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Power of Joint Decision-Making in a Finitely-Repeated Dilemma

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Abstract:

A rich body of literature has proposed that pairs behave significantly differently from individuals due to a number of reasons such as group polarization. This paper experimentally compares cooperation behaviors between pairs and individuals in a finitely-repeated two-player public goods game (continuous prisoner's dilemma game). We show that pairs contribute significantly more than individuals to their group accounts. Especially, when two pairs are matched with each other for the entire periods, they successfully build long-lasting cooperative relationships with their matched pairs. Our detailed analyses suggest that the enhanced cooperation behavior of pairs may be driven by (a) the mere fact that they have partners when they make decisions, (b) group polarization – those who initially prefer to contribute smaller amounts are more affected by the partners in their pairs, and (c) stronger conditional cooperation behavior of pairs to their matched pairs.

JEL classification: C91, C92, H41

Keywords: experiment, cooperation, dilemma, team work, public goods

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1. Introduction

Cooperation problems are one of the central features in our society (e.g., Ostrom 1990). Many cooperation decisions are often made by pairs, rather than by individuals. For instance, many decisions couples make at home are made jointly. A couple may jointly decide either to clean up after their dog or leave it behind when taking a walk. They may also jointly decide to play music loudly at night or keep it at a low volume. The similar holds also for two university friends that always hang out together visiting a library or cafeterias. They may decide to speak loudly or keep quiet at the library. They may also decide to return their trays where they are supposed to or just leave them on a table at a cafeteria. How do people's joint cooperation decisions – by joint cooperation decision we mean that a pair makes a single decision – differ from individual cooperation decisions? How do joint cooperation decisions affect the evolution of cooperation norms in a dilemma situation? Do their joint cooperation decisions differ by the frequency of their interactions with others?

This paper experimentally addresses the above research questions using two kinds of matching protocols: (a) partner matching between two pairs and (b) stranger matching within a community.² Both matching protocols are prevalent in the real world. Imagine, for example, that two couples are living in a duplex property (a house that has separate entrances for two households). Their interactions with each other would last for some time. Also, imagine another situation where a pair lives in a house in an area in which community events are occasionally held. They meet with other pairs rather randomly when the pair participates in some of the events.

Experiments in past several decades have intensively studied people's *individual* cooperation behaviors. On the one hand, the literature suggests that some people prefer to cooperate in dilemma situations. But on the other hand, it has also shown that we may need some institutions to sustain cooperation among them. For instance, some individuals attempt to cooperate even in one-shot dilemma games, or in earlier periods of finitely repeated dilemma games when they individually make cooperation decisions (e.g., Ledyard 1995, Zelmer 2003,

² Each decision-making unit is always matched with the same decision-making unit in the partner matching protocol. By contrast, each decision-making unit is randomly matched with another decision-making unit from round to round in the stranger matching protocol.

Chaudhuri 2011). However, usually cooperation gradually declines over time.³ Various institutions are proven to be effective in encouraging people to cooperate in finitely-repeated dilemma games. Examples include costly punishment (e.g., Fehr and Gächter 2000 and 2002), nonmonetary punishment (e.g., Masclet et al. 2003), sorting (e.g., Gunnthorsdottir et al. 2007, Gächter and Thöni 2010) and endogenous group formation (e.g., Page, Putterman and Unel 2005, Kamei and Putterman 2014). Almost all of these studies on institutions to enhance cooperation, however, are conducted by using individuals as the decision-making unit. It is somewhat surprising that little attentions have been paid to joint cooperation decisions as joint cooperation decisions are ubiquitous in our societies and organizations. This paper focuses on how joint cooperation decisions, as opposed to individual cooperation decisions, affect the dynamics of cooperation behavior in repeated dilemma situations.

Joint cooperation in repeated setups, or joint reputation building behavior, can be different from individual one, considering the large volume of experimental research on team behaviors. The literature, for example, suggests that (a) joint or team decision-making may make them choose more materially beneficial options, (b) the less cooperative may be more affected by the more cooperative, (c) teams may exhibit less myopic loss aversion, (d) teams may be more likely to overcome coordination failure than individuals, (e) a member in a team may exhibit some social effects such as shame and a desire to be respected (e.g., Charness and Sutter 2012 for a survey).⁴ However, to our knowledge, there is no agreement among scholars whether people contribute more or less when they make contribution decisions as a pair or a team.

Our experiment is based on a framework of a finitely-repeated, two-player public goods game (a continuous version of prisoner's dilemma game).⁵ Each group contains two decision-making units that simultaneously make allocation decisions using their endowments between their private accounts and group account. Our design is set so that it is privately optimal for each decision-making unit to contribute nothing to their group account. We design two joint-decision

³ One main reason of this decay is that cooperators give up cooperating with others after seeing the defection or free-riding by their partners.

⁴ In this paper, we use the term “team” (“team decision-making”) to generally express a decision-making unit whose size is more than one (decision-making whose unit has more than one subject). By contrast, we use the term “pair” (“joint decision-making”) to refer to a decision-making unit whose size is exactly two (decision-making whose unit has exactly two subjects).

⁵ We chose a finitely-repeated game as the framework of our study. We acknowledge that in some real-world interactions people's interactions can be described as infinitely-repeated interactions, however. We use a finitely-repeated setup because economic theory provides a clearer prediction when games are played finitely.

treatments and two individual-decision treatments. In the two joint-decision treatments, each subject is randomly paired with another subject at the beginning of the experiment; and they act as a decision-making unit. The pairing is fixed during the entire session. In one treatment, a partner matching protocol is used. That is, each pair is randomly matched with another pair to form a group at the onset of the experiment and plays with each other for the entire periods. In the other treatment, a stranger matching protocol is used. In this treatment, each pair is randomly matched with another pair in each period within a session and plays with them for that round. Each pair is given an ample time — one minute in each period — to discuss their joint allocation amounts, and then jointly makes a contribution decision. Before entering the communication stage in each period, subjects are also elicited their hypothetical contribution amounts that they would prefer if they could decide without communicating with their partners. We include this elicitation task in order to study (a) how a subject's willingness to contribute changes due to the mere fact that she has a partner as a decision-making unit and (b) how their personal preferences are affected by their partners through communication (group polarization). The two control treatments are designed to be comparable to the corresponding joint-decision treatments. In the control treatment, each subject is given an endowment and then simultaneously and independently decides contribution amounts to their group accounts, either under the partner matching with another individual or under the stranger matching within a session.

Our experiment finds that the joint contribution decisions of pairs are significantly different from the contribution decisions of individuals under the control treatment. This difference is especially large when each pair repeatedly plays the dilemma games with a fixed pair. Under the partner matching procedure, most pairs establish long-sustained, highly cooperative relationships with their matched pairs until near the known end period. This is in a sharp contrast with the corresponding individual-decision treatment with the partner matching protocol in which contribution amounts quickly decline in the earlier rounds and then stay at a low level until the end period.

Under the stranger matching protocol, like pairs under the partner matching protocol, pairs contribute significantly higher amounts to their group account in the first half of the periods than individuals do under the control condition. However, their contribution amounts steadily decline from period to period similar to the corresponding individual-decision treatment with the stranger matching protocol.

An exploration of the subjects' contribution preferences elicited before they communicate with their partners in each period suggests two driving forces behind the high effectiveness of the joint decision-making system. First, the subjects on average have higher contribution amounts in their mind when they have been paired with someone as a decision-making unit, compared with when they are asked to make contribution decisions alone without having partners. This suggests that the mere fact that they have partners may enhance people's willingness to cooperate. Second, we find strong evidence of group polarization. Our data shows that the subjects with the lower willingness to contribute in pairs increase contribution amounts significantly towards their pair partners' contribution amounts. At the same time, we also find that those with the higher willingness to contribute in pairs decrease contribution amounts significantly towards their partners'. But, the former group polarization effect is significantly stronger than the latter group polarization effect. This suggests that the positive net group polarization effects could help people keep contributing to their group accounts over the periods.

Lastly, the subjects, whether they have pair partners or not, exhibit strong conditional contribution behaviors. The more their matched pairs (individuals) in the last period contributed, the larger amounts pairs (individuals) contribute in the current period in the joint-decision (individual-decision) treatments. The conditional cooperative reaction to their last-period counterparts' contribution decisions is stronger in the joint-decision treatments than in the corresponding individual-decision treatments. This also explains a mechanism behind the paired subjects' significantly higher cooperation behavior in our experiment.

The rest of the paper proceeds as follows: Section 2 describes our experimental design. Section 3 briefly provides predictions along with related literature. Section 4 reports results, and Section 5 concludes.

2. Experimental Design

The design frame of our experiment is a two-player linear public goods game.⁶ We set up two sets of two treatments (four treatments in total). Each set consists of a joint-decision treatment and an individual-decision treatment. The design of individual-decision treatment is

⁶ We use a two-player public goods game, instead of a standard prisoner's dilemma game, because subjects have more flexibility in selecting the degree of cooperation in the public goods game, rather than a binary choice of "cooperate" and "defect." This feature allows us to analyze the subjects' behavior more precisely.

identical to the corresponding joint-decision treatment other than the feature that the subjects make decisions alone. The first set of two treatments uses a partner matching protocol while the second set uses a stranger matching protocol (see Table 1). In the joint-decision treatments, two individuals act as one decision-making unit, which we refer to as a “pair.” Two two-person pairs (four subjects in total) are grouped and interact with each other. We denote this set of two pairs “group” in the joint-decision treatments. In the individual-decision treatments, a “group” consists of two individuals that make decisions individually.⁷ The number of interactions is 15 in all of the treatments.⁸

The joint-decision treatments in each set are named the “Joint Decision, Partner” (dubbed J-P) treatment and the “Joint Decision, Stranger” (dubbed J-S) treatment. In those two treatments, each subject is randomly paired with another subject at the beginning of the experiment.⁹ The pairing is fixed throughout the entire experiment. In the J-P treatment, we use a partner matching protocol for group formation. That is, each pair is randomly and anonymously matched with another pair at the onset of the experiment to form a group; and the grouping becomes fixed throughout the entire experiment. By contrast, a stranger matching protocol is used in the J-S treatment: each pair is randomly matched with another pair in every period by the computer.

In the J-P and J-S treatments, each pair is given an endowment of 40 points and makes a joint allocation decision between their private account and group account in every period. Only non-negative integers are allowed for their contribution amounts. The payoff consequence follows the standard linear public goods game (see Eq. (1) below). A pair obtains 1 point for each point the pair allocates to their private account; and the pair and their matched pair each obtain 0.8 points for each point the pair allocates to their group account. In short, the payoff of pair i in period $t \in \{1, 2, \dots, 15\}$ is calculated by:

$$\pi_{i,t} = 40 - C_{i,t} + 0.8 \cdot \sum_{j=1}^2 C_{j,t}, \quad (1)$$

⁷ In order to avoid confusion, we separate the meaning of the terms “group size” and “the number of decision-making units.” The former refers to the number of subjects in a group and the latter refers to the number of subject(s) that make decisions either individually or jointly. While both numbers are the same in the treatments where subjects make decisions individually, the “group size” is 4 and “the number of decision-making units” is 2 in the joint-decision treatments.

⁸ Subjects were clearly informed of the number of periods at the beginning of the experiment.

⁹ In order to ensure that pairs were randomly formed, each subject was asked to draw a slip of paper with a seat number before the start of the experiment and sit at the seat with the number indicated on the paper. Two subjects that were seated next to each other became a pair. No communication was permitted during this pairing process until the joint decision stage described later.

where $C_{i,t} \in \{0,1,2, \dots, 40\}$ is the joint contribution decision of pair i in period t . Each member in pair i obtains half of $\pi_{i,t}$ as his or her period t payoff.

The procedure in which each pair decides their joint allocation amounts is as follows: subjects in the J-P and J-S treatments are given one minute to freely discuss their strategies and decisions with their partners using an electronic chat system in each period. Although their partners sit next to them, they are not allowed to communicate verbally and are only permitted to communicate with each other via chat windows.¹⁰ This ensures that the content of communication within pairs is their private information. Once the communication stage is over, each individual in a pair privately and simultaneously submits an amount they wish to allocate to the group account using their computer terminal. If a subject and his partner in the pair submit the same allocation amount, then the amount becomes their pair's allocation amount to the group account for this period. If the subject and his partner submit different amounts, then one of the two amounts will be selected with a probability of 50% by the computer.¹¹ Both subjects will be informed of what amount their pair partners submitted before being informed of their interaction outcome with the other pair.

In the J-P and J-S treatments, we elicit the subjects' hypothetical contribution amounts before entering the communication stage in each period. Specifically, we ask them what amount they would choose if they could decide allocation amounts unilaterally using the 40 points without communicating with their partners. This elicitation task is not incentivized to avoid a hedging problem.¹²

We set up an individual-decision treatment to correspond to each of the J-P and J-S treatments. In the “Individual Decisions, Partner” treatment (dubbed I-P) and the “Individual Decisions, Stranger” treatment (dubbed I-S), subjects play two-person public goods games 15 rounds. Each subject is given an endowment of 40 points in each period, as is each pair in the J-P and J-S treatments. Two subjects in each group then simultaneously and independently decide

¹⁰ As explained later, the sessions were conducted at an experimental laboratory at the University of Michigan. In this laboratory, there are partitions between desks, which made it easy for us to implement this rule.

¹¹ This rule was applied to a small number of the pairs in the experiment. In 37 out of 240 (= 16 pairs \times 15 periods) joint decisions (15.4% of the decisions) in the J-P treatment and in 46 out of 240 joint decisions (19.2% of the decisions) in the J-S treatment, two subjects in pairs submitted different amounts after the communication stage.

¹² In addition, this questionnaire is included only on the subjects' computer screen. At the onset of the experiment, they are told that some additional questions related to the experiment may be asked while the experiment is in progress.

contribution amounts to their group account. Their allocation amounts must be integers between 0 and 40. To make the I-P (I-S) treatment parallel to the J-P (J-S) treatment, the payoff consequence of each subject's decision is set as half of a pair's payoff in the joint-decision treatment. That is, subject k obtains 0.5 points for each point she allocates to her private account; and she and her partner each obtain 0.4 points for each point she allocates to her group account.¹³ In short, the payoff of subject k in period $t \in \{1, 2, \dots, 15\}$ is expressed by:

$$\begin{aligned}\pi_{k,t} &= 0.5 \cdot [(40 - c_{k,t}) + 0.8 \cdot \sum_{l=1}^2 c_{l,t}] \\ &= 0.5 \cdot (40 - c_{k,t}) + 0.4 \cdot \sum_{l=1}^2 c_{l,t},\end{aligned}\tag{2}$$

where $c_{k,t} \in \{0, 1, 2, \dots, 40\}$ is the contribution amount of subject k in period t . The I-P and I-S treatments use the partner matching protocol and the stranger matching protocol, respectively. The matching process is identical to the corresponding joint-decision treatments explained above. As in the joint-decision treatments, the subjects are informed of the outcome of their interactions at the end of each period.

Finally, at the end of the experiment, all subjects are asked their reasoning behind their allocation decisions.

3. Predictions and Specific Questions

Predictions based on standard theory for the four treatments are straightforward. Contributing zero points to their group account is a strictly dominant strategy for each subject. Thus, mutual full free riding ($c_{j,t} = 0$ for all j and t) is a unique Nash Equilibrium in each treatment.

As mentioned in Section 1, however, established evidence from finitely-repeated dilemma game experiments suggests that some subjects may attempt to cooperate in earlier periods. But the cooperation rate will most likely keep declining over the periods when subjects individually make allocation decisions in our environment.¹⁴ This dynamic can be rationalized if we assume that some subjects have other-regarding preferences (see Sobel (2005) for a survey) or that they at least believe that some subjects do so. One can presume that the same behavior

¹³ The marginal per-capita return (MPCR) is 0.8 in both the joint-decision and individual-decision treatments.

¹⁴ More cooperation-oriented subjects are quickly discouraged if they see others free ride (e.g., Fischbacher and Gächter 2010).

can be seen when subjects make decisions jointly under the assumption that pairs behave the same way as individuals do.

However, experiments in recent decades seem to suggest that people's decisions made jointly by more than one person substantially differ from those made individually in repeated dilemma situations. This is because people tend to have deeper insights and better understanding of the nature of interactions, which enables them to choose more materially beneficial options when they make decisions jointly with others, in comparison to when they make decisions alone (see Charness and Sutter for a survey).¹⁵ There are two possible opposing predictions regarding how making decisions jointly affects people's behavior in our context. On the one hand, pairs may behave more in line with what standard theory predicts if joint decision-making strengthens their game theoretic reasoning. For instance, Kocher and Sutter (2005) find that teams learn to submit lower numbers in beauty-contest games more quickly than individuals do when they repeat the games.¹⁶ If something similar happens in our environment, cooperation will decline more quickly in the J-P (J-S) treatment than in the I-P (I-S) treatment. On the other hand, letting subjects make decisions jointly may contribute to sustaining cooperation in repeated dilemma situations. There are especially three reasons why this may be the case. First, if pairs believe that not all subjects are selfish, then they may consider that free-riding in earlier periods is not the best strategy if they want to maximize their total payoff across the 15 periods.¹⁷ Pairs may expect that if they discourage their matched pairs by free-riding, it would deteriorate their relationships with their matched pairs, by which they may end up obtaining lower payoffs as groups in the rest of the interactions. Each pair would be materially better off if they could successfully build a trustful relationship and encourage their matched pair(s) to keep cooperating with them.¹⁸ Thus, pairs in the joint-decision treatments might value building such trustful relationships more highly

¹⁵ Note that the number of subjects in a team is more than 2 in the majority of research. We acknowledge that some implications found in previous studies may not extend to our environment.

¹⁶ The size of a decision-making unit is three, and the number of decision-making units in a group is five in Kocher and Sutter unlike our setup.

¹⁷ Joint or team decision-making can be helpful in overcoming coordination failure among subjects. For example, Feri *et al.* (2010) find that groups are more likely to choose mutually beneficial, Pareto-efficient equilibrium among multiple equilibria when playing weakest-link games.

¹⁸ A pair in the J-P and J-S treatments obtains 40 points if the pair and their matched pair both contribute 0 points to their group account. By contrast, they obtain 64 points if they and their matched pair both contribute 40 points to the group account. (The pair profit is divided by half between two individuals in a pair.)

compared with a gain from one-time defection.¹⁹ Note, however, that they may attempt to severely milk their established relationships with their matched pairs near the end period if they are primarily motivated strategically. Second, some studies have shown that teams tend to exhibit less myopic loss aversion than individuals in a risky situation (e.g., Sutter, 2007). In our environment, a pair incurs a loss if the pair decides to cooperate but their matched pair(s) does not reciprocate the intention. However, as in the past studies, pairs may be more willing than individuals to take risks in investing in encouraging their matched pairs to cooperate by sending signals to them via their own high contributions. Third, some studies suggest that team decision-making can be helpful in raising an effort level of a member in workplace because her effort choice influences the compensation of their team members. For instance, Babcock et al. (2012) define such social effects as “*those that are related in a direct way to the utility an individual derives from interacting with others, including but not limited to effects from altruism, guilt, shame, embarrassment, commitment devices, fear of social punishment, or a desire to be liked or respected.*” Babcock et al. conducted two field experiments, confirming such social effects. In our context, the mere fact that there is another person in her pair (decision-making unit) may encourage a subject to do the right thing or behave pro-socially because of some social effects. Or, the presence of a partner in her pair may encourage the subject to attempt to build cooperative relationships with other pairs, which would raise the payoff of the paired person as well. These considerations lead to our first specific question in our study:

Question 1: Are the pairs’ contributions more sustained in the J-P (J-S) treatment than the individuals’ contributions in the I-P (I-S) treatment?

The significance of such social effects can be examined by comparing (a) the pre-communication hypothetical contribution amounts elicited in the J-P (J-S) treatment with (b) the subjects’ individual contribution amounts in the I-P (I-S) treatment. The subjects’ pre-communication willingness to contribute in the J-P (J-S) treatment can be inflated if such social effects are present.

¹⁹ Gillet *et al.* (2009), using three teams with a team size of three in each interaction unit, find that teams make decisions in a less myopic manner than individuals in repeated common pool resource problems when teams make joint decision via unanimity rule.

Question 2: Is the average hypothetical contribution elicited before the discussion with partners in the J-P (J-S) treatment higher than the average individuals' contribution in the I-P (I-S) treatment?

If Question 1 has an affirmative answer, then we could furthermore expect that building such a trustful relationship would be easier for pairs in the treatment with the partner matching protocol as each pair repeatedly interacts with the same pair in every round. In the J-S treatment, unlike the J-P treatment, a pair meets with a specific pair in two consecutive periods with a probability of 14.3% ($= 1/7 \times 1/7 \times 100\% \times 7$ potential pairs). This difference in the re-matching probability has implications for the timing of subjects' end-game defection. In the J-S treatment, even if a pair milks their already-established trustful relationship within a community by defecting in some later period, the probability that they will meet with that pair again in the rest of the periods is small. This means that they have higher incentives to defect than pairs in the J-P treatment. This consideration leads to our third specific question:

Question 3: Is cooperation more sustained in the J-P treatment than in the J-S treatment?

Lastly, the opportunity to make a joint decision may affect the subjects' cooperative attitudes due to what psychologists call group polarization, although there exists competing evidence. On the one hand, some studies suggest that joint decisions may enhance cooperation in subjects as the less cooperative subject is more influenced by the more cooperative one (e.g., Cason and Mui 1998). Other studies, on the other hand, suggest that people behave more strategically and in more selfish manners when making decisions jointly (e.g., Luhan et al. 2009). Our experiments use repeated games: as discussed earlier, a pair would receive a higher payoff if they successfully establish a trustful relationship with their matched pair. Thus, if at least one person in a pair finds building such a relationship with a specific pair (pairs) in the J-P (J-S) treatment materially beneficial, then the pair may be more willing to take a risk in building such a relationship. This material motive can also be aligned with other-regarding one that is held by cooperative subjects. Thus, less cooperative subjects might shift their original inclination towards more cooperative ones, regardless of which experimental finding is valid for our setting concerning the group polarization. This is the fourth specific question in the paper:

Question 4: Is a subject in a pair who initially has the lower willingness to contribute affected more by her partner who has the higher willingness to contribute?

4. Results

Two sessions per treatment were conducted at the University of Michigan in Ann Arbor. A total of 96 subjects participated in the experiment.²⁰ No subject participated in more than one session. The experiment was programmed in z-tree (Fischbacher 2007). All instructions were neutrally framed.²¹ Subjects were asked to answer a number of control questions to confirm their understanding of the experiment.

We first compare the average contributions between the J-P (J-S) and I-P (I-S) treatments (Figure 1).²² First, both the levels and the trends of average contributions substantially differ between the individual-decision and joint-decision treatments under the partner matching protocol. The average contributions in the J-P treatment begin at around 70% of the endowment, increase gradually, and then remain at a level of around 80% of the endowment until period 13. As usual in the standard public goods or prisoner's dilemma game experiments, strong end game defection is seen in the J-P treatment (Andreoni 1988, Andreoni and Miller 1993). This observation on the end-game effect suggests that the high cooperation level in the J-P treatment partially stems from the subjects' strategic motives. By sharp contrast, in the I-P treatment, the average contributions decline steadily over the periods. The differences in the average contribution between the J-P and I-P treatments are significant in all periods except periods 1, 2 and 15 – the end period (Appendix Table B.1).²³ A regression analysis, shown in Table 2, confirms that the overall declining trend of contribution amounts in the I-P treatment is significant but it is not in the J-P treatment.

Result 1: Average contributions are sustained at a high level in the J-P treatment. By contrast, they are in a significantly decreasing trend in the I-P treatment.

²⁰ Solicitation messages were sent via ORSEE (Online Recruitment System For Economic Experiments) to all eligible potential subjects. Subjects then voluntarily signed up for the experiment. Most participants were undergraduate students at the University of Michigan. The average payoff (except the participation payment) was \$14.35 with a standard deviation of \$2.05. The number of female subjects was 57 (59%). The sessions in the I-S and I-P treatments lasted a little above 30 minutes, and the sessions in the J-P and J-S treatments lasted around 80 minutes (including payment to the subjects).

²¹ For example, terms having neutral connotation, such as “group account” and “allocate,” instead of “public account” and “contribute,” were used. See Appendix A for the instructions of the J-P treatment.

²² Average payoffs in the joint-decision (individual-decision) treatments are simply linear transformations of average contributions based on Equation (1) (Equation (2)).

²³ Also see the coefficient estimates of variable (i) in columns (1) and (2) of Table 2.

Second, the levels of average contributions are substantially different between the individual-decision and joint-decision treatments under the stranger matching protocol as well (Panel (b) of Figure 1). A regression analysis confirms that the overall difference in the contribution level between the two treatments is statistically significant (columns (3) and (4) of Table 2). However, average contributions are in declining trends over the periods in both the J-S and I-S treatments; and the decrease rate in the J-S treatment is significantly larger than that in the I-S treatment. Consequently, the average contributions are often significantly higher in the J-S treatment than in the I-S treatment in the first eight periods, but not in later periods (Appendix Table B.1).

Result 2: Average contributions are often significantly higher in the J-S treatment than in the I-S treatment in the first eight periods in the experiment. They are in significantly decreasing trends in both the J-S and I-S treatments.

Potential driving forces behind the difference in the subjects' contribution behavior between the J-P (J-S) and I-P (I-S) treatments can be explored by using hypothetical contribution amounts elicited before the communication stage under the joint-decision treatments. Our data suggests two possible driving forces: (a) social effects of having a partner in her pair and (b) group polarization. The former can be measured by comparing (i) period 1 hypothetical contribution amounts in the J-P (J-S) treatment with (ii) period 1 individual contribution amounts in the I-P (I-S) treatment. The period 1 hypothetical contribution amounts are the subjects' willingness to cooperate as pairs before entering the first communication stage.²⁴ Our data indicates that the average period 1 hypothetical contribution amounts are statistically similar between the two joint-decision treatments (28.2 points in the J-P treatment versus 27.2 points in the J-S treatment). But, the average hypothetical contributions in the J-P and J-S treatments are both higher than the average contributions in the I-P and I-S treatments, respectively, although the difference is statistically significant only between the J-S and I-S treatments (see Appendix Table B.1). This suggests that the mere fact that subjects have their partners in their decision-making units in the joint-decision treatments may enhance their willingness to contribute to their group accounts, as is seen in people's effort provision in teams (Babcock et al. 2011).

²⁴ We can also measure the social effects by comparing these two kinds of decisions in periods 2 to 15. But, pre-communication hypothetical contribution amounts elicited in periods 2 to 15 may be affected by their partners' preferences the subjects learned through communication in past periods.

Result 3: The average period 1 pre-communication hypothetical contribution in the J-P (J-S) treatment is higher (significantly higher) than the average period 1 contribution in the I-P (I-S) treatment.

A period-by-period exploration of the average pre-communication contribution preferences finds that the trends are similar to those of the average realized joint contributions in each of the J-P and J-S treatments (Figure 1) —the subjects’ pre-communication willingness to contribute stays at a high level in each of the two joint-decision treatments.²⁵ A potential factor that helps sustain the subjects’ willingness to cooperate is group polarization (e.g., Cason and Mui 1997). The group polarization may have functioned well especially in the J-P treatment. The average realized joint contribution amounts are slightly higher than the average hypothetical contributions in most periods in that treatment. This could mean that those with the lower willingness to contribute in pairs may have been more affected by their partners.

In order to explore the possibility of group polarization, we conduct a regression analysis in which the dependent variable is the contribution amount that subject i submits after the communication stage in period t (which we denote as $c_{i,t}$) minus the hypothetical contribution amount that subject i prefers before communicating with her partner in that period (which we denote as $c_{i,t}^{hypo}$). Independent variables include (a) the positive deviation of hypothetical contributions in period t ($= \max\{c_{partner,t}^{hypo} - c_{i,t}^{hypo}, 0\}$) and (b) the negative deviation of hypothetical contributions in period t ($= \min\{c_{partner,t}^{hypo} - c_{i,t}^{hypo}, 0\}$). As shown in Table 3, our data shows that a subject who originally prefers to contribute a larger amount than her partner will significantly reduce her willingness to contribute after their communication (see the coefficient estimates of variable (b)). But at the same time, the subject that originally prefers to contribute a smaller amount than his partner will significantly raise his willingness to contribute after communication (see the coefficient estimates of variable (a)). Moreover, the latter positive group polarization effect is significantly larger than the former negative group polarization effect in each of the joint-decision treatments. The difference between the two group polarization effects is especially large in the J-P treatment (column (1) of Table 3). This suggests that the

²⁵ The average hypothetical contributions in the J-P treatment are significantly higher than the average individuals’ contributions in the I-P treatment in all periods except periods 1 and 15. The average hypothetical contributions in the J-S treatment are significantly higher than the average individuals’ contributions in the I-S treatment in all periods until period 10. See Appendix Table B.1 for the details.

joint decision process may effectively help prevent people from engaging in opportunistic behavior through the group polarization especially in the JP treatment.

Result 4: The subjects that originally prefer to contribute smaller amounts than their pair partners significantly raise their willingness to contribute after discussion. The subjects who originally prefer to contribute larger amounts than their pair partners significantly decrease their willingness to contribute after discussion. The former positive group polarization effect is stronger than the latter negative effect.

A possible reason for the phenomenon of the group polarization is that the subjects in the joint-decision treatments, especially in the J-P treatment, are more willing to reciprocate their matched pairs' willingness to cooperate. Suppressing their temptation to defect and responding to their counterparts' intentions to cooperate could be a key for people to build trustful relationships with their matched counterparts and to obtain potentially better material outcomes.

In order to investigate the degree of the pairs' (individuals') reciprocation to the intentions of their matched pairs (individuals), we perform a regression where the dependent variable is joint or individual contribution decisions in period $t \in \{2, 3, \dots, 15\}$. Independent variables include their period $t - 1$ matched counterparts' contribution decisions in period $t - 1$. As shown in Appendix Table B.2, regardless of the matching protocols, both pairs and persons exhibit significantly stronger conditional contribution behavior, as shown in many related studies (e.g., Fischbacher et al. 2001).²⁶ However, the strength of the conditional willingness to contribute differs by the decision process. That is, the pairs in the J-P (J-S) treatment exhibit significantly (weakly significantly) stronger conditional willingness to contribute than the individuals in the I-P (I-S) treatment. This result suggests that pairs' stronger conditional

²⁶ The subjects' responses to a post-experiment, open-ended question provide additional evidence on the subjects' conditional contribution behavior and their reputation building motives. This question reads: "On what basis did you make allocation decisions?" Many subjects in each treatment explained either conditional behavior or the importance of building trustful relationships with the other pairs in obtaining a higher total payoff. We acknowledge, however, that these responses could have been contaminated by their experiences in the experiment and thus can be used for suggestive evidence only. The details are omitted to conserve space. See online Appendix C for all subjects' responses.

willingness to cooperate could help them establish cooperative relationships with their matched pairs in the joint-decision treatments.²⁷

Result 5: The conditional willingness to contribute in the J-P (J-S) treatment is significantly (weakly significantly) stronger than that in the I-P (I-S) treatment.

5. Conclusions

This paper experimentally compared cooperation and reputation building behavior in a finitely-repeated dilemma situation between pairs and individuals under two matching protocols – partner matching of two pairs and stranger matching in a community. First, our experiment finds that regardless of the matching protocols, pairs on average contribute significantly more than individuals do. The power of joint decision-making is especially strong under the partner matching protocol. Almost all pairs successfully establish long-lasting, cooperative relationships with their matched pairs over the periods in the J-P treatment. By contrast, individuals in the I-P treatments fail to build such relationship and continue to decrease their contributions to their group accounts over the periods. Second, the data from our elicitation task suggests two possible driving forces behind the high efficiency of the joint decision-making system. The first possible force is that the mere fact that they have partners in pairs may raise the subjects' willingness to contribute. The average hypothetical contribution amounts elicited before the communication stage in the joint-decision treatments are much higher than the average contribution amounts in the corresponding individual-decision treatments. The second possible force is group polarization. Those who initially prefer to contribute smaller amounts than their pair partners raise their willingness to contribute significantly after communicating with the partners. Finally, we also find that pairs reciprocate their matched pairs' intentions to cooperate significantly more strongly under the J-P treatment than under the I-P treatment.

One may wonder how the effectiveness of joint decision-making compares to that of other institutions that may sustain cooperation in dilemma situations. To explore this question, we additionally conducted two treatments, each of which was exactly identical to the I-P and I-S

²⁷ The motives behind the group polarization or the conditional contribution behavior are mixed between strategic ones (e.g., pairs behave cooperatively to obtain higher material payoffs) and non-strategic ones (e.g., pairs behave cooperatively affected by more cooperative partners in their pairs), as evidenced by the strong end-game defection in the J-P treatment (Figure 1).

treatments except that it had a standard informal punishment stage after the individual contribution stage.²⁸ In the informal punishment stage, for each punishment point assigned by a subject, 1.5 points were deducted from the punished and 0.5 points were deducted from the punisher.²⁹ We refer to the two additional treatments as the “I-P-Punishment” treatment and the “I-S-Punishment” treatment.³⁰ Our data shows that neither the average contributions nor the average payoffs are significantly different between the J-P and I-P-Punishment treatments.³¹ In addition, while the average contributions are almost identical between the J-S and I-S-Punishment treatment, the average payoff in the J-S treatment is higher, although insignificantly, than that in the I-S-Punishment treatment.³² This additional data suggests a high potential of joint decision-making in deterring people’s opportunistic behavior in dilemma situations.

²⁸ Two sessions per each additional treatment were conducted at the University of Michigan. One session of the I-P-Punishment treatment had 8 subjects and the other had 10 subjects. Each session in the I-S-Punishment treatment had eight subjects as in the I-S treatment.

²⁹ The payoff consequence of a subject’s decision in the I-P-Punishment (I-S-Punishment) treatment was set as half of the J-P (J-S) treatment. That is, in the punishment treatments, the payoff of subject i in period t was calculated as: $\pi_{i,t} = 0.5 \cdot [\max\{(40 - c_{i,t}) + 0.8 \cdot \sum_{l=1}^2 c_{l,t} - 3p_{j \rightarrow i,t}, 0\} - p_{i \rightarrow j,t}] = \max\{0.5 \cdot (40 - c_{i,t}) + 0.4 \cdot \sum_{l=1}^2 c_{l,t} - 1.5p_{j \rightarrow i,t}, 0\} - .5p_{i \rightarrow j,t}$. Here, j is the period t partner of subject i , and $p_{j \rightarrow i,t}$ is punishment points given from subject j to subject i in period t .

³⁰ Appendix D includes instructions for the I-P-Punishment treatment for reference.

³¹ The average contributions are 29.2 points and 29.4 points in the J-P and I-P-Punishment treatments, respectively. The difference in the average contribution is not significant according to a group-level Mann-Whitney test (p -value = .700, two-side). The average payoffs are 30.8 points and 31.8 points in the J-P and I-P-Punishment treatments, respectively. The difference in the average payoff is not significant either according to a group-level Mann-Whitney test (p -value = .700, two-side). See Appendix E for period-by-period comparisons.

³² The average contributions are 21.3 points and 21.4 points in the J-S and I-S-Punishment treatments, respectively. The difference in the average contribution is not significant according to a group-level Mann-Whitney test (p -value = .674, two-side). The average payoffs are 26.4 points and 24.5 points in the J-S and I-S-Punishment treatments, respectively. The difference in the average payoff is not significant either according to a group-level Mann-Whitney test (p -value = .1415, two-side). See Appendix E for period-by-period comparisons.

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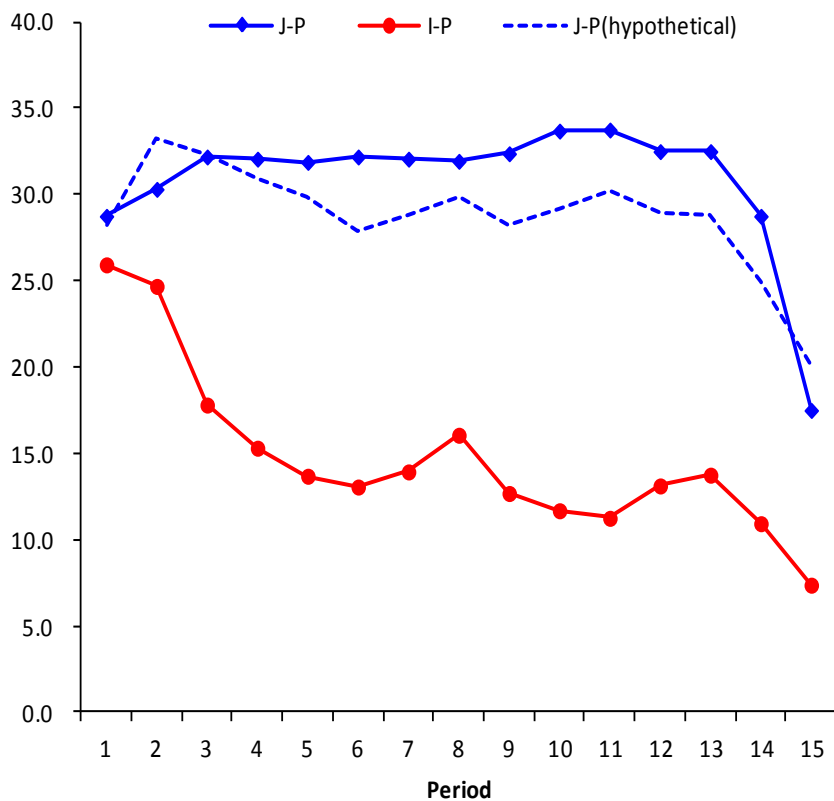
Table 1: Summary of Treatments

Treatment name	Decision	Number of subjects per session	Number of decision-making units in a group	Prob. of meeting with a specific counterpart (pair, individual) in a period	Endowment	Per-point return from private acc't	Per-point return from group acc't	Avg. Contribution ^{#1}
I. Treatments with Partner Matching Protocol								
J-P	Joint	16	2 pairs (4 persons)	100%	40 per pair	1 per pair (0.5 per person)	0.8 per pair (0.4 per person)	30.8 (77.1%)
I-P	Individual	8	2 persons	100%	40 per person	0.5 per person	0.4 per person	14.8 (36.9%)
II. Treatments with Stranger Matching Protocol								
J-S	Joint	16	2 pairs (4 persons)	14.3% (1/7×100%)	40 per pair	1 per pair (0.5 per person)	0.8 per pair (0.4 per person)	21.3 (53.2%)
I-S	Individual	8	2 persons	14.3% (1/7×100%)	40 per person	0.5 per person	0.4 per person	12.5 (31.3%)

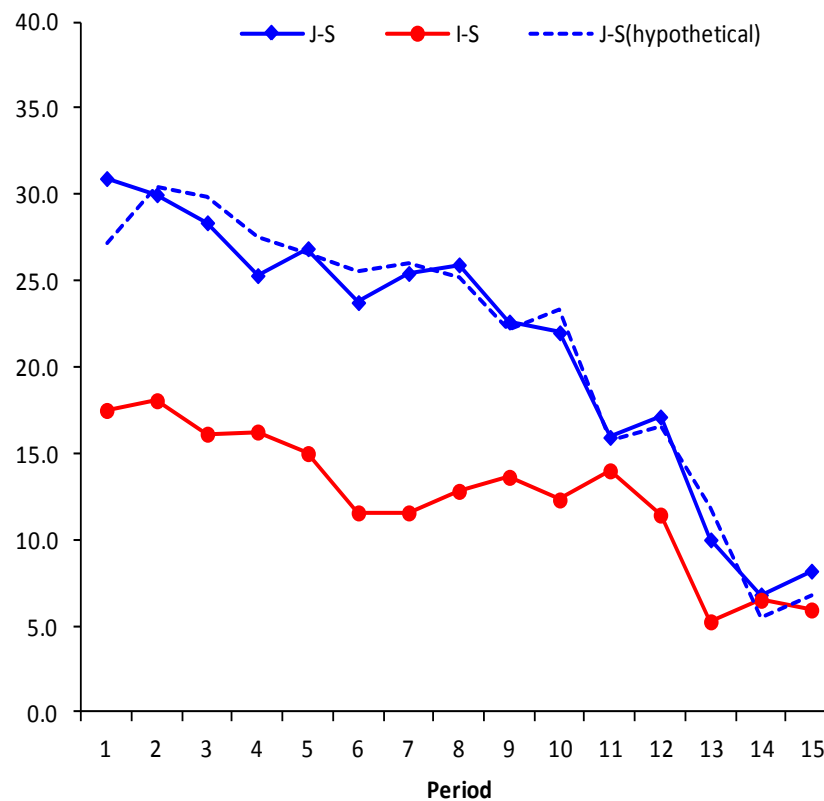
Notes: We also conducted two additional treatments (named the “I-P-Punishment” treatment and the “I-S-Punishment” treatment) in order to compare the efficiency of the joint-decision system in the J-P and J-S treatments to that of an informal sanctioning institution. See Section 5 (Conclusion) for the brief description.

^{#1} The numbers in parenthesis are the average contributions as percentages of the endowment.

Figure 1: Trends of Average Contributions



(a) Partner Treatments



(b) Stranger Treatments

Notes: The dash lines indicate the average hypothetical contribution amounts elicited before communicating with their partners in the joint-decision treatments. Appendix Table B.1 reports period-by-period, group-level Mann-Whitney test results for the differences in the average contribution across the treatments.

Table 2: The Effects of Joint Decision-Making on Enhancing ContributionsDependent variable: The contribution amount of subject i in period t .

Independent Variable	Partner Treatments: J-P treatment versus I-P treatment		Stranger Treatments: J-S treatment versus I-S treatment	
	(1)	(2)	(3)	(4)
(i) Joint Decision-Making Dummy {= 1 for the J-P and J-S treatment; 0 otherwise}	49.2*** (12.7)	29.7** (13.7)	18.8** (8.55)	34.5*** (9.49)
(ii) Period {= 1, 2, ..., 15}	---	-2.85*** (.53)	---	-1.55*** (.34)
(iii) Variable (i) \times Variable (ii)	---	2.37*** (.76)	---	-2.07*** (.51)
Constant	5.51 (8.73)	27.4 (9.40)	4.51 (6.05)	17.7*** (6.55)
# of Observations	480	480	480	480
Log likelihood	-847.6	-830.9	-1200.1	-1145.0
Wald Chi-squared	14.92	41.76	4.82	105.4
Prob > Wald Chi-squared	.0001	.0000	.0282	.0000
Chi-squared test (two-sided) for $H_0: (ii) + (iii) = 0$				
Chi-squared	---	0.75	---	84.57
Prob > Chi-squared	---	.3866	---	.0000***

Notes: Random Effects Tobit Regressions. The number of left(right)-censored observations is 142(205) in columns (1) and (2). The number of left(right)-censored observations is 159(108) in columns (3) and (4).

*, **, and *** indicate significance at the .10 level, at the .05 level and at the .01 level, respectively.

Table 3: Contribution Decisions and Group Polarization

Dependent variable: The contribution amount subject i submitted after the communication stage minus the hypothetical contribution amount of subject i before that stage in period t .

Independent Variable	J-P treatment (1)	J-S treatment (2)
(a) The positive deviation of hypothetical contributions in period t $\{= \max\{c_{partner,t}^{hypo} - c_{i,t}^{hypo}, 0\}\}$	0.71*** (0.044)	0.47*** (0.053)
(b) The negative deviation of hypothetical contributions in period t $\{= \min\{c_{partner,t}^{hypo} - c_{i,t}^{hypo}, 0\}\}$	0.21*** (.041)	0.33*** (0.053)
Constant	0.28 (0.67)	-0.31 (0.46)
# of Observations	480	480
Log likelihood	-1640.4	-1613.8
Wald Chi-squared	324.82	140.46
Prob > Wald Chi-squared	.0000	.0000
Chi-squared test (two-sided) for (a) = (b)		
Chi-squared	57.11	15.71
Prob > Chi-squared	0.0000***	0.0933*

Notes: Random effects Tobit regressions. In order to compare the coefficient estimates between the J-P and J-S treatments, we jointly estimated the coefficients of all variables and then performed Chi-squared tests. We find that the coefficient estimates of variable (a) are significantly different between the J-P and J-S treatments (p -value = .0003, two-sided). We also find that the coefficient estimates of variable (b) are significantly different between the J-P and J-S treatments (p -value = .0478, two-sided). The number of left(right)-censored observations is 5(22) and 2(3) in columns (1) and (2), respectively.

*, **, and *** indicate significance at the .10 level, at the .05 level and at the .01 level, respectively.

Not for Publication

Supplementary Online Appendix for Kamei, 2015,

“Power of Joint Decision-Making in a Finitely-Repeated Dilemma”

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Appendix A: Instructions in the J-P treatment

The following are instructions for the J-P treatment.¹

Instructions

You are now taking part in a decision-making experiment. Depending on your decisions and the decisions of other participants, you will be able to earn money in addition to the \$5 guaranteed for your participation. Please read the following instructions carefully.

During the experiment, you are not allowed to communicate with other participants. If you have a question, raise your hand. One of us will come to answer your question.

During the experiment, your earnings will be calculated in points. At the end of the experiment, points will be converted to U.S. dollars at the following rate:

1 point = 3.6 cents

(This means that around 27.8 points will be exchanged for 1 dollar of real money). At the end of the experiment your total earnings (including the \$5 for participation) will be paid out to you in cash.

During the entire experiment, you are paired with a participant next to you. Your pair and another randomly assigned pair form a group. This means that you are in a group with 3 other participants. **You will be part of the same group throughout the entire experiment.** No one knows which other pair (other 2 participants) is in their group, and no one will be informed which other pair was in which group after the experiment.

This experiment has 15 periods. In each period, each pair will be given an **endowment of 40 points** and will make an allocation decision based on the endowment. We will first explain the nature of the interactions and will then describe how you make decision as a pair.

Your decision as a pair:

Each pair simultaneously decides how to use the endowment every period. There are 2 possibilities:

- 1. You, as a pair, can allocate points to a group account.**
- 2. You, as a pair, can allocate points to a private account.**

¹ Instructions of the other three treatments are available from the author upon request.

For this purpose, each pair will be asked to indicate the number of points they want to allocate to the group account. The remaining points (40 minus their allocation to the group account) will be automatically allocated to their private account. The earnings of your pair depend on the total number of points in the group account and the number of points in your pair's private account.

How to calculate your earnings:

The earnings of your pair from the private account are equal to the number of points your pair allocates to the private account. That is, **for each point your pair allocates to the private account your pair obtains 1 point as earnings**. For example, the earnings of your pair from the private account equal 3 points if it allocates 3 points to it. The points your pair allocates to your private account do not affect the earnings of the other pair.

The earnings of your pair from the group account equal the **sum** of points allocated to the group account by your pair and the other pair multiplied by 0.8. That is, **for each point your pair allocates to the group account, your pair and the other pair each get 0.8 points as earnings**. For example, if the sum of points in the group account is 20, then your earnings from the group account and the earnings of the other pair each equal to 16 ($= 20 \times .8$) points.

In summary, your pair's earnings can be calculated with the following formula:

$$40 - (\text{points your pair allocates to the group account}) + 0.8 * (\text{sum of points allocated by your pair and the other pair to the group account})$$

You and your partner in your pair each obtain **half** of the earnings that your pair obtains in this period.

Note that your pair receives 1 point as earnings for each point your pair allocates to the private account. If your pair instead allocates 1 extra point to the group account, the earnings of your pair from the group account increase by $0.8 * 1 = 0.8$ points; and your pair's earnings from the private account decrease by 1 point. However, by allocating 1 extra point to the group account, the earnings of the other pair also increase by 0.8 points. Therefore, the total group earnings increase by $0.8 * 2 = 1.6$ points. Note that your pair also obtains earnings from points allocated to the group account by the other pair in your group. You obtain $0.8 * 1 = 0.8$ points for each point allocated to the group account by the other pair.

Example:

Suppose your pair allocates 15 points to the group account, and the other pair in your group allocates 20 points to it. In this case, the sum of points in the group account is $15 + 20 = 35$ points. Therefore, each pair obtains earnings of $0.8 * 35 = 28.0$ points from the group account.

The earnings of your pair in this case are: $40 - 15 + (28.0) = 53.0$ points. You and your partner each obtain $53/2 = 26.5$ points.

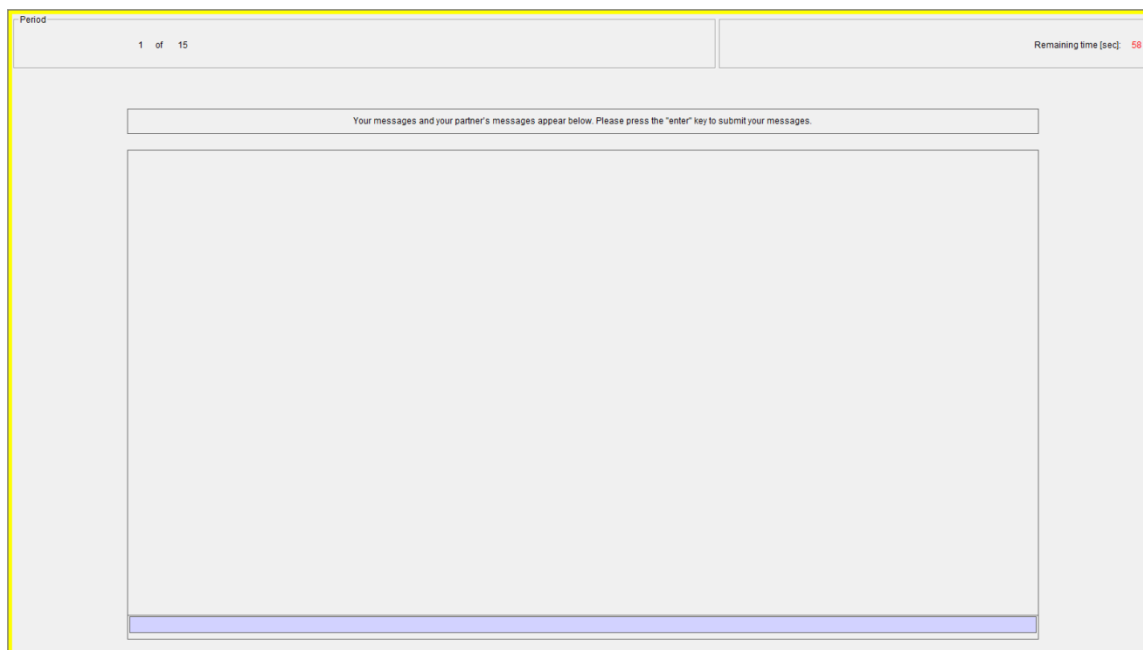
The other pair's earnings are: $40 - 20 + (28.0) = 48.0$ points. Thus, each person in this pair obtains $48/2 = 24$ points.

At the end of each period, you are informed of (1) the outcome of the allocation decisions along with (2) the information concerning the other pair's joint allocation amount.

How to decide allocation amounts in your pair:

At the beginning of each period, you and your partner in your pair have 1 minute to communicate using the computer to jointly decide the allocation amount for the period. Specifically, you can send any messages via a chat window as illustrated below. Although your partner sits next to you, you are not allowed to communicate during the entire experiment except this communication stage (via the computer screen).

An example of the computer screen:



In the communication stage, any kind of offensive language is prohibited. With a clear violation of this rule you will be deducted 10 dollars from your today's payment. Once the communication stage is over, you and your partner each submit your agreed joint allocation decision on your computer screen. In case that you do not agree what you allocate as a pair, you can submit whatever amount you prefer to allocate as a pair to your group account. If both you and your partner submit the same (agreed) amount, then the amount becomes your pair's joint allocation decision in this period. If you and your partner submit different amounts, then one of the two is randomly selected by the computer as your pair's joint allocation decision. Once both of you press the "OK" button to submit your pair's allocation decision, you will be informed of what allocation amount your partner submitted before you are informed of the outcome of the allocation stage in the period.

Summary:

At the onset of the experiment, you are paired with a person next to you. Your pair is randomly matched with another pair (2 individuals), forming a group of 4 individuals. The group assignment and your pairing do not change during the entire experiment; and you will play the following interactions 15 times with the 3 other participants. In each period,

(1) you and your partner in your pair communicate using a chat window to discuss how to allocate as a pair (you have one minute for this purpose);

(2) you and your partner in your pair each submit preferred (agreed) allocation amount of your pair. If you and your partner submit the same allocation amount, then the amount becomes your pair's joint allocation decision. If the allocation amount you submit is different from that your partner submits, then one of the two submitted allocation amounts is randomly selected by the computer. Once you and your partner submit your pair's allocation decision, you and your partner will be informed of what each of you submitted as your pair's joint decision.

(3) you will be informed of your pair's earnings in the period, along with the allocation decision of the other pair in your group. The earnings of your pair are dependent on (a) the number of points in your pair's private account and (b) the total allocation amounts to the group account by your pair and the other pair in your group. Your earnings in the present period are half of your pair's total earnings. See the equation on page 2 for how your pair's total earnings are calculated.

At the end of the experiment, you will be paid based on your accumulated earnings.

You may also be asked to answer some additional questions related to the experiment.

Please raise your hand if you have any questions. Once all questions have been answered, the experiment will begin.

Comprehension questions:

Please answer the following questions to check your understanding of the instructions. Please raise your hand if you have any questions.

1. Suppose that each of the 2 pairs in your group allocates 0 points to the group account.

a) How much does your pair earn? _____

b) How much do you earn? _____

c) How much does the other pair earn? _____

d) How much does each member in the other pair earn? _____

2. Suppose that each of the 2 pairs in your group allocates 20 points to the group account.

a) How much does your pair earn? _____

b) How much do you earn? _____

c) How much does the other pair earn? _____

d) How much does each member in the other pair earn? _____

3. Suppose that the other pair in your group allocates 20 points to the group account.

a) How much does your pair earn if your pair allocates 0 points to the group account? _____
In this case, how much do you earn? _____

b) How much does your pair earn if your pair allocates 20 points to the group account? _____
In this case, how much do you earn? _____

c) How much does your pair earn if your pair allocates 40 points to the group account? _____
In this case, how much do you earn? _____

Appendix B: Additional Tables

Table B.1: Period-by-period Average Contribution by Treatment

(1) Partner Treatments

Treatment name	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Period 7	Period 8	Period 9	Period 10	Period 11	Period 12	Period 13	Period 14	Period 15
I. Avg. Contribution															
a. I-P ^{#1}	25.9	24.7	17.8	15.3	13.7	13.1	13.9	16.1	12.7	11.7	11.3	13.1	13.8	10.9	7.4
b. J-P ^{#2}	28.8	30.3	32.2	32.1	31.9	32.2	32.1	31.9	32.4	33.7	33.8	32.5	32.5	28.8	17.5
II. Avg. Hypothetical Contribution Elicited Before the Communication Stage															
c. J-P ^{#3}	28.2	33.3	32.3	30.9	29.9	27.9	28.8	29.8	28.3	29.2	30.2	28.9	28.8	25.0	20.0
III. Group-level Mann-Whitney Tests															
H ₀ : a = b															
<i>p</i> -value (2-sided)	.749	.245	.020**	.017**	.022**	.027**	.039**	.045**	.015**	.019**	.014**	.031**	.031**	.049**	.226
H ₀ : a = c															
<i>p</i> -value (2-sided)	.568	.046**	.002***	.002***	.002***	.012**	.007***	.014**	.002***	.001***	.000***	.002***	.003***	.018**	.051*

(2) Stranger Treatments

Treatment name	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Period 7	Period 8	Period 9	Period 10	Period 11	Period 12	Period 13	Period 14	Period 15
I. Avg. Contribution															
a. I-S ^{#1}	17.5	18.1	16.1	16.3	15.0	11.6	11.6	12.8	13.6	12.3	14.0	11.4	5.3	6.5	5.9
b. J-S ^{#2}	30.9	30.0	28.4	25.3	26.9	23.8	25.4	25.9	22.6	22.0	15.9	17.1	10.0	6.8	8.2
II. Avg. Hypothetical Contribution Elicited Before the Communication Stage															
c. J-S ^{#3}	27.2	30.4	29.9	27.5	26.5	25.6	26.1	25.2	22.1	23.3	15.8	16.6	11.9	5.5	6.8
III. Group-level Mann-Whitney Tests															
H ₀ : a = b															
<i>p</i> -value (2-sided)	.029**	.020**	.073*	.154	.063*	.081*	.030**	.035**	.225	.140	.958	.751	1.000	.915	.825
H ₀ : a = c															
<i>p</i> -value (2-sided)	.019**	.004***	.003***	.026**	.026**	.006***	.004***	.009***	.083*	.023**	.849	.347	.450	.474	.549

Notes: Regression results measuring the average treatment effects of joint decision-making are found in Table 2 of the manuscript. ^{#1} The number of observations is 8 (= 4 groups × 2 sessions) in each period. ^{#2} The number of observations is 8 (= 4 groups × 2 sessions) in each period. ^{#3} The number of observations is 32 (= 16 subjects × 2 sessions) in each period.

*, **, and *** indicate significance at the .10 level, at the .05 level and at the .01 level, respectively.

Table B.2: Conditional Contribution Behavior by the Matching Protocol

Regression Results

Dependent variable: The contribution amount of pair (individual) i in period $t \in \{2, 3, \dots, 15\}$.

Independent Variable	Partner Treatments: J-P treatment versus I-P treatments		Stranger Treatments: J-S treatment versus I-S treatments	
	(1)	(2)	(3)	(4)
(i) The contribution amount made by the period $t - 1$ counterpart of pair (individual) i	.97*** (.16)	.70*** (.18)	.54*** (.089)	.37*** (.12)
Variable (i) \times Joint Decision-Making Dummy {= 1 for the J-P and J-S treatment; 0 otherwise}	----	.70*** (.25)	----	.32* (.12)
Constant	6.10 (7.14)	1.39 (6.55)	3.38 (4.51)	2.93 (4.35)
# of Observations	448	448	448	448
Log likelihood	-740.4	-736.7	-1098.6	-1096.8
Wald Chi-squared	35.21	43.54	36.13	39.39
Prob > Wald Chi-squared	.0000	.0000	.0000	.0000

Notes: Random Effects Tobit Regressions. The number of left(right)-censored observations is 139(190) in columns (1) and (2), and 155(96) in columns (3) and (4).

*, **, and *** indicate significance at the .10 level, at the .05 level and at the .01 level, respectively.

Results: Pairs in the J-P (J-S) treatments reciprocate their period $t - 1$ matched pairs in period t significantly more strongly (weakly significantly more strongly), compared with individuals in the I-P (I-S) treatment.

Appendix C: Additional Data for the Subjects' Reasoning

All subjects were asked to answer the following open-ended question: "On what basis did you make allocation decisions?" They answered privately using their computer terminals (The following comments are exactly what they wrote. We did not edit their responses. Each comment is by different subject.)

1. Partner Treatments

[J-P Treatment:]

"Whatever would maximize my points"

"Conversation with my partner."

"Maximum outcome"

"maximal payoff"

"Tried to get all point in group until last 2 rounds"

"I made allocation decisions based on what was best for the entire group until round 14 when I thought that allocating 0 was the best decision because they might try to play a trick on us and not allocate anything to the group."

"What could get me and my partner the maximum payout."

"earning the most money for my partner and i"

"I gave the other pair a chance to work together and they accepted so we just kept giving 40 to the group account and it was mutually beneficial."

"The main driver behind my allocation decision was maintaining cooperation between our group and the group with which we were paired. Although we could have made more profits by allocating less money to the group account, and thus being less cooperative, this would have led to a breakdown of our cooperative relationship and made the outcomes of each period completely unpredictable, which i believe would have led to less profits in the long run."

"Trying to get the most number of points in the end of the experiment as possible."

"I feel pretty generous, but I was weary at first. After the fourth round I was comfortable with putting in all the points"

"if both groups contribute 40, we will each get the most points"

"What I expected others to do. eventually felt failed by the people in the room bidding 0."

"We made decisions through group compromise and through what we thought the other group was going to do."

"greatest possible earnings"

“I decided to earn as many points as possible; even though I know the fact that the other pair will earn much.”

“Getting max points for both pairs”

“random chance”

“We made decisions based on what the other groups did in the past. Initially I wanted to put 40 in the group and hoped that the other group would too so we could both make the most money. But that didn't happen, so we had to be conservative to avoid making less than 20 points. Which was disappointing because we both could have been better off.”

“My partner and I both decide together.”

“At first, I put in a small amount and waited to see what the other pair put before making future decisions. Since they put in 40, I increased the number of points I put in to 40 for the next two times, but they started putting 0 every time. After that, I mostly just put 0 every time because the other pair was not contributing to the group account.”

“Mathematically. Group outcome was higher if we all pooled in, and assumption that they would be smart enough to do the same.”

“I wanted to make the most amount of money.”

“Best outcome for the group leading to a larger expected outcome for everyone”

“We wanted stability between my pair and the other pair....largest group fund seemed like the best decision. Yes, American dollars with the group fund took a hit of 0.8 compared to personal points keeping their actual value but in the end, group account being highest seemed the best”

“I agreed early with my partner that we want the other pair to continue allocate high amounts between 30 and 40, so we allocate 35-40 points.”

“We first started with establishing a sense of trust, so the other team bid higher throughout the 15-round period. We knew that since we weren't randomly assigned, this would be key. so, we bid high, and continued to bid high once the other team did the same (they caught onto our plan quickly).”

“Well the first round was mainly to get a better idea of what the group was thinking, so we only gave 20. But then once we say that they did 40, we immediately decided to do the same.”

“based on the other pair's decision. if they are not selfish and contribute to the group account, I'd do the same too.”

“Based on my partners, and other pair's previous decisions.”

“building trust, mirroring their actions, worried about last round good faith or psychopath leveraging”

[I-P treatment:]

“basis on the result”

“I accepted 20 points per round gladly and put all of my points into my private account and let my counterpart put money into the group account for me.”

“After completing the worksheet, I had a better understanding of how much I would earn depending on different allocations. I started using one of the higher risk, more beneficial strategies and allocated half of my points to the group. However, when I saw that others weren't reciprocating, I changed my allocations to 0.”

“Initially tried to allocate all of my points into group account, but when partner did not cooperate after ~5 rounds, I decided to allocate all my points to my private account”

“wanted to see what the other person decided and then attempted to match it”

“In the beginning, I wanted to allocated as many points to the group account for a mutual benefit”

“I tried to contribute to the group fund originally, but my partner wasn't contributing anything so I maximized my benefit by keeping all of my points”

“My intuition”

“I based my decisions partly on my partner's decisions and the fact that I would get more points if my partner and I both allocated to the group account, but more points individually if i allocated all to my private account”

“On first it was kind of random, but towards the end there was a range that the allocations fell to and I just followed along with that.”

“what numbers that I tried produced the most amount of total earnings and I repeated those numbers”

“I made full allocations to group pool for first three rounds, when it became apparent that my partner was unwilling to do the same I withdrew my allocations to the group pool on principal.”

“Solve the optimization problem - balance individual earnings with group earnings”

“what would maximize my earnings”

“Based on my trust that the other person would allocate all resources to group account.”

2. Stranger Treatments

[J-S Treatment:]

“Started off near the midpoint and adjusted from there based on how the rounds were going”

“partner”

“If both pairs gave 40 points to the group, each individual would maximize their total points.”

“We picked 40 and went with it”

“To generate the greatest level of earnings”

“40 was a mutual benefit to the most people and thus the best choice”

“The most is to be gained if everyone gives all, so we gave all.”

“Share the profits to start in order to gain trust, and then take it all when either everyone is trusting or everyone is doing the same thing you are.”

“previous interactions”

“jesus”

“\$\$\$”

“at first trying to get people to play towards getting the best outcomes for both pairs. then once groups seemed to be playing for the good of the team, took advantage towards last few rounds to try to maximize our pair's gains.”

“discuss with pair partner”

“Came to agreement with partner.”

“PLAYING IT SAFE”

“Logic? It was the best decision to hold on to as many points as possible”

“After pairing up with the first couple of teams, we noticed not many people were pushing for 40 in fear of losing points. So, we chose a decision lower every time.”

“I wanted to balance out making the most with giving some up to keep everyone from "going negative" very early on. I guess just undercut people a tiny bit while keeping overall contributions high.”

“Tried to comply with my paartner”

“luck”

“Me and my partner both started out with 15 so we agreed to put in 15 majority of the time.”

“based on what I thought others would do”

“tested the highs and lows, then decided it was more interesting to choose at random”

“Whatever my partner and I felt like doing is what we did. We agreed on basiclaly every round, until finally we decided to both enter random #s and let the computer choose!”

“Upon discussing with my partner and then get our compromise and also evaluating from the previous rounds.”

“I wanted to try to get as close to a dollar earning each round without risking too much.”

“My partner and I based our decisions on what the general trend of the group was.”

“Based on previous rounds and the opinions of my partner”

“discussion with partner”

“I wanted to spread a generosity ethos.”

[I-S treatment:]

“my earnings”

“At first I allocated 40 to the group account, but people were not allocating much to the group, so I started allocating 0 to the group and 40 to private account.”

“Began with the best thing for both of us (allocating most or all), when I saw they weren't doing the same I moved to allocating nothing”

“I knew to get the optimal amount of points, both people would have to allocate 40 points to make it 80, which would give both of us 32 points.”

“Figuring out what would be the maximum for both persons”

“depending on previous round decisions”

“Based on previous results”

“I picked 0 every time.”

“Based on former decision of my partner”

“To make the most money”

“I tried to see how the numbers were changing and tried to put values that would give me the biggest number.”

“I went in a pattern. So I started at 20 and then went down in increments of 5 to zero and once I reached zero I started from 20 again but instead went up in increments of 5. I repeated this process until the experiment was finished.”

“I wanted to maximize my points by putting 20 points in the group account expecting that the other person would also put 20 points. But when after a few rounds the other person started allocating 0 points I started allocating 0 points to the group account to assure myself at least 20 points in each round. I knew that both can get 32 points by putting 40 each in the group account but no one was really doing that so I stuck to putting 0 points to the group account”

“random and feeling”

“because the experiment was anonymous, there were no negative repercussions for putting in 0 just about every time, whatever anybody else put into the group was simply my gain”

“Whether or not my last earnings were high or low, if I should allocate more or less to the group account.”

Appendix D: The Additional Treatments – Instructions for the I-P-Punishment treatment

The following are instructions for the I-P-Punishment treatment.²

Instructions

You are now taking part in a decision-making experiment. Depending on your decisions and the decisions of other participants, you will be able to earn money in addition to the \$5 guaranteed for your participation. Please read the following instructions carefully.

During the experiment, you are not allowed to communicate with other participants. If you have a question, raise your hand. One of us will come to answer your question.

During the experiment, your earnings will be calculated in points. At the end of the experiment, points will be converted to U.S. dollars at the following rate:

1 point = 3.6 cents

(This means that around 27.8 points will be exchanged for 1 dollar of real money). At the end of the experiment your total earnings (including the \$5 for participation) will be paid out to you in cash.

In the experiment, all participants are randomly divided into **groups of 2 individuals**. This means that you are in a group with another participant. **You will be part of the same group throughout the entire experiment**. No one knows which participant is in their group, and no one will be informed who was in which group after the experiment.

This experiment has 15 periods. In each period, each group member, yourself included, will be given an **endowment of 40 points**. You will then make an allocation decision based on the endowment and reduction decision.

Your first decision:

You and your counterpart simultaneously decide how to use the endowment. There are 2 possibilities:

- 1. You can allocate points to a group account.**
- 2. You can allocate points to a private account.**

For this purpose, you will be asked to indicate the number of points you want to allocate to the group account. The remaining points (40 minus your allocation to the group account) will be automatically

² Instructions of the I-S-Punishment treatment are available from the author upon request.

allocated to your private account. Your earnings depend on the total number of points in the group account and the number of points in your private account.

How to calculate your earnings:

Your earnings from your private account are equal to the number of points you allocate to the private account multiplied by 0.5. That is, **for each point you allocate to the private account you get 0.5 points as earnings**. For example, your earnings from your private account equal 2 points if you allocate 4 points to it. The points you allocate to your private account do not affect the earnings of your counterpart.

Your earnings from the group account equal the **sum** of points allocated to the group account by you and your counterpart multiplied by 0.4. That is, **for each point you allocate to the group account you and your counterpart each obtain 0.4 points as earnings**. For example, if the sum of points in the group account is 20, then your earnings from the group account and your counterpart's earnings from the group account each equal to 8 ($= 20 \times .4$) points.

Your earnings can be calculated with the following formula:

$$0.5 * \{40 - (\text{points you allocate to the group account})\} \\ + 0.4 * (\text{sum of points allocated by you and your counterpart to the group account})$$

Note that you get 0.5 points as earnings for each point you allocate to your private account. If you instead allocate 1 extra point to the group account, your earnings from the group account increase by $0.4 * 1 = 0.4$ points and your earnings from your private account decrease by 0.5 points. However, by allocating 1 extra point to the group account, the earnings of your counterpart also increase by 0.4 points. Therefore, the total group earnings increase by $0.4 * 2 = 0.8$ points, which is greater than 0.5. Note that you also obtain earnings from points allocated to the group account by your counterpart. You obtain $0.4 * 1 = 0.4$ points for each point allocated to the group account by your partner.

Example:

Suppose you allocate 15 points to the group account and your counterpart allocates 10 points to the group account. In this case, the sum of points in the group account is $15 + 10 = 25$ points. Thus, each group member obtains earnings of $0.4 * 25 = 10.0$ points from the group account.

Your earnings are: $0.5 * \{40 - 15\} + (10.0) = 22.5$ points.

Your counterpart's earnings are: $0.5 * \{40 - 10\} + (10.0) = 25.0$ points.

Your earnings might be reduced by the decisions of your counterpart in the next stage explained below.

Your second decisions:

Once everybody reviews the outcome of the allocation stage and clicks the “Continue” button, each member is given an opportunity to reduce their counterpart’s earnings at their cost. Your earnings **decrease by 0.5 points** for each reduction point you assign to your counterpart; but, by doing so, **1.5 points will be deducted from the earnings of your counterpart**. Your earnings could also be reduced by your counterpart. For each reduction point you receive from your counterpart, your earnings will decrease by 1.5 points. If you don’t want to reduce the earnings of your counterpart, you can assign 0 reductions points to him or her.

There are some restrictions for your reduction decisions in this stage. First, your reductions given to your counterpart cannot make their earnings in the present period less than zero. However, each member incurs the cost of giving reduction points to their partner. As a result, you may obtain negative earnings (see the formula of calculating your earnings below for details). If you receive negative earnings, these points will be deducted from your earnings in other periods. Second, your reduction points must be integers between 0 and 20. After this stage, your earnings are calculated as:

Part 1: Earnings from the allocation stage minus $1.5 \times$ reductions given by your counterpart, or 0 if it is negative

-- minus --

Part 2: $0.5 \times$ Reduction points you assign to reduce the earnings of your counterpart

Note that you incur the cost in Part 2 even if it causes your net earnings for the period to be negative.

At the end of each period, you are informed of (a) the number of reduction points you received from your counterpart along with (b) your final earnings in the period.

At the end of the experiment, you will be paid based on your accumulated earnings over the 15 periods.

Please raise your hand if you have any questions. Once all questions have been answered, the experiment will begin.

Comprehension questions:

Please answer the following questions to check your understanding of the instructions. Please raise your hand if you have any questions.

1. Suppose you and your counterpart allocate 0 points to the group account.

a) How many points do you have after the allocation stage? _____

b) How many points does your counterpart have after the allocation stage? _____

2. Suppose you and your counterpart allocate 20 points to the group account.

a) How many points do you have after the allocation stage? _____

b) How many points does your counterpart have after the allocation stage? _____

3. Suppose your counterpart allocates 20 points to the group account.

a) How many points do you have after the allocation stage if you allocate 0 points to the group account?

b) How many points do you have after the allocation stage if you allocate 20 points to the group account?

c) How many points do you have after the allocation stage if you allocate 40 points to the group account?

4. Answer the following questions.

a) How much does it cost you if you assign 4 reduction points to your counterpart? _____

b) How many points are deducted from your counterpart's earnings if you assign 4 reduction points to her? _____

Appendix E: The Additional Treatments – Basic Data (The I-P-Punishment and I-S-Punishment treatments)

Table E.1: Period-by-period Average Contributions

(1) Partner Treatments

Treatment name	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Period 7	Period 8	Period 9	Period 10	Period 11	Period 12	Period 13	Period 14	Period 15
I. Avg. Contribution															
A. I-P ^{#1}	25.9	24.7	17.8	15.3	13.7	13.1	13.9	16.1	12.7	11.7	11.3	13.1	13.8	10.9	7.4
B. J-P ^{#2}	28.8	30.3	32.2	32.1	31.9	32.2	32.1	31.9	32.4	33.7	33.8	32.5	32.5	28.8	17.5
C. I-P-Punishment ^{#3}	27.2	31.9	34.7	30.8	29.0	30.6	34.1	33.7	33.3	33.4	31.9	32.8	31.7	31.7	30.6
II. Group-level Mann-Whitney Tests															
H ₀ : A = C															
<i>p</i> -value (2-sided)	.8058	.1429	.0028***	.0256**	.0628*	.0247**	.0103**	.0146**	.0183**	.0067***	.0150**	.0238**	.0395**	.0201**	.0057***
H ₀ : B = C															
<i>p</i> -value (2-sided)	.6947	.5873	.6365	.8388	.9167	.5661	.9141	.6766	.9103	.9101	.6757	.8576	.8109	.7782	.0858*

(2) Stranger Treatments

Treatment name	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Period 7	Period 8	Period 9	Period 10	Period 11	Period 12	Period 13	Period 14	Period 15
I. Avg. Contribution															
A. I-S ^{#1}	17.5	18.1	16.1	16.3	15.0	11.6	11.6	12.8	13.6	12.3	14.0	11.4	5.3	6.5	5.9
B. J-S ^{#2}	30.9	30.0	28.4	25.3	26.9	23.8	25.4	25.9	22.6	22.0	15.9	17.1	10.0	6.8	8.2
C. I-S-Punishment ^{#4}	20.1	20.0	19.2	18.7	20.8	19.6	20.3	23.3	21.4	24.6	23.4	20.9	25.4	23.9	19.1
II. Group-level Mann-Whitney Tests															
H ₀ : A = C															
<i>p</i> -value (2-sided)	.5215	.8323	.3417	.4913	.3041	.0352**	.0449**	.0655*	.1138	.0307**	.0922*	.0345**	.0009***	.0015***	.0232**
H ₀ : B = C															
<i>p</i> -value (2-sided)	.0135**	.0558*	.0288**	.2194	.3019	.4349	.3263	.5966	.8441	.6778	.2527	.5885	.0121**	.0013**	.0560*

Notes: ^{#1} The number of observations is 8 (= 4 groups × 2 sessions) in each period. ^{#2} The number of observations is 8 (= 4 pairs × 2 sessions) in each period.

^{#3} The number of observations is 9 (= 5 groups in one session + 4 groups in the other session) in each period. ^{#4} The number of observations is 8 (= 4 groups × 2 sessions) in each period.

*, **, and *** indicate significance at the .10 level, at the .05 level and at the .01 level, respectively.

Table E.2: Period-by-period Average Payoffs

(1) Partner Treatments

Treatment name	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Period 7	Period 8	Period 9	Period 10	Period 11	Period 12	Period 13	Period 14	Period 15
I. Avg. Contribution															
A. I-P ^{#1}	27.8	27.4	25.3	24.6	24.1	23.9	24.2	24.8	23.8	23.5	23.4	23.9	24.1	23.3	22.2
B. J-P ^{#2}	28.6	29.1	29.7	29.6	29.6	29.7	29.6	29.6	29.7	30.1	30.1	29.8	29.8	28.6	25.3
C. I-P-Punishment ^{#3}	28.1	29.6	30.4	29.2	28.7	29.2	30.2	30.1	30.0	30.1	29.6	29.8	29.5	29.5	27.5
II. Group-level Mann-Whitney Tests															
H ₀ : A = C															
<i>p</i> -value (2-sided)	.8058	.1429	.0028***	.0256**	.0628*	.0247**	.0103**	.0146**	.0183**	.0067***	.0150**	.0238**	.0395**	.0201**	.0108**
H ₀ : B = C															
<i>p</i> -value (2-sided)	.6947	.5873	.6365	.8388	.9167	.5661	.9141	.6766	.9103	.9101	.6757	.8576	.8109	.7782	.1188

(2) Stranger Treatments

Treatment name	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Period 7	Period 8	Period 9	Period 10	Period 11	Period 12	Period 13	Period 14	Period 15
I. Avg. Contribution															
A. I-S ^{#1}	25.3	25.4	24.8	24.9	24.5	23.5	23.5	23.8	24.1	23.7	24.2	23.4	21.6	22.0	21.8
B. J-S ^{#2}	29.3	29.0	28.5	27.6	28.1	27.1	27.6	27.8	26.8	26.6	24.8	25.1	23.0	22.0	22.5
C. I-S-Punishment ^{#4}	23.9	25.1	22.9	24.4	24.1	23.6	25.5	26.0	24.4	25.6	22.9	23.9	27.1	26.6	21.4
II. Group-level Mann-Whitney Tests															
H ₀ : A = C															
<i>p</i> -value (2-sided)	.7087	.5982	.6728	.9578	.8715	.7520	.1394	.1553	.7518	.2691	.7926	.1706	.0016***	.0061***	.6330
H ₀ : B = C															
<i>p</i> -value (2-sided)	.0191**	.0346**	.0200**	.0917*	.1843	.1709	.2926	.3424	.5280	.6337	.9162	.9580	.0353**	.0061**	.7087

Notes: ^{#1} The number of observations is 8 (= 4 groups × 2 sessions) in each period. ^{#2} The number of observations is 8 (= 4 pairs × 2 sessions) in each period.

^{#3} The number of observations is 9 (= 5 groups in one session + 4 groups in the other session) in each period. ^{#4} The number of observations is 8 (= 4 groups × 2 sessions) in each period.

*, **, and *** indicate significance at the .10 level, at the .05 level and at the .01 level, respectively.