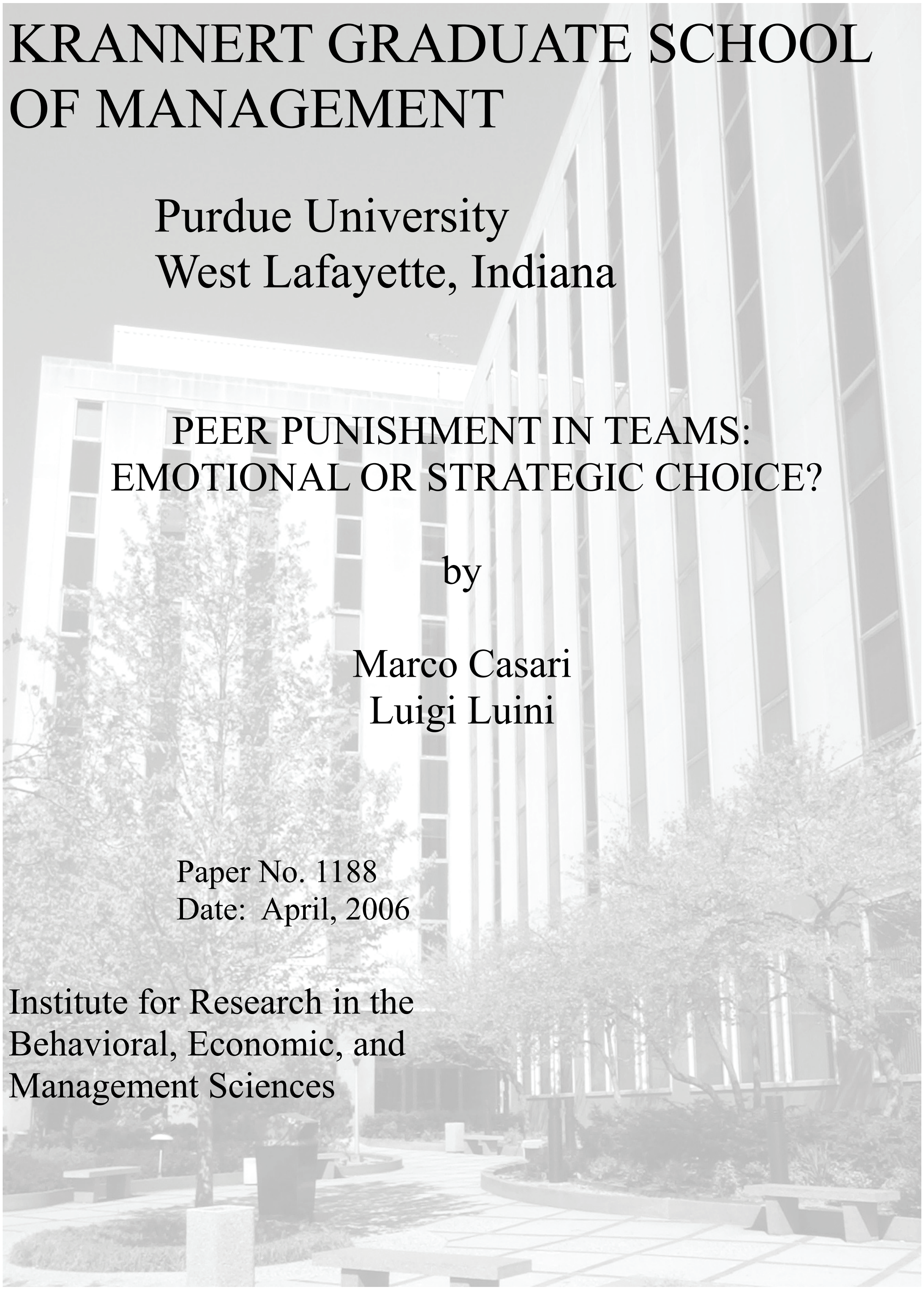

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PEER PUNISHMENT IN TEAMS: EMOTIONAL OR STRATEGIC CHOICE?

by

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Comments are welcome

PEER PUNISHMENT IN TEAMS:

EMOTIONAL OR STRATEGIC CHOICE?

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Abstract

Punishing the free-riders of a team can promote group efficiency but is costly for the punisher. For this reason, economists see punishment as a second-order public good. We show in an experiment that subjects do not value punishment for its deterrence but instead for the satisfaction of retaliating. Punishment choices are made with little strategic reasoning.

JEL C91, C92, D23

Keywords: experiments, public goods, informal punishment, emotions, legal systems

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1. Introduction

Why are modern societies governed by a system of legal punishment and not peer punishment? Economists would argue that in a one-shot cooperative task, peers under-provide punishment of free-riders; hence a legal system is required. We show that an additional reason why a legal system is advantageous could be that punishment is an emotional issue. Emotions have often been referenced as an explanation for peer punishment in teams (Fehr and Gaechter, 1999; Gaechter and Herrmann, 2005; Xiao and Houser, 2005). While the most common view among economists is that emotions simply shape the reward parameters for rational choice (Anderson and Putterman, 2006; de Quervain et al., 2004; Fehr and Schmidt, 1999), psychologists claim that emotions may affect the ability to make rational choices within those parameters (Elster, 1998). We suggest that emotions may interfere with strategic reasoning, which provides an additional rationale for why in many situations judicial enforcement is preferred to peer punishment. We put forward and test alternative specifications regarding the role of emotions.

For legal systems, the main goal is how much a criminal is getting punished (Becker, 1968). This paper presents an experimental study which shows that peer punishment is largely insensitive to the cumulation of sanctions and is instead motivated by the satisfaction of personally punishing a subject. Punishment of free-riders may make the punisher feel better off but may have tenuous relations with the rationale of legal punishment systems. Situations may even exist where peers over-provide punishment.

The concepts of strategic and emotional punishment are introduced in section 2 and a more formal model is presented in section 4. The two novel experimental designs used to disentangle the alternative models are outlined in section 3. In the first design, strategic reasoning in punishment plays no role (one-to-one treatment) and this serves as a benchmark for the individual taste for punishment. The second design measures how people respond when strategic reasoning is involved (sequential treatment). The results are reported in section 5 and the conclusions follow in section 6.

2. Strategic Reasoning in Punishment

Consider a group of three people where agents 1 and 2 want to punish agent 3 (the target). Assume that agent 1 has a quasi-linear utility function, $u_1 = \pi_1 + v_1 (p_{13}, p_{23})$, which is strictly increasing in personal monetary earnings π_1 and weakly increasing (and concave) in the punishment points inflicted on the target by either herself, p_{13}, or agent 2, p_{23}. Agent 2 has a similar utility function.

In our one-to-one treatment, only agent 1 can punish agent 3. Hence, agent 1 decides on her punishment request p_{13} knowing that nobody except her has the opportunity to punish agent 3. She will have to balance her personal cost to punish ($– p_{13}$) versus the benefit of having agent 3 punished ($v_1 (p_{13}, 0) – v_1 (0, 0)$). We define agent 1’s optimal choice in the one-to-one treatment as her *standalone punishment*, $s_{13}=s$, which gives us a measure of the agent’s taste for punishment absent any strategic consideration.

The most common design in the literature allows for simultaneous punishments from agent 1 and agent 2, which are then cumulated to reduce agent 3’s earnings. Because of *strategic* considerations, agent 1’s optimal choice could now be to punish anywhere between zero and her standalone punishment level, ($\partial v_1/\partial p_{13}=\partial v_1/\partial p_{23}$). Consider the standard assumption that agent 1 cares only about the fact that, as a consequence of everyone’s actions, agent 3 receives a certain level of punishment. Hence, her marginal utility from punishment is identical whether she or agent 2 is doing the punishment (v_1 (s, 0) = v_1 (0, s)). For instance, if agent 2 already requests *s* points of punishment, agent 1's best response is to punish zero. This assumption formalizes the concept of punishment as a second-order public good. Agents care about the free-rider getting punished but dislike having to pay the cost. Unfortunately, when agent 1 and 2 have an identical taste for punishment (s_{13}=s_{23}=s) and choices are simultaneous, any combination of punishment requests that sum up to *s* is an equilibrium (Varian, 1994). A coordination problem arises given this multiplicity of equilibria, which makes the interpretation of empirical evidence ambiguous.

In order to study strategic behavior in punishment with the convenience of a unique equilibrium, we introduce a sequential treatment. Suppose that first, agent 1 decides on her punishment request for agent 3 and then, after learning agent 1's choice, agent 2 decides how many additional points to give. If both agents have an identical taste for punishment, there exists a unique equilibrium where agent 1 punishes zero and agent 2 requests *s* points (p_{13}=0, p_{23}=s, point R in Figure 1).[1] Being the first to move puts agent 1 in a position to free-ride on the cost of punishment while enjoying a punishment equal to her standalone punishment level. In fact, any reduction in punishment by agent 1 will be exactly offset by an equivalent increase in punishment by agent 2.

If punishment is strategic, a one-to-one treatment should yield substantially different patterns of punishment than a sequential treatment. As reported in section 5, the data largely refutes this prediction. Punishment is not treated as a second-order public good. To explain the data, we introduce a model of *emotional* punishment. Agents engage in emotional punishment when their utility from punishment is derived from personally inflicting the punishment. While the identity of the punisher is irrelevant for a strategic punisher, this is not the case for an

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[1] We thank Steve Gjerstad for suggestions on Figure 1. More details on the emotional and strategic models are provided in section 4.

emotional punisher. If agent 1 is an emotional punisher, agent 2's punishment of agent 3 has no impact on agent 1's utility ($v_1(s, 0) > v_1(0, s) = v_1(0, 0)$).[2] The emotional model predicts the same amount of punishment in the one-to-one, simultaneous, and sequential treatments (point E in Figure 1). Moreover, as group size grows, it predicts in expectation a linear increase in overall punishment.

3. The Experimental Design

Our design consists of a public good experiment with three treatments within each session. There are N=15 participants in each session. In every period, the participants are randomly partitioned into five groups of n=3 individuals. In all treatments, subjects participate for twenty-four periods in a finitely repeated public good game with and without punishment opportunities. In the first four periods, there is no punishment opportunity while in the last twenty periods there is. Punishment opportunities are structured in two different ways: ten periods of "one-to-one" and ten periods of "sequential" punishment. Experimental instructions are in the Appendix.

The voluntary contribution to the public good has the standard linear structure. Every period, each of the n subjects in a group receives an endowment of y=20 tokens and makes a simultaneous decision to either keep these tokens for oneself or contribute g_i tokens ($0 \le g_i \le y$) to the public good. The period monetary payoff for each subject i is given by

$$\pi_i^1 = y - g_i + a \sum_{j=1}^{n} g_j \qquad (1)$$

where a is the marginal per capita return from a contribution to the public good, a=0.6.

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[2] Elster (1998, p.69) provides an example of the opposite emotional preferences: an envious person generally prefers a third person to make her rival worse off than doing it herself.

In the one-to-one punishment treatment, once group members are informed about each member's contribution to the public good, each subject simultaneously submits two punishment requests. At a private cost of one token per punishment point, a subject can decrease the earnings of one other individual in her group by four tokens. Let us designate group members with the letters A, B, and C. While group member A submits one punishment request for member B and one for C, one request is going to be carried out and the other is ignored. We toss a coin and when the outcome is "heads", individual A's target is B, B's target is C, and C's target is A. When "tails", individual A's target is C, B's target is A, and C's target is B. Hence, each individual has the opportunity to punish exactly one other group member and every group member can be punished by just one other individual.

In the sequential treatment, once group members are informed about each member's contribution to the public good, each subject submits two punishment requests sequentially. There are two steps in the sequence, which will be explained through an example. In step one, subject A decides on the punishment of B. In addition, A makes a forecast about how many *additional* points of punishment B will receive in step two from C. This last prediction carries no payoff consequences. In step two, A decides on the punishment of C. Before her step two decision, A learns how many points were assigned in step one to C. The order of the sequence is random. In each period, every subject submits two punishment requests and both will be executed. Punishment points received from the two group members cumulate. Punishment points can be added but never subtracted.

In all punishment conditions, subject i can punish any group member j by requesting punishment points, ${p^k}_i \in \{0,1,\ldots,10\}$. For each punishment point assigned to j, the first–stage payoff of j, π^1_j, is reduced by four tokens. In the sequential treatment, all the (n-1) punishment requests received cumulate and group member *j*'s payoff is reduced by $\sum_{k\neq j}^{n} e(p_k^j)$, where $e(p) = 4\,p$ is the effectiveness of punishment function. For subject *i* there is a cost to request punishment points, which is $\sum_{k\neq i}^{n} c(p_i^k)$, where $c(p^j_i) = p^j_i$ is the cost of punishment. In the sequential treatment, the monetary payoff for subject *i* from both stages, π_i , can be written as:

$$\pi_i = \pi_i^1 - \sum_{k\neq i} e\left(p_k^i\right) - \sum_{k\neq i} c\left(p_i^k\right) \tag{2}$$

In the one-to-one treatment, only one punishment request is selected to be actually carried out. For received punishment points, subject *i*'s payoff is reduced by $e(p_{k(i)}^i)$, where *k(i)* is the punishment request of the group member randomly assigned to subject *i*. For punishment points given to others, subject *i*'s payoff is reduced by $c(p_i^{k(i)})$. The total payoff for a session is the sum of the period–payoffs for all twenty-four periods.

The experiment is conducted on computers using the "z-Tree" program (Fischbacher, 1998) with subjects anonymously interacting with each other. No subject is ever informed of the identity of the other group members. No communication among subjects is allowed. At the beginning of a session, subjects are informed that the experiment has three parts and the instructions for part one are read. When part one of the experiment is completed, instructions for part two are read, and so on. Each punishment condition was preceded by a trial period to familiarize the subjects with the software. The payoff function, parameter values of *y*, *n*, *N*, *a* and the protocol of the punishment requests are common knowledge. At the end of each period, subjects in each group are informed both about the total and individual contributions to the project in their group.

To prevent the possibility of individual reputation formation across periods, each subject's own contribution is always listed in the first column of his or her computer screen and the remaining two subjects' contributions are listed without subject ID in the other two columns. Subjects know their own punishment activities, the aggregate punishments imposed on them by the other group members, and the *aggregate* punishment imposed on *other* group members.

4. Predictions

We outline the predictions of three alternative models: canonical, emotional and strategic. All predictions are made for a one-shot interaction where agents' preferences are common knowledge. The three models differ only in the utility from punishment, v_i:

- Canonical, $u_i = \pi_i$
- Emotional punishment, $u_i = \pi_i + v_i\,(p^j_i;\ g_1, g_2,..., g_n)$
- Strategic punishment, $u_i = \pi_i + v_i\,(p^j_i + p^j_{-i};\ g_1, g_2,..., g_n)$

Agent *i*'s utility is quasi-linear in her monetary payoffs π_i (see equation 2) and is increasing and concave in the points of punishment given to agent *j*, $v_i'(p^j_i) \geq 0$ and $v_i''(p^j_i) \leq 0$.[3]

The canonical predictions for the experimental treatments of section 3 are well known. Group payoff $\sum_{i=1}^{n} \pi_i^1$ is maximized if each group member fully cooperates ($g_i = y$) but full free–riding ($g_i = 0$) is a dominant strategy in the contribution game. This follows from $\partial \pi_i^1 / \partial g_i = -1 + a < 0$ in (1). In equilibrium, subjects will contribute nothing to the public good and will not punish others, either in the sequential or in the one-to-one treatments. In fact,

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[3] A more complete model is $u_i = \pi_i + v_i\,(p_{13}, p_{23}, p_{12}, p_{32}, p_{21}, p_{31})$. In the experimental design, revenge was not possible because the information about the punishment received by the subject was revealed only at the end of a period. For instance, agent 1 could not condition her punishment strategy on p_{21} or p_{31}. The adopted specification still rules out some more complex strategies. For instance, the possibility that agent 1's punishment strategy is conditional on p_{32}.

choosing $p^j_i>0$ is a monetary cost that does not generate any monetary benefit in a one-shot interaction.

The models of emotional and strategic punishment are not new specifications of other-regarding preferences. Rather, each represents a class of other-regarding utility functions. A basic difference between the two is that for an emotional agent *i* what matters is only the punishment that she *personally* carries out, p_i, while a strategic agent *i* values the punishment she gives and the punishment that others give, p_{-i} equally. Except for some examples of v_i, general equilibrium predictions for the contribution *and* punishment game have not been worked out. In order to focus on the punishment decision without committing to a specific model of other-regardness, this section carries out only a partial equilibrium analysis. The agents have completed the contribution stage, know the results and face the decision about how many punishment points to give in the second stage.

For an *emotional agent i*, one can measure her taste for punishment through $\hat{p}_i^j$:

$$\hat{p}_i^j = \underset{p_i^j \in \{0,1,\ldots,10\}}{\arg\max} \left\{ u_i\left(\pi_i, p_i^j\right)\right\} \qquad (3)$$

Given a contribution profile $g_{-i}=\{g_1, \ldots, g_{i-1}, g_{i+1}, \ldots, g_n\}$, $\hat{p}_i^j$ is the optimal number of points of punishment for agent *i* to give to agent *j*. We say that agent *i* has a higher taste for punishment than agent *k* if and only if $\hat{p}_i^j > \hat{p}_k^j$.[4] The cost of punishment is linear, $c_i=c \cdot p^j_i$. An emotional punisher will respond to a higher cost of punishment *c* by lowering $\hat{p}_i^j$. This “price effect” of

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[4] $\hat{p}_i^j$ can be zero. Note that the function v_i can vary for a different target agent *j*, a different vector of first-stage contributions ($g_1, \ldots, g_n$), and a different effectiveness function $e(p^j_i)$, which sets the fine-to-fee ratio. This definition, like all the discussion in this Section, is done in reference to a generic target agent *j* and not to the whole group. For this reason, we will sometimes drop the *j* subscript from expressions without fear of confusion.

punishment is documented by several experimental studies (Carpenter, 2006; Andreoni et al., 2003; Putterman and Anderson, 2006).

Predictions for emotional punishment. As others' punishment choices do not impact the utility of an emotional agent, in each treatment there exists (trivially) a unique equilibrium where, given a contribution profile (g_i , g_{-i}),

1) Agent i will request the same punishment level $\hat{p}_i^j$ in both treatments.
2) In the sequential treatment, the expected aggregate levels of punishment in step one and step two are identical.
3) In the sequential treatment, the overall punishment received by agent j is the *sum* of each agent's $\hat{p}_i^j$, $\boldsymbol{P^{ES}} = \sum_{i=1}^{n} \hat{p}_i^j$.
4) In the one-to-one treatment, the expected overall punishment received by agent j is the *average* of each agent's $\hat{p}_i^j$, $E[\boldsymbol{P^{EO}}] = \sum_{i=1}^{n} \hat{p}_i^j /n$.

Similarly, in the *strategic model* one can measure agent i's taste for punishment through $\overline{p}_i^j$:

$$\overline{p}_i^j = \underset{p_i^j \in \{0,1,\ldots,10\}}{\arg\max} \left\{ u_i\left(\pi_i ,\ p_i^j ,\ 0\right)\right\} \qquad (4)$$

Notice that for a strategic agent, the optimal number of points of punishment to give to agent j in general depends on how many points of punishment the others will give, p^j_{-i}. With a slight abuse of notation, we will simply use $\overline{p}_i$ instead of $\overline{p}_i^j$. The measure $\overline{p}_i$ defines the *standalone punishment level* for the case when nobody else punishes, $p^j_{-i} = 0$. While the punishment choice of the emotional agent is always $\hat{p}_i^j$, the optimal punishment choice of the strategic agent depends on the expected punishment of others and her standalone punishment level $\overline{p}_i$ is the upper bound. The one-to-one treatment is a special case where $p^j_{-i}=0$ by design and hence $\overline{p}_i$ is the optimal choice for the strategic punisher.

For a strategic punisher, the essential issue is the total impact on agent *j*, and – unlike emotional punishers – she has no objections to others doing the "dirty job" of punishing. She actually prefers it because it saves her the punishment cost. This framework was adapted from the model that Bergstrom et al. (1986) and Varian (1994) developed for voluntary public good contributions.

Predictions for strategic punishment. In each treatment, there exists a unique equilibrium where, given a contribution profile (g_i, g_{-i}),

1) In the one-to-one treatment agent *i* punishes at her standalone punishment level, $\overline{p}_i^j$.
2) In the sequential treatment, the cost of punishment falls disproportionately on the punisher who moves in step two.
3) In the sequential treatment, in a given period only one agent carries out the punishment on agent *j*.
4) In the sequential treatment, the overall punishment received by agent *j* is *less than or equal to* the *maximum* of all agents' standalone punishment levels, $\boldsymbol{P}^{SS} \leq \max_i \{\overline{p}_i^j\}$.
5) In the one-to-one treatment, the expected overall punishment received by agent *j* is the *average* of each agent's punishment, $\mathrm{E}[\boldsymbol{P}^{SO}] = \sum_{i=1}^{n} \overline{p}_i^j / n$.

We discuss predictions 2 and 3 using a group of $n=3$ members where agent 1 is moving in step one and agent 2 in step two. When just one agent has a positive standalone punishment level, prediction 3 is trivial. Moreover, given that the probability of moving in step one is one half, punishment will be equally distributed between the two steps. Suppose instead that two agents want to punish agent 3, $\bar{p}_k > 0$ for k=1,2. If agent 1 does not punish, then agent 2 will choose to punish $\bar{p}_2$ points. In equilibrium, agent 1 should not punish agent 3 at all unless her standalone punishment level is *much* higher than agent 2‘s. In the latter case, agent 2 will not punish. More formally, the best reply of agent 1 can be derived from his indirect utility function (Figure 1):

$$u_1 = \pi_1 + v_1 (p_1 + B_2(p_1)) \qquad (5)$$

$$u_1 = \pi_1 + v_1 (p_1 + \max\{(\bar{p}_2 - p_1), 0\}) \qquad (6)$$

Let us consider the three possible cases. When agent 2 has the highest preference to punish, $\bar{p}_2 > \bar{p}_1$, the optimal strategy for agent 1 is to choose zero punishment. When preferences are identical, $\bar{p}_1 = \bar{p}_2$, agent 1 chooses zero points of punishment for agent 3, knowing that the best response of agent 2 is to choose $\bar{p}_2$. In equilibrium, agent 2 bears all the cost of punishing. The order of moves solves the coordination problem that exists when choices are simultaneous. When agent 2 has the lowest preference to punish, agent 1’s optimal strategy is to punish for the whole amount $\bar{p}_1$ only if he likes to punish *much* more than agent 2 and to punish zero therwise. That happens when $u_1(\pi_1, 0, \bar{p}_2) < u_1(\pi_1 - \bar{p}_1, \bar{p}_1, 0)$, which reduces to $\Delta_1 > \bar{p}_1$ where $\Delta_1 = v_1(\bar{p}_1) - v_1(\bar{p}_2)$.[5]

Consider an example with the following utility function:

$$u_i = \pi_i + \alpha_i \ln(p_i + p_{-i}), \qquad \text{with } \alpha_i > 0 \qquad (7)$$

The preference for punishment v_i is increasing and concave, $v' = \alpha_i/(p_i + p_{-i}) > 0$ and $v'' = -\alpha_i/(p_i + p_{-i})^2 < 0$. The standalone punishment level is $\bar{p}_i = \alpha_i$. The best reply function is $B_i(p_{-i}) = \max\{0, \alpha_i$

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[5] The intuition behind this strategy is that agent 1 chooses between not punishing, hence getting the preferred punishment level of agent 2, and fully paying for his preferred level of punishment, which is higher. He will punish if the additional utility of the higher punishment is worth the cost. On the other hand, when preferences are similar, $\Delta_1 < \bar{p}_1$, the optimal strategy is zero punishment as in the case of identical preferences.

$-p_{-i}\}$. The indirect utility function of agent 1 is $u_1 = \pi_1 + \alpha_1 \ln(p_1 + \max\{0, \alpha_2 - p_1\})$. In general, agent 1 punishes if $\ln(\alpha_1/\alpha_2) > 1$. For instance, when $\alpha_1=4$ and $\alpha_2=2$, agent 1's best response is not to punish; when $\alpha_1=6$ and $\alpha_2=2$ the best response is to punish.

5. Results

A total of 90 subjects were recruited among the undergraduate student population of the University of Siena via ads posted around campus. No subject had participated in public good experiments before. Six sessions were conducted in May 2005. In half of the sessions, the sequential treatment was part two and in the other half it was part three. Including the reading of instructions, each session lasted about 2 hours. Payment was done privately in cash at the end of each session and was $13.90 (11 euros) per subject on average. There are four main results.

Result 1**:** *In the sequential treatment, the patterns of punishment are not explained by strategic behavior. In particular, the data do not support the prediction of a relatively higher punishment in step two than in step one. Average punishment in step one was 10% higher than in step two.*

Figure 2 shows that a contribution action in step one received on average 1.36 points of punishment compared with 1.24 points in step two. If subjects were strategic, step one punishment would be considerably lower than step two punishment. Previous studies carried out in an explicit context of sequential provision of a public good report that subjects do understand these strategic implications and dramatically reduce their contribution when choosing in step one (Harrison and Hirshleifer, 1989, SQ-1 treatment). The punishment choices reported in this study, instead, exhibit a different pattern.

We build a quantitative prediction of strategic punishment using one-to-one treatment data. This benchmark seems reasonable given that the underlying contribution patterns are similar between the two treatments (Figure 3).[6] The simulation relies on two assumptions; first, subject 1's utility is $u_1 = \pi_1 + \alpha_1 \ln(p_{13} + E[p_{23}])$; second, the expectation about step two punishment $E[p_{23}]$ is estimated with a regression on information concerning the actual contribution of the target subject in relation to others in her group, period dummies, and session dummies.[7] Simulation 1 is introduced for illustrative purposes and relies on somewhat subjective assumptions but provides nevertheless a relevant benchmark. The simulation yields a strategic reduction of punishment in step one as shown by Simulation 1 in Figure 2. In particular, for every point of punishment in step two, there are just 0.35 points of punishment in step one. The experimental results are instead closer to the predictions of the emotional model of equal punishment between steps.[8]

***Result 2**. Using one-to-one treatment data, one can rank subjects from light to heavy punishers. When the sequential treatment is introduced, there is no systematic change in punishment levels among subjects as classified by rankings. In particular – and contrary to strategic behavior – on average, light and medium punishers do not scale back punishment in step one.*

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[6] Using a two-sample Kolmogorov-Smirnov test, one cannot reject that the distribution of group contributions by period in sequential and one-to-one treatments are different (0.05 level, N=60, 15 equally-spaced intervals).

[7] OLS individual random effects regression on one-to-one treatment only; regressors included the average contribution of the other two persons in own group, deviation of own contribution from group average (one variable for positive and one for negative deviation) five session dummies, nine period dummies, dummy for contributions above 15 tokens.

[8] Similar punishment across steps is found also by Casari and Luini (2005) for sequential punishment within a group of five agents. A drawback of Casari and Luini (2005) is that with n=5, a strategic punisher needs 3 steps of reasoning to compute the equilibrium. In the present study (n=3), only one step is required.

In both emotional and strategic models, the one-to-one treatment reveals individual taste for punishment. We can rank subjects in each session based on their average taste for punishment. Figure 4 illustrates the punishment requested by the ranking of the subject within each session (thick line). Punishers 1-5 (*light punishers*) are on average responsible for 11.1% of the requested punishment in their session, while punishers 11-15 (*heavy punishers*) are responsible for 54.3% of the requested punishment. Using the above ranking, we computed individual shares of step one punishment in the sequential treatment. The strategic prediction from Simulation 1 is that step one punishment shares should go down for light punishers and go up for heavy punishers. That is clearly shown by the dashed line in Figure 4. On the contrary, the actual distribution of step one punishment is very similar to one-to-one punishment. Using a two-sample Kolmogorov-Smirnov test, one can reject that step one punishment is equal to simulation 1 while one cannot reject the emotional model hypothesis that curves for sequential and one-to-one treatments are identical (0.05 level, N=90, 15 equally-spaced intervals).

We draw similar conclusions when data are disaggregated by subject. Figure 5 plots the average subject punishment in step one versus step two. When a subject made the same average choice between the two steps, she would be represented as a dot on the 45 degree line. Most choices are clustered around the 45 degree line. Strategic behavior implies that, on average, light punishers should punish more in step two and heavy punishers may be punishing less in step two. As Simulation 1 in Figure 6 shows, strategic reasoning should bring a dramatic shift away from the 45 degree line. Simulation 2 is also reported as an alternative benchmark. In Simulation 2, we employ one-to-one treatment data and the same assumption on subject 1's utility, $u_1 = \pi_1 + \alpha_1 \ln (p_{13} + p_{23})$. Now subjects are assumed to have a myopia that induces them to behave as if there were no punishment in step two, $E[p_{23}]=0$. Hence, the step one punishment choice would be the standalone punishment level $p_{13}=\alpha_1$. In step two, agent 2 adds $p_{23}=\alpha_2 - \alpha_1$ points if she has a higher taste for punishment, i.e. if $\alpha_2 - \alpha_1 > 0$, and zero points otherwise. In Simulation 2, there is no strategic reasoning (zero-step) and most of the punishment takes place in step one. For every point of punishment in step two, there are 1.70 points of punishment in step one (Figure 2). One can think of Simulation 2 as agents in step one being temporally blinded by emotion after the results. Neither Simulation 1 nor Simulation 2 captures the experimental results at an individual level.

Result 3. *Contrary to strategic reasoning, in step one often it is the case that subjects do punish when they expect the other in step two to add to their punishment. Excluding trivial cases where no punishment is given in step one nor expected in step two, about half of the decisions involve positive step one punishment coupled with expectation of additional step two punishment by someone else.*

Result 3 is based on analysis at the level of single choices, which provide the most direct evidence on the extent (or lack) of strategic behavior in punishment. Table 1 classifies each step one punishment choice into five cases depending on how much additional punishment is expected on the same target in step two. If no punishment is given nor expected, the situation is trivial and classified as case one. Of the remaining cases, three are compatible with both strategic and emotional punishment (2, 3, 4) and one directly contradicts strategic punishment (5). If a subject punishes in step one while expecting another subject to top it in step two (5), she could save on costs by letting the step two punisher do it all and choosing zero. Case 5 is evidence of non-strategic behavior and it amounts to half of the non-trivial cases.[9] All five cases are compatible with the emotional model of punishment.

This direct contradiction of strategic punishment relies on the credibility of the elicited expectation about step two punishment. Subjects received no additional compensation for accurate estimates. Still, the distribution of step two estimates is remarkably similar to the received step two punishment (Figure 7), and estimates have a robust, positive correlation with received step two punishment (Table 2).

Result 4. *The joint punishment of the same target in step one and step two cannot be explained by reciprocal behavior in punishment.*

Evidence for Result 4 comes from the comparison of step one and step two punishments. A reciprocal response involves a "less-than-usual" step two punishment when step one punishment is not "adequate" and a "more-than-usual" step two punishment otherwise. Figure 8 shows the empirical evidence when the benchmark for "usual" punishment is taken from the one-to-one treatment. The benchmark informs of the frequency of punishment in both steps that is simply due to similarity of punishment norms among subjects. We conjecture that in the reciprocal model, zero points of punishment would be considered inadequate more often than other choices and hence elicit a less-than-usual response. Little evidence emerges from Figure 8, which measures the corresponding fraction of step two choices with zero punishment. The line for the sequential treatment is not "steeper" than the one-to-one treatment but roughly parallel.

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[9] It is a lower bound to the amount of violations of strategic punishment.

6. Conclusions

Emotions can both shape the utility function in a similar way to material rewards as well as prevent people from thinking clearly about the consequence of an action (Elster, 1998). We use an experiment on peer punishment to illustrate this point. One major result is that most subjects fail to reason strategically when deciding on punishment.

Cooperation among strangers is often possible because those who free ride on the cooperation of others are punished. Several experimental studies have shown that punishers are willing to bear the cost of punishing the free-riders. In a one-shot interaction, peer punishment could make the group better off, although it yields punishers no personal material benefits (Falk et al., 2005, Page et al., 2005, Sefton et al., 2002).

For this reason, punishment of free-riders is generally seen as a second-order public good (Ostrom et al., 1992; Denant-Boemont et al., 2005) which is provided in modern societies through legal punishment systems. One could conjecture that the human tendency to punish free-riders may enable teams, and societies more generally, to govern themselves without the need of legal punishment systems. We find that the performance of peer punishment can be fundamentally compromised because punishers do not treat peer punishment as a second-order public good. Subjects take satisfaction from the personal action of punishing, not from rationally providing incentives for the free-rider to contribute. We conclude that the violation of a norm clouds the ability of subjects to think strategically in their punishment decisions. Hence, legal institutions have at least two advantages over peer punishment. First, they aim at deterring free-riding through an overall sanction proportional to the crime. Second, they follow strict formal procedures in an attempt to isolate punishment decisions from emotional responses to the crime.

There is a generic agreement in the literature that emotions play an important role in peer punishment. A novel aspect of this paper is to put forward specific models that incorporate emotions into the utility from punishment and to test them empirically. The model of strategic punishment takes the standard view that agents care only about the consequence of their actions. The model of emotional punishment, instead, assumes that what provides utility is the personal act of punishing. We present results about peer punishment from two novel experimental designs, a one-to-one and a sequential treatment. In the one-to-one treatment, there is no strategic element to punishment and predictions are identical for both types of agents. While the emotional model predicts no differences in punishment between the one-to-one and the sequential treatment, the strategic model predicts distinct patterns. More precisely, it makes predictions about the timing, magnitude, and identity of the punishment choices. None of the predictions of the strategic model find support in the data. We introduce two additional variants of the strategic model to include the possibility of zero-steps of reasoning and of reciprocation in punishment behavior. Neither variant is capable of explaining the majority of the evidence. We conclude that the model of emotional punishment is a better explanation for the data. When punishment is emotional, large groups may be better off by having alternative, less destructive channels to express emotions (Xiao and Houser, 2005) or by appropriately restraining peer punishment (Casari and Plott, 2003). In important ways, peer punishment is not guided by the aim of deterring crime but instead by the personal satisfaction of taking revenge.

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Table 1: A classification of step one punishment requests in the sequential treatment

Case	Punishment given in step 1	Prediction about additional punishment in step 2	Description	Number of obs.	Fraction of obs.
1	0	0	No punishment done nor expected	277	31%
2	+	0	Either the subject is the only one wanting to punish OR is a heavy punisher who jumps in step 1	116	13%
3	0	+	Either the subject will not punish in any case OR let the other do the punishment for her	156	17%
4	++	++	The expected sum is greater than 10; The subject needs the cooperation of the other to reach desired level of punishment	41	5%
5	+	+	The expected sum is less than or equal to 10; The subject punishes knowing that the other will punish as well	310	34%
			Totals	900	100%

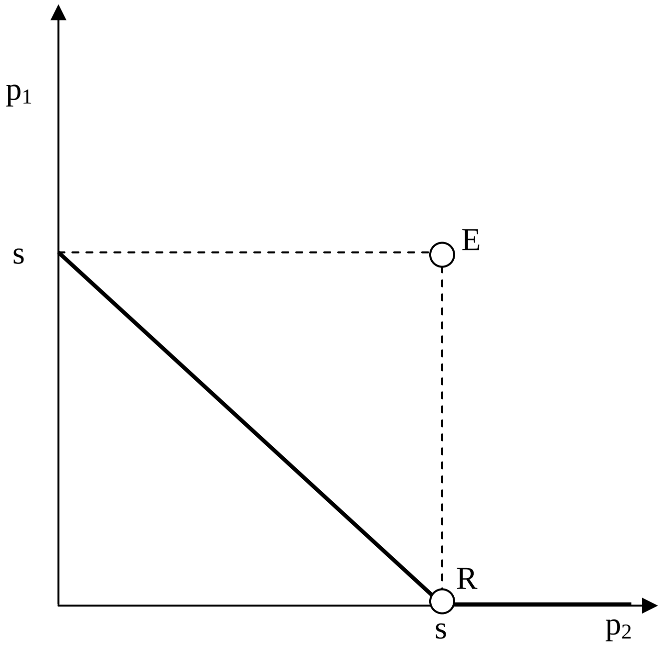
Notes: Cases 2, 3, 4, 5 are labeled as "non-trivial."

Table 2: Relation between predictions and punishment in step two

Dependent variable: Received step two punishment	(1) session and period dummies	(2) session dummies	(3) no dummies
Prediction about additional step two punishment	0.1076* (0.0588)	0.1131* (0.0587)	0.1597*** (0.0583)
Constant	0.1596 (0.4667)	0.1432 (0.3015)	-0.3555** (0.1695)
Observations	900	900	900

*Notes: Tobit regression; * significant at 10%; ** significant at 5%; *** significant at 1%; Standard errors in parentheses; session and period dummies omitted from table.*

Figure 1: Example of agent 1's best response to punishment



Notes: p_1 and p_2 are the number of punishment points given to agent 3 by agent 1 and 2, respectively. s *is the standalone punishment level of agent 1 and 2. When agent 1 is a strategic punisher and moves in step one, the prediction is R. When both agents are emotional punishers, the prediction is E.*

Figure 2: Aggregate Patterns of Punishment

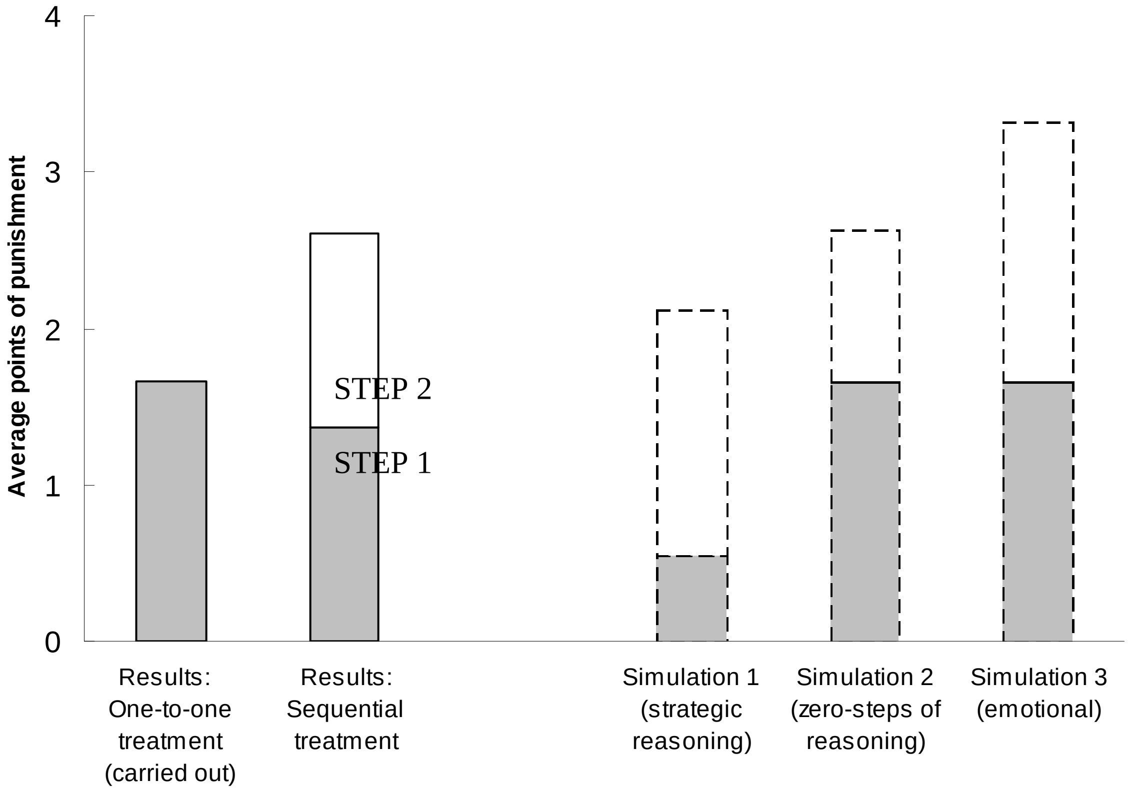


Figure 3: Contribution in the punishment treatments

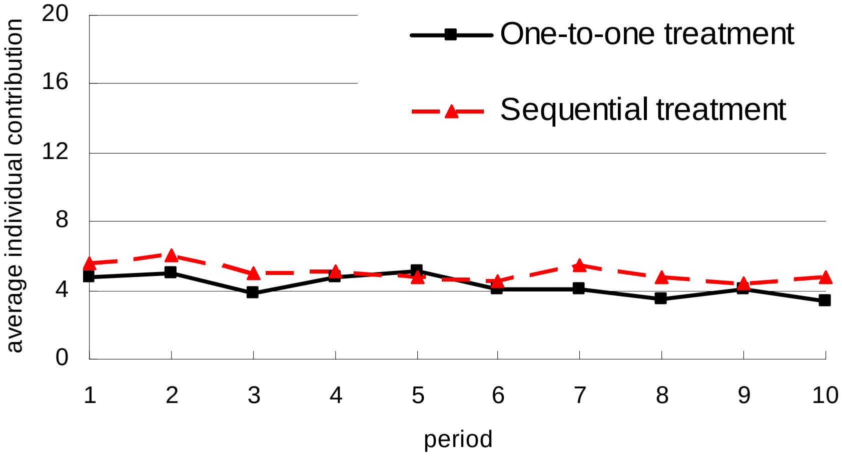
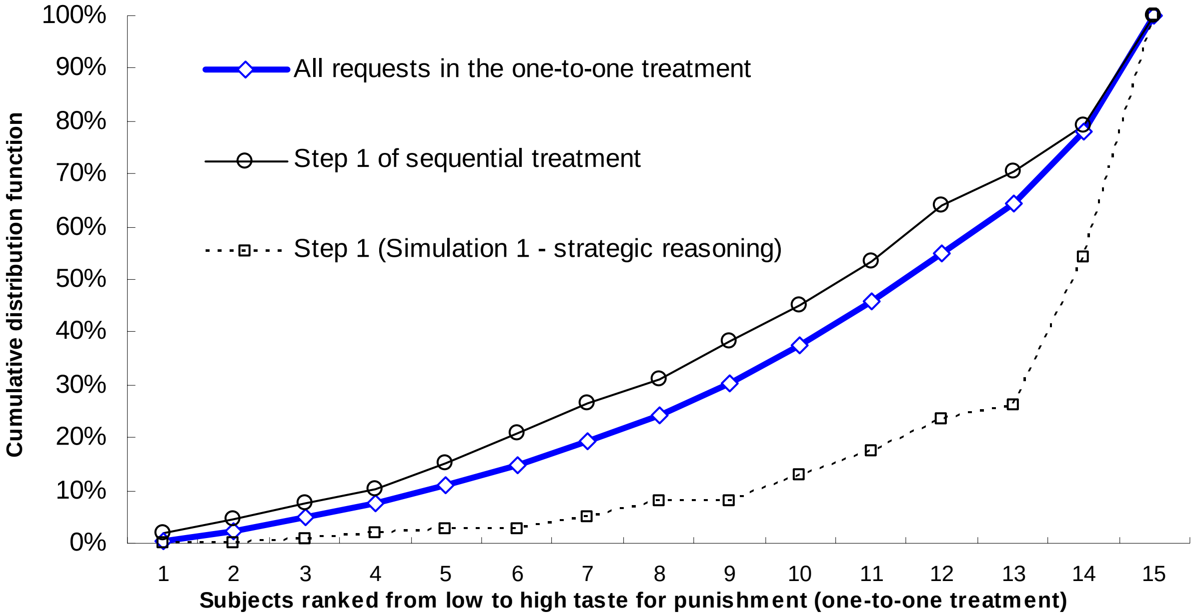
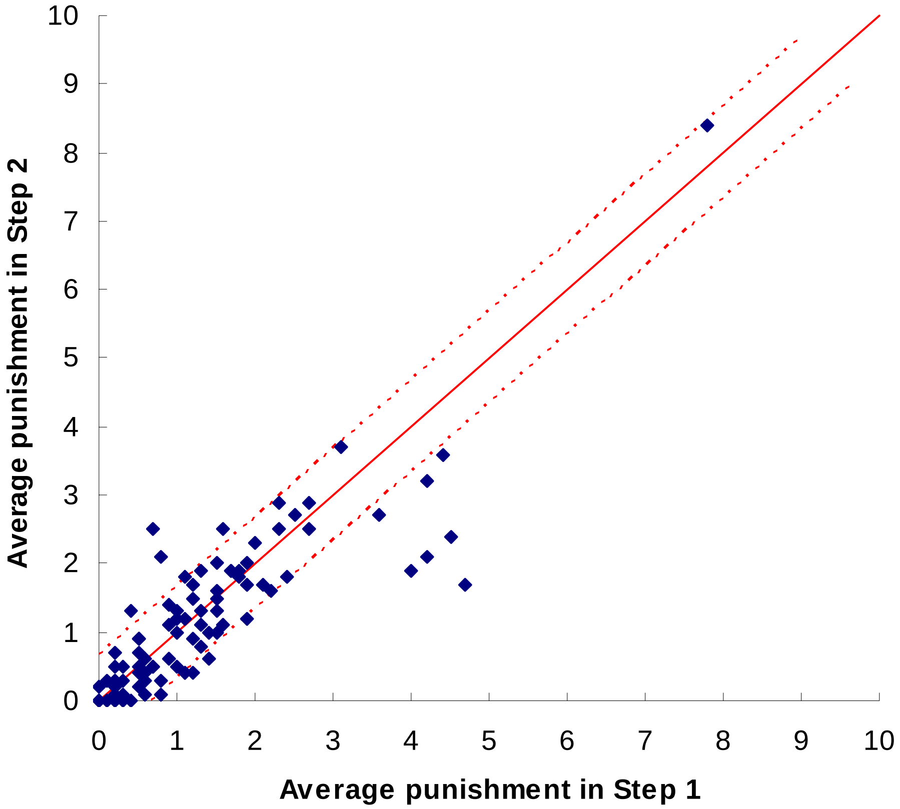


Figure 4: Subjects ranked by taste for punishment



Notes: The vertical axis reports shares of total punishment in a session; the figure reports averages of all six sessions. Step 1 simulation is done using one-to-one treatment data.

Figure 5: Do subjects punish differently in step 1 versus step 2?



Note: Sequential treatment data. The solid line is the 45 degree line; the dotted line indicates one standard deviation of the individual (step one – step two) difference.

Figure 6: Simulations of step one/step two punishment using one-to-one treatment data

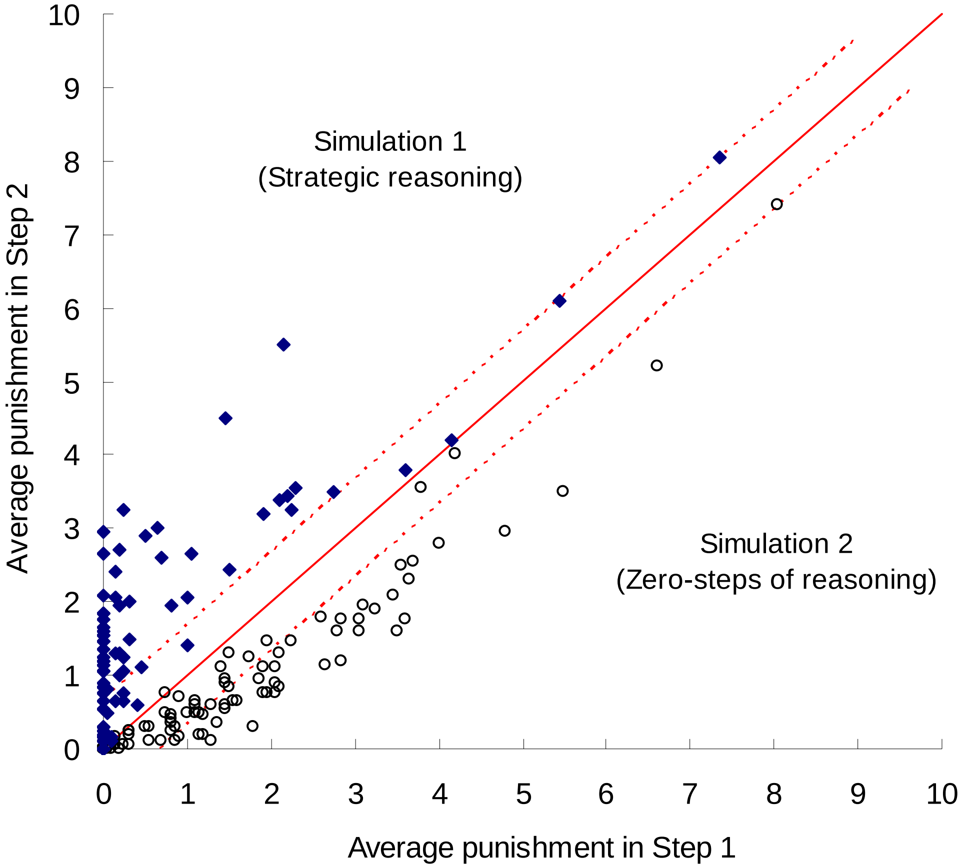
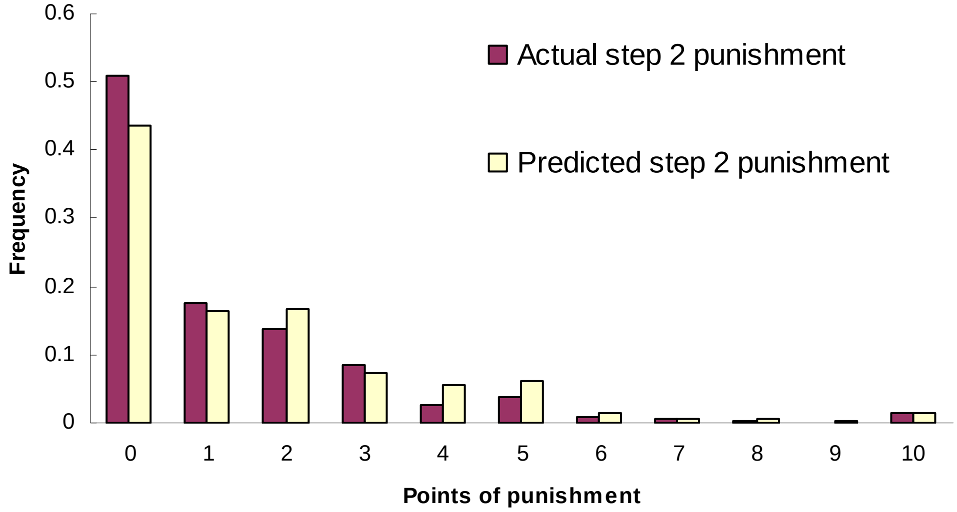
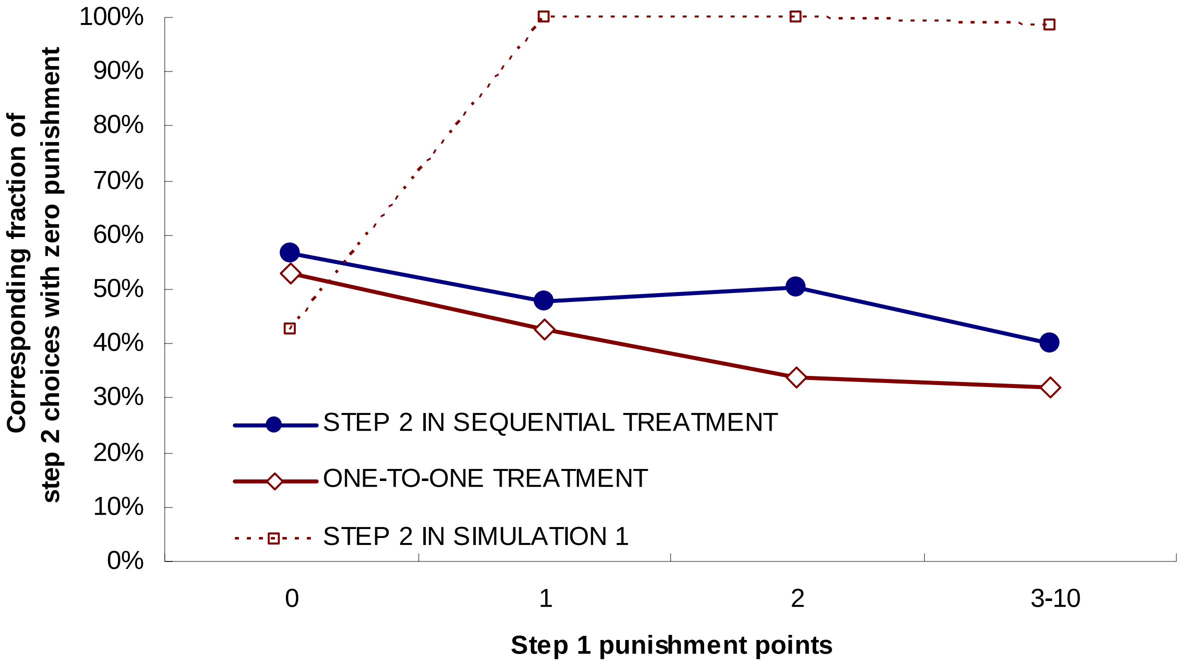


Figure 7: Punishment predictions for step two are relatively accurate



Notes: N=900, Overall distribution by punishment level

Figure 8: Little evidence of reciprocal punishment



Notes: The one-to-one treatment line is computed as the average of two scenarios. One is when the first request is considered step one punishment while the other is when the second request is considered step one punishment.

Instructions (translation from Italian)

You are now taking part in an economic experiment on decision-making. If you read the following instructions carefully, you can, depending on your decisions, earn a considerable amount of money. During the experiment, your earnings will be calculated in "tokens." Your earnings depend on your decisions and the decisions of other people. At the end of the experiment, the tokens you have earned will be converted into Euros at the rate of

1 token = 2 euro cents.

To the cumulative amount you must add 3 Euros as a participation fee. At the end of the experiment your earnings will be privately paid in cash.

During the experiment, you will not be asked to reveal your identity and your name will not be associated with the decisions you are going to make. Moreover, you are not allowed to talk or otherwise communicate with the other participants during the experiment. Please turn off you cell phones now.

This experiment is divided into **three parts**. The following instructions are related to the first part

INSTRUCTIONS PART ONE

The first part is composed of **4 periods**. In each period, you interact with two other persons. The experiment participants will be randomly re–matched after each period and therefore it is highly likely that in each period you will interact with different people. Nobody knows the identity of the people with whom you interact.

At the beginning of each period, each participant receives 20 tokens. You task is deciding how you would like to use these tokens. The other participants will simultaneously face the same scenario. You have to decide how many tokens out of the 20 available you want to contribute to a project and how many not to contribute.

Each token that you do not contribute to the project increases your earnings by its face value. The tokens that you have contributed to the project plus the points that all the other two persons have contributed are increased by eighty percent. The resulting total amount is then divided in equal shares among the three people. Therefore, you will receive one third of the tokens in the project after the eighty percent increment. To sum up, your earnings consist of two parts:

Your earnings this period = tokens not contributed + earnings from the project
= (20 – your contribution) + $^1/_3$ x ((sum of yours' and other
two people's contribution
to the project) x 1.8)

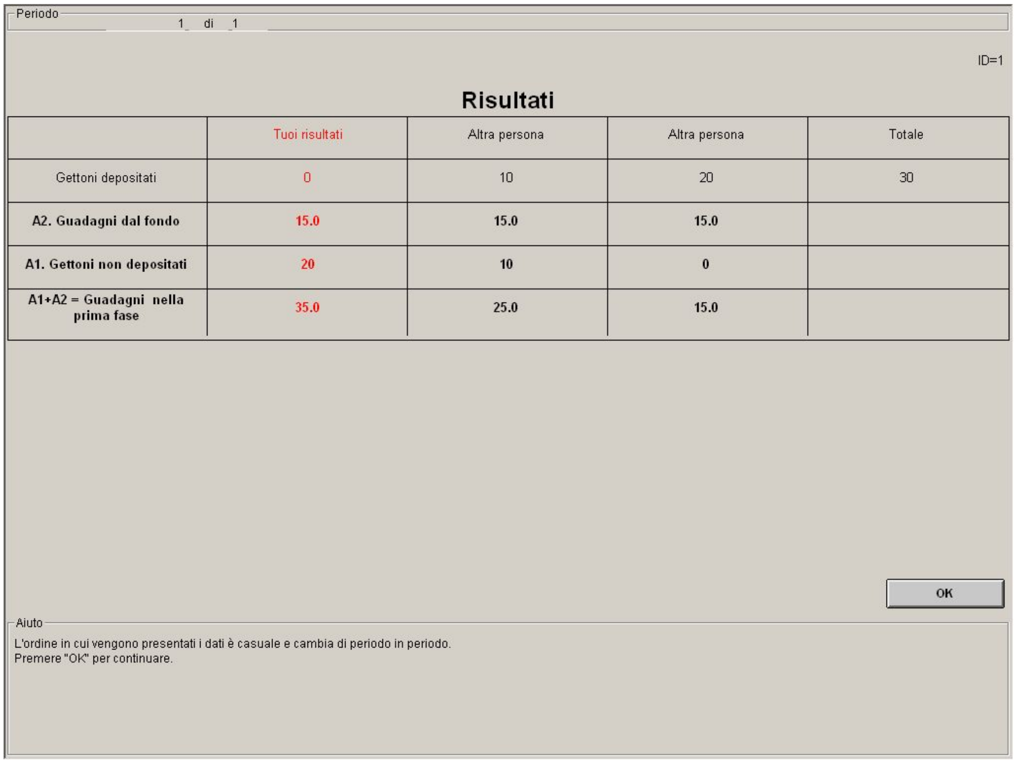
Each of the other two people will receive from the project the same amount that you will. For example, consider a situation where the sum of the *overall* contributions of the three people is 5 tokens. In this case, each person receives from the project (5x1.8)/3=3 tokens. Instead, if the total contribution to the project is 45 tokens, each of the three people receives (45x1.8)/3=27 tokens. The following table gives you some examples of earnings from the project:

Sum of the tokens contributed	0	10	20	30	40	50	60
Earnings from the project for each of the 3 persons	0	6	12	18	24	30	36

For each token that you do not contribute, you earn 1 token. If you contribute this token to the project instead, then the total contribution to the project would rise by one token. Your earnings rise by 1x1.8/3=0.6 tokens. Your contribution to the project would also raise the earnings of other people. More precisely, the other two people will earn an additional 0.6 tokens each, so that the overall earnings increase for you and the others would be of 1.8 tokens.

After everybody has completed his or her decision, you will learn your period earnings. As you can see from the screen below, you will also learn the number of tokens contributed to the project by each one of the two people that could contribute with you as well as their period earnings. Your final earnings are the sum of the earnings from each period. The identity of the other people changes randomly from one period to the next.

This procedure will be repeated 4 periods.



Periodo
1 di 1

ID=1

Risultati

	Tuoi risultati	Altra persona	Altra persona	Totale
Gettoni depositati	0	10	20	30
A2. Guadagni dal fondo	**15.0**	**15.0**	**15.0**	
A1. Gettoni non depositati	**20**	**10**	**0**	
A1+A2 = Guadagni nella prima fase	**35.0**	**25.0**	**15.0**	

Aiuto
L'ordine in cui vengono presentati i dati è casuale e cambia di periodo in periodo.
Premere "OK" per continuare.

In the input screen you can press the “Show previous decisions” button and you will see a table with your choices and the choices of the others in previous periods.

Please record period by period on paper the decision you input into the computer.

Are there any questions?

If you have questions during the experiment, we kindly ask you to raise your hand and somebody will assist you in private.

INSTRUCTIONS PART TWO

These are the instructions for the second part of the experiment. The second part consists of 10 periods and, as before, in each period you have to make a decision about the use of 20 tokens.

In this part of the experiment, each period is composed of two phases. Phase one is identical to the procedure already described, while in phase two you can choose whether and how much to reduce the earnings of other people that have benefited from the same project.

In phase one you have 20 tokens. You task is deciding how you would like to use these tokens. The other participants will simultaneously face the same scenario. You have to decide how many tokens out of the 20 available you want to contribute to a project and how many not to contribute.

Each token that you do not contribute to the project increases your earnings by its face value. The tokens that you have contributed to the project plus the points that all the other two persons have contributed are increased by eighty percent. The resulting total amount is then divided into equal shares among the three people. Therefore, you will receive one third of the tokens in the project after the eighty percent increment. To sum up, your earnings consist of two parts:

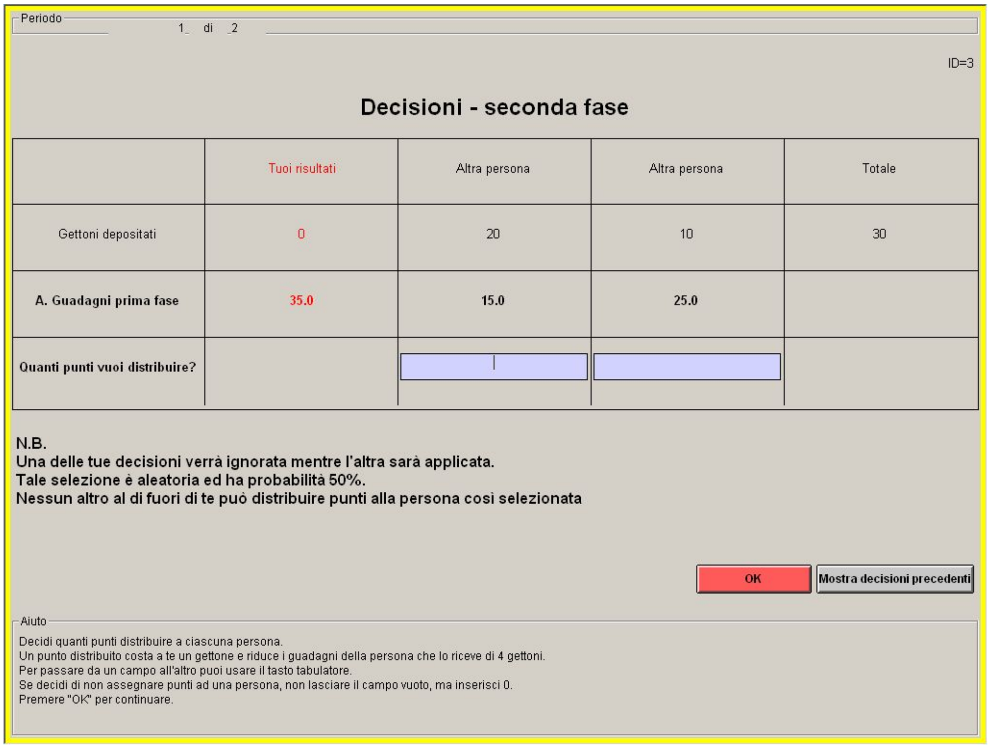
Your earnings in phase one = tokens not contributed + earnings from the project
= (20 – your contribution) + $^1/_3$ x ((sum of yours’ and other
two people’s contribution
to the project) x 1.8)

For each token that you do not contribute, you earn 1 token. If you contribute this token to the project instead, then the total contribution to the project would rise by one token. Your earnings rise by 1x1.8/3=0.6 tokens. Your contribution to the project would also raise the earnings of other people. More precisely, the other two people will earn an additional 0.6 tokens each, so that the overall earnings increase for you and the others would be of 1.8 tokens.

After everybody has completed his or her decision, you will learn your phase one earnings. You will learn also the number of tokens contributed to the project by each one of the two people that could contribute with you as well as their period earnings.

In phase two of a period you can reduce or leave equal the earnings of each of the two people that have benefited from the same project.

Your decision is about distributing points. Every point you distribute reduces the earnings of a person by **4 (four) tokens**. For the person that distributes it, every point has a **cost of 1 token**. You can distribute points separately to each of the other two people. If you do not wish to change the earnings of a specific person, you can choose 0. If you wish to reduce the earnings of a specific person, you can distribute to her a number of points from 0 through 10. You know only the decision made in phase one by the other people. There is no way for you to know either the identity or previous choices of the others.
In the screen below you can see how the requests can be submitted (last row of the table).



Decisioni - seconda fase

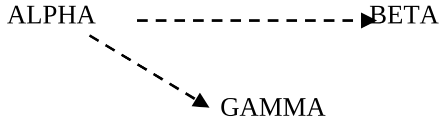
	Tuoi risultati	Altra persona	Altra persona	Totale
Gettoni depositati	0	20	10	30
A. Guadagni prima fase	**35.0**	**15.0**	**25.0**	
Quanti punti vuoi distribuire?				

N.B.
Una delle tue decisioni verrà ignorata mentre l'altra sarà applicata.
Tale selezione è aleatoria ed ha probabilità 50%.
Nessun altro al di fuori di te può distribuire punti alla persona così selezionata

Decidi quanti punti distribuire a ciascuna persona.
Un punto distribuito costa a te un gettone e riduce i guadagni della persona che lo riceve di 4 gettoni.
Per passare da un campo all'altro puoi usare il tasto tabulatore.
Se decidi di non assegnare punti ad una persona, non lasciare il campo vuoto, ma inserisci 0.
Premere "OK" per continuare.

Of the two requests to distribute points, just one will be actually implemented while the other will be ignored. This selection is made by the computer through a coin flip (random selection with probability 50%). When you make your choice you do not know which one of the two decisions will be selected.
Let us call the three persons ALPHA, BETA, and GAMMA. Suppose you are ALPHA and have distributed 2 points to BETA and 3 points to GAMMA. Just one of the following results will be carried out. With probability 50%, BETA's earnings will be reduced by 8 tokens (2x4) and GAMMA's earnings will not change. With probability 50% BETA's earnings will not change while GAMMA's earnings will be reduced by 12 tokens (3x4), (see figure below).

TWO DECISIONS



ONE OF THE FOLLOWING RESULTS

50% (random selection) 50% (random selection)

In phase two, **everyone could receive points but from only one other person**. If you have the opportunity to distribute points to BETA, nobody else will have that opportunity. If you have the opportunity to distribute points to GAMMA, nobody else will have that opportunity. In other words, if you do not distribute her points, nobody will have the opportunity to do it.

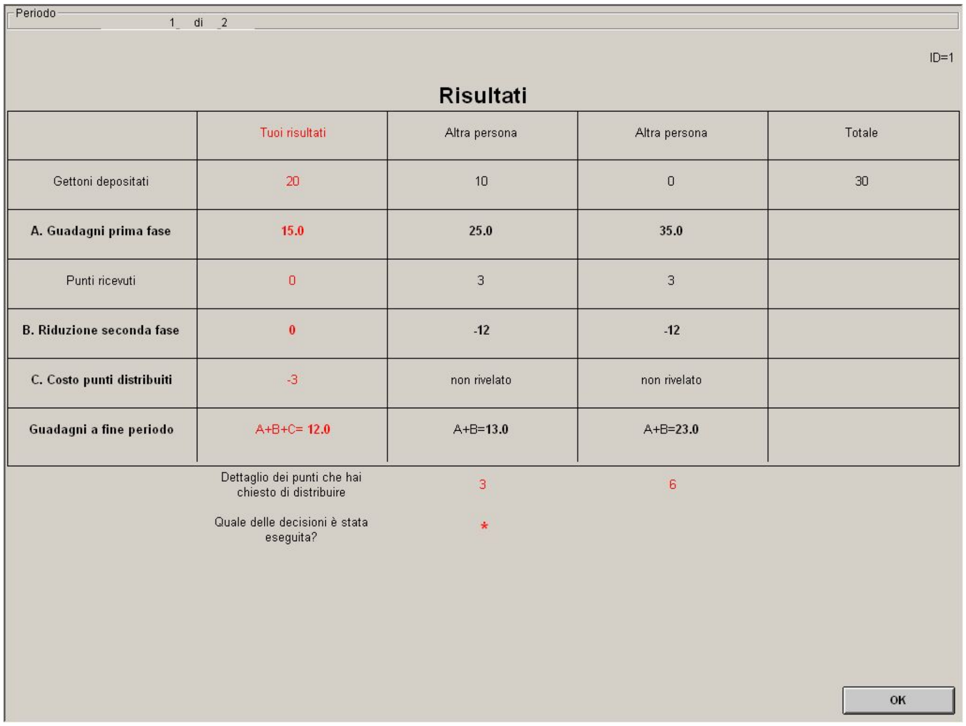
You will pay only the cost for the selected decision. Hence the overall cost for distributed points cannot be higher than 10 tokens. Your cost is always 0 if you do not distribute points to anybody.

Your overall period earnings are

Period earnings = phase one earnings – earning reduction – cost for distributed points
= phase one earnings – (received points)x4 – (actually distributed points)x4

Your final earnings are given by the sum of earnings in every period. Please notice that your period earnings can be negative. In that case they will be deducted from your cumulative earnings at the end of the experiment.

After everybody has completed his or her decision, you will learn phase two results. For each other person you will learn the earnings reduction due to point distributions. You will be informed about which one of your point distribution decisions was selected for implementation (asterisk in last row of the screen below). To protect anonymity, you will not know who distributed the points.



Periodo
1 di 2

ID=1

Risultati

	Tuoi risultati	Altra persona	Altra persona	Totale
Gettoni depositati	20	10	0	30
A. Guadagni prima fase	**15.0**	**25.0**	**35.0**	
Punti ricevuti	0	3	3	
B. Riduzione seconda fase	**0**	**-12**	**-12**	
C. Costo punti distribuiti	-3	non rivelato	non rivelato	
Guadagni a fine periodo	A+B+C= **12.0**	A+B=**13.0**	A+B=**23.0**	

Dettaglio dei punti che hai chiesto di distribuire	3	6
Quale delle decisioni è stata eseguita?	*	

In the input screen you can press the “Show previous decisions” button and you will see a table with your choices and the choices of the others in previous periods.

Please record period by period on paper the decision you input into the computer.

Are there any questions?

INSTRUCTIONS PART THREE

These are the instructions for the third and last part of the experiment. The third part consists of 10 periods and, as before, in each period you have to make a decision about the use of 20 tokens. As before, each period is composed of two phases. Phase one is identical to the procedure already described while phase two has different rules.

Phase one instructions do not change and hence you can refer back to the previous text. Only phase two instructions will now be read.

In phase two of a period you can reduce or leave equal the earnings of each of the two persons that have benefited from the same project.

Your decision is about distributing points. Every point you distribute reduces the earnings of a person by **4 (four) tokens**. For the person who distributes it, every point has a **cost of 1 token**. You can distribute points separately to each of the other two people. If you do not wish to change the earnings of a specific person, you can choose 0. If you wish to reduce the earnings of a specific person, you can distribute to her a number of points from 0 through 10. You know only the decision made in phase one by the other people. There is no way for you to know either the identity or previous choices of the others.

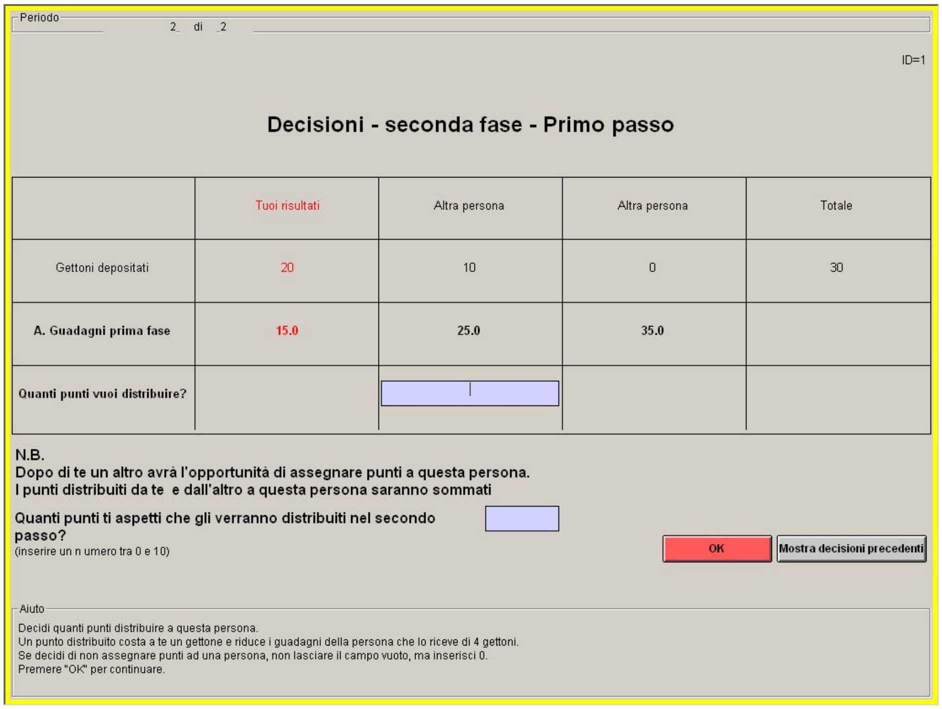
For instance, if you distribute 2 points to a person and 3 points to another one, your overall cost is 5 tokens (2+3). Instead, if you choose 0 points for a person, you do not change her earnings. If you distribute 2 points to a person, you reduce her earnings by 8 tokens (2x4). The entirety of the earnings reduction depends on the *sum* of received points. If a person receives 2 points from somebody and 1 point from somebody else, her earnings are reduced by 12 tokens (((1+2)x4).

The distribution of points is carried out one person at a time in a sequence of two steps.
Each period can be described as follow:

Phase one	Phase two	
	Step one (other person)	Step two (other person)

In step one, you decide how many points to distribute to a specific person. You are the first to decide if and how many points to distribute to this person. After you, somebody else will have the opportunity to distribute points to the same person.

After you have chosen how many points to assign to this specific person, you are asked to make a forecast about how many points the person who will decide after you will distribute in step two to the same person (see outside the table, screen below). This forecast does not affect your earnings.



Decisioni - seconda fase - Primo passo

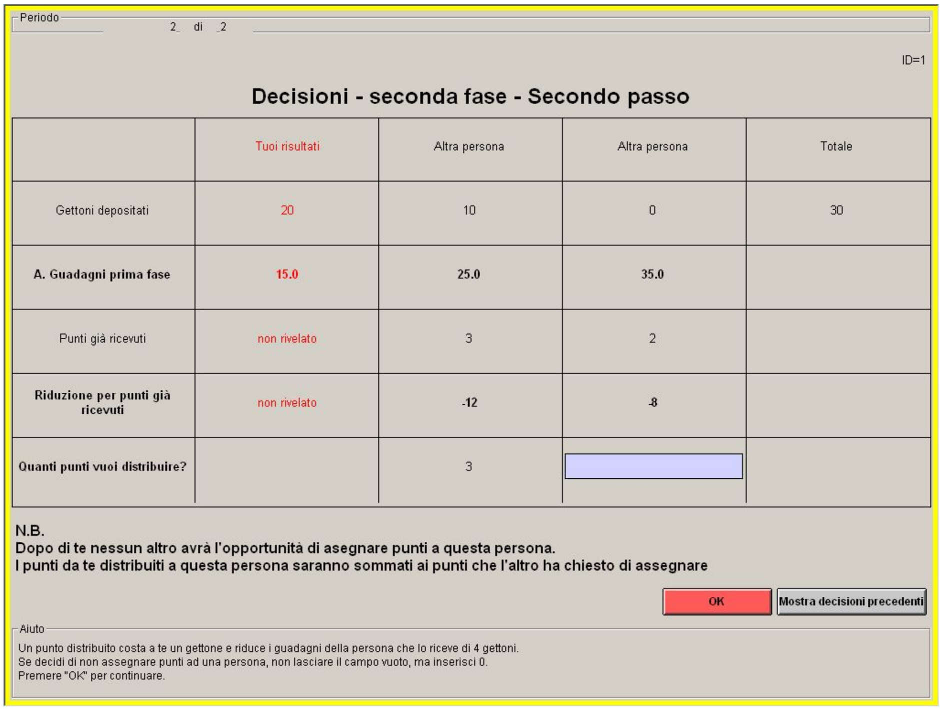
	Tuoi risultati	Altra persona	Altra persona	Totale
Gettoni depositati	20	10	0	30
A. Guadagni prima fase	**15.0**	**25.0**	**35.0**	
Quanti punti vuoi distribuire?				

N.B.
Dopo di te un altro avrà l'opportunità di assegnare punti a questa persona.
I punti distribuiti da te e dall'altro a questa persona saranno sommati

Quanti punti ti aspetti che gli verranno distribuiti nel secondo passo?
(inserire un n umero tra 0 e 10)

Decidi quanti punti distribuire a questa persona.
Un punto distribuito costa a te un gettone e riduce i guadagni della persona che lo riceve di 4 gettoni.
Se decidi di non assegnare punti ad una persona, non lasciare il campo vuoto, ma inserisci 0.
Premere "OK" per continuare.

In **step two** you decide how many points to distribute to the other person in addition to those already received. You will learn the points already received in step one from the one-before-the-last line of the table reported below. After you, nobody else will have the possibility to distribute her points.



Decisioni - seconda fase - Secondo passo

	Tuoi risultati	Altra persona	Altra persona	Totale
Gettoni depositati	20	10	0	30
A. Guadagni prima fase	**15.0**	**25.0**	**35.0**	
Punti già ricevuti	non rivelato	3	2	
Riduzione per punti già ricevuti	non rivelato	**-12**	**-8**	
Quanti punti vuoi distribuire?		3		

N.B.
Dopo di te nessun altro avrà l'opportunità di asegnare punti a questa persona.
I punti da te distribuiti a questa persona saranno sommati ai punti che l'altro ha chiesto di assegnare

Un punto distribuito costa a te un gettone e riduce i guadagni della persona che lo riceve di 4 gettoni.
Se decidi di non assegnare punti ad una persona, non lasciare il campo vuoto, ma inserisci 0.
Premere "OK" per continuare.

At the end of the two steps, every one of the persons that have benefited from the same project will have had the opportunity to distribute points to each one of the others.

Remember that the amount of earning reduction depends on the sum of the points received in the first and the second step. Your overall cost in tokens is equal to the sum of the points that you have distributed to others. That cost cannot be higher than 20 tokens. (10 points times 2 people). Your cost is always 0 if you do not distribute points to anybody.

Your overall period earnings are

Period earnings = phase one earnings – earning reduction – cost for distributed points
= phase one earnings – (sum of received points)x4 – (total points distributed)x4

Please notice that your period earnings can be negative. In that case they will be deducted from your cumulative earnings at the end of the experiment.

After everybody has completed his or her decision, you will learn phase two results. For each other person you will learn the earning reduction due to point distributions.

After everybody has completed his or her decision, you will learn phase two results. For each other person you will learn the cumulative earning reduction due to point distributions. To protect anonymity, you will not know who distributed the points.

In the input screen you can press the “Show previous decisions” button and you will see a table with your choices and the choices of the others in previous periods.

Please record period by period on paper the decision you input into the computer.

Are there any questions?