Partner Selection in Public Goods Experiments

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The effect of introducing costly partner selection for the voluntary contribution to a public good is examined. Participants are in six sequences of five rounds of a two-person public good game in partner design. At the end of each sequence, they can select a new partner out of six group members. Unidirectional and bidirectional partner selection mechanisms are introduced and compared to controls with random partner rematching. Results demonstrate significantly higher cooperation in correspondence to unidirectional partner selection than to bidirectional selection and random rematching. Average monetary effort for being able to choose a partner is substantially high and remains stable.

Keywords: *public goods; partner selection; experimental economics*

Mounting evidence about reciprocal behavior in various social interactions (Andreoni 1988; Isaac and Walker 1988; Fehr and Gächter 2000) suggests that the usually observed decline of contributions in public goods experiments is due mainly to the influence of low contributors and reciprocal reaction of cooperators. In repeated public goods experiments, participants usually start contributing a large proportion of their endowment and then drastically reduce their contribution during subsequent interactions. When starting over with a new sequence of repeated public good games, average contributions typically rise again substantially before they decrease, which is commonly referred to as the restart effect. These phenomena are robust against variations of the game, for example, group size, marginal per capita return, or partner and

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stranger design (e.g., Andreoni 1988; Ledyard 1995; Croson 1996; Andreoni and Croson forthcoming). They indicate that the decline in contributions is due not to learning the incentive structure of the game but to reciprocity. This means that "in response to friendly actions, people are frequently much nicer and much more cooperative than predicted by the self-interest model; conversely, in response to hostile actions they are frequently much more nasty and even brutal" (Fehr and Gächter 2000, 159).

To address this conjecture, Gunnthorsdottir et al. (2001) sorted participants in a public good experiment into high, middle, and low contributors based on their initial contribution. During the course of the experiment, highly cooperative individuals who interacted repeatedly with similar types sustained high cooperation with only little decline, whereas participants in the less cooperative group continued to free ride. This evidence impressively confirms the hypothesis that heterogeneity of individuals and reciprocity are the major driving forces of poor efficiency in privately providing public goods. The evidence gives rise to the idea that specific regrouping might improve the sustainment of cooperation.

That people are often able to choose their interaction partners in daily life can be considered an endogenous regrouping device, which is also an effective way to escape exploitation. Indeed, people frequently change or quit relationships with individuals who are not fulfilling the expected cooperative standards and look out for better opportunities, even if this involves substantial costs. Economic examples are various; producers, for instance, break off established relationships and switch to different suppliers, managers lay off and recruit employees for work teams, families migrate to better districts or neighborhoods, and even sports teams spend huge amounts of money to purchase their future team members.

The main object of the present study is to investigate whether endogenous regrouping involving self-determined cost is effective in raising the voluntary contribution to a public good. We provide participants with the opportunity to select their future interaction partner in a two-person public good game and employ two plausible selection mechanisms—unidirectional and bidirectional. Cooperative behavior in these two treatments of partner selection is compared to control treatments with random rematching. Evidence indicates an increase in cooperation, particularly with unidirectional partner selection compared to the control treatments. Despite theoretical predictions, the monetary effort for choosing a partner is substantial, highlighting the importance of deliberately establishing and quitting particular relationships.

The study is organized as follows: the second section reviews related literature, especially experimental studies on endogenous regrouping in social dilemma situations and summarizes again our research agenda. The third section proceeds with an illustration of the design and procedure of our experiment, and the fourth section reports the findings. The final section concludes the study with a brief discussion.

RELATED LITERATURE

In the economic literature, Tiebout (1956) was the first to propose local governments and the "freedom to move/choose" to overcome the conclusion of Musgrave

(1939) and Samuelson (1954) that no market solution for public good provision at the central level can be found. Migration, thus, can solve the problem of efficient public provision of collective goods.[1] In particular, the larger the number of communities, the higher the opportunity of heterogeneous agents to find the community that best fulfills their preferences, which pertain to economic and noneconomic variables, such as the desire to associate with "nice people" (Tiebout 1956, 418). In the context of a public good game, nice people are those who increase the group benefit by prosocial behavior (Fehr and Gächter 2000).

Ehrhart and Keser (1999) tried to reproduce an experimental environment that corresponds to the world depicted by Tiebout (1956). Participants were free to move to or create a new community (group) at a small fixed cost, based on the information about average group contributions and the history of per capita returns from the public good in each group. The standard Nash-solution of the game is to contribute nothing and never incur the cost of switching or creating a group, but results of this experiment demonstrate significantly higher average contributions compared to standard public good experiments and frequent migration across groups. Especially, cooperators tried to escape free riders who in turn attempted to "chase" the former. Although the findings seem convincing, economic incentives to contribute to the public good repeatedly change with group size. The individual return from the contribution to the public good decreases in group size, but the social benefit increases. These opposing dynamics render it difficult to disentangle the effects of the change in group size and the freedom to move.

By using the standard voluntary contribution mechanism in a public good experiment with group sizes of four, Page, Putterman, and Unel (2002) investigated endogenous regrouping. Based on the information about past average contributions of their fellows, participants were asked to rank others, expressing their desire to be matched together, whereby a small fixed amount was charged for each rank. According to an algorithm that calculated mutual rank assignments, participants were assigned to new groups of four. Average contributions in the regrouping condition were significantly higher than in the baseline, and the vast majority of participants chose to rank at least once in the experiment. In the baseline treatment, however, participants repeatedly interacted in the same group throughout the experiment and thus lacked potential restart effects, which might already trigger the results in favor of higher efficiency with endogenous regrouping.

Hauk and Nagel (2001) experimentally studied a finitely repeated prisoner's dilemma game with two different partner selection mechanisms. Participants could choose to take an outside option, which gave them a payoff higher than the one received when being exploited, or to enter the game, where they had to play with a partner who had been unilaterally or mutually selected. In the unilateral treatment, the decision of one of the two potential partners to enter was enough to play the game, whereas in the mutual treatment both had to agree. Results of this experiment suggest that unilateral partner selection is more effective in lowering defection and increasing the proportion of unconditional cooperators in comparison to mutual selection.

1. Tiebout's model is concerned with the public provision of public goods. Glomm and Lagunoff (1998), for instance, propose an extension of the model to private provision of public goods.

The importance of investigating the freedom to choose interaction partners in social dilemma situations has been endorsed previously (e.g., Hayashi and Yamagishi 1998). However, little attention has yet been paid to the question whether cooperative behavior is sensitive to the institutional design of choosing the interaction partner. Furthermore, to the best of our knowledge, until now no attempt has been made to elicit subjective valuation of being able to choose the interaction partner. Both issues are addressed in our study.

EXPERIMENTAL DESIGN AND PROCEDURE

Aside from concentrating on the two main topics above, the experimental design attempts to cover two methodological concerns. First, in contrast to Page, Putterman, and Unel (2002), our control treatments comprise random rematching of participants with the same frequency as partner selection in the experimental treatments, thereby testing whether mere restart effects already account for the possible efficiency increase found in their study. Second, providing the opportunity to select an interaction partner requires publicizing the past behavior of participants. The prospect of having such information announced may alone trigger more cooperative behavior. Thus, to disentangle this reputation effect from the efficacy of partner selection, we additionally consider a control treatment without revealing past behavior.

In general, our experiment comprises six sequences of a five-round public good game in which participants interact repeatedly with the same partner. At the end of each sequence, new pairs are formed within a constant group of six participants. Participants are identifiable by a unique code (ID) from “A” to “F” that is once randomly assigned to group members for the whole experiment. Rematching of participants into pairs is done either randomly (two control treatments) or endogenously (two experimental treatments). In the first experimental treatment, endogenous rematching is based on a unidirectional selection mechanism (unidirectional), whereas in the second treatment it resembles a mechanism based on two-sided selection (bidirectional). In the two control treatments (random partner rematching and random partner rematching without history), partners are randomly determined at the beginning of each sequence. In each treatment, participants are aware of participating in a finitely repeated public good experiment with the same partner during one sequence but possibly another partner out of the group of six in other sequences. The particular partner rematching mechanism is explained in detail before the experiment starts.

THE TWO-PERSON PUBLIC GOOD GAME

In each round, participants receive an endowment of 25 experimental currency units (ECU).[2] Each participant can contribute part or all of his or her endowment to a public good and receive a constant marginal return of 0.8 from each ECU invested. The decision about the contribution to the public good is made simultaneously. At the end

2. The exchange rate to Euro is 100:1, that is, 100 experimental currency units (ECU) correspond to 1 Euro.

of each round, participants receive feedback about the total amount contributed to the public good by both partners and their payoff in this round. The individual payoff π_i is the following:

$$\pi_i^t = (y_i^t - g_i^t) + a\sum_{i=1}^{n} g_i^t \quad \text{with } n = 2,\ a = 0.8, \tag{1}$$

whereby y_i^t is the endowment in each round, g_i^t is the amount contributed to the public good by Participant i, and $\sum_i^n g_i^t$ is the sum of contributions of the two partners. Following the backward induction rationale, zero contribution is the only strategy that survives repeated elimination of dominated strategies in this finite game, whereas the socially efficient outcome is achieved when both partners contribute their entire endowment. Although the parameters of the public good games are constant for all treatments, partner rematching mechanisms and information provided at the end of each sequence vary between treatments.

ENDOGENOUS PARTNER SELECTION TREATMENTS

In both endogenous partner-selection treatments, participants receive a fixed amount of 100 ECU that can be used for partner selection. Each ECU that is not invested in partner selection is added to the payoff. Again, applying the backward induction rationale, a contribution of zero and hence no investment in the partner-selection mechanism is the only strategy that survives repeated elimination of dominated strategies. However, by employing partner selection, we want to explore individuals' evaluation of the opportunity to choose a partner instead of being randomly paired.

Unidirectional partner selection. In the treatment with unidirectional partner selection, participants can use their endowment of 100 ECU for bidding in a two-stage, second-price auction for the right to choose their preferred partner.

At the end of a sequence of public good games, that is, after five rounds, participants receive information about each group member's past contributions to the public good and the matching of the respective pairs. Then, participants are asked to submit a ranking of the other five group members according to their preference of being paired. Afterwards, they can bid any amount between 0 and 100 ECU on the right to choose their partner for the next sequence of public good games.

The winner, who bids the highest amount, pays a price that corresponds to the second highest bid and is entitled to choose any of the other five group members. Once the first pair has been determined, a second stage, including only the four remaining group members, follows with the same auction mechanism as before. Their identification codes and matching are again displayed together with the past contributions. The winner of the second auction, who pays the second highest bid, chooses then one of the three available participants as his or her partner, and the last pair is residually determined from the two remaining members.

Bids that do not win are not deducted from participants' final earnings. In case of ties in the winning bid, the winner is randomly chosen from among those involved. If there is no positive bid, the partner rematching is done randomly, which is eventually announced to the participants. Before starting the next sequence, the ID of the new partner is displayed on screen.

Bidirectional partner selection. As in the unidirectional treatment, information on past contributions and the matching of group members is publicized after each sequence. Participants are then asked to allocate their endowment according to their willingness to find a new partner. Participants can either keep the whole amount of 100 ECU, adding to their payoff, or allocate positive amounts to one or more of the group members. Assigned amounts are only deducted from the endowment but not added to any person's payoff.

Once everyone has decided on the allocation of amounts, the computer rematches participants into pairs according to the principle of maximizing the auctioneer's revenue by using the following algorithm: for each possible combination of pairs within the group of six, mutual assignments of points are calculated and summed up. Subsequently, the specific combination of pairs that maximizes the sum of mutual assignments is selected for implementation.[3] Mutual agreement is granted when two participants allocate the entire available amount to each other, because, in this case, they will surely end up together.[4] Assigning positive amounts to more than one group member enables participants to state their ranking of group members or to express their preference in case of indifference between participants.

If nobody allocates a positive amount, or if everyone allocates the same amount to everyone else, random matching is announced and employed. Before entering the next sequence, participants learn the ID of their new partner.

The bidirectional partner-selection mechanism is designed to ensure maximum comparability with the unidirectional mechanism: participants are endowed with the same initial amount of 100 ECU that can be spent on partner selection, assigned amounts are collected by the auctioneer, and rankings of preferred partners are implicitly possible. Also, game theoretically, the two mechanisms yield the same equilibrium solution of zero monetary effort for partner selection.

RANDOM PARTNER-REMATCHING TREATMENT

In the first control treatment, participants are randomly rematched into pairs. However, the information about group members received at the end of each sequence is the

3. This procedure resembles a simultaneous centralized clearinghouse mechanism. Empirical and experimental results (see Roth 2002) show that simultaneous mechanisms of this type produce stable matchings, compared to those in which mutually most preferred pairs are sequentially excluded (defined as priority matching mechanisms). Stable matchings are feasible when the mutual allocation of two partners is greater than any single allocation from a nonpreferred group member addressed to one of the partners. Therefore, stability is always ensured when two participants allocate their entire endowment to each other. Indeed, if a participant has a strict preference for or against a potential partner, he or she has the incentive to allocate part or all of the endowment to avoid random matching.

4. For this reason, it is necessary to provide a fixed amount of extra endowment to everyone.

same as in the two experimental treatments, that is, past contributions of each group member and the matching of group members. The timing of this information screen is self-paced; participants can decide when to exit the screen by pressing a button. Once all group members have exited the information screen, 180 seconds pass before the next sequence starts. This period of time, called the cooling off period, has been introduced to induce a time interval between each sequence of the experiment similar to the interval in the treatments with partner selection. Before entering the new sequence, the ID of the new partner is displayed.

RANDOM PARTNER-REMATCHING TREATMENT WITHOUT HISTORY

The second control treatment is identical to the first one with one major exception: at the end of each sequence, information on past contributions of group members is not provided, but the matching of participants is revealed. Previous experimental evidence about the augmenting effect of providing information about individual contributions on cooperation is ambiguous (e.g., see Sell and Wilson 1991, Weimann 1994). In this treatment, however, general reputation effects by disclosing the contribution histories of group members cannot affect behavior. By comparing the two control treatments, we are able to determine whether these general reputation effects are already a major source of increasing cooperation and whether they might even be more important than introducing partner selection (in case there was no difference in the results between the random partner-rematching treatment and the experimental treatments). However, this speculation cannot be confirmed.

EXPERIMENTAL PROCEDURE

At Jena University, 144 students from various disciplines volunteered to participate. The 59 males and 85 females ranged in age from 18 to 50 ($M = 23.35$, $SD = 3.71$). Participants were invited by way of a mailing list or personal recruitment on campus to take part in a decision experiment. The experiment was computerized, using *z*-tree (Fischbacher 1999), in the experimental laboratory of the Max Planck Institute for Research into Economic Systems. It was conducted in one session with 24 participants and one session with 12 participants for each treatment. Each session lasted for about 70 minutes, and average earnings amounted to 14.9 Euros ($SD = 2.3$), including a show-up fee of 2.50 Euros.

Figure 1 displays the sequence of events in the experiment. After reading the instructions and answering control questions, which were checked privately by the experimenters, participants in all treatments started with the first sequence of a five-round, public good game in randomly matched pairs. Afterwards, the respective rematching procedure (random or endogenous) was applied, subsequent to receiving information on the matching of pairs (in all treatments) and either learning the contribution history of group members (random rematching, unidirectional selection, bidirectional selection) or not (random rematching without history). At the beginning of the next sequence of public good games, participants had to confirm that they had read the identification code of their new partner on screen. The procedure of partner

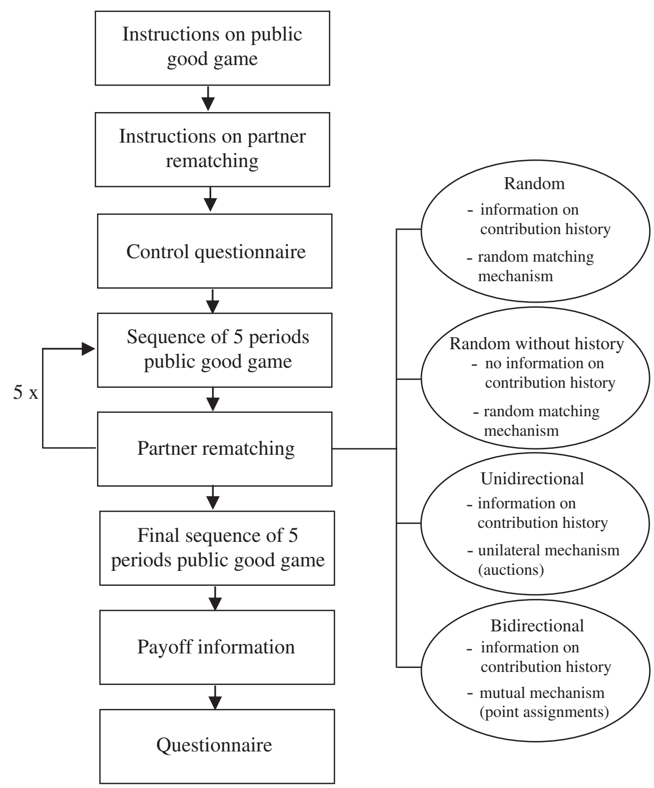


Figure 1: Sequence of Events in the Experiment

rematching was repeated five times, concluding with a final sequence of public good games. After completing a short socioeconomic questionnaire, participants were paid privately.

RESULTS

This section begins with some descriptive results and subsequently tests for differences between endogenous and random partner rematching on the aggregate, with respect to increases in cooperation due to endogenous rematching mechanisms and qualitative differences in contribution behavior. Finally, evidence about the monetary effort on partner selection and patterns of individual behavior is presented.

CONTRIBUTION BEHAVIOR

Partner selection and random partner rematching compared. Figure 2 displays the average contribution to the public good over time for the two experimental treatments

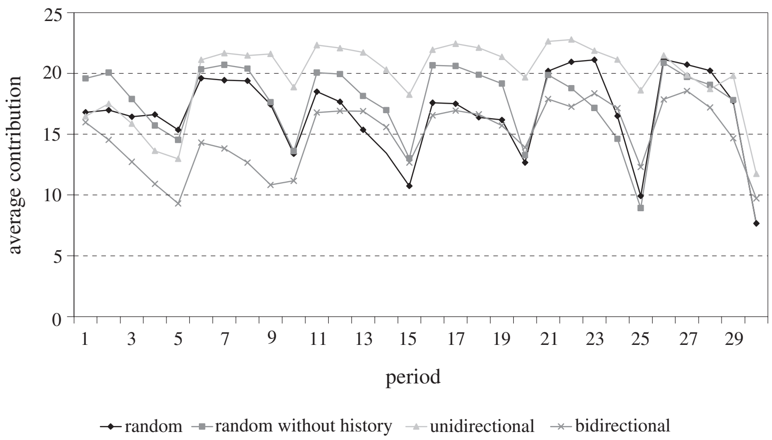


Figure 2: Average Contribution to the Public Good over Time

(unidirectional and bidirectional) and the two control treatments (random rematching and random rematching without history). A Kruskal-Wallis test rejects the hypothesis of equivalence between the mean contributions over time for the four treatments, $\chi^2(3) = 35.58$, $p < .01$.

When comparing the two control treatments, we cannot reject the hypothesis of equivalence of sample means[5] ($M_R = 16.79$, $SD_R = 4.27$, $M_{RwH} = 17.55$, $SD_{RwH} = 3.23$; robust rank order test: $\grave{U}_{m=n=6} = 0.22$, $p > .10$).[6] Furthermore, Figure 2 and separate tests for each phase reveal no substantial difference between the two patterns of contributions at any time during the experiment.[7] This indicates that the reputational effect of publicizing the contribution histories plays only a minor role.

Result 1: Voluntary contribution to the public good is not affected by revealing individual contribution histories.

To answer the question whether the freedom to choose a partner significantly increases inclination to contribute to a public good, we start by testing the differences between the endogenous selection treatments and the random partner-rematching treatment.[8]

5. For all subsequent tests, we consider six independent observations for each treatment—one for each group of six participants.

6. Critical values for the robust rank order test are obtained from Siegel and Castellan (2000) and are available only for p values of .10, .05, .025, and .01.

7. Only in sequence 5 are contributions in the random rematching treatment marginally higher than in the random selection treatment without history ($\grave{U}_{m=n=6} = 1.43$, $0.5 < p < .10$). This evidence is accompanied by an increase in average contributions from sequence 4 to 5 in the random selection treatment (Wilcoxon signed ranks test: $z = 2.20$, $p = .03$).

8. We compare behavior to the random partner-rematching treatment, because it equals the endogenous selection treatments, except for random determination of partners. Because we cannot reject the hypothesis of equivalence of the two control treatments, we do not expect differing results when comparing the endogenous regrouping mechanisms with the random partner rematching without history. This intuition is confirmed by applying all tests additionally to the treatment random partner rematching without history.

TABLE 1
Average Contribution of Pairs in the Unidirectional Treatment

Sequence	*Pair 1*	*Pair 2*	*Pair 3*
1	14.9	14.9	16.0
	Endogenously Formed		*Residual*
2	23.7	20.6	18.5
3	20.3	23.3	19.2
4	22.6	21.9	20.0
5	24.5	23.1	16.6
6	22.2	21.9	10.9
Total average	22.7	22.2	17.0

Taking into account average contributions throughout all six sequences of public good games, we cannot reject the null hypothesis of equivalence between random partner rematching and unidirectional partner selection (robust rank order test: $\grave{U}_{m=n=6} = 1.59$, $.05 < p < .10$, and bidirectional partner selection, respectively $\grave{U}_{m=n=6} = .76$, $p > .10$). However, Figure 2 indicates higher cooperation in the unidirectional than in the random partner rematching treatment only in sequences 2, 3, 4, and 5. It might well be that in the first sequence, where pairs are randomly formed, and in the very last one, where the game has almost ended, the opportunity of partner selection plays a minor role. Indeed, considering only sequences 2, 3, 4, and 5, the results are highly in favor of augmented cooperation with unidirectional partner selection ($M_R = 16.70$, $SD_R = 4.78$, $M_{UD} = 21.20$, $SD_{UD} = 2.68$; robust rank order test: $\grave{U}_{m=n=6} = 2.62$, $p < .025$). An examination of the time trend over sequences reveals that contributions in the unidirectional treatment increase significantly from sequence 1 to 2 (Wilcoxon signed ranks test: $z = 2.20$, $p = .03$), remain stable until sequence 5, and decline thereafter ($z = 2.20$, $p = .03$).

Still, if unidirectional partner selection is indeed a successful instrument to foster cooperation, one should expect higher average contributions from the two pairs that were voluntarily formed than from the remaining pair that was residually determined. Table 1 provides an overview of average contributions for each pair for each sequence and in total. In sequence one, where group members are randomly matched into pairs, contributions are roughly equal among pairs. Throughout sequences, the difference in contributions between the endogenously formed pairs and the remaining pair is significant, Friedman test, $\chi^2(2) = 11.92$, $p < .01$, supporting the effectiveness of unidirectional partner selection to increase cooperation.[9]

9. Although cooperation is higher within the endogenously selected pairs, this difference is not reflected in higher efficiency measured by relative earnings, that is, actual earnings compared to the maximum welfare level. A comparison of the efficiency per sequence of the endogenously selected pairs with the residual pair in the unidirectional treatment does not reveal significant differences. This is also the case when comparing the efficiency between the two pairs with the highest mutual assignments and the pair with the least mutual assignments in the bidirectional partner selection treatment.

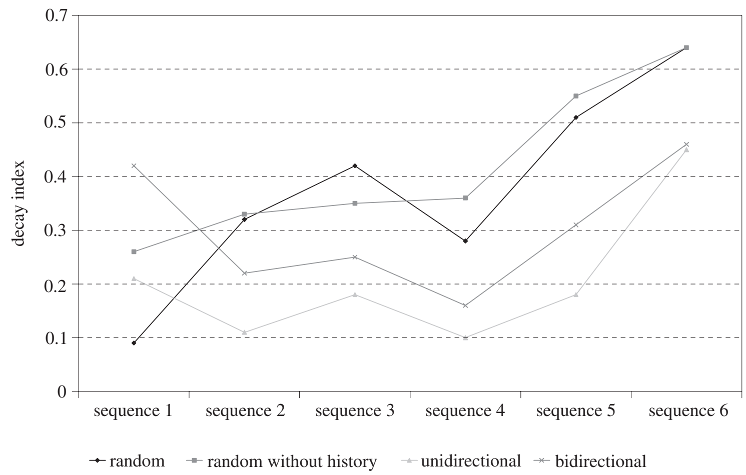


Figure 3: Decay Index in Each Sequence by Treatment

Result 2: Unidirectional partner selection considerably improves cooperation compared to random partner rematching.

In addition to quantitative data analysis, it is important to consider qualitative effects, especially the time trend of behavior. The usual pattern of decreasing contributions is also evident in our experiment. Figure 3 plots decay indices, calculated by the ratio of the difference between the contribution in the first and the last round to the contribution in the first round for each treatment, which illustrates the percentage decrease of contributions throughout each sequence. After the second sequence, contributions in the endogenous partner-matching treatments decrease less dramatically ($M_E = 0.25$, $SD_E = 0.13$) than in the two controls ($M_R = 0.40$, $SD_R = 0.16$) with random rematching (robust rank order test: $\grave{U}_{m=n=12} = 3.28$, $p < .025$). This evidence implies the presence of a structural difference induced by the endogenous selection procedures: cooperation in both partner selection treatments is more stable than in the control treatments. Figure 3 also illustrates the "end-game effect," and indicates the dramatic reduction of contributions to the public good in the last sequence of all treatments.

Result 3: Cooperation in the treatments with partner selection is more stable over time than in the treatments with random partner rematching.

Comparison of partner-selection mechanisms. To investigate whether cooperation is sensitive to the specific partner-selection mechanism, we compare behavior in the unidirectional and bidirectional treatment and find significantly higher average contributions (robust rank order test: $\grave{U}_{m=n=6} = 3.07$, $p < .025$) in the unidirectional selection treatment ($M_{UD} = 19.73$, $SD_{UD} = 2.23$) than in the bidirectional selection treatment ($M_{BD} = 14.86$, $SD_{BD} = 4.01$). Overall, the average contribution to the public good in the unidirectional treatment corresponds to 79%, whereas in the bidirectional treatment it amounts to 59% of the endowment. Although average contributions in the bidirectional treatment increase significantly from sequence 2 to sequence 3 (Wilcoxon signed ranks test: $z = 2.20$, $p = .03$), they are still considerably lower than in the unidirectional treatment throughout rounds, as Figure 2 illustrates.

> *Result 4:* The efficacy of partner selection in improving cooperation is sensitive to the mechanism employed. Voluntary contributions are higher when partners are selected unidirectionally rather than bidirectionally.

Although unidirectional partner selection fosters cooperation, overall efficiency, that is, the level of feasible welfare that is actually reached, is another important indicator. We measure efficiency by the relation of individuals' earnings to the maximum possible amount that can be earned by full cooperation of both partners.[10] Average efficiency per sequence is highest in the unidirectional treatment (92%), closely followed by the random selection treatment (88%), and lowest in the bidirectional treatment (75%).[11] Pairwise robust rank-order tests of the efficiency levels aggregated over six matching groups reveal a significant difference of efficiency levels only between the random selection and the bidirectional selection treatment ($\grave{U}_{m=n=6} = 5.26, p < .01$) and the unidirectional and the bidirectional treatment ($\grave{U}_{m=n=6} = 10.46, p < .01$). Although unidirectional partner selection enhances cooperation compared to random selection, the relation cannot be confirmed when efficiency is considered: expenditures for partner selection seem to deplete the welfare effect from high cooperation. Cooperation on a lower, although stable level and high monetary effort for partner selection are responsible for low efficiency levels in the bidirectional selection treatment.

> *Result 5:* Although unidirectional partner selection does not increase overall efficiency, bidirectional partner selection yields lower efficiency than random and unidirectional selection.

MONETARY EFFORT FOR PARTNER SELECTION

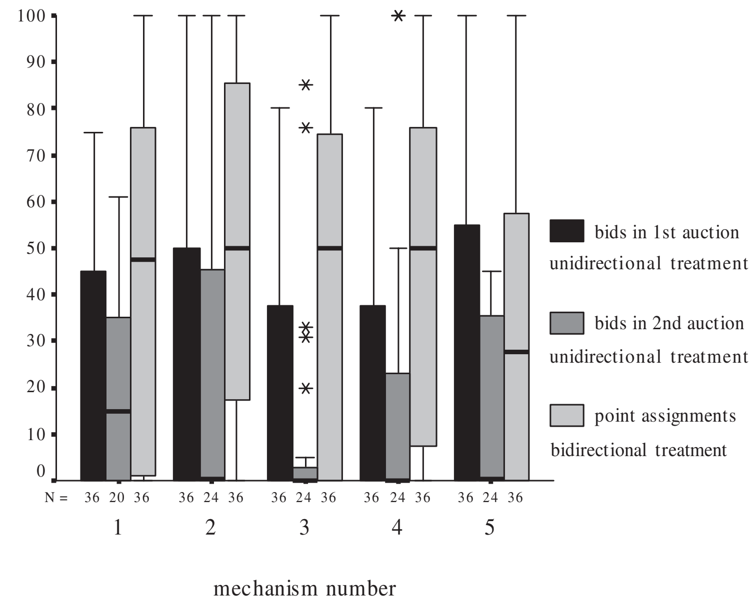
Descriptive evidence. The box plots of Figure 4 give a first impression of the distribution of bids in the first and second auction for each unidirectional mechanism and the amounts assigned for each bidirectional mechanism. Monetary effort for partner selection is dispersed over the entire possible range from 0 to 100 and skewed to the ends of the interval, implying that medians and quartile distances are rather suitable measures of describing data.[12]

Table 2 displays the 95% confidence intervals around the median for the average bids in the first and second auctions of the unidirectional treatment and for the amount assignments in the bidirectional treatment. If zero is not within the lower boundary of

10. To be able to compare the endogenous selection treatments with random partner rematching, the additional endowment of 100 ECU that is received for each mechanism is taken into account when calculating the maximum welfare for the unidirectional and the bidirectional treatment.

11. The first sequence in which participants are randomly matched in any treatment is disregarded for this analysis.

12. Quartile distances are calculated as the difference of the third and second quartile.



Note: * symbolizes data outliers

Figure 4: Boxplots of the First and Second Bids in the Unidirectional and Amounts Assigned in the Bidirectional Treatment over Time

TABLE 2

Confidence Intervals for the Median Monetary Effort for Partner Selection in the Unidirectional and Bidirectional Treatment

Treatment		*Median*	$Q_{0.25}$	$Q_{0.75}$	*95% Confidence Interval*
Unidirectional	1st auction	17.5	1.3	38.9	[10; 31]
	2nd auction	10.0	0.4	23.5	[1; 51]
Bidirectional		49.0	16.5	65.6	[30; 60]

the interval, we can infer that average bids are significantly greater than zero and thus reflect substantial monetary effort for influencing pair constitution.

In the unidirectional treatment, the median first bid amounts to 17.5 (*QD* = 37.6), and the median second bid to 10 (*QD* = 23.1). Table 2 leads to the conclusion that bids in the unidirectional treatment are, on average, significantly greater than zero, providing counterevidence to the theoretical Nash-prediction of zero bidding. A Friedman test reveals that neither first bids, $\chi^2(4) = 2.89$, $p = .58$, nor second bids, $\chi^2(4) = 0.81$, $p = .94$, decline significantly over the auction rounds.[13] However, bids in the second auction are noticeably lower than in the first auction.

13. Even with pairwise comparisons (Wilcoxon signed ranks tests) of average bids throughout auctions, no difference can be found.

The fraction of zero bids in the first and second auctions (on average, 13.9% and 21.2%, respectively) is contrasted by a considerable fraction of bids equal or higher than 50 (19.6% and 14%, respectively). In total, 5 participants out of 36 never bid a positive amount in any auction. Random matching within one's group due to equal bids occurred one time in the first auctions and three times in the second auctions.

Result 6: Participants' bids for choosing a partner in the unidirectional treatment are, on average, significantly greater than zero.

A comparison of actual partner selection by auction winners with the rankings of group members reveals that the overwhelming majority of participants (45 out of 55) acted consistently with respect to the preferences they submitted earlier. That is, they chose the highest ranked group member who was still available.

In the bidirectional partner selection treatment, the median total amount assigned was 49 (*QD* = 49.1), which is significantly positive according to a 95% confidence interval. As in the unidirectional treatment, participants spend considerable amounts of money to avoid random rematching, which is contradictory to the standard Nash prediction. Only 3 of the 36 participants were never willing to assign amounts to preferred partners, whereas 17 participants spent, on average, more than half of their endowment. Over time, average amount assignments remain fairly constant, Friedman test, $\chi^2(4) = 5.15$, $p = .27$. On total average, 25% did not assign amounts to any group member; 41.1% of the participants stated 1 group member as a preferred partner; 7.2%, 6.1%, and 5.6% of participants seized the opportunity to assign amounts to 2, 3, and 4 group members, respectively; and 11.1% assigned amounts to each group member, thereby providing a full ranking.

By relating the bids in the first auctions of the unidirectional treatment to the amounts assigned for endogenous rematching in the bidirectional treatment, it becomes evident that subjective eagerness to shape the future partnership is significantly higher in the latter treatment (robust rank order test: $\grave{U}_{m=n=6} = 3.03$, $p < .025$).

Result 7: Individuals in the bidirectional selection treatment exhibit higher monetary effort for shaping the future partnership than individuals in the unidirectional treatment.

To understand potential benefits from selecting a partner rather than being randomly assigned, one has to consider the expected excess gains from two-sided cooperation over two-sided defection.[14] In the former case, participants earn 200 ECU per sequence; in the latter case, the expected income amounts to 125 ECU, that is, the endowment accumulated over the five periods. Assuming merely payoff maximization, therefore, the difference of 75 ECU is a sensible measure of potential gains by actively engaging in partner selection. Even when deviating from the strict rationale of dominant strategies, expenditures should not exceed 75 ECU. Remarkably, 10.6% of bids in the first auctions, 10.3% of bids in the second auctions in the unidirectional

14. The worst case, that is, a cooperator being repeatedly exploited by a full free rider, is not reasonable to consider, because this situation can easily be avoided by investing the whole endowment in the private account.

TABLE 3
Panel Tobit Regression on Individual Contributions

	Random		*Random without History*		*Unidirectional*		*Bidirectional*	
	M	SE	M	SE	M	SE	M	SE
Constant	1.911	0.850*	5.308	1.136**	2.844	1.012**	2.791	0.716**
Lagged partner contribution g_j^{t-1}	0.255	0.055**	0.069	0.073	0.281	0.060**	0.221	0.048**
Lagged own contribution g_i^{t-1}	0.322	0.057**	0.066	0.073**	0.315	0.062**	0.299	0.050**
Interaction $g_j^{t-1} * g_i^{t-1}$	0.010	0.003**	0.022	0.003	0.009	0.003**	0.011	0.002**
Log likelihood	–2,848.52		–2,826.70		–2,690.97		–2,742.39	
Wald $\chi^2(3)$	708.69		531.27		741.88		760.18	
$p > \chi^2$	< .0001		< .0001		< .0001		< .0001	

NOTE: Dependent variable: Individual contribution. Method: Panel Tobit regression $g_i^t \in [0; 25]$ with individual random effects.
*Significant at the 5% level.
**Significant at the 1% level.

treatment, and 25% of point assignments in the bidirectional treatment exceed this value.

BEHAVIOR AT THE INDIVIDUAL LEVEL

Reciprocal behavior. To investigate whether participants base their contributions on the past behavior of their interaction partner, a panel Tobit regression is run, with past own and partner's contribution to the lag one and their interaction as explanatory variables, and participants' individual contributions as dependent variable. Table 3 shows that reciprocal behavior is present in at least three of the four treatments, because the coefficient for lagged partner contribution is significant for the random partner rematching treatment and the unidirectional and bidirectional partner-selection treatments. Thus, participants adjust their own contribution positively to the experienced contribution of their partner in the previous round; they increase their contribution if their partner's contribution was high and decrease it if it was low.[15] We also find that the individual's own contribution in the past round and its interaction with a past partner's contribution are crucial for current behavior.

Result 8: Reciprocal behavior is prominent, especially in the random partner-rematching and the two endogenous partner-selection mechanisms.

15. Public good games in partner design, and especially two-person interactions, facilitate two aspects of strategic behavior: first, participants may try to induce the partner to cooperate by using high contributions as a signal during the game. Second, punishment by reducing contributions is forthrightly directed to the partner, as becomes evident from the findings on reciprocal behavior. Although both effects presumably lead to an increase in cooperation rates, they are prevalent in all four treatments and operate independently of the partner-rematching mechanism. If they were the main driving force of behavior, partner selection would have only a marginal effect on contributions.

TABLE 4
Categories of Individual Behavior in the Four Treatments (in percentages)

Treatment	*Free Riding* ($0 \leq g_i < 10$)	*Cooperation* ($g_i = 25$)	*Middle Range* ($10 \leq g_i < 25$)
Random	23.6	46.3	30.1
Random without history	16.6	46.1	37.2
Unidirectional	12.8	53.2	34.0
Bidirectional	25.8	33.0	41.2

Patterns of individual behavior for all treatments. A total of 1,080 data points for each treatment (the contributions of 36 participants in 30 periods) are available when the individual contributions to the public good are considered. Based on this large number of observations, roughly three clusters of behavior can be identified: free riding, characterized by a contribution in the range of 0 to 9;[16] cooperation, defined by investing the whole endowment of 25 to the public good; and the remaining category in the middle range, which subsumes contributions from 10 to 24. Table 4 summarizes the relative frequencies of these behavioral categories in the experiment, but separately for the four treatments. According to a chi-square test on absolute frequencies, one can reject the hypothesis of equal distribution of behavioral categories among the four treatments, $\chi^2(6) = 129.13$, $p < .01$.

In the unidirectional treatment especially, a high fraction of cooperative behavior is observed, which supports the evidence that unidirectional partner selection improves the voluntary contribution to public goods. This finding is further strengthened if only the last rounds of each public good sequence are considered: free-riding noticeably outweighs cooperative behavior in the random rematching and the random rematching-without-history treatments (47.2% to 30.6% and 41.7% to 30.6%, respectively) as well as in the bidirectional partner-selection treatment (43.5% to 25.4%), but cooperation is the modal behavior (43.5%) in the unidirectional selection treatment, followed by free riding (25.0%).

> *Result 9:* In the unidirectional treatment, full cooperation is the model behavior overall, and particularly in the final periods of the sequences, and thus clearly dominates free riding.

Monetary effort and partner selection by behavioral types. The distinction of behavioral types according to contributions advises us to take an additional look at the activities of these types during partner selection. Very cooperative participants may display a different strategy than free riders for spending money for partner selection. Therefore, we examine the monetary effort for partner selection in both treatments, conditional on contribution patterns.

16. Because observations of free riders in the strict sense, that is, contributions of zero, are rarely found in the two endogenous partner-selection treatments, we extend the strict definition of free riding behavior to an interval of an average contribution below 10 ECU.

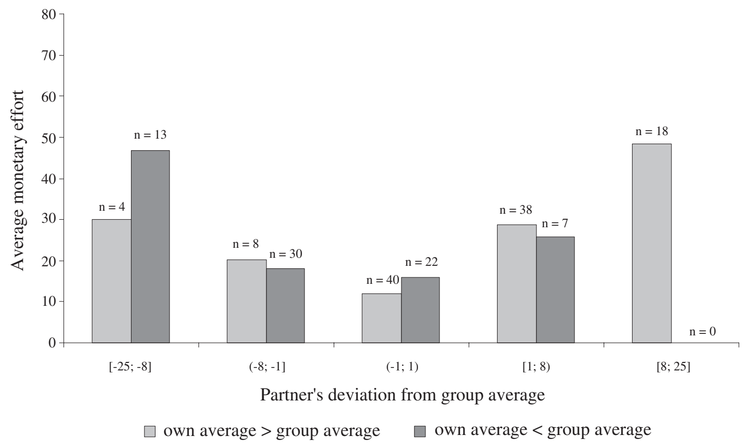


Figure 5: Average Bids in the Unidirectional Partner-Selection Treatment Subject to Own and Partner's Deviation from the Average Group Contribution in the Past Sequence

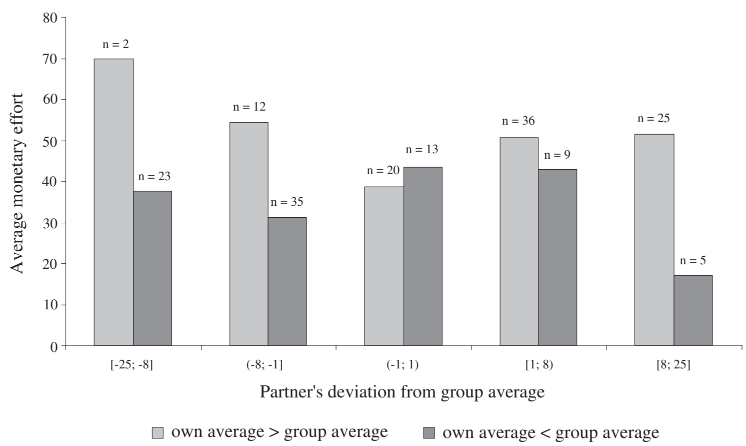


Figure 6: Average Amounts Assigned in the Bidirectional Partner-Selection Treatment Subject to Own and Partner's Deviation from the Average Group Contribution in the Past Sequence

Deviating from the strict classification of individual types employed above, one can apply a more flexible scheme of behavior with respect to average group behavior and partner's behavior in the previous sequence. Figures 5 and 6 display the average monetary effort exhibited by individual types, depending on the deviation of own contributions in the previous sequence from the group average[17] (below or above) and the abso-

17. Group average is calculated as the average of contributions in the previous sequence by all five other group members.

TABLE 5
Frequencies of Pair Classifications Aggregated over All Five Partner-Selection Mechanisms in the Unidirectional and the Bidirectional Treatment

Deviation from the Group Average		*Unidirectional Treatment*		*Bidirectional Treatment*	
Partner 1	*Partner 2*	n	%	n	%
Above	Above	15	16.7	26	28.9
Above	Equal	6	6.7	5	5.6
Above	Below	38	42.2	25	27.8
Equal	Equal	12	13.3	2	2.2
Equal	Below	9	10.0	12	13.3
Below	Below	10	11.1	20	22.2
Total sum		90	100.0	90	100.0

NOTE: Deviations from the past group average correspond to the following intervals: above [1, 25], below [–1, –25], and equal (–1, 1).

lute deviation from the group average by the partner in the unidirectional and the bidirectional treatment, respectively.[18]

The highest bids in the unidirectional treatment are submitted by individuals who contribute more than the group average and who also interact with highly cooperative partners and by individuals who are less cooperative than the average and also have less cooperative partners. Remarkably, high contributors who are stuck with a less cooperative partner are less willing to spend money on partner selection than low contributors in the same situation.

In the bidirectional treatment, individuals who contribute above the average mostly tend to spend more money on partner selection than those who contribute below the average. This relation is especially pronounced for very low and very highly cooperative partners. The highest monetary effort is, on average, exhibited by participants who are more cooperative than the average but are paired with a less cooperative partner. High contributors seem to be more concerned about selecting a partner than low contributors.

To gain a deeper insight in the two different procedures of partner selection, it is worthwhile to look at the constitution of pairs in the unidirectional and the bidirectional treatment. Relying on the previous categorization of individual behavior, Table 5 displays the classification of pairs according to the deviations from the group average of own and partner's contributions in the previous sequence for the unidirectional and the bidirectional treatment, respectively.

In the unidirectional treatment, the modal pair consists of one partner who contributed below and one who contributed above average in the previous sequence. This is not surprising, because individuals who contribute less than the group average are more likely to be winners in an auction (40%, or 22 times out of 55 auctions) and tend

18. In the following, individuals who contribute more than the group average are also referred to as high contributors, whereas participants who contribute less than the group average are referred to as low contributors.

TABLE 6
Proportion of Participants Indifferent to Random Matching in the Unidirectional and Bidirectional Partner-Selection Treatment Subject to Own Deviation from the Average Group Contribution in the Past Sequence

	Deviation from the Group Average						
	Above		*Below*		*Equal*		
	n	f	n	f	n	f	*Total Sum*
Unidirectional	29	43.3%	25	37.3%	13	19.4%	67
Bidirectional	10	22.2%	28	62.2%	7	15.6%	45

NOTE: Deviations from the past group average correspond to the following intervals: above [1, 25], below [–1, –25], and equal (–1, 1).

to choose high contributors. Participants who contribute more than the group average win an auction in 30.9% of the cases, about as often as participants whose contributions are average (29.1%). In the bidirectional treatment, however, the most frequent pairings consist of two high contributors, or a low and high contributor. In contrast to the unidirectional treatment, the monetary effort exhibited by high contributors mostly exceeds that of low contributors (see Figure 6); therefore, high contributors are more likely to end up together in the bidirectional treatment than in the unidirectional treatment.

In summary, behavior of high and low contributors differs considerably among mechanisms. In the unidirectional treatment, high contributors bid low in contrast to low contributors, whereas in the bidirectional mechanisms, high contributors are willing to spend more money on shaping the future partnership than low contributors. Recalling the finding of Ehrhart and Keser (1999) that cooperators try to escape free riders (although, in turn, free riders chase them), we find similar results in our experiment even though differences among partner-selection mechanisms are prominent. In the unidirectional treatment, high contributors are more passive whereas low contributors try to chase them, whereas in the bidirectional treatment, highly cooperative participants are more active in avoiding low cooperators than the latter are in chasing them.

Result 10: Partner selection differs across behavioral types as well as across treatments. In the unidirectional treatment, low contributors are more engaged in partner selection than high contributors, whereas in the bidirectional treatment, high contributors are more engaged in partner selection than low contributors.

To confirm this impression statistically, we contrast the fraction of behavioral types who do not engage in active partner selection in both experimental treatments. Table 6 displays absolute and relative frequencies of participants in the three behavioral categories (past contributions below, above, or equal to the group average) who do not submit a positive first bid (in the unidirectional treatment) or do not assign a positive amount to any other group member (in the bidirectional treatment).[19] At first glance, participants in the unidirectional treatment are generally less active (67 zero bids out of 180) than participants in the bidirectional treatment (45 assignments of zero out of 180).

A chi-square test for homogeneity reveals that the distribution of participants who are not investing in partner selection among behavioral categories differs between the two partner selection treatments, $\chi^2(2) = 7.20$, $p < .05$. Apparently, in the unidirectional treatment, high contributors abstain from bidding more often than low contributors (43.28% vs. 37.32%), whereas in the bidirectional treatment, the pattern is reversed: fewer high contributors than low contributors are passive in partner selection (22.2% vs. 62.22%). This evidence indicates that in the unidirectional treatment, low contributors are more occupied by "chasing" high contributors than the latter are by fleeing away from them and looking for equal types. In the bidirectional treatment, however, low contributors are more passive in assigning amounts than high contributors, suggesting that high contributors are more engaged in affecting the partner rematching, and thus are potentially "fleeing" from low contributors.

DISCUSSION

In his seminal paper, Tiebout (1956) suggests "voting with one's feet" to overcome the impracticality of a market solution to the provision of public goods. More precisely, individuals should be free to move to the communities that best satisfy their preferences for collective goods. Similarly, recent literature on reciprocal behavior suggests that grouping individuals by their cooperative disposition substantially increases overall efficiency in public good provision because initial high contributors continue their cooperative behavior undisturbed by free riders who, in turn, also maintain their attitude facing similar coplayers. In real life, the common retreat from being exploited is to quit one's membership in an abusive societal environment. The reason social dilemmas are frequently resolved in various fields of social interaction might be the possibility to choose with whom to collaborate. Examples are various: a scientist chooses the coauthors of a paper; people decide to live in a neighborhood for various reasons, such as safety or social exchange with similar people; or soccer-team coaches buy future players.

To investigate how the opportunity to choose the interaction partner in a social dilemma affects cooperative behavior, we employ a repeated two-person public good game where players can spend amounts on being paired with their desired partner of a group of six. As illustrated by the previous examples from everyday life, the choice to join a group can but need not rely on mutual agreement. Thus, the infinite number of possible mechanisms for how to endogenously create partnerships can be divided into at least two broad categories: unidirectional selection, in which one partner can choose the other without his or her explicit agreement, or bidirectional selection, where indi-

19. Only the first bids are considered in the unidirectional treatment to have a direct comparison with the bidirectional treatment, where the willingness to choose a partner is elicited only once during a mechanism.

viduals must have some degree of mutual appreciation to collaborate. In our study, we compare unidirectional and bidirectional partner selection in a public good game to control treatments with random partner rematching and we elicit the participants' monetary effort for being able to choose their partners.

We find that unidirectional partner selection fosters cooperation considerably and attenuates the usual decline of cooperation over time. For bidirectional partner selection, we cannot confirm higher average cooperation compared to randomly matched pairs, yet the usual decline of contributions over time is also alleviated. An investigation of the presumably aggrandizing effect on cooperation rates of publishing the contribution histories of individuals shows that this reputation effect among group members does not play a major role.

Individuals, on average, are willing to spend significant amounts to avoid random partner matching, but the average monetary effort is higher in the bidirectional than in the unidirectional treatment. Surprisingly, the evaluation of choosing a partner does not decrease over time, even though cooperation is substantially high in the unidirectional selection treatment and at least stable on a lower level in the bidirectional selection treatment. Both mechanisms differ in how heterogeneous types of contributors behave during partner selection. In the unidirectional treatment, high contributors engage little in bidding, whereas low contributors pursue active partner selection by submitting higher bids. Conversely, in the bidirectional partner-selection treatment, high contributors assign higher amounts to affect partner rematching than low contributors. Therefore, it is important to note that both the efficacy of partner selection and the specific reaction of individuals with distinct cooperative dispositions are sensitive to the matching method.

In general, the opportunity to choose interaction partners seems to be one solution to the problem of the efficient private provision of collective goods, because it is a natural way to punish free riders by turning one's back on them. Even when the costs of choosing partners are endogenous, constituting a realistic aspect in our view, individuals are willing to give up substantial parts of their income to determine their future partnership.

Yet why do the two mechanisms of partner selection trigger different results from different behavioral types in terms of contributions, efficiency, and the monetary effort for partner selection? The most obvious reason why bidirectional partner selection performs worse than unidirectional is that the former gives rise to an additional coordination problem within the social dilemma situation, whereas in the unidirectional treatment, partner selection is straightforward and easy to implement. Additionally, being selected by someone—even though not necessarily because of mutual appreciation—might enhance group identity (for the theoretical concept, see Tajfel and Turner 1979) and thus reinforce commitment to the partnership. The vast literature on costly signaling (e.g., Spence 1973; Riley 1979) suggests yet another explanation: in the unidirectional treatment, the preplay signal of investing in partner selection is inherent in the mechanism because the auction winner is at least revealed to the person selected. Because monetary effort for partner selection is a credible signal for a cooperative intention, coordination on an efficient outcome is more readily achieved. Mutual signaling of a cooperative disposition is nearly unattainable in the setting of the bidirectional treatment and might be a major reason for its poor performance in encouraging cooperation. Especially in the unidirectional treatment, low contributors who are very actively engaged in partner selection seem to make use of the signaling possibility. In the bidirectional treatment, where this signaling opportunity is unavailable, they are far less active.

Our results resemble the superiority of Hauk and Nagel's (2001) unilateral partner choice for cooperation in prisoner's dilemma games. However, their mechanisms imply a choice between exiting and earning a sure payoff or entering the game (on unilateral or mutual agreement) and hoping for a cooperative partner. In our setting, participants cannot exit the game but can strive only to be matched with a cooperative partner. From both studies, one could conclude that the natural intuition that mutual agreement in forming teams is superior to unidirectional selection is waning. Mutual agreement may give rise to coordination problems that do not exist when one partner is eligible for the initiation of the relationship. Even though individuals may be reluctant if selected by an undesirable partner, resentments can be overcome by the entitlement of being chosen.

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