

# Variation in experimental instructions: Punishment in public goods games

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## Abstract

We provide evidence that more explicit, and hence longer, instructions can affect behaviour in a public goods game with punishment. Instructions that highlight the positive externality associated with public goods contributions, provide more examples, and emphasize fundamental aspects of the decision setting are associated with higher contribution levels in games with punishment opportunities when compared to shorter, less explicit instructions. These changes are not found to impact behaviour in the simpler contribution game without punishment.

## JEL classification codes

C72, C91, C92, H41

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public goods, experiment, instructions, contributions, punishment, methodology

# Variation in experimental instructions: punishment in public goods games<sup>†</sup>

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## Abstract

We provide evidence that more explicit, and hence longer, instructions can affect behaviour in a public goods game with punishment. Instructions that highlight the positive externality associated with public goods contributions, provide more examples, and emphasize fundamental aspects of the decision setting are associated with higher contribution levels in games with punishment opportunities when compared to shorter, less explicit instructions. These changes are not found to impact behaviour in the simpler contribution game without punishment.

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## 1. Introduction

Subjects' understanding of the structure of strategic interactions in an experiment is crucial to drawing inferences from their behaviour. In a repeated linear public goods experiment, Bigoni and Dragone (2012) (henceforth BD12) find that short on-screen instructions worsen comprehension, while actively solving examples increases comprehension. However, BD12 observe the usual pattern of behaviour (see Chaudhuri 2011), declining contributions across treatments. Our study presents evidence that differences in instructions may impact behaviour when the decision setting is more complex.

Peer punishment has been shown to be effective in raising public good contributions (e.g. Fehr and Gächter, 2000). Peer punishment, however, involves more decisions and more complicated reasoning. Successful punishment is associated with three factors: (i) sufficient punishment to render the threat credible, (ii) punishment targeted at free-riders, and (iii) punishment of low contributors not being crowded-out by anti-social punishment of high contributors (see Hermann et al., 2008 and Rand et al., 2010).

We implement a between-subject design to compare the effectiveness of two forms of instructions. We find that differences in instructions do not significantly affect contribution behaviour in the absence of punishment. However, longer instructions that make explicit the positive externality associated with the public good are associated with significantly higher contributions when the punishment opportunity is provided, and better targeting of punishment towards low contributors.

## 2. Experimental design

Groups of four subjects played a repeated public goods, VCM, game. Each player was endowed with 20 tokens which could be invested in an *Individual Project (IP)* or a *Group Project (GP)*. A token invested in IP yielded a return of one token and a token invested in GP yielded a return of 0.5 tokens for each group member.

In VCM treatments, subjects played only the VCM game. In Pun treatments, subjects played a second stage, where they could use up to 5 tokens from their first-stage earnings to punish each other (maximum of 5 tokens per group member), at a cost of 1 token to reduce the earnings of another group member by 3 tokens. The stage game was repeated for 20 periods. The Nash equilibrium, unchanged by finite repetition, is zero contributions and zero punishment. The social optimum is full contributions and zero punishment.

In both VCM and Pun treatments, we explore differences in subject comprehension and behaviour, contrasting behaviour when subjects read shorter/less explicit instructions versus longer/more explicit instructions (online Appendix A). Treatments VCM-S and Pun-S used shorter/less explicit instructions, while VCM-L and Pun-L used longer/more explicit instructions. The shorter instructions were based on an English translation of those used in Fatas and Mateu (2015). The longer instructions were based on those used in Gächter et al. (2008).<sup>1</sup> Both sets of instructions were edited to use the same terminology.

The two sets of instructions differ in several ways. For brevity, we use the terms “long” and “short” to differentiate between the two forms of instructions. First, in the long instructions, the positive externality associated with public good contributions was made more explicit. The short instructions simply described the calculation of earnings. The long instructions stated “For each token you allocate to the Group Project, you will earn 0.5 tokens. Each of the other three people in your group will also earn 0.5 tokens. Thus, the allocation of 1 token to the Group Project yields a total of 2 tokens for all of you together.” They also stated “you will earn from your own allocation as well as from the allocations of others.” The instructions also differed somewhat in the examples provided. The short and long instructions contained, respectively, two and three solved examples each. The two examples in VCM-S illustrated the payoff consequence of different levels of contributions by the four subjects in the group. Pun-S used the same contribution examples as VCM-S, with additional examples tied to how a subject’s earnings were affected by punishing others and by being punished. In the VCM-L and Pun-L instructions, one example illustrated the zero contribution outcome, one example the social optimum outcome, and the third an intermediate level of contribution by one subject when the other subjects contributed nothing. Finally, the longer instructions used a bold font to emphasize key attributes of the decision settings.

After decisions were made, subjects were shown the individual contributions in their group in descending order, and their earnings. In the punishment treatments, once subjects had assigned punishment, they were shown the *total* punishment they received and their earnings.

Data was collected on 11 groups in VCM-S, 15 groups in Pun-S, 10 groups in VCM-L and 12 groups in Pun-L. The experiment was programmed in z-Tree (Fischbacher, 2007). All sessions

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<sup>1</sup> The long instructions and the data from VCM-L and Pun-L were used in Ramalingam et al. (2016).

were conducted at EssexLab at the University of Essex by the same experimenter. Subjects were undergraduate students inexperienced in public goods games.

Token earnings from all rounds were converted to Pounds at the rate of 60 tokens to £1. Average payments were approximately £12, including a £2.50 show-up fee.

### 3. Results

#### *Game Comprehension*

The post-instruction quiz on contributions was common to all treatments (online Appendix B), with common additional questions for the punishment stage. In paired treatment comparisons, average individual time to answer the pre-experiment quiz and variance across subjects are significantly lower in the treatments with longer instructions. Further, the average time taken to make contribution and punishment decisions is significantly lower in VCM-L and Pun-L (analysis in online Appendix C1). On average, sessions with shorter (longer) instructions lasted 70 (55) minutes. Thus, there is evidence that longer/more explicit instructions provided subjects with a better understanding of the game choices and payoff incentives.

#### *Group Public Good Contributions*

**Figure 1. Mean group contributions**

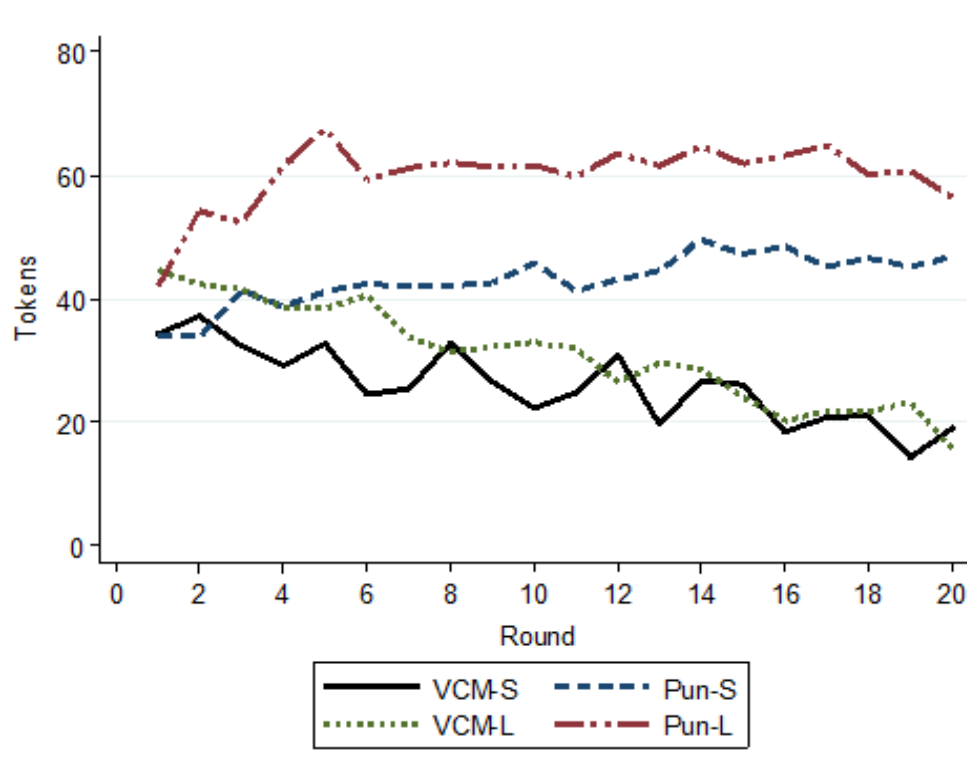


Figure 1 presents mean group contributions across rounds in all treatments. The different instruction formats lead to different contribution behaviour in the very first round; contributions start higher in the treatments with longer instructions, both with and without punishment. Parallel to BD12, average group contributions (over all rounds) in VCM-S are not significantly different from those in VCM-L (25.98 vs. 31.01; Wilcoxon  $p = 0.4595$ ). Punishment leads to a significant increase in contributions in Pun-S (43.12 vs. 25.98;  $p = 0.0274$ ) and Pun-L (60.02 vs. 31.01;  $p = 0.0056$ ). However, contributions in Pun-L are significantly greater than in Pun-S (60.02 vs. 43.12;  $p = 0.0218$ ).

**Result 1:** *Instruction format is not found to significantly affect average contribution behaviour in the absence of punishment opportunities. The longer, more explicit, instructions are associated, however, with greater contributions in the decision environment that allows for punishment.*

To investigate the impact of instruction format in the punishment treatments, we explore differences in the use of punishment. Averaging over all 20 rounds, a Wilcoxon test shows no significant difference in the average amount of punishment used in a round between Pun-S and Pun-L (7.55 vs. 6.96;  $p = 0.7883$ ).

Panel random-effects regressions were used to examine the amount of punishment received by an individual in a round. The model results are presented in Table 1 (first two columns). The amount of punishment received increases with the size of the negative deviation, but not with the size of the positive deviation of an individual's contribution from the average of the others in the group. Instruction format does not significantly impact the *amount* of punishment received.

**Table 1. Determinants of received punishment**

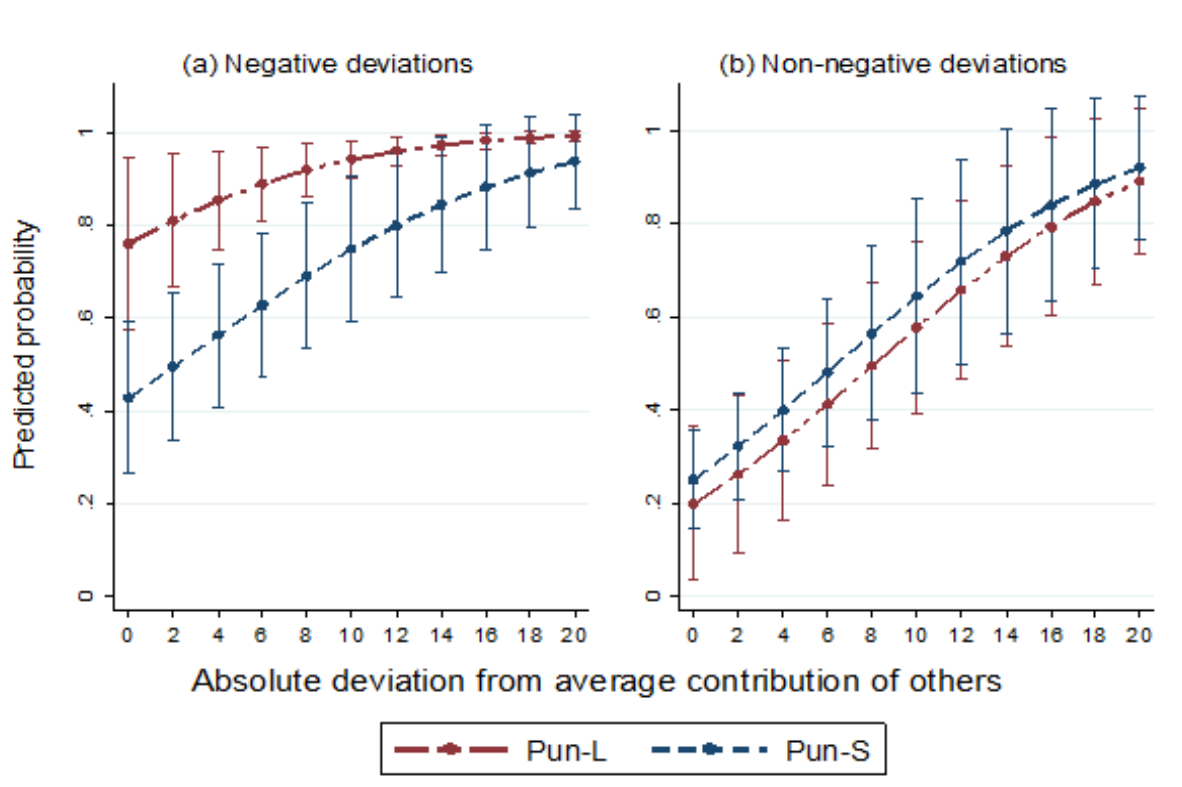
	Random effects		Probit	
	Negative deviations	Non-negative deviations	Negative deviations	Non-negative deviations
Absolute deviation from average contribution of others	0.328*** (0.067)	0.022 (0.026)	0.094*** (0.022)	0.110*** (0.031)
Short instructions dummy	-0.216 (0.740)	0.208 (0.526)	-0.984*** (0.365)	0.185 (0.341)
Absolute deviations $\times$ Short instructions dummy	-0.082 (0.078)	0.023 (0.044)	0.096*** (0.034)	-0.049 (0.039)

Constant	1.627*** (0.548)	2.421*** (0.570)	0.764 (0.422)	-0.055 (0.384)
Observations	765	1395	765	1395

Standard errors clustered at group level in parentheses. Includes round dummies (not reported). \*, \*\*, \*\*\* - Significant at, resp., 10%, 5% and 1%.

To examine targeting of punishment, Probit regressions were estimated. The dependent variable is 1 if an individual received *any* punishment in the round and 0 otherwise (Table 1, last two columns). No difference between treatments is found in the case of non-negative deviations. With negative deviations, the likelihood of punishment is increasing in the deviation of one's contribution from that of others.<sup>2</sup> Importantly, the short instructions dummy is negative and significant. Further, punishment is somewhat more responsive to the magnitude of the deviation in Pun-S. To identify the net effect on punishment likelihood, Figure 2, presents predicted probabilities of receiving punishment, as a function of negative and positive deviations.

**Figure 2. Predicted probabilities of receiving punishment**



Vertical bars are 95% confidence intervals.

<sup>2</sup> This is so also for positive deviations. This is most likely related to anti-social punishment associated with “blind” revenge (Hermann et al., 2008).

As shown in Figure 2(a), negative deviations are less likely to be punished in Pun-S than in Pun-L, and significantly so for deviations up to 10 tokens. The predicted probability of receiving punishment at the average negative deviation of 6.44 tokens is 0.643 in Pun-S and 0.897 in Pun-L. These are remarkably close to the actual punishment frequencies of 0.70 and 0.92. The differences are not found to be significant for non-negative deviations, i.e., for ‘anti-social’ punishment.

**Result 2:** *Subjects contributing below the mean of other group members are punished with a significantly higher frequency in Pun-L than in Pun-S.*

#### 4. Conclusion

Carefully crafted instructions are crucial for ensuring that experimental subjects fully understand the incentive structures within the laboratory decision setting. While previous evidence suggests that the length and format of instructions can significantly affect comprehension levels of experimental subjects in public goods games, we know of no evidence that *behaviour* is significantly affected. We hypothesise that comprehension levels might significantly affect behaviour, and results, in more complicated settings.

In summary, in a public goods game with punishment, longer instructions with a more explicit discussion of the positive externality associated with public goods contributions are associated with more consistent targeting of low contributors and higher contributions to the public good.

While our results provide evidence that instruction format can affect behaviour of experimental subjects in complex settings, our short and long instructions varied in more than one dimension. More work is thus needed to identify the particular details of experimental instructions that might affect subject behaviour.

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# Electronic Supplementary Material

## Online Only

### Appendix A: Experimental Instructions

#### I. Instructions for VCM-S

- The experiment consists of 20 rounds. In each round you are member of a group of 4 participants. The composition of each group is randomly determined at the beginning of Part 1 and does not change during the course of the 20 rounds. You will never get to know the identities of the other group members. Each group member faces the same set of decision tasks. The decisions to be made by each group member are explained below.
- At the beginning of each round, you will be endowed with 20 tokens. Your decision in this stage is how many of your 20 tokens you want to assign to a Group Project (GP). The remainder will automatically be assigned to an Individual Project (IP), i.e.,  
 $IP = (20 - \text{your assignment to the GP})$ .
  - Your earnings from the Individual Project equal your token assignment to the Individual Project and do not depend on the decisions of others.
  - Your earnings from the Group Project depend on the total number of tokens assigned to this Project by members of your group. The total number of tokens assigned to the Group Project will be doubled and then equally divided among the four group members.
  - Thus, your earnings in this round are

$$\text{Earnings from the round} = IP + \frac{2 \times GP}{4}$$

- At the end of the round, each of you will be informed of the individual assignments to the GP in your group, ranked from top to bottom, so you will not be able to track individual decisions across rounds. You will also be informed of your earnings in this round.
- At the end of the experiment, the sum of your earnings over the 20 rounds will be converted to Pounds at the exchange rate of 60 Tokens = 1 Pound.

**The following examples are for illustrative purposes only.**

**Example 1.** Assume that you have assigned 5 tokens to the Group Project. Suppose that the other group members have assigned 0, 15 and 20 tokens to the Group Project. Thus the total number of tokens in the Group Project is 40. Your earnings from this round will be 35 tokens (= 15 tokens from your Individual Project and  $40 \times 0.5 = 20$  tokens from the Group Project). The earnings of the other group members from this round will be 40 tokens (= 20 + 20), 25 tokens (= 5 + 20) and 20 tokens (= 0 + 20) respectively.

**Example 2.** Assume that you have assigned 15 tokens to the Group Project. Suppose that the other group members have assigned 0, 5 and 20 tokens to the Group Project. Thus the total number of tokens in the Group Project is 40. Your earnings from this round will be 25 tokens (= 5 tokens from your Individual Project and  $40 \times 0.5 = 20$  tokens from the Group Project). The earnings of the other group members from this round will be 40 tokens (= 20 + 20), 35 tokens (= 15 + 20) and 20 tokens (= 0 + 20) respectively.

## II. Instructions for VCM-L

Thank you for coming! This is an experiment about decision-making. You will receive £2.5 for showing up on time. If you follow the instructions carefully, you can earn more money depending both on your own decisions and on the decisions of others.

These instructions and your decisions in this experiment are solely your private information. During the experiment you are not allowed to communicate with any of the other participants or with anyone outside the laboratory. Please switch off your mobile phone now. If you have any questions at any time during the course of this experiment, please raise your hand. An experimenter will assist you privately.

**The experiment consists of twenty (20) consecutive decision rounds.** Your total earnings will be the sum of your earnings from all these rounds.

**At the beginning of the experiment, participants will be randomly divided into groups of four (4) individuals.** The composition of the groups will remain the same in each round. This means that you will interact with the same people in your group throughout the experiment.

Your decisions will be recorded privately at your computer terminal. Other participants will never be informed about your decisions or earnings from the experiment. You will be paid individually and privately in cash at the end of the experiment.

During the experiment all decisions are made in tokens (more details below). Your total earnings will also be calculated in tokens and, at the end of the experiment will be converted to Pounds at the following rate:

$$60 \text{ tokens} = \text{£}1$$

You are a member of a group of four participants. At the beginning of each round, each member receives an endowment of **20 tokens**. **Your task is to decide how many tokens you would like to allocate to a Group Project (GP) and how many to keep for yourself in an Individual Project (IP).** Each token not allocated to the Group Project will automatically be allocated to your Individual Project (IP). Your total earnings from the round include earnings from both your Individual Project and the Group Project. All participants in your group will simultaneously face the same decision situation.

### **Your earnings from the Individual Project in each round**

**You will earn one (1) token for each token allocated to your Individual Project.** No other member in your group will earn from your Individual Project.

### **Your earnings from the Group Project in each round**

**For each token you allocate to the Group Project, you will earn 0.5 tokens. Each of the other three people in your group will also earn 0.5 tokens. Thus, the allocation of 1 token to the Group Project yields a total of 2 tokens for all of you together.** Your earnings from the Group Project are based on the total number of tokens allocated by all members in your group. Each member will profit equally from the amount allocated to the Group Project. For each token allocated to the Group Project, each group member will earn 0.5 tokens regardless of who made the allocation. This means that you will earn from your own allocation as well as from the allocations of others.

### **Your total earnings in each round**

Your total earnings consist of earnings from your Individual Project *and* the earnings from the Group Project.

**Your earnings in the round = Earnings from your Individual Project + Earnings from the Group Project**

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**The following examples are for illustrative purposes only.**

**Example 1.** Assume that you have allocated 0 tokens to the Group Project. Suppose that each of the other group members has also allocated 0 tokens to the Group Project. Thus the total number of tokens in the Group Project in your group is 0. Your earnings from Stage 1 of this round will be 20 tokens (20 tokens from your Individual Project and 0 tokens from the Group Project). The earnings of the other group members in Stage 1 of this round will be 20 tokens each.

**Example 2.** Assume that you have allocated 10 tokens to the Group Project. Suppose that each of the other group members has allocated 0 tokens to the Group Project. Thus the total number of

tokens in the Group Project in your group is 10. Your earnings from Stage 1 of this round will be 15 tokens (= 10 tokens from your Individual Project and  $10 \cdot 0.5 = 5$  tokens from the Group Project). The earnings of the other group members from Stage 1 of this round will be 25 tokens each (= 20 tokens from the Individual Project +  $10 \cdot 0.5 = 5$  tokens from the Group Project).

**Example 3.** Assume that you have allocated 20 tokens to the Group Project. Suppose that each of the other group members has also allocated 20 tokens to the Group Project. Thus the total number of tokens in the Group Project in your group is 80. Your earnings from Stage 1 of this round will be 40 tokens (= 0 tokens from your Individual Project and  $80 \cdot 0.5 = 40$  tokens from the Group Project). The earnings of the other group members will similarly be 40 tokens each.

After all individuals have made their decisions in the round, you will be informed of the total allocation to the Group Project and your earnings from the round. You will also be informed of the individual allocation decisions of each group member, ranked from top to bottom. Individuals in your group will NOT be identified in anyway. Thus, information about individual allocations will be completely anonymous.

The same process will be repeated for a total of 20 rounds. Your earnings from earlier rounds cannot be used in the following rounds. You will receive a new endowment of 20 tokens in each round.

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### Questions to help you better understand the decision tasks

When everyone has finished reading the instructions, and before the experiment begins, we will ask you a few questions regarding the decisions you will make in the experiment. The questions will help you understand the calculation of your earnings and ensure that you have understood the instructions.

Please answer these questions on your computer terminal. Please type your answer in the box next to the corresponding question. Once everyone has answered all questions correctly we will begin the experiment.

### III. Instructions for Pun-S

- The experiment consists of 20 rounds. In each round you are member of a group of 4 participants. The composition of each group is randomly determined at the beginning of Part 1 and does not change during the course of the 20 rounds. You will never get to know the identities of the other group members. Each group member faces the same set of decision tasks. The decisions to be made by each group member are explained below.
- Each round is composed of two stages.
- Stage 1: At the beginning of stage 1 you will be endowed with 20 tokens. Your decision in this stage is how many of your 20 tokens you want to assign to a Group Project (GP). The remainder will automatically be assigned to an Individual Project (IP), i.e.,  
 $IP = (20 - \text{your assignment to the GP}).$

- Your earnings from the Individual Project equal your token assignment to the Individual Project and do not depend on the decisions of others.
- Your earnings from the Group Project depend on the total number of tokens assigned to this Project by members of your group. The total number of tokens assigned to the Group Project will be doubled and then equally divided among the four group members.
- Thus, your earnings in this first stage are

$$\text{Earnings from stage 1} = IP + \frac{2 \times GP}{4}$$

- At the end of this stage each of you will be informed of the individual assignments to the GP in your group, ranked from top to bottom, so you will not be able to track individual decisions across rounds. You will also be informed of your earnings at this stage.
- Stage 2: In this stage, you can use your earnings from Stage 1 to decrease the earnings of any other member in your group by assigning deduction tokens to them (with a limit of 5 tokens per individual member). Each deduction token assigned by you to a group member will decrease your earnings by one token and will decrease the earnings of that group member by 3 tokens. If you do not want to change the earnings of a member of your group, enter zero in the corresponding box.
- Your earnings in the round will be as follows:
  - Earnings from Stage 1 – Total number of deduction tokens used by you to reduce earnings of other group members –  $3 \times (\text{Total number of deduction tokens assigned to you by other group members})$

- At the end of Stage 2 you will be informed of the total number of deduction tokens received by you and of your earnings in the round. You will not be informed of who assigned deduction tokens to you.
- At the end of the experiment, the sum of your earnings over the 20 rounds will be converted to Pounds at the exchange rate of 60 Tokens = 1 Pound.

**The following examples are for illustrative purposes only.**

**Example 1.** Assume that you have assigned 5 tokens to the Group Project in Stage 1. Suppose that the other group members have assigned 0, 15 and 20 tokens to the Group Project in Stage 1. Thus the total number of tokens in the Group Project is 40. Your earnings from Stage 1 of this round will be 35 tokens ( $= 15$  tokens from your Individual Project and  $40 \times 0.5 = 20$  tokens from the Group Project). The earnings of the other group members from Stage 1 of this round will be 40 tokens ( $= 20 + 20$ ), 25 tokens ( $= 5 + 20$ ) and 20 tokens ( $= 0 + 20$ ) respectively.

Suppose in Stage 2, you assign a total of 3 deduction tokens to others, your Stage 1 earnings will be reduced by 3 tokens. Suppose in Stage 2 you receive a total of 3 deduction tokens from others, your Stage 1 earnings will be reduced by a further 9 tokens. Your earnings from this round will be 23 tokens ( $= 35 - 3 - 9$ ).

**Example 2.** Assume that you have assigned 15 tokens to the Group Project in Stage 1. Suppose that the other group members have assigned 0, 5 and 20 tokens to the Group Project in Stage 1. Thus the total number of tokens in the Group Project is 40. Your earnings from Stage 1 of this round will be 25 tokens ( $= 5$  tokens from your Individual Project and  $40 \times 0.5 = 20$  tokens from the Group Project). The earnings of the other group members from Stage 1 of this round will be 40 tokens ( $= 20 + 20$ ), 35 tokens ( $= 15 + 20$ ) and 20 tokens ( $= 0 + 20$ ) respectively.

Suppose in Stage 2, you do not assign any deduction tokens to others, your Stage 1 earnings will be unaffected by your decision. Suppose in Stage 2 you receive a total of 3 deduction tokens from others, your Stage 1 earnings will be reduced by 9 tokens. Your earnings from this round will be 16 tokens ( $= 25 - 9$ ).



#### IV. Instructions for Pun-L

Thank you for coming! This is an experiment about decision-making. You will receive £2.5 for showing up on time. If you follow the instructions carefully, you can earn more money depending both on your own decisions and on the decisions of others.

These instructions and your decisions in this experiment are solely your private information. During the experiment you are not allowed to communicate with any of the other participants or with anyone outside the laboratory. Please switch off your mobile phone now. If you have any questions at any time during the course of this experiment, please raise your hand. An experimenter will assist you privately.

**The experiment consists of twenty (20) consecutive decision rounds.** Each decision round consists of two stages described below. Your total earnings will be the sum of your earnings from all these rounds.

**At the beginning of the experiment, participants will be randomly divided into groups of four (4) individuals.** The composition of the groups will remain the same in each round. This means that you will interact with the same people in your group throughout the experiment.

Your decisions will be recorded privately at your computer terminal. Other participants will never be informed about your decisions or earnings from the experiment. You will be paid individually and privately in cash at the end of the experiment.

During the experiment all decisions are made in tokens (more details below). Your total earnings will also be calculated in tokens and, at the end of the experiment will be converted to Pounds at the following rate:

$$60 \text{ tokens} = \text{£}1$$

##### **First Stage of each round**

You are a member of a group of four participants. At the beginning of each round, each member receives an endowment of **20 tokens**. **Your task is to decide how many tokens you would like to allocate to a Group Project (GP) and how many to keep for yourself in an Individual Project (IP).** Each token not allocated to the Group Project will automatically be allocated to your Individual Project (IP). Your total earnings from Stage 1 include earnings from both your

Individual Project and the Group Project. All participants in your group will simultaneously face the same decision situation.

**Your earnings from the Individual Project in each round**

**You will earn one (1) token for each token allocated to your Individual Project.** No other member in your group will earn from your Individual Project.

**Your earnings from the Group Project in each round**

**For each token you allocate to the Group Project, you will earn 0.5 tokens. Each of the other three people in your group will also earn 0.5 tokens. Thus, the allocation of 1 token to the Group Project yields a total of 2 tokens for all of you together.** Your earnings from the Group Project are based on the total number of tokens allocated by all members in your group. Each member will profit equally from the amount allocated to the Group Project. For each token allocated to the Group Project, each group member will earn 0.5 tokens regardless of who made the allocation. This means that you will earn from your own allocation as well as from the allocations of others.

**Your total earnings in Stage 1 in each round**

Your total earnings consist of earnings from your Individual Project *and* the earnings from the Group Project.

**Your earnings in Stage 1 = Earnings from your Individual Project + Earnings from the Group Project**

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**The following examples are for illustrative purposes only.**

**Example 1.** Assume that you have allocated 0 tokens to the Group Project. Suppose that each of the other group members has also allocated 0 tokens to the Group Project. Thus the total number of tokens in the Group Project in your group is 0. Your earnings from Stage 1 of this round will be 20 tokens (20 tokens from your Individual Project and 0 tokens from the Group Project). The earnings of the other group members in Stage 1 of this round will be 20 tokens each.

**Example 2.** Assume that you have allocated 10 tokens to the Group Project. Suppose that each of the other group members has allocated 0 tokens to the Group Project. Thus the total number of tokens in the Group Project in your group is 10. Your earnings from Stage 1 of this round will be 15 tokens (= 10 tokens from your Individual Project and  $10 \cdot 0.5 = 5$  tokens from the Group Project). The earnings of the other group members from Stage 1 of this round will be 25 tokens each (= 20 tokens from the Individual Project +  $10 \cdot 0.5 = 5$  tokens from the Group Project).

**Example 3.** Assume that you have allocated 20 tokens to the Group Project. Suppose that each of the other group members has also allocated 20 tokens to the Group Project. Thus the total number of tokens in the Group Project in your group is 80. Your earnings from Stage 1 of this round will be 40 tokens (= 0 tokens from your Individual Project and  $80 \cdot 0.5 = 40$  tokens from the Group Project). The earnings of the other group members will similarly be 40 tokens each.

After all individuals have made their decisions in the first stage, you will be informed of the total allocation to the Group Project and your earnings from Stage 1. You will also be informed of the individual allocation decisions of each group member, ranked from top to bottom. Individuals in your group will NOT be identified in anyway. Thus, information about individual allocations will be completely anonymous.

### **Second Stage of each round**

In this stage, you can use your earnings from Stage 1 to decrease the earnings of any other member in your group by assigning deductions tokens to them. Each deduction token assigned by you to a group member will cost you one token and will decrease the earnings of that group member by 3 tokens. If you do not want to change the earnings of a member of your group, enter zero in the corresponding box.

You can assign a maximum of 5 deduction tokens to any group member. The maximum number of deduction tokens you can assign to all members of the group in total is 15 tokens **OR** your Stage 1 earnings, whichever is lower.

### **Your total earnings in each round**

**Your earnings in the round = Earnings from Stage 1**

**- Total number of deduction tokens used by you**

**-  $3 \times$  Total number of deductions tokens assigned to you by other group members**

After all participants have made their decisions in the second decision stage, you will be informed of the total number of deduction tokens received by you and of your earnings in the round. You will not be informed of who assigned deduction tokens to you.

The same process will be repeated for a total of 20 rounds. Your earnings from earlier rounds cannot be used in the following rounds. You will receive a new endowment of 20 tokens in each round.

Notice that your total calculated earnings in tokens at the end of a decision round can be negative if the costs from assigned and received deduction tokens exceed your earnings from the first stage. If your cumulative earnings from all 20 rounds at the end of the experiment are negative, the computer will automatically record zero earnings for you from the experiment. Thus, while your earnings from any particular round can be negative, your earnings from the experiment CANNOT be negative.

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### **Questions to help you better understand the decision tasks**

When everyone has finished reading the instructions, and before the experiment begins, we will ask you a few questions regarding the decisions you will make in the experiment. The questions will help you understand the calculation of your earnings and ensure that you have understood the instructions.

Please answer these questions on your computer terminal. Please type your answer in the box next to the corresponding question. Once everyone has answered all questions correctly we will begin the experiment.

## Appendix B: Pre-experiment quiz

*The quiz below also contains the explanatory answers. All subjects were given these answers before the main experiment began.*

**1. In each round, each group member has an endowment of 20 tokens. Suppose that no one in your group, including you, assigns any tokens to the Group Project.**

**a. What would be your earnings (in tokens) from the round? Answer: 20**

Earnings from your Individual Project = 20 (since you assigned 0 tokens to the Group Project). Total tokens assigned to the Group Project = 0. Thus earning from the Group Project =  $0.5 \cdot 0 = 0$ . In summary, your earnings from the round =  $20 + 0 = 20$  tokens.

**b. What would be the earnings (in tokens) of each of the other members of your group from the round? Answer: 20**

Same calculation as above.

**2. In each round, each group member has an endowment of 20 tokens. Suppose everybody in your group, including you, assigns 20 tokens to the Group Project.**

**a. What would be your earnings (in tokens) from the round? Answer: 40**

Earnings from your Individual Project = 0 (since you assigned all 20 tokens to the Group Project and kept nothing in your Individual Project). Total tokens assigned to the Group Project = 80 (all 4 group members assigned 20 tokens each). Thus earning from the Group Project =  $0.5 \cdot 80 = 40$ . In summary, your earnings from the round =  $0 + 40 = 40$  tokens.

**b. What would be the earnings (in tokens) of each of the other members of your group from the round? Answer: 40**

Same calculation as above.

**3. In each round, each group member has an endowment of 20 tokens. You do not assign anything to the Group Project. Suppose that each other member of your group assigns 20 tokens to the Group Project.**

**a. What would be your earnings (in tokens) from the round? Answer: 50**

Earnings from your Individual Project = 20 (since you assigned 0 tokens to the Group Project). Total tokens assigned to the Group Project = 60 (all the 3 other group members assigned 20 tokens each). Thus earning from the Group Project =  $0.5 \times 60 = 30$ . In summary, your earnings from the round =  $20 + 30 = 50$  tokens.

**b. What would be the earnings (in tokens) of each of the other members of your group from the round? Answer: 30**

For each of the other players, Earnings from the Individual Project = 0 (since each of them assigned 20 tokens to the Group Project and kept nothing in their Individual Projects). Total tokens assigned to the Group Project = 60 (all the 3 other group members assigned 20 tokens each). Thus earning from the Group Project =  $0.5 \times 60 = 30$ . In summary, each of the other 3 group members would have earnings from the round =  $0 + 30 = 30$  tokens.

*The following questions were included only in the punishment treatments*

**4. In the second stage of a round, what is the cost (in tokens) to a group member of assigning a total of 2 tokens? Answer: 2**

Each token a group member assigns to another group member costs that group member one token. Thus, if a group member assigns two tokens, their total cost is  $2 \times 1 = 2$  tokens.

**5. In the second stage of a round, by how many tokens will the earnings of a group member be decreased if he/she is assigned a total of 3 tokens? Answer: 9**

Each token a group member is assigned reduces that group member's earnings by 3 tokens. Thus, if a group member is assigned 3 tokens in total by other group members, that group member's earnings are decreased by  $3 \times 3 = 9$  tokens.

## Appendix C: Additional Analyses

### C1. Analysis of decision times

BD12 found that instruction format and length affected subject comprehension levels. In the test, we focus on the effects on behaviour. We also explore the possibility that the short instructions affected the understanding of the nature of the games. Our proxy measure for understanding is the time taken by subjects to correctly answer the pre-experiment quiz and the time taken to make decisions (contribution or punishment) once the experiment began.

Table C1 presents mean time taken (in seconds) by individuals to complete the pre-experiment quiz, as well as the time to make contribution decisions (VCM-S and VCM-L) and contribution-punishment decisions (Pun-S and Pun-L) in a round.<sup>1</sup> In the case of quiz times, each subject represents an independent observation, as subjects were not placed in decision groups at this stage and answered the quiz independently with no feedback on others' performance or decision times. The number of observations in each treatment was thus the number of participants in each treatment. In relation to contribution or punishment decisions, because subjects made decisions within their groups, we treat a group as an independent observation. For each group, we first calculate the average of the variable for all 4 players in a round and then over all 20 rounds, thus resulting in one observation per group. The summary statistics in the table use this average for each group.

**Table C1. Mean decision time in seconds**

Treatment	Individual Quiz Task		Group Experiment Tasks		
	Obs	Quiz	Obs.	Contribution	Punishment
<b>VCM-S</b>	44	423.39 (289.75)	11	5.03 (1.37)	-
<b>Pun-S</b>	60	549.38 (305.98)	15	5.58 (1.31)	18.58 (1.81)
<b>VCM-L</b>	40	222.43 (144.04)	10	3.72 (1.11)	-
<b>Pun-L</b>	48	328.63 (150.30)	12	4.48 (1.39)	16.67 (1.45)

<sup>1</sup> While answering the quiz, subjects' screens showed a timer of 600 seconds and when making contribution and punishment decisions, their screens showed a timer of 30 seconds. But we did not enforce this time limit and subjects could take as long as necessary. However, note that the experiment could not begin until *all* subjects had answered all questions correctly. At any point during the quiz and the experiment, subjects could ask questions, which the experimenter answered privately.

Figures in parentheses are standard deviations across individuals within a treatment for the Quiz task and across groups within a treatment for the group experiment tasks. We dropped 6 instances (out of 3840) with a recorded contribution decision time of 99999, i.e., where subjects made decisions instantly.

As shown, subjects in the two treatments with longer instructions took less time to complete the quiz than did those in the two treatments with the short instructions. It is striking that subjects took less time to complete the quiz in Pun-L than in VCM-S, especially given that the quiz in the punishment treatments contained two more questions than did the quiz in the VCM treatments. In paired treatment comparisons, average time spent on the quiz was significantly lower when subjects read the long instructions in both the VCM ( $n$  = number of individuals in each treatment,  $p = 0.0009$ ) and the punishment ( $n$  = number of individuals in each treatment,  $p = 0.0003$ ) treatments.

This suggests that instruction length may be associated with significant differences in average comprehension levels *across individuals* in the different treatments. We next explore if they also affect the variance in comprehension across subjects within treatments. Table C1 shows that standard deviations in individual quiz times are not very different within treatments using the same instruction format, but are higher in both treatments with short instructions. Variance comparisons tests reveal that there are no significant differences within VCM and punishment treatments using the same instruction format ( $p > 0.10$  for short and long instructions). Comparing across instruction formats, the variance of individual quiz times is significantly higher when subjects receive short instructions in both the VCM and punishment ( $p = 0.0000$  for both) treatments.

One possible reason for why subjects perform better on the quiz in the treatments with long instructions could be that two of the examples in the instructions also appeared on the quiz, while this was not the case in the treatments with the short instructions. Thus, looking at quiz times alone might present an incomplete picture of comprehension levels. However, once the experiment began, subjects had to respond to actual decisions made by others in their groups. If comprehension level are indeed affected, we may observe differences in decision times across the instruction formats.

Table C1 shows that subjects also took less time to make decisions in the treatments with long instructions. The differences are statistically significant for contribution decisions in both the VCM ( $n$  = number of groups in each treatment,  $p = 0.0221$ ) and the punishment treatments ( $n$  = number of groups in each treatment,  $p = 0.0570$ ). Subjects also take



significantly less time to make punishment decisions in Pun-L than in Pun-S ( $n$  = number of groups in each treatment,  $p = 0.0097$ ).

The standard deviations for contribution and decision times in Table C1 do not measure within-group variation. Instead, they measure the variation across *groups* in average decision times. Comparisons of these standard deviations thus do not inform us of variation in decision times across individuals. Further, lack of independence implies that comparisons of variance in times for contribution and punishment decisions are not as straightforward as for quiz times, i.e., we cannot simply compare the standard deviations across all individuals in a treatment. Hence, we construct an alternative measure of within-group variation in decision times.

As before an independent observation is a group of 4 players. To allow comparisons, we first calculate standard deviations of decision times within a group in each round. We then calculate the average of this standard deviation for the group over all 20 rounds. We thus have one observation of mean (over all 20 rounds) within-group standard deviation in decision times for each group. Table C2 presents means of within-group standard deviations in decision times in the different treatments.

**Table C2. Means of (mean) *within*-group standard deviation in decision times**

Treatment	Obs	Decision	
		Contribution	Punishment
<b>VCM-S</b>	11	4.17	-
<b>Pun-S</b>	15	3.92	5.11
<b>VCM-L</b>	10	2.88	-
<b>Pun-L</b>	12	2.87	3.66

Wilcoxon rank-sum tests are used to compare these across treatments. The number of observations for each test is the number of groups in each treatment. Once again, the difference between treatments using the same instruction format is not significantly different ( $p > 0.10$  for short and long instruction). However, mean *within group* variance in decision times for contributions is significantly higher in VCM-S than in VCM-L ( $p = 0.0573$ ) and in Pun-S than in Pun-L ( $p = 0.0510$ ). Further, within-group variance in punishment decision times is also significantly higher in Pun-S than in Pun-L ( $p = 0.0248$ ).

The above results reveal that instruction length is associated with significant differences in the comprehension levels of subjects, both across *and* within groups.<sup>2</sup> Moreover, this is so despite the fact that subjects were required to take the same quiz in both VCM treatments and the same quiz in both punishment treatments. BD12 found that forcing subjects to solve examples significantly improved subject comprehension. Our results suggest that that may not be sufficient; forced inputs (as in our pre-experiment quiz) are not a substitute for clearer instructions.

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<sup>2</sup> BD12 found that short on-screen instructions reduced comprehension relative to longer instructions, albeit not significantly so.

## C2. Heterogeneity across groups in the punishment treatments

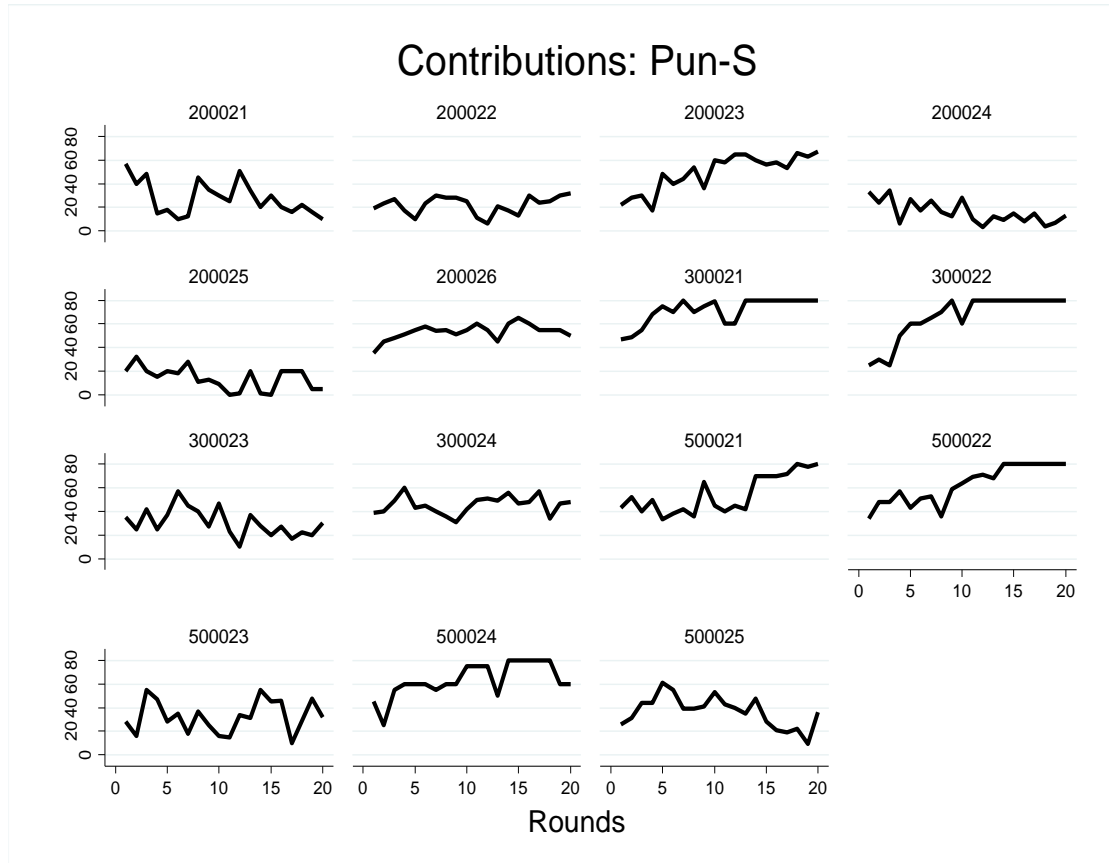
Aggregating across groups, results presented in the main text document that groups in Pun-L achieve higher levels of contributions than those in Pun-S. In the following, we explore the performance of individual groups in the two punishment treatments. Our aim is to identify patterns, and the evolution over time, of cooperation and punishment in the successful groups in the two treatments.

We apply a relatively stringent definition for success. We define successful groups as those that simultaneously satisfy two criteria:

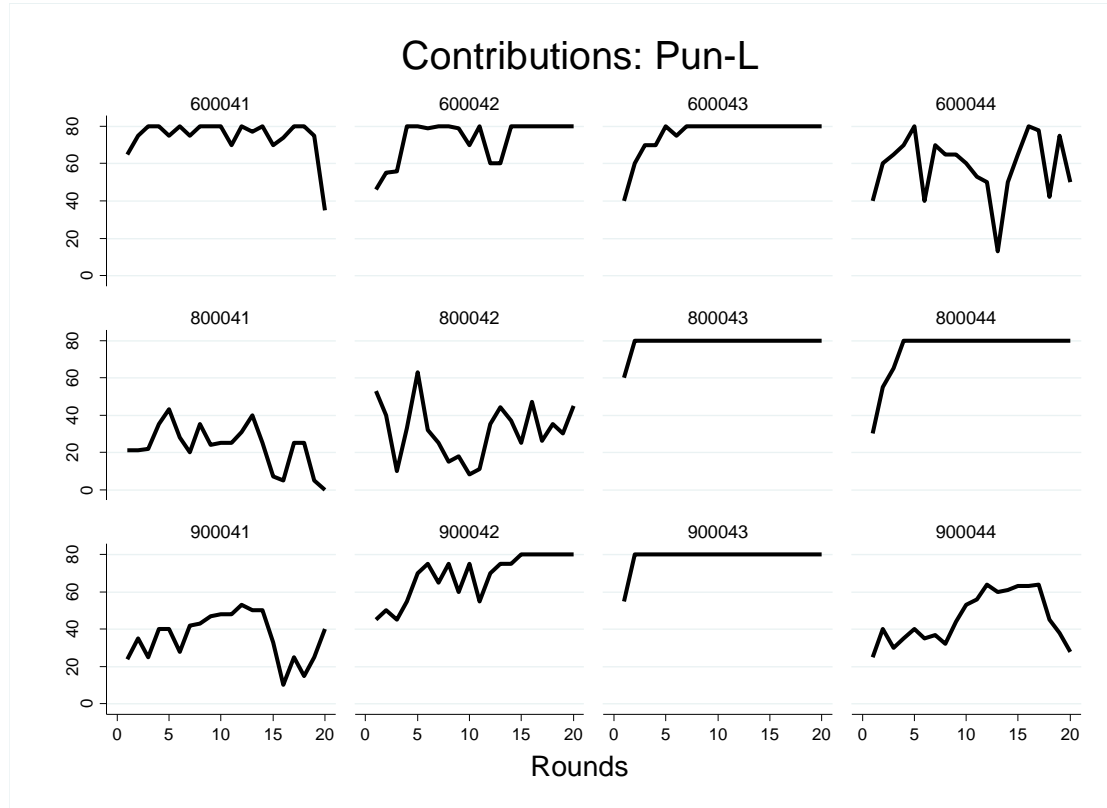
- (i) attain 100% contributions *before* the end of the 20 rounds, *and*
- (ii) maintain 100% contribution in the final round.

We identify such groups in both treatments and then compare the relative frequency of success in the two treatments. Figure C1 presents mean group contributions over time for the 15 groups in Pun-S and Figure C2 presents mean group contributions over time for the 12 groups in Pun-L.

**Figure C1. Mean group contributions in Pun-S**



**Figure C2. Mean group contributions in Pun-L**



First, Figures C1 and C2 show that there is substantial heterogeneity in performance across groups in both Pun-S and in Pun-L. Groups attain varying degrees of success in raising contributions in both treatments. Figure C1 shows that only 3 out of 15 groups – 300021, 300022 and 500022 – are successful in Pun-S. In contrast, Figure C2 shows that 6 out of 12 groups – 600042, 600043, 800043, 800044, 900042 and 900043 – attain success in Pun-L. Thus, while only 20% of groups in Pun-S are successful, 50% of groups in Pun-L are successful.

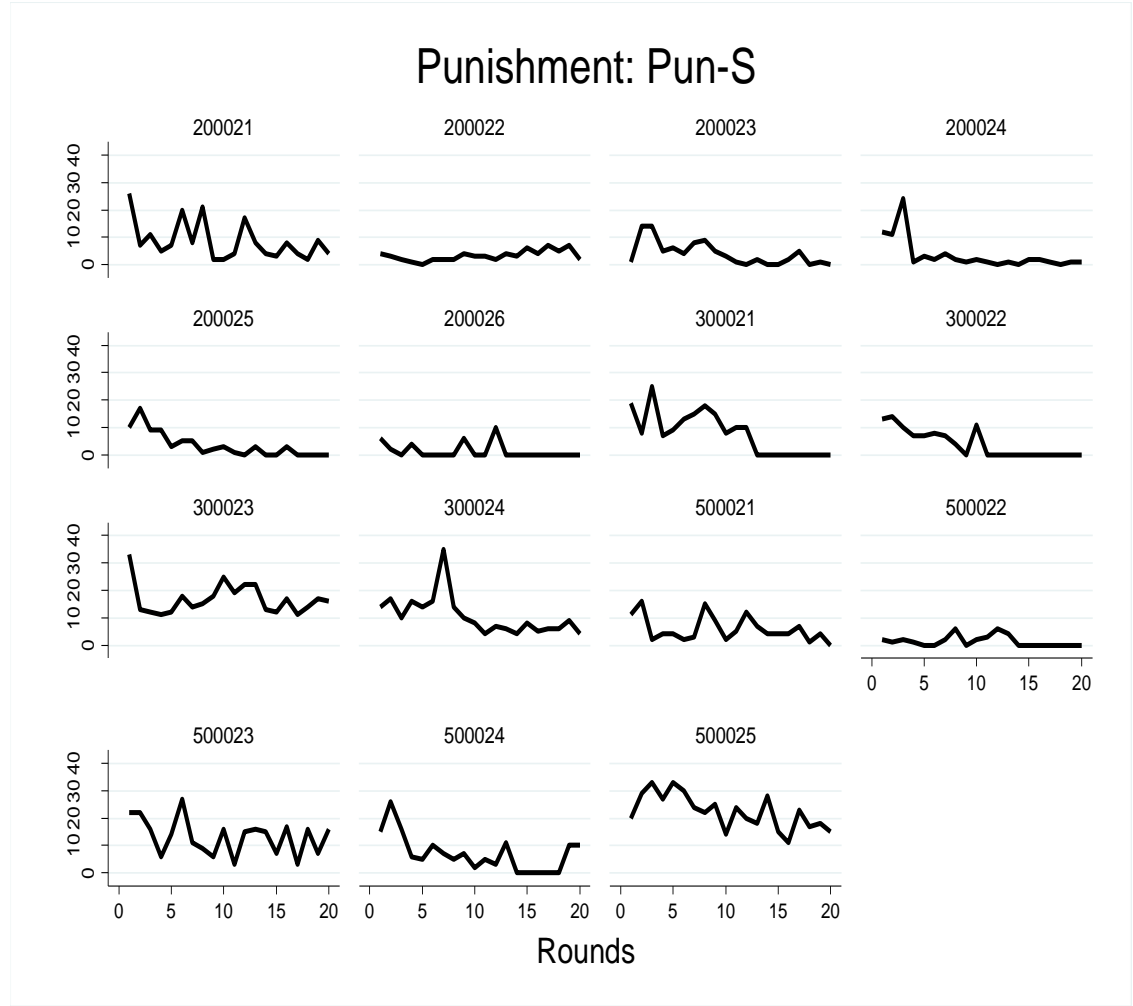
Focusing attention only on the successful groups in the two treatments, the figures show that, in Pun-S, all three groups attain 100% contributions only in the second half of the series of decision rounds and in one case (group 500022) only in the last 5 rounds. In Pun-L, on the other hand, 3 out of 6 groups (groups 800043, 800044 and 900043) attain 100% cooperation almost immediately, one (600043) attains success by round 7 and only two groups (600042 and 900042) take more than 10 rounds to reach 100% contributions.<sup>3</sup>

<sup>3</sup> Group 300021 in Pun-S and group 600042 in Pun-L reach high contribution levels early on but then contributions drop to 75% early in the second half of the experiment before rising again. Because of this drop, we do not classify them as being immediately successful.

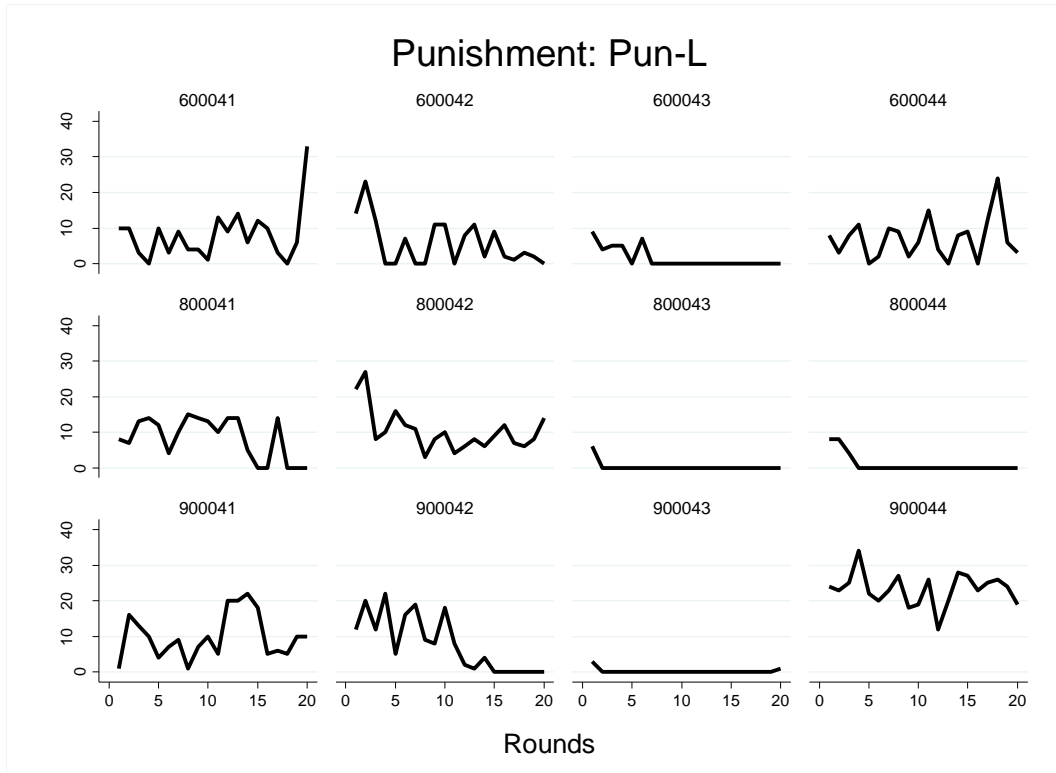
Thus, in addition to the difference in the rate of success among groups, the speed at which successful groups attain success is also higher in Pun-L than in Pun-L.

The fact that we did not find any differences in (aggregate) contribution behavior between VCM-S and VCM-L suggests that the differences in results noted above are not due solely to the explicit discussion of the positive externality of group contributions included in the long instructions. The results from our investigation of aggregate behavior suggest that differences in punishment behavior could drive the observed difference in success rates of groups. Figures C3 and C4 present the average punishment used by all groups, in respectively, Pun-S and Pun-L.

**Figure C3. Mean group punishment in Pun-S**



**Figure C4. Mean group punishment in Pun-L**



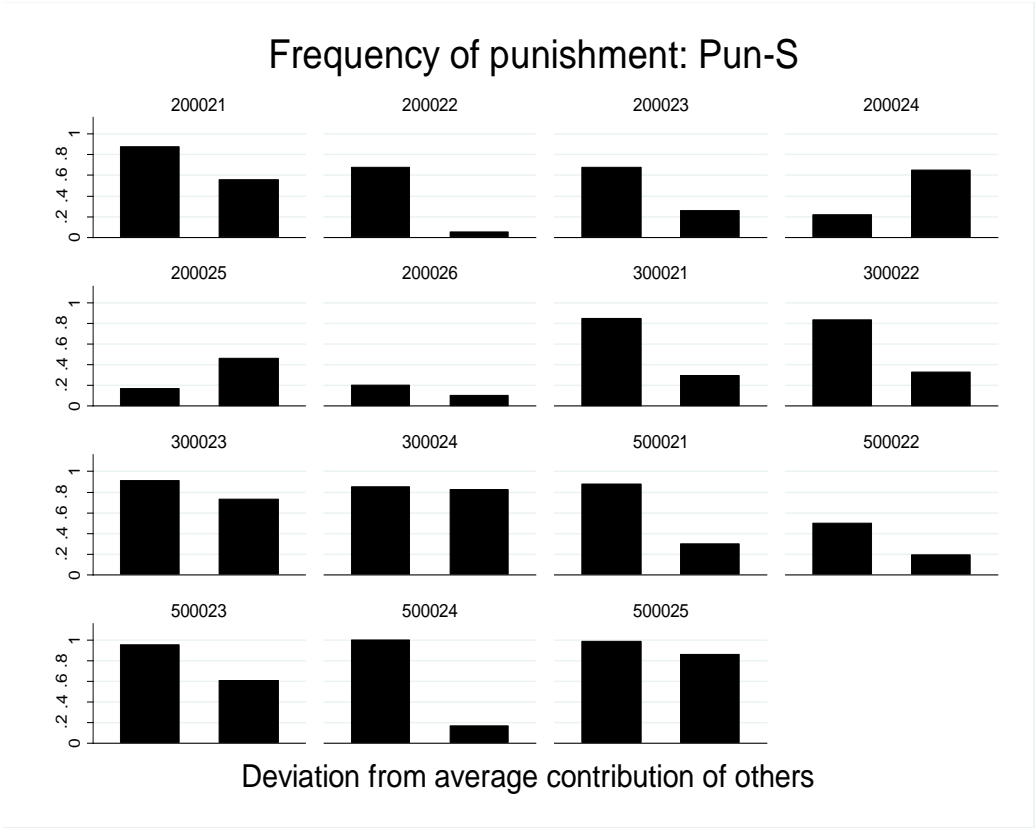
With one exception (group 600042 in Pun-L), all successful groups in Pun-S and in Pun-L initially make use of positive amounts of punishment and then reduce punishment use over time. Crucially, the attainment of sustainable 100% cooperation coincides with the near-zero use of punishment. This suggests that successful groups are able to use non-trivial amounts of punishment early on to establish a norm of cooperation and, once the norm is established, do not need to rely on continued use of punishment to enforce it.

Most unsuccessful groups either do not make use of sufficient punishment or do not show the pattern observed in successful groups. For example, groups 200022 and 200023 in Pun-S use almost no punishment throughout the experiment and never attain high cooperation rates. On the other hand, groups 300023 and 800042 use substantial punishment but punishment use never declines.

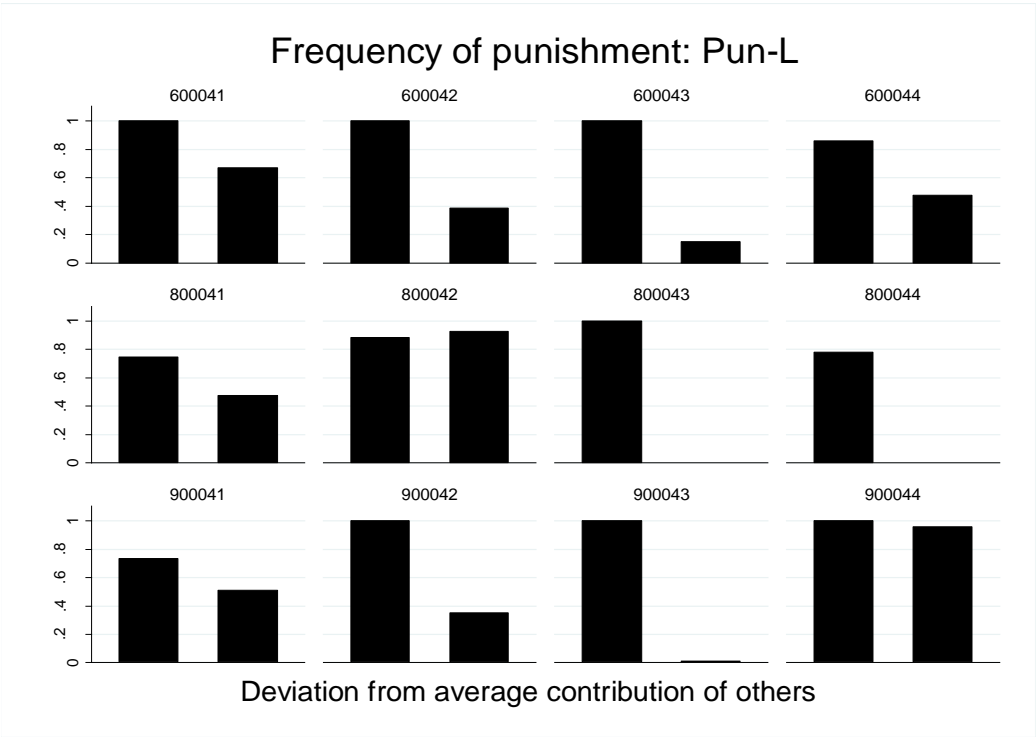
On the other hand, Group 600042 in Pun-L is an exception that never reaches a point where punishment use is no longer necessary, but nevertheless attains success in terms of sustained high cooperation. We explore the potential role of (mis-) targeting of punishment in the success of groups. Figure C5 and C6 present the mean frequency with which individuals are targeted for punishment in, respectively, Pun-S and Pun-L. In both figures, the bars on the left correspond to those individuals with negative deviations from

the average contributions of the others in the group and the bars on the right to those with non-negative deviations.

**Figure C5. Frequency of punishment received by individuals in Pun-S**



**Figure C6. Frequency of punishment received by individuals in Pun-L**



The two figures are illuminating. Figure C6 shows that (near) perfect targeting of punishment is the key to (almost) instant success. Particularly, there is *no* anti-social punishment in groups 800043, 800044 and 900043 in Pun-L while below average contributors are nearly always targeted for punishment. In groups that take longer to achieve success - groups 600042, 600043 and 900042 in Pun-L and groups 300021, 300022 and 500022 in Pun-S, we observe positive amounts of anti-social punishment. However, below average contributors are targeted substantially more frequently for punishment.

In contrast, in some unsuccessful groups, below average contributors are not targeted for punishment any more frequently than are above average contributors. In some groups, while they are targeted more frequently, the difference in punishment rates is not substantial.

The analysis above identifies three key features of successful groups:

1. Sufficient punishment must be used to serve as a credible deterrent to norm violation.
2. Punishment must be targeted at below average contributors and *not* at above average contributors in order to establish a cooperative norm.
3. Use of punishment is not always necessary in the long run to enforce this norm.

The above analysis reveals that groups that received the longer instructions were more likely to display the above patterns of behaviour and, thus more likely to achieve high and sustained cooperation, than those that received the shorter instructions.