Fischbacher, Gächter and Fehr (2001).

Consistent with the finding of no order effect in the raw contribution table data, there is also no significant relationship between the proportions of participants classified as free-riders,

conditional contributors or ‘others’, and the order in which the games are played ($p = 0.384$ in a Pearson chi-square test with two degrees of freedom).

Result 3: Conditional contributions decrease significantly with a mean-preserving spread in the contribution of the other group members.

In the contribution table, participants are asked to specify contributions conditional upon all ten possible combinations of the contributions of the other group members. This is in contrast to previous studies in which contributions were only elicited as a function of the others’ average contributions. As a result, the data in this study include three pairs of cases in which the contributions in one case are a mean-preserving spread of those in the other. On all three occasions, conditional contributions are always significantly lower in the case in which the others’ contributions are more unequally divided.

The mean conditional contribution in response to (0, 4) is 0.416 points compared to 0.715 in response to (2, 2). This difference is highly significant, with $p = 0.002$ in a two-sided paired t -test, and $p = 0.003$ in a Wilcoxon signed-rank test. Similarly, the mean contribution is 0.748 in response to (0, 6), compared to 0.976 in response to (2, 4). This difference is also significant, with $p = 0.043$ in a t -test and $p = 0.008$ in a signed-rank test. Finally, the mean contribution in response to (2, 6) is 1.024, compared to 1.203 in response to (4, 4). The difference is again significant, with $p = 0.021$ in a t -test and $p = 0.025$ in a signed-rank test.

Result 4: There is a selfish bias in the contributions of conditional cooperators, even when the contributions of the other group members are equal.

A conditional cooperator is someone who increases his or her conditional contribution as the contributions of the others increase from (0, 0) through (2, 2) and (4, 4) to (6, 6). Nonetheless, as previously identified by Fischbacher, Gächter and Fehr (2001), even among this group contributions do not increase one-for-one with the contributions of others.

Among conditional cooperators, the mean value of $c(2, 2)$ is 1.610. This is significantly different from two with $p = 0.031$ in a two-sided one-sample t -test (also $p = 0.033$ in a one-sample median test). Similarly, among conditional cooperators the mean value of $c(4, 4)$ is 3.024, and the mean value of $c(6, 6)$ is 4.830. Each of these values is highly significantly different from four and six respectively, with $p = 0.000$ in both the t -test and the median test.

Figure 6 summarises Results 3 and 4, by plotting the mean conditional contributions of the conditional cooperators as a function of the average contribution of the other group members on the horizontal axis. The solid diagonal line corresponds to perfect conditional cooperation. Figure 6 shows that there are two sources of selfish bias in the behaviour of conditional cooperators. Firstly, they do not fully match the contributions of the other group members, even when the latter contribute equally. Secondly, other things being equal, contributions are depressed even further when the others contribute unequally. A possible explanation for this effect is that it is easier to rationalise one's selfish bias in this scenario – perhaps on the grounds that it suffices to match the contribution of the lower contributor.

Contributions in the game with punishment

Inspection of Figure 1 highlights the possibility of an order effect in contributions in the game with punishment. When the game with punishment is played first the mean contribution is 3.111, compared to 2.133 when this game is played after the one without punishment. Thus there is a difference of nearly one full contribution point, out of an initial endowment of six. This difference indeed proves to be significant both in a two-sided independent-samples t -test ($p = 0.016$) and a Wilcoxon rank-sum test ($p = 0.015$).

Figure 7 sheds further light on the nature of this order effect by showing the distribution of contributions in the game with punishment separately for the N-P and P-N treatment orders. It shows that when the game with punishment is played after the game without punishment in the N-P order, the modal choice remains to contribute zero. By contrast, when the game with punishment is played first in the P-N order, the modal choice is a contribution of four. Accordingly, the contributions data for the game with punishment is analysed separately across the two treatment orders in the discussion that follows.

Result 5: Participants anticipate the effect of punishment in their initial contribution decisions, even when they have no prior experience in the experiment.

In a between-groups comparison, contributions are much higher in the game with punishment when it is played first (mean contribution of 3.111) than in the game without punishment when it too is played first (mean contribution of 1.467). This difference is highly significant, with $p = 0.000$ in both a two-sided independent-samples t -test and a Wilcoxon rank-sum test.

Result 6a: Contributions increase significantly with the introduction of punishment.

Result 6b: Contributions decrease significantly with the removal of punishment.

In a within-group comparison, mean contributions in the N-P treatment order are 1.467 in the game without punishment, and 2.133 in the game with punishment. This difference is significant with $p = 0.026$ in a two-sided paired t -test, and $p = 0.057$ in a Wilcoxon signed-rank test. Similarly, in the P-N treatment order mean contributions are 3.111 with punishment and 1.365 without punishment. This difference is highly significant, with $p = 0.000$ in both tests.

At an individual level, in the N-P treatment order 18 of the 60 participants (30 percent) increased their contribution with the introduction of punishment, while 33 (55 percent) made no change and 9 (15 percent) actually decreased their contribution. In the P-N treatment order, 31 of the 63 participants (49 percent) decreased their contribution with the removal of punishment, while 29 (46 percent) made no change and only 3 (5 percent) increased their contribution. Note that since participants did not receive any feedback about the contributions of others until the end of the session, these changes in contributions must arise solely from their own introspection in response to the news of the introduction or removal of punishment.

Conditional punishment

One of the major innovations in the design of this study is the use of the strategy method in the punishment stage of the game with punishment. Participants were presented with all ten possible combinations of the contributions of the other two group members, and asked how many punishment points they would assign to each player in each of the cases. As such, there are a total of twenty possible occasions on which each participant can choose to conditionally assign punishment to another player.

Result 7: In aggregate, one-half of all participants are willing to punish on at least one occasion, however this proportion is sensitive to treatment order.

In the N-P treatment order, 24 of the 60 participants (40 percent) are willing to punish on at least occasion. In the P-N treatment order the corresponding figure is 37 out of 63 participants (59 percent). A Pearson chi-square test with one degree of freedom confirms a significant relationship between willingness to punish and treatment order, with $p = 0.038$.

Nonetheless, *conditional upon willingness to punish*, there is little evidence of any order effect in the punishment behaviour of those participants who are willing to punish on at least

one occasion. For these participants, the null hypothesis of no order effect cannot be rejected with $p \geq 0.126$ in a two-sided t -test in all twenty cells of the conditional punishment function. When a nonparametric rank-sum test is used, the null hypothesis again cannot be rejected (with $p \geq 0.106$) in all but one of the cases. The exception is when both of the other group members make the full contribution of six. In this case, the mean punishment assigned by the 24 participants in the N-P treatment order is 0.625 points whereas for the 37 participants in the P-N treatment order the corresponding mean is 0.324. In this case only, the null hypothesis of no treatment effect is rejected by a Wilcoxon rank-sum test with $p = 0.028$ (however $p = 0.169$ in the corresponding t -test).

Taking the above evidence into consideration, it was decided to proceed with caution in pooling the punishment data from the two treatment orders. This was done on the grounds that the *comparative statics* of punishment appear unlikely to be greatly affected by treatment order. However, it is also subject to the caveat that the *absolute level* of punishment depends also upon the proportion of participants who are willing to punish in the first place, which is clearly influenced by the treatment order.

Figure 8 summarises the frequency distribution of the number of instances of punishment, for those participants who chose to punish on at least one occasion. It demonstrates that the use of the strategy method is effective in detecting a large incidence of willingness to punish.

Result 8: Conditional upon willingness to punish, the amount of punishment that a participant assigns to another player is on average greater the lower the contribution of the recipient – both in absolute terms and relative to the contribution of the third group member.

Figure 9 summarises the means of the punishment data conditional upon willingness to punish. That is, the reported means have been computed relative to the 61 participants who assign nonzero punishment on at least one occasion. In this Figure, the first panel depicts the number of punishment points assigned to a player who contributes zero ($c = 0$), as the contribution of the third group member (c') varies between zero and six. The second panel refers to the cases in which the contribution of the recipient is two, and so on.

It is apparent from Figure 9 that the most severe punishment is imposed upon those who contribute zero, and that the severity of punishment decreases as the contribution of the recipient increases. At the same time, for a given contribution by the recipient, the severity of punishment tends to be greater the larger is the shortfall in the contribution of the recipient

relative to that of the third group member. Conversely, punishment is somewhat less severe in cases in which the contribution of the recipient is greater than that of the third player.

Finally, it is notable that even those who make the maximum contribution of six points do not necessarily escape punishment. Thus the application of the strategy method to punishment behaviour is able to detect the presence of so-called antisocial punishment. Indeed, as reported in Result 9, the incidence of such behaviour is surprisingly high.

Result 9a: Among those participants who are willing to punish on at least one occasion, over one-half are also willing to punish antisocially, where antisocial punishment is defined as when the contribution of the recipient is greater than or equal to that of the punisher.

Result 9b: Among those participants who are willing to punish on at least one occasion, one-third are ‘strong antisocial punishers’, defined as those who punish antisocially in at least one-half of all instances in which they assign nonzero punishment.

For the purposes of this study, antisocial punishment is defined as where a participant indicates that he or she would punish someone whose contribution is greater than or equal to his or her own. To see why this is the case, observe that in these circumstances, the effect of punishment is to increase the earnings differential between the punisher and someone whose earnings before punishment are already less than or equal to his or her own. Note also that in the context of a one-shot game, antisocial punishments cannot be motivated by revenge.

Of the 61 participants who assign nonzero punishment on at least one occasion, there are only 27 (44 percent, or 22 percent of the entire sample) who never punish antisocially. These 27 behave strictly as altruistic punishers in the sense of Fehr and Gächter 2002: they are willing, at a cost to themselves, to contribute to the second-order public good of disciplining free-riders, even though this brings no prospect of any material gain.

The remaining 34 (56 percent of those who punish, or 28 percent of the entire sample) indicate that they would punish antisocially on at least one occasion. However, it may be unduly harsh to classify someone as an antisocial punisher on account of a single instance of such behaviour. To provide a stricter test of a robust and consistent taste for antisocial punishment, define a ‘strong antisocial punisher’ as someone who punishes antisocially in at least 50 percent of all instances in which he or she assigns nonzero punishment. Then there

are 20 participants (33 percent of those who punish, or 16 percent of the entire sample) who qualify as strong antisocial punishers.

Result 10: The punishment behaviour of strong antisocial punishers is essentially indiscriminate. In particular, they do not necessarily direct their punishment exclusively toward high contributors.

Figure 10 depicts the mean punishment function of the 20 participants classified as strong antisocial punishers. Comparing this to Figure 9, it is clear that the strongly antisocial group does indeed assign more punishment to high contributors than do those who punish generally. Indeed, the strong antisocial punishers are responsible for 79.2 percent of the punishment points assigned to those who contribute six, and 62.3 percent of the punishment assigned to those who contribute four. However it is also clearly not the case that they punish high contributors exclusively, or that free-riders are spared their wrath. To the contrary, Figure 10 indicates that they assign more punishment to free-riders than they do to any other group. Strongly antisocial punishers are responsible for 35.8 percent of the punishment assigned to those who contribute zero, which is in line with their representation at 33 percent of those who ever punish.

Efficiency

Result 11: Overall efficiency is lower under punishment because the increase in contribution brought about under punishment is outweighed by the cost of the punishment incurred.

In the game without punishment in the N-P (P-N) treatment order, participants attain 74.8 (74.3) percent of the maximum possible earnings that could be achieved if all were to contribute fully. For the game with punishment, the corresponding figures are 55.6 percent in the N-P treatment order, and 45.1 percent in the P-N treatment order. Thus, even though the increase in contribution brought about by punishment is smaller in the N-P treatment order, overall efficiency is lower in the P-N treatment order because there are more participants who are willing to punish.

As a further indication of the costliness of punishment, in the game with punishment in the N-P treatment order, 47 percent of the participants earn less than six points, the earnings that would obtain under purely self-interested behaviour. For the game with punishment in the P-N treatment order, the corresponding figure is 56 percent.

Beliefs

An analysis and discussion of the data on beliefs will follow in a later draft of this paper.

CONCLUSION

Through the application of the strategy method, this paper makes several major contributions toward understanding behaviour in voluntary contribution games both without and with punishment. In the game without punishment, it is found that conditional contributions are responsive not only to the average contribution of the other players, but also to the spread. It is thus shown that there are two sources of selfish bias in the contributions of conditional cooperators. Firstly, they do not match the contributions of others, even when the latter contribute equally. Secondly, they reduce their contributions even further when the others contribute unequally.

In the game with punishment, it is demonstrated that the strategy method can indeed be applied to detect contingent willingness to punish. This goes some way toward allaying the concern that, by taking away the emotional element from the interaction, willingness to punish might be attenuated under the strategy method. The aggregate punishment function elicited under the strategy method varies in a plausible manner both with the contribution of the recipient and that of the third player. Finally, the strategy method is also able to detect antisocial punishment. By examining the punishment function of those identified as strong antisocial punishers, it is found that rather than expressing their disdain toward ‘do-gooders’, these individuals in fact punish in an essentially indiscriminate manner.

REFERENCES

- Artinger, F., Exadaktylos, F., Koppel, H. and Sääksvuori, L. (2010). 'Applying quadratic scoring rule transparently in multiple choice settings: A note', Jena Economic Research Papers in Economics 2010-021, Max-Planck-Institute of Economics, Friedrich-Schiller-University Jena.
- Blanco, M., Engelmann, D., Koch, A. K. and Normann, H.-T. (2010). 'Belief elicitation in experiments: Is there a hedging problem?'
- Fehr, E. and Gächter, S. (2000). 'Cooperation and punishment in public goods experiments', *American Economic Review*, vol. 90(4), pp. 980–994.
- Fehr, E. and Gächter, S. (2002). 'Altruistic punishment in humans', *Nature*, vol. 415(6868), pp. 137–140.
- Fischbacher, U. (2007). 'z-Tree: Zurich toolbox for ready-made economic experiments', *Experimental Economics*, vol. 10(2), pp. 171–178.
- Fischbacher, U. and Gächter, S. (2010). 'Social preferences, beliefs, and the dynamics of free riding in public goods experiments', *American Economic Review*, vol. 100(1), pp. 541–556.
- Fischbacher, U., Gächter, S. and Fehr, E. (2001). 'Are people conditionally cooperative? Evidence from a public goods experiment', *Economics Letters*, vol. 71(3), pp. 397–404.
- Gächter, S. and Herrmann, B. (2009). 'Reciprocity, culture and human cooperation: Previous insights and a new cross-cultural experiment', *Philosophical Transactions of The Royal Society B*, vol. 364, pp. 791–806.
- Gächter, S. and Renner, E. (2006). 'The effects of (incentivized) belief elicitation in public good experiments', Discussion Paper 2006-16, Centre for Decision Research and Experimental Economics, School of Economics, University of Nottingham.
- Greiner, B. (2004). 'The online recruitment system ORSEE 2.0: A guide for the organization of experiments in economics', Working Paper 10, Department of Economics, University of Cologne.
- Herrmann, B., Thöni, C. and Gächter, S. (2008). 'Antisocial punishment across societies', *Science*, vol. 319(5868), pp. 1362–1367.
- Neugebauer, T., Perote, J., Schmidt, U. and Loos, M. (2009). 'Selfish-biased conditional cooperation: On the decline of contributions in repeated public goods experiments', *Journal of Economic Psychology*, vol. 30(1), pp. 52–60.
- Rey-Biel, P. (2009). 'Equilibrium play and best response to (stated) beliefs in normal form games', *Games and Economic Behavior*, vol. 65(2), pp. 572–585.
- Walker, J. M. and Halloran, M. A. (2004). 'Rewards and sanctions and the provision of public goods in one-shot settings', *Experimental Economics*, vol. 7(3), pp. 235–247.

Figure 1: Mean unconditional contributions by treatment and order

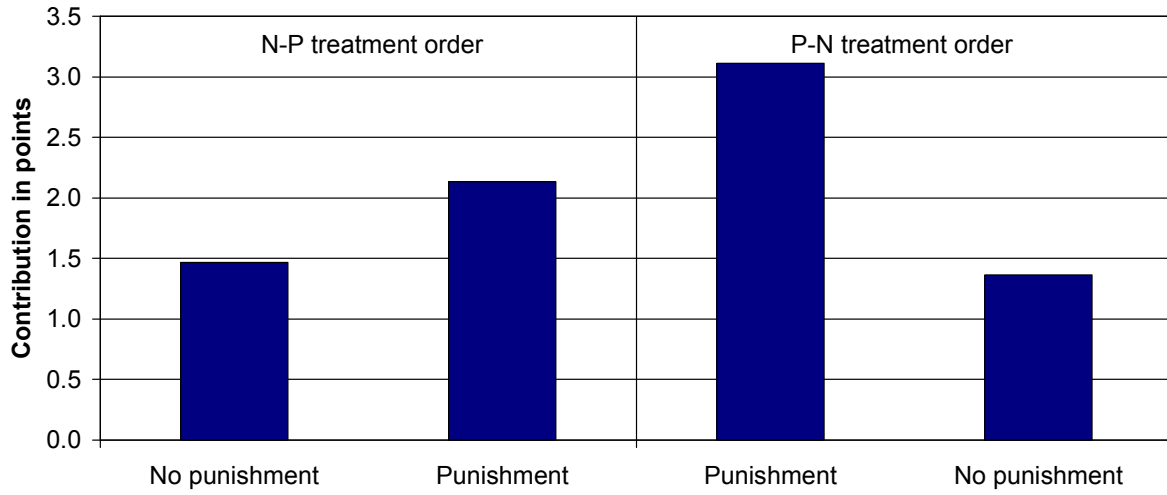


Figure 2: Unconditional contributions in the game without punishment

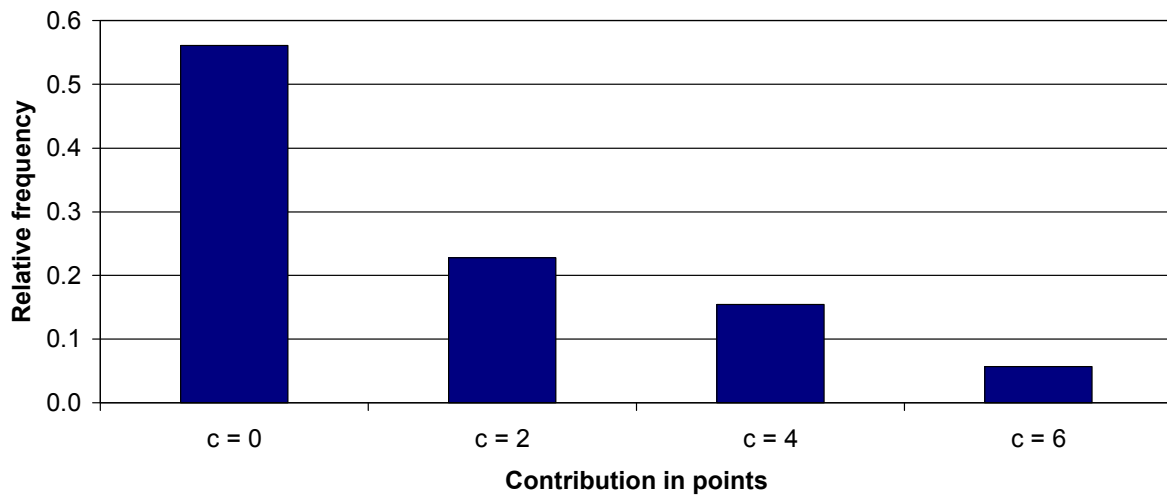


Figure 3: Mean conditional contributions

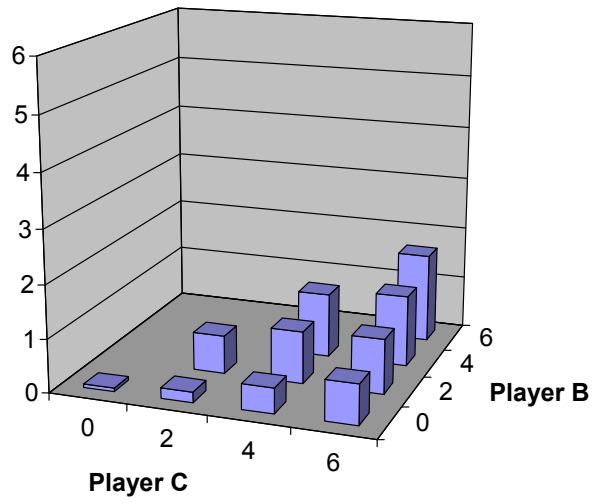


Figure 4: Mean conditional contributions of conditional cooperators

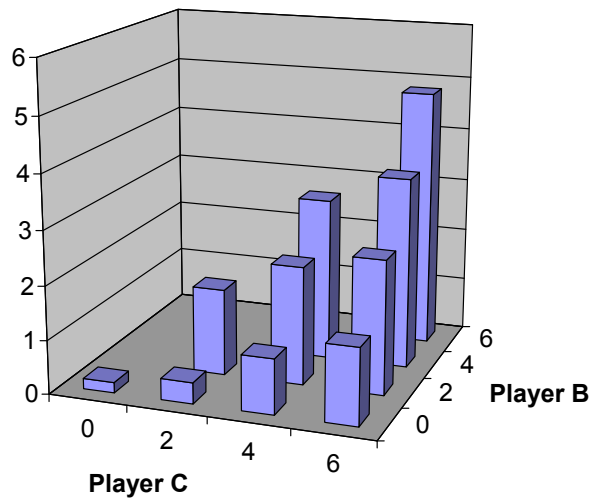


Figure 5: Mean conditional contributions of 'others'

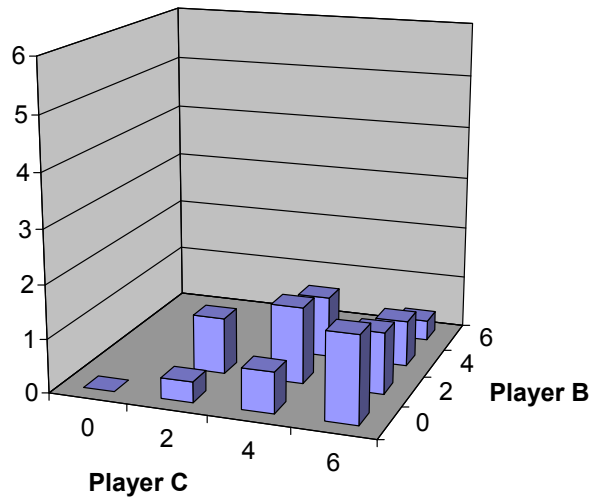


Figure 6: Mean contributions of conditional cooperators, as a function of other players' average contributions

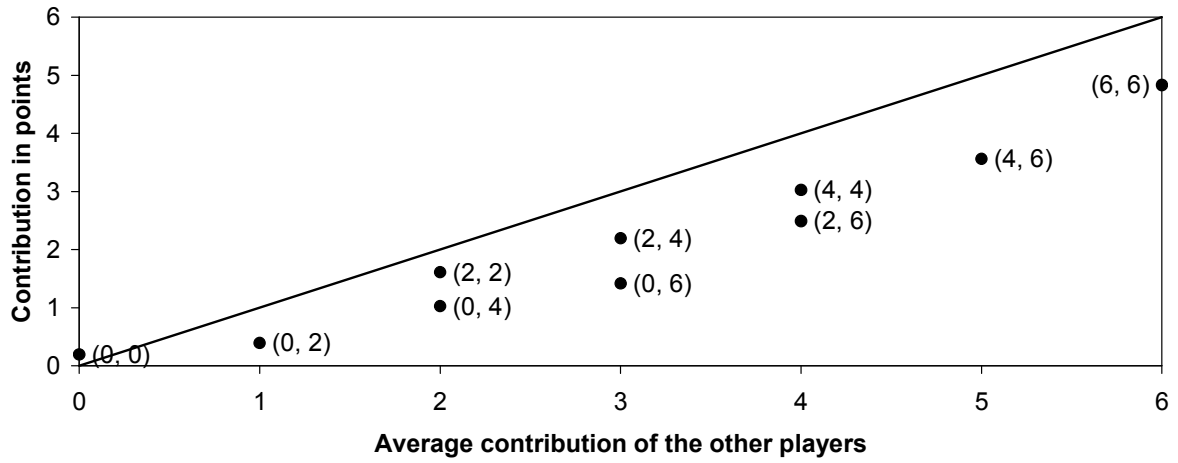


Figure 7: Contributions in the game with punishment

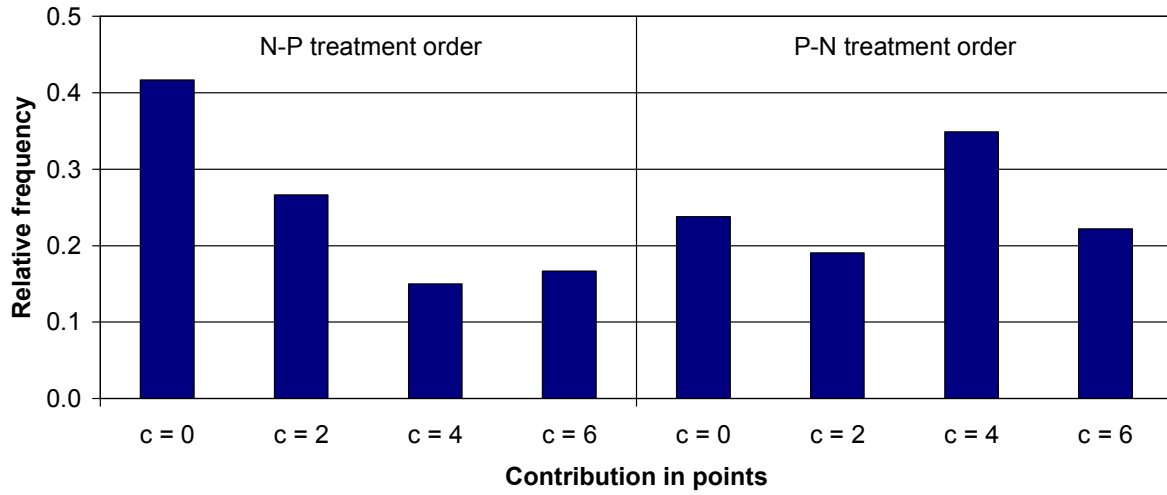


Figure 8: Frequency of punishment



Figure 9: Mean punishment, conditional upon willingness to punish

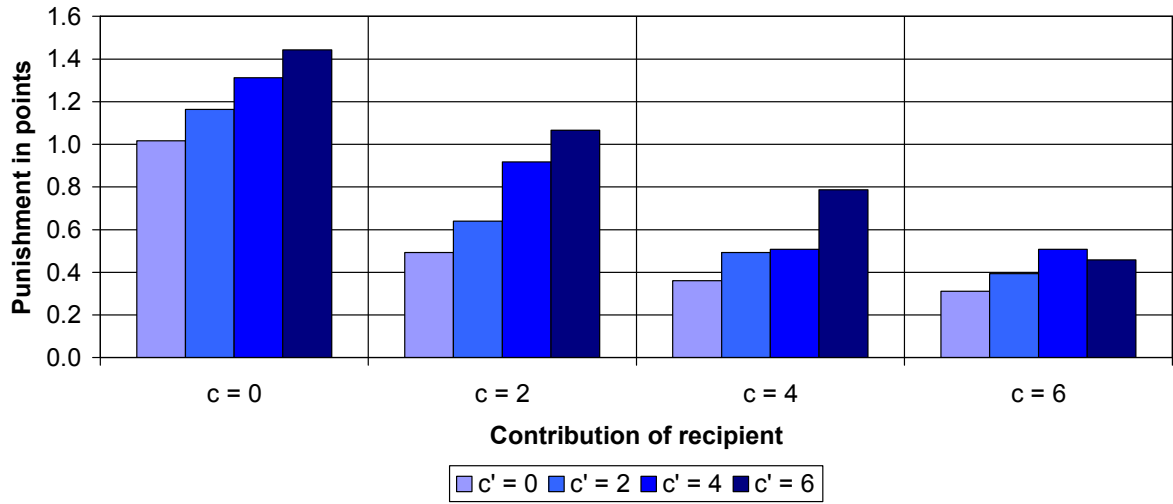
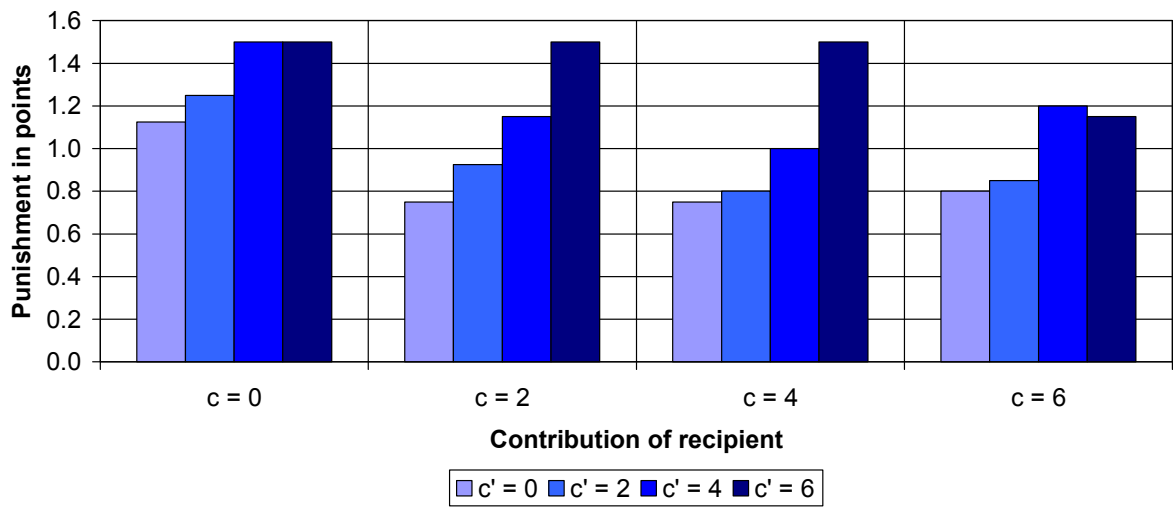


Figure 10: Mean punishment by strong antisocial punishers



**APPENDIX (NOT FOR PUBLICATION):
INSTRUCTIONS FOR THE N-P TREATMENT ORDER**

*Horizontal rules denote the positions of page breaks in the original instructions.
Control questions were displayed on screen.*

GENERAL INFORMATION

Welcome to today's session. In this session we will conduct two experiments on economic decision making. These experiments are simple, and if you read the instructions carefully and make good decisions, you may earn a considerable amount of money.

It is strictly prohibited to communicate with the other participants. If you violate this rule, you will be dismissed from the lab and forfeit all earnings. If you have any questions please raise your hand, and an experimenter will assist you.

In each of the two experiments, we will proceed through the following steps:

- Firstly, you will be given information about the decision situation for the experiment.
- You will then be asked to answer some questions at your computer to check that you fully understand the decision situation.
- Next, you will be given further instructions on how to use the computer screens to enter your decisions.
- Finally, you will enter your decisions into the computer.

At the end of the second experiment you will be given information about the results of your decisions in both experiments. After this, you will be asked to complete a questionnaire.

Throughout the session, your earnings will be calculated in "points". At the end of the session, the total number of points you have earned will be converted into Australian Dollars and paid to you in cash. You will be paid for your decisions in both experiments.

The conversion rate will be 1 point = 1.5 Australian Dollars.

At the beginning of the session, you will have a starting balance of three points. This is in addition to the other points that you earn throughout the session.

FIRST EXPERIMENT: DECISION SITUATION

In this experiment, you will be in a group of three players, consisting of yourself and two others. All decisions will be made anonymously, and you will never learn the identity of the other two players in your group.

At the beginning of the experiment you will be given six points. (This is in addition to your starting balance of three points.) You have to decide how many of these six points you want to contribute to a project, and how many to retain for yourself.

You can choose to contribute 0, 2, 4, or 6 points to the project.

Each point that you do not contribute to the project will be automatically retained for yourself. The other two players will face the same decision situation.

Your earnings from this decision

Your earnings will depend on both your own decision, and the decisions of the other two players in your group. These earnings consist of two parts:

1. Your earnings from the points you retain for yourself:

$$\text{Your earnings from points you retain for yourself} = 6 - \text{Your contribution.}$$

No-one other than you earns anything from the points you retain for yourself.

2. Your earnings from the project. This is calculated as:

$$\text{Your earnings from the project} = 0.5 \times \text{Sum of all three players' contributions.}$$

All three players receive the same earnings from the project. For each point that anyone contributes to the project, the total earnings of the group therefore increase by 1.5 points.

Your contribution to the project thus increases the earnings of the other two players. At the same time, you also receive earnings as a result of the other players' contributions.

Your total earnings are the sum of the points you retained and your earnings from the project:

$$\text{Your earnings} = (6 - \text{Your contribution}) + (0.5 \times \text{Sum of all three players' contributions})$$

The earnings of the other two players are calculated in the same manner.

Please answer the following questions. These serve to check your understanding of the decision situation and earnings calculations. When everyone has completed all the questions correctly, we will explain how the experiment itself will take place.

If you have any questions, please raise your hand.

1. Suppose that no-one contributes anything to the project.
 - a. What are your earnings in points?
 - b. What are the earnings of each of the other two players?
2. Suppose that all three players each contribute 6 points to the project.
 - a. What are your earnings in points?
 - b. What are the earnings of each of the other two players?
3. Suppose that you contribute 0 points, and the other two players each contribute 6 points.
 - a. What are your earnings in points?
 - b. What are the earnings of each of the other two players?

4. Suppose that the other two players contribute a total of 8 points to the project.
 - a. What are your earnings if you contribute 2 points?
 - b. What are your earnings if you contribute 4 points?
 5. Suppose that you contribute 4 points to the project.
 - a. What are your earnings if the other two players contribute a total of 4 points?
 - b. What are your earnings if the other two players contribute a total of 8 points?
-

FIRST EXPERIMENT: PROCEDURES

This experiment will take place only once. You will complete three tasks: an “unconditional” contribution, a “contribution table”, and your prediction of the contributions of the other participants in the laboratory.

Unconditional contribution

In the “unconditional” contribution decision, you simply indicate how many points you want to contribute to the project. You can contribute 0, 2, 4, or 6 points. You enter your decision by typing one of these numbers in the input field on your screen:

Please enter your UNCONDITIONAL contribution to the project.
Your contribution must take one of the values 0, 2, 4, or 6.

Please enter your unconditional contribution:

OK

Help

Your earnings = $(6 - \text{Your contribution}) + (0.5 \times \text{Sum of all three players' contributions})$

After you enter the amount you want to contribute, you must click the OK button. As long as you have not clicked OK, you can still change your decision. After you have clicked OK, your decision can no longer be revised.

Contribution table

In the “contribution table”, you indicate how many points you want to contribute to the project *for every possible combination of the contributions of the other two players* in your group. There are ten possible combinations, as you can see from the decision screen:

Please complete the CONTRIBUTION TABLE for each combination of the contributions of the other two players in your group. Your contribution must take one of the values 0, 2, 4, or 6.

Contribution Table. Please enter your contribution:

If the contributions of the other two players are 0 and 0 :	<input type="text"/>
If the contributions of the other two players are 0 and 2 :	<input type="text"/>
If the contributions of the other two players are 0 and 4 :	<input type="text"/>
If the contributions of the other two players are 0 and 6 :	<input type="text"/>
If the contributions of the other two players are 2 and 2 :	<input type="text"/>
If the contributions of the other two players are 2 and 4 :	<input type="text"/>
If the contributions of the other two players are 2 and 6 :	<input type="text"/>
If the contributions of the other two players are 4 and 4 :	<input type="text"/>
If the contributions of the other two players are 4 and 6 :	<input type="text"/>
If the contributions of the other two players are 6 and 6 :	<input type="text"/>

OK

Help

Your earnings = (6 - Your contribution) + (0.5 × Sum of all three players' contributions)

For each of the ten cases, you can choose to contribute 0, 2, 4, or 6 points to the project. You must make an entry in each of the ten input boxes. Once you have finished, please click OK.

Afterwards, the computer will randomly determine whether your unconditional contribution or your contribution table will be used to decide your earnings:

- For two of the three players in your group, the unconditional contribution will be used to decide that player’s contribution to the project.
- For the third player, the contribution table will be used. The computer will first look up the unconditional contributions of the first two players. It will then choose the appropriate contribution from the third player’s contribution table.

Your earnings will then be computed in the manner that was explained earlier:

$$\text{Your earnings} = (6 - \text{Your contribution}) + (0.5 \times \text{Sum of all three players' contributions})$$

Since you do not know, at the time you make your decisions, whether your unconditional contribution or your contribution table will be used to decide your earnings, you should treat both sets of decisions as if they would count for your earnings.

Prediction of the other participants' contributions

You can earn additional points by predicting the *unconditional* contributions of the other participants in the laboratory. In particular, you will be asked in how many cases out of 100 you think the other participants contributed 0, 2, 4, and 6 points:

Please enter your PREDICTION of the unconditional contributions of the other participants in the laboratory. For each question you should enter a number between 0 and 100. The four numbers must add up exactly to 100.

In how many cases out of 100 do you think the other participants contributed 0 points?	<input type="text"/>
In how many cases out of 100 do you think the other participants contributed 2 points?	<input type="text"/>
In how many cases out of 100 do you think the other participants contributed 4 points?	<input type="text"/>
In how many cases out of 100 do you think the other participants contributed 6 points?	<input type="text"/>

For each of the four contribution levels you should enter a number between zero and 100. These numbers must add up exactly to 100. Afterwards, the computer will compare your predictions to the actual unconditional contributions of the other participants in the laboratory.

You can earn up to two extra earnings points for your predictions. *The closer your predictions are to the actual percentage of participants who chose each contribution level, the more you earn.* You cannot lose points from making predictions; it is only possible to earn more points.

The formula that determines your earnings from your predictions is as follows:

$$\text{Earnings from predictions} = 2 - \left(\frac{A-a}{100}\right)^2 - \left(\frac{B-b}{100}\right)^2 - \left(\frac{C-c}{100}\right)^2 - \left(\frac{D-d}{100}\right)^2$$

where:

A = Percentage of the other participants who contribute 0,	a = Your prediction of A ,
B = Percentage of the other participants who contribute 2,	b = Your prediction of B ,
C = Percentage of the other participants who contribute 4,	c = Your prediction of C ,
D = Percentage of the other participants who contribute 6,	d = Your prediction of D .

SECOND EXPERIMENT: DECISION SITUATION

We will now conduct a new experiment, in which there are some changes. You will complete this second experiment before you learn the results from the first experiment. After this, you will learn the results from both experiments and there will be no further experiments.

In this new experiment, you will be in a new group of three players, consisting of yourself and two others. Your new group will not include either of the players you were grouped with in the first experiment. Again, you will never learn the identity of the other two players.

The new experiment consists of two stages.

Stage one

Stage one is identical to the *unconditional* contribution in the first experiment. At the beginning of this stage you will again be given six points. You have to decide how many of these six points you want to contribute to a project, and how many to retain for yourself.

You can choose to contribute 0, 2, 4, or 6 points to the project.

Each point that you do not contribute to the project will be automatically retained for yourself. You will only make an unconditional contribution decision – there is no contribution table.

Your earnings from stage one will be computed in the same manner as in the first experiment:

$$\text{Earnings from stage one} = (6 - \text{Your contribution}) + (0.5 \times \text{Sum of all three players' contributions})$$

Stage two

Stage two is new to this experiment. In this stage you can assign deduction points to reduce the earnings of one or both of the other players, or you can leave their earnings unchanged. The other players can also assign deduction points to reduce your earnings if they so wish.

You can assign 0, 1, 2, or 3 deduction points to each of the other two players.

If you assign deduction points to another player, *each deduction point will reduce the earnings of that player by three earnings points*. If you do not assign any deduction points to a player, then that player's earnings will be unchanged.

For each deduction point that you assign to another player, you will incur a cost of one earnings point. If you do not assign any deduction points, you will not incur any costs.

Your earnings from these decisions

Your final earnings in this experiment will depend on your earnings from stage one, the number of deduction points you received from the other two players in your group, and the number of deduction points you assigned to them.

In particular, the computer will first take the number of deduction points (if any) you received from the other two players, and multiply this by three.

- If this amount (three times the number of deduction points you received) is no greater than your earnings from stage one, then your earnings will be reduced by this amount.

- Otherwise, if this amount is greater than your earnings from stage one, your earnings will be reduced to zero. Notice that this means that the deduction points you receive from the other players cannot cause you to suffer a loss.

After it has done this, the computer will then deduct the cost of any deduction points you assigned to the other two players. Notice that this means that you must always incur the cost of any deduction points you assign to the other players, even if this causes you to suffer a loss.

If your final earnings are negative, the loss will be taken out of the starting balance that you were given at the beginning of the session. Notice, however, that it is always possible to avoid such a loss for certain through your own decisions.

The earnings of the other two players will be calculated in the same manner.

Please answer the following questions. These serve to check your understanding of the decision situation and earnings calculations. When everyone has completed all the questions correctly, we will explain how the experiment itself will take place.

If you have any questions, please raise your hand.

6. Suppose that you assign 3 deduction points to the second player and 0 deduction points to the third player.
 - a. What cost do you incur to assign these deduction points?
 - b. By how much will the earnings of the second player be reduced?
 - c. By how much will the earnings of the third player be reduced?
7. By how much will your earnings be reduced:
 - a. If you receive a total of 1 deduction points from the other players?
 - b. If you receive a total of 2 deduction points from the other players?

SECOND EXPERIMENT: PROCEDURES

This experiment takes place only once. You will complete four tasks: a contribution in stage one, a set of ten “cases” to assign deduction points in stage two, your prediction of the other participants’ contributions, and your prediction of the number of deduction points you receive.

Stage one contribution

In the contribution decision in stage one, you indicate how many points you want to contribute to the project. You can contribute 0, 2, 4, or 6 points.

In this experiment *you only make an unconditional contribution decision – there is no contribution table*. This means that the amount you enter in the contribution screen will for certain be your contribution to the project.

Stage two deduction cases

In the second task, you indicate how many deduction points, if any, you want to assign to each of the other two players.

When you assign deduction points, you will not know the actual contributions of the other two players. Instead, you will assign deduction points for ten cases, corresponding to *all ten possible combinations of the other two players' contributions*.

Of the two other players in your group, we refer to the one who contributes less to the project as “Player B”, and the one who contributes more as “Player C”. Then the ten cases are:

	Player B's contribution	Player C's contribution
Case 1	0	0
Case 2	0	2
Case 3	0	4
Case 4	0	6
Case 5	2	2
Case 6	2	4
Case 7	2	6
Case 8	4	4
Case 9	4	6
Case 10	6	6

You can assign up to three deduction points to each player in each of the ten cases. These deduction points will only actually be allocated for one of the ten cases. This is the case that corresponds to the actual contributions of the other two players.

For each case, you will complete a decision screen similar to the one shown for Case 1:

Please enter the number of deduction points, if any, that you would assign to each player in each of the ten cases.
Deduction points will only actually be assigned for the case that corresponds to the actual contributions of the other two players.
You can assign 0, 1, 2, or 3 deduction points to each player in each of the cases.

CASE 1 of 10.	YOU	Player B	Player C
Contribution:	...	0	0
Earnings from stage one:
Deduction points:	--	<input style="width: 100px; height: 20px;" type="text"/>	<input style="width: 100px; height: 20px;" type="text"/>

Help
 If you assign deduction points to another player, each deduction point will reduce the earnings of that player by three earnings points.
 For each deduction point that you assign to another player, you will incur a cost of one earnings point.

In each of the ten cases, your own contribution is always the amount you chose in stage one. In the actual experiment, each decision screen will show your own contribution in the first column, and you will also be able to see the earnings from stage one for each of the players.

For each of the cases, you must decide how many deduction points, if any, you want to assign to Player B and Player C. You must enter a number for each of the players. If you do not wish to reduce the earnings of a player, then you must enter “0”.

You can use the “Next” and “Back” buttons to move between the ten cases. The “OK” button appears after you have filled in all ten cases. As long as you have not clicked “OK”, you can change any of your decisions. After you click “OK”, your decisions can no longer be revised.

Afterwards, the computer will look up the stage one contributions of the other two players in your group. From this, it will determine which of the ten cases is the relevant one and use your decisions from that case to assign deduction points to the other two players.

The computer will also do the same for the two other players in your group. In this way it will determine how many deduction points, if any, you receive from each of the other players. Your earnings will then be computed in the manner that was explained previously.

Prediction of the other participants’ contributions

You can again earn additional points by predicting the contributions of the other participants in the laboratory. As before, you will be asked in how many cases out of 100 you think the other participants contributed 0, 2, 4, and 6 points in the second experiment.

For each of the four contribution levels you should enter a number between zero and 100. These numbers must add up exactly to 100. Afterwards, the computer will compare your predictions to the actual contributions of the other participants in the laboratory.

You can earn up to two extra earnings points for your predictions. *The closer your predictions are to the actual percentage of participants who chose each contribution level, the more you earn.* You cannot lose points from making predictions; it is only possible to earn more points.

The formula that determines your earnings from your predictions is the same as before:

$$\text{Earnings from predictions} = 2 - \left(\frac{A-a}{100}\right)^2 - \left(\frac{B-b}{100}\right)^2 - \left(\frac{C-c}{100}\right)^2 - \left(\frac{D-d}{100}\right)^2$$

where:

A = Percentage of the other participants who contribute 0,	a = Your prediction of A ,
B = Percentage of the other participants who contribute 2,	b = Your prediction of B ,
C = Percentage of the other participants who contribute 4,	c = Your prediction of C ,
D = Percentage of the other participants who contribute 6,	d = Your prediction of D .

Prediction of deduction points received

Finally, you will be asked to predict the total number of deduction points assigned to you by the other two players in your group. This must be a number between zero and six. Afterwards, the computer will compare your prediction to the actual number of deduction points you received.

You can earn up to one extra earnings point for your prediction. *The closer your prediction is to the total number of deduction points the other players assigned to you, the more you earn.* You cannot lose points from making predictions; it is only possible to earn more points.

The formula that determines your earnings from your prediction is as follows:

$$\text{Earnings from prediction} = 1 - \left(\frac{X - x}{6} \right)^2$$

where X is the actual number of deduction points you received, and x is your prediction of X .