Voluntary Association in Public Goods Experiments: Reciprocity, Mimicry, and Efficiency [1]

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Abstract

We study the incentive effects of endogenous group formation in a voluntary contribution experiment. Subjects are given information on the past contributions of others and allowed to express a preference for partners. On the basis of the stated preferences, new groups are formed. We find that the opportunity to form new groups increases both contributions and efficiency. We also compare the regrouping mechanism with a mechanism allowing targeted reductions of others' earnings ("punishment"). In the experiment, both mechanisms increase contribution levels significantly, but only endogenous grouping or the combination of the two increase efficiency significantly.

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1 Introduction

Collective action in the provision of public goods, protection of common pool resources, and cooperative effort in teams is often compromised by free riding. In practical life, one of the commonest ways of controlling free riding is by changing the membership of groups. Consider, for example, teams of partners in a venture in which the effort of each individual makes a critical but only partly measurable contribution to the productivity of the others. A given team's competitive prospects are at risk from the potential undersupply of effort. In response to this threat, teams attempt to reduce free riding by selecting members having reputations as good team players and holding out the threat of expulsion to those who fail to pull their weight.

The experiment reported in this paper studies the incentive effects of endogenous determination of group membership on cooperation. We do this in the framework of a voluntary contribution mechanism in which subjects rank one another to determine whom they are grouped with. We find that endogenous group formation significantly increases cooperation and efficiency; that individuals given a costly opportunity to rank others to determine group membership are willing to pay the cost of doing so; and that the experiment provides additional evidence of the existence of differing "types" of individuals. In the experiment, the treatment of endogenous grouping increased contributions over baseline by about the same amount as did a comparison treatment of punishment. The endogenous regrouping treatment increased efficiency significantly above baseline; the comparison punishment treatment also increased efficiency above baseline, but not significantly.

The paper proceeds as follows. Section 2 discusses theoretical issues and reviews related literature; Section 3 describes our experiment; Section 4 discusses the experimental results of endogenous group formation compared with a baseline treatment without regrouping; Section 5 compares the opportunity to regroup with the opportunity to punish and compares the baseline with the combined opportunities to regroup and to punish; and Section 6 discusses the results in an evolutionary context.

2 Theory and Literature

Beginning with Marwell and Ames (1979), experimentalists have studied the problem of collective action or public goods provision using a protocol known as the voluntary contribution mechanism (VCM). A group of n subjects is provided with an endowment of money or tokens, and each member is asked to allocate this endowment between a private account and a group account. Units placed in a subject's personal account are kept by the subject, while those placed in the group account pay some fraction α of their value, $1/n < \alpha < 1$, to all group members, contributor and non-contributor alike. In most of the experimental designs, subjects cannot communicate about their choices, and each acts independently in a given allocation decision, without knowledge of the decisions of the others. With this structure, the game is an n-person prisoners' dilemma where individuals have a dominant strategy to contribute nothing.

In the finitely repeated game, iterated dominance predicts that the game will unravel from the end and no one will contribute anything in any period.

A possible explanation for the experimental finding of substantial contributions in early periods followed by a decline in contributions over time is that it takes time for the subjects to learn how the incentive system works.[2] But Andreoni (1988) and Isaac and Walker (1988) find that when a second finitely repeated game is played, there is a "restart" effect where contributions again begin at a high level and then decline.[3]

This evidence supports an alternative, more Bayesian explanation, along the lines of Kreps, Milgrom, Roberts and Wilson (1982). Here the subjects can be of different types. For example, one type may have a utility function that only values the individual's own monetary payoff, another type's utility function may include a preference for cooperation or reciprocity as well as for his or her own payoff. Kreps et al. show that if a narrowly self-interested player believes that there is a positive (but possibly) small probability that others may be reciprocators, it may be advantageous for the first player to mimic a reciprocator as well until near the end of the repeated game, and this can happen even when nature's drawing of types does not include any cooperative or reciprocative individuals. By a reciprocator type we mean someone who values his own contributions more when others contribute more, has a distaste for being made a "sucker" when others free ride, and takes satisfaction in punishing free-riders, even at a cost to himself. We use

[2]The typical finding of finitely repeated VCM experiments is that cooperation is relatively high, with 50 to 60% of endowments being contributed, in the initial period of play, and drops off toward contributions of about 10% of endowments in the last period.

[3]Andreoni (1995) observed a restart effect with and without new partners.

the term "cooperator" interchangeably with "reciprocator."[4]

Recent experiments provide evidence of reciprocity in human interactions. McCabe, Rassenti and Smith (1996) offered subjects the choice between (a) a Nash equilibrium with a positive pay-off pair that can be reached through a sequence of strictly self-interested moves, and (b) a Pareto improving cooperative equilibrium that can be reached only when the first mover trusts the second mover to respond to a choice of the relevant game path with a "reciprocally fair" rather than an "opportunistic" move. They found that many subjects tried to reach the cooperative equilibrium, trusting second-movers to reciprocate. In their experiment this trust was more often than not validated by the second-movers' actions.[5]

Fehr, Gächter, and Kirschsteiger (1997) find other evidence of reciprocity. In their experiment, some subjects ("employers") offer to enter into "wage-and-effort" agreements with other subjects ("employees"). Both "wages" and "effort" in this experiment are transfers of experimental endowment funds from one subject to the other. The design is such that employers are required to actually pay the wage offered, but employees can "shirk" by providing less than the promised amount of effort-an asymmetry meant to reflect the typical non-contractability of effort. The experimental results suggest that many employees reciprocate high wages with high effort despite the non-enforceability of their contracts.[6]

[4]See also Fehr and Gächter (2000b) for definitions.

[5]See also Hoffman et al. (1998) for a review of this and related experiments as well as of other evidence regarding reciprocity.

[6]Other studies that support the presence of substantial numbers of positive reciproca-

Fehr and Gächter (2000a, 2000b) suggest that heterogeneity of types can explain the initial high level of contributions and their decay in public finitely repeated public goods experiments. In a group including both reciprocators and free riders, the reciprocators start out by contributing substantially. Some payoff-maximizers mimic the reciprocators, but some free ride. Observing the free riding and having no other way to punish or to protect themselves from it, reciprocators and those mimicking them reduce their contributions. Total contributions fall, and the reciprocators and mimickers reduce their contributions more. If this first game is followed by another finitely repeated game, especially with different group membership, the reciprocators again start with high initial contributions and the mimickers also act like reciprocators, explaining the restart effect.

Fehr and Gächter (2000a) tested this intuition by offering subjects the opportunity to assign costly punishment to free riders (and others) without reducing their own contributions. With this added dimension, the reciprocators can signal to the free-riders their willingness to punish while simultaneously signaling to the contributors their continued reciprocity. Fehr and Gächter found that the opportunity to punish eliminated the decay in contributions.

Gunnthorsdottir et al. (2000) investigate subject heterogeneity and its persistence by having the experimenter directly sort subjects into groups. Based on their initial contribution levels subjects are sorted into groups of high, middle and low contributors. High contributors see only high contri-

tors include Berg et al. (1995) and Gächter & Falk (1997). A review is provided by Fehr and Gächter (2000b).

butions at the beginning and tend to sustain their high contributions, with little tendency to decline over time. The groups formed by low contributors in the first period continue to make low contributions. The experiment thus supports the interpretation that free riding of low contributors leads to the decline in contributions by higher contributors in the standard VCM.

Whereas Gunnthorsdottir et al. bring more cooperative subjects together by the exogenous action of the experimenter, Tiebout's (1956) earlier theoretical study of "voting with one's feet" suggests the possibility of endogenous sorting by type. In this vein Ehrhart and Keser (1999) allowed subjects in a voluntary contribution experiment to move freely from one group to another. But because, in their experiment, subjects can move unilaterally without agreement of those whose groups they join, the experimenters found unbridled chasing of cooperative players by free riders, undermining sorting by type.

Our experiment was designed so that all subjects symmetrically have a say as to who joins their group, providing some protection to reciprocators from free riders. We conjectured that a symmetric, endogenous process of regrouping might create incentives for building reputation and increased contributions.

3 Experimental Design for Baseline and Regrouping

In our experiment we compared a baseline treatment without endogenous grouping to a treatment with endogenous grouping (or regrouping). In the

latter treatment subjects had periodic opportunities to rank prospective partners and be regrouped accordingly. The experiment as a whole consisted of sixteen experimental sessions involving 256 subjects. In each experimental session, sixteen inexperienced subjects drawn from the general undergraduate population at Brown University played 20 periods of a finitely repeated VCM in groups of four. Subjects did not know whom they were grouped with, and interacted only through computer terminals.[7]

In each period, each subject was provided (i.e., electronically credited) with 10 experimental dollars, with one experimental dollar converting at the end of the session to \$0.07 in real money. The subject's first (and, in the baseline treatment, only) task was to divide this endowment, in integer amounts, between a private and a group account before learning the others' contributions. Money assigned to the private account entered personal earnings, while an amount equal to 0.4 times the sum of contributions to the group account was distributed to each group member, regardless of what he or she contributed to that account. Thus, the earnings of a subject, i, in a

[7]Subjects were recruited mainly through the distribution of flyers to the campus mailboxes of all Brown undergraduates, with the experiments being identified as being conducted by researchers in the Economics Department. A brief post-experiment debriefing questionnaire shows that 11% of the subjects were economics concentrators, almost identical to the percentage of graduates completing this concentration in 2000. Widely distributed over all classes from freshmen to seniors, 42% of subjects had taken one or more economics classes, the average number of economics courses taken being just over 1. Fifty-eight percent of the subjects were female, slightly higher than the share of females among Brown undergraduates as a whole.

given period, were

$$(10 - C_i) + 0.4 \sum_j C_j, \tag{1}$$

where C_i is the amount i assigns (contributes) to the group account, and the summation is taken over all members of i's group, i included. At the end of the experiment, the sum of the earnings in all twenty periods was converted into real dollars, and each subject was paid a $5 participation fee. Experiment sessions lasted from one to two hours, and real earnings, including the participation fee, averaged around $25.

In the four baseline sessions, subjects interacted in the same randomly assigned groups of four for all twenty periods, with no knowledge of behaviors in other groups.[8] The four sessions with regrouping started out in the same fashion, with groups of four subjects each being assigned randomly. After interacting for three periods, however, each subject was shown a list, without other identifying information and in a random order, of each of the other 15 participants' average contribution to their group accounts over the experiment so far. Subjects were then given the opportunity to express a preference among future partners. If the subject chose to do this, he or she typed a number in a box next to the information about each other subject. The same ranking number could be assigned to two or more subjects, allowing ties. If a subject chose not to rank others, he or she could click on a "don't rank" box. Potential ranks ran from 1 to 15, with 1 standing for the most preferred prospective partner.[9] Subjects were charged 25 experimental cents for the first rank (or group of tied ranks) assigned, and 5 experimental

[8]Thus, this is a "partners" treatment in the senese of Andreoni (1988).

[9]The rankings were scaled so that each person's rankings added to $1+2+\ldots+15 = 120$,

cents for each additional rank (or group of tied ranks).

When all subjects had completed this process, the computer assigned subjects to groups by searching, first, for that group of four individuals the sum of whose mutual ranks of one another was the smallest among the universe of potential groups, then repeating this process over the remaining subjects, to form the second and third groups, leaving the last four subjects in the fourth group. Ranking and regrouping also took place after periods 6, 9, 12, 15 and 18, with subjects being provided, at each ranking stage, a list of the average contribution of all other subjects up to that point in the experiment. Subjects were informed of the regrouping procedure and its frequency in the pre-play instructions at the beginning of the experiment.

We made the rankings costly so that iterated dominance predicts no rankings and if we observed rankings, this would provide further evidence of the Bayesian interpretation, where there are stable enough types to establish reputations, with sufficient perceived benefits for subjects to pay the costs of ranking in the attempt to establish more favorable groups. Instructions are in the Appendix.

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with ties set equal to the average ranking within the ties. For example, in a 2 way tie for the highest rank the first and second rankings would be 1.5, 1.5; someone choosing not to rank would be assigned a 15 way tie, with rank of 8 for each other subject.

4 Results for the Baseline and Regrouping Treatments

In our baseline treatments (lower line in Figure 1), contributions began at an average of 60% of endowments, and declined to 9% in the last period, similar to the trends reported in the literature.[10]

Insert Figure 1 Here

The upper line shows that average contributions with regrouping are higher than without regrouping, decline more gradually, and have an increase after each regrouping (after periods 3, 6, 9, 12, 15, and 18), consistent with the restart effect. Over the course of the experiment as a whole, in the baseline treatment the average contribution to the group account is 38% of endowment, compared with 70% of endowment in the treatment with endogenous grouping. Mann-Whitney tests show that average contributions to the group account and average earnings are significantly higher in the regrouping treatment than in the baseline treatment.[11] (Figure 2 below

[10] A regression of average contributions on period for periods 1 through 19 (excluding period 20 because of end game effects) shows a large and statistically significant downward trend.

[11] We conducted this test two ways. The first way was to include one observation per partner group in the baseline treatment and one observation per 16-person experiment session in regrouping treatments. With 16 baseline observations and 4 regrouping observations, the Mann-Whitney test statistic for average contributions is 6, which has a p-value less than 0.01 (one-tailed test p-value is 0.006); the corresponding statistic for earnings is 7, with a p-value less than 0.01 (one-tailed test p-value is 0.008). In the second way we took each baseline experiment as a single observation. While this reduces the

investigates the source of the decline in the average contribution in the regrouping treatment.)

Contrary to the prediction of iterated dominance, 94% of the subjects chose to rank at some time, with an average of 79% choosing to rank in any given ranking period. The subjects tended to give lower (more favorable) rankings to those who had previously contributed more,[12] so that for each regrouping, subjects with the highest previous contributions tended to be grouped together in the first-formed group, of the remaining subjects those with highest previous contributions tended to be grouped together in the second-formed group, and so on for the remaining subjects down to the last-formed group, which tended to have the lowest previous contributions.

Insert Figure 2 Here

baseline sample to 4 observations only, it can be considered more appropriate because we then average the contributions of 16 different subjects when looking at both baseline and regrouping treatments, and thus we avoid differences in variance due to differences in numbers of subjects per group. (The reason we do not study groups of 4 separately for the regrouping experiments is that subjects move from group to group, and thus some subjects in one group are contaminated by experience in interacting with subjects in other groups over the course of a session.) Under this alternative method, the Mann-Whitney test statistic for average contributions is 0, which has a p-value of 0.015 in a one-tailed test; the corresponding statistic for earnings is 6, with a one-tailed test p-value of 0.015.

[12]Regressions show that ranks are significantly negatively correlated with the displayed past contributions to the group account of the person being ranked. For each ranking stage, we regressed average ranking on average contribution, across all individuals, and found a statistically significant negative relationship.

Figure 2 shows the average contribution, in each period, in the first-, second-, third- and forth-formed groups in the regrouping treatment. The first-formed groups, which change membership from time to time as low contributors are weeded out and higher contributors substituted, shows little or no decline in average contribution prior to the final regrouping, after which an end-game effect appears. The second- and third-formed groups show some decline, but much of the decline in Figure 1 for the regrouping treatment is attributable to the fourth-formed group.[13]

We tested for evidence of sorting by type as follows. First, for each session, we aggregated the average contributions of the first-, second-, third- and fourth-formed group over the 20 periods as a whole, see Figure 3. The figure shows the average contribution of the subjects in each group, from left to right for each of the four sessions.[14] In every session, the order of average contributions is the same as the order of group formation. The p-value for this pattern of ordering against the null hypothesis that the pattern of ordering is random is 0.000003.

Insert Figure 3 Here

[13]Recall that in the regrouping treatment, group membership is assigned randomly for periods 1-3.

[14]To calculate the height of the left-most bar in the table, we calculated the average contribution in the first-formed group of periods 4-6 in session 1, the average contribution in the (possibly different) first-formed group of periods 7-9 in session 1, etc., then averaged over the averages for the six sets of periods (4-6,7-9,10-12,13-15,16-18,19-20) in session 1, and similarly in the other groups and sessions.

Second, while it is impossible to fully distinguish between mimicking and reciprocator types before the final period of play, contributions in the last period, when there is no incentive for a payoff maximizing type to contribute at all, provide more direct evidence of sorting by type. As Figure 2 shows, in the final period the average contribution in the first-formed groups was higher than the average contribution in the second-formed groups, and so on down to the last-formed groups.

(For a rough partitioning of high contributors into those who make high contributions for strategic reasons and those who display a preference for reciprocity, consider the 13 of the 64 subjects in the regrouping treatment who contributed their entire endowment of 10 dollars for the first 18 periods. Of these 13 subjects, 7 continued to contribute their entire endowment in the last two periods; 2 switched to contributing 0 the next-to-last period; and 2 switched to 0 in the last period although their groups had seen no defections in the next-to-last period. Hence, among the 13 highest contributors prior to the final regrouping, 7 reveal themselves to be cooperators or reciprocators,[15] 4 to be mimickers,[16] and the remaining 2 possible reciprocators or mimickers.[17] More broadly, of the 64 subjects who participated in the

[15]Alternatively, some could simply suffer from confusion. However, the fact that some subjects who switch to low contributions following a defection in their group (see footnote 16) cannot be classified but may also be reciprocators, means that this rough count of 7 reciprocators may be an undercount or an overcount.

[16]By virtue of the fact that they defected from cooperation without any indication of planned defection by fellow group members.

[17]These last two switched to low contributions after others in their groups had done so, a behavior consistent with reciprocity, but also consistent with planned last-round

endogenous grouping treatment, 38 (59%) contributed a positive amount in the last period, and in half of all groups, the average contribution was 5 or more. In the experiment, the propensity to reciprocate cooperation appears to be far from rare.)

Third, if the regrouping process sorts subjects by their propensity to contribute, we should find less variation of contributions within groups in the regrouping treatment than in the baseline treatment. To test this prediction we used the coefficient of variation to measure within-group differences while controlling for differences in the average contributions level across groups. We found the average coefficient of variation significantly lower for endogenously formed groups in the regrouping treatment, compared with the randomly formed groups in the baseline treatment.[18]

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defection by a strategic mimicker of cooperation.

[18]For the regrouping treatments, we calculated the within-group coefficient of variation for each period between first and final regrouping, and then we averaged across periods (beginning with the period after the first ranking and regrouping) to obtain an average coefficient of variation (c.v.) for the first-formed group (that is, for the first-formed groups of a given session, since group membership may change), another for the second-formed group, etc. With one averaged c.v. per first-formed group, one per second-formed group, etc., per session, we have 4x4 = 16 averaged c.v.'s of contributions in regrouping session groups. For experiments without regrouping, we calculate within-group coefficients of variation for each period and average them for each partner group (whose membership is fixed for the session); 4 groups x 4 sessions also yields 16 averaged c.v.'s. The p-value for the one-tailed Mann-Whitney test on these 32 data points is 0.0002.

5 Comparison with Punishment

To compare the effects of endogenous grouping to the effects of a reduction ("punishment") option similar to Fehr and Gächter (2000a), we conducted an additional four sessions with a reduction treatment (with reductions but no regrouping) and four more sessions with a combined treatment (both reductions and endogenous regrouping).[19] The reduction treatment differs from the baseline treatment as follows. At the beginning of each period, each subject (in a group of 4) makes a contribution decision, before learning of the others' contributions. When everyone in a group has made his or her contribution decision, subjects learn the contribution levels of the others in their group and have an opportunity to reduce the earnings of fellow group members at a cost of 25 experimental cents for each experimental dollar of reductions.[20] In a given period, earnings of subject i after reductions are thus

$$(10 - C_i) + 0.4 \sum_j C_j - 0.25 \sum_j R_{ij} - \sum_j R_{ji}, \tag{2}$$

[19] In the paper, we use the term "reduction" interchangeably with "punishment." Note that motives for reducing others' earnings vary, sometimes including a desire to reduce the earnings of other group members relative to one's own, regardless of their actions. The experimental instructions refer to "reducing another subject's earnings," avoiding the term "punish."

[20] The cost of reductions differs from Fehr and Gächter (2000a), where each punishment point reduces the pre-reduction earnings of the individual targeted by 10% and there is an increasing marginal cost of purchasing points.

where R_{ij} is the number of dollars by which i reduces j's income, and conversely for R_{ji}.[21] In the punishment treatment as in the baseline, groups are formed randomly in the first period and remain fixed for the 20 periods. The combined treatment is the punishment opportunity described added to the regrouping treatment described in Section 2.

Insert Table 1 Here

Table 1 summarizes the design for the four treatment combinations of the experiment. Figure 4 adds the reduction and combined treatments to Figure 2. The results obtained in our reduction treatment largely replicate the earlier experiment and results by Fehr and Gächter for their partners' treatment VCM with punishment stage. In our treatment and theirs, iterated dominance predicts unraveling from the end in the finitely repeated game, leading to no punishment and no contributions. However, Fehr and Gächter find that their punishment treatment substantially increases the level of contributions over their baseline, and there are substantial numbers of reductions, mainly aimed at low contributors.

Insert Figure 4 Here

In our reduction treatment, contributions began with an average of 76% of endowments in the first period, then declined very gradually, remaining

[21] Subjects in the reduction treatments learned of the contributions of other individual group members after each contribution stage and we let subjects in both regrouping and reduction treatments learn of individual contributions each period, for comparability across treatments. Identification letters changed randomly from period to period, so that the behaviors of particular group members could not be tracked over time, reducing the opportunity for vendettas.

above 65% until the last period[22] with a noticeable end-game effect (see Figure 4). Mann-Whitney tests show that average contributions over the 20 periods taken as a whole are significantly higher in the treatment with reductions compared with the baseline treatment. Average earnings over the same periods are also higher in the reduction treatment (see Table 1), but the increase in earnings is small, because (net) earnings include the cost of punishment, and because earnings are not always higher in reduction-treatment groups, the difference is not statistically significant in a Mann-Whitney test.[23] In our reduction treatment, 70% of subjects reduce another subject's earnings, and 81% have their own earnings reduced at some point in their session, with most reductions aimed at low contributors.[24] There

[22]A regression of average contributions on period for periods 1 through 19 shows a small but statistically significant downward trend. Note that while contributions declined with repetition, their average in the last period was the same as the average contribution in the first period of the baseline treatment. The higher starting value of contributions in the reduction than in the baseline treatment suggests that the likelihood of being "punished" for free-riding was anticipated by subjects even before they had evidence that it actually happens.

[23]The test statistic for contributions is U=37, with p-value less than 0.0002 for the one-tailed test; but for earnings is U=99, with p-value of 0.29 (two-tailed test).

[24]To check that reductions are mainly meant to "punish" low contributors to the group account, we estimated a regression equation matching a specification used by Fehr and Gächter (2000a), in which the dependent variable is the number of dollars by which subject j's earnings were reduced by other group members in period t, and the independent variables are the absolute positive deviation of j's contribution from the average in the group in that period, the absolute negative deviation from that average, and the average contribution. (Absolute negative deviation is a positive number when j contributed less than the average, zero otherwise; and conversely for absolute positive deviation.) There

is a substantial amount of reduction in the final period: in 56% of groups, at least one subject reduces others' earnings, and total dollars of reductions are not statistically significantly different in period 20 compared with period 19.[25]

As Figure 4 also shows, contributions in the reduction treatment are about the about the same as contributions in the regrouping treatment until period 17 (the difference between the two treatments for average contributions by group over the full 20 periods is insignificant in the Mann-Whitney test). The cost of punishment is greater than the cost of expressing preference rankings, and earnings (and efficiency) are higher in the regrouping treatment than in the reduction treatment, but this difference is not statistically significant. Earnings are significantly higher in the regrouping treatment compared with baseline, but not significantly higher in the reduction treatment compared with baseline.

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are 1280 observations, 20 for each of the 64 subjects in the reduction treatment. The result is qualitatively the same as Fehr and Gächter's: a positive coefficient (of .47) on absolute negative deviation, significant at the .001 level; a negative coefficient on average contribution, significant at the .01 level; and a very small and highly insignificant negative coefficient on absolute positive deviation. Thus, the further below the group average, the more a subject tended to be "punished," but reductions of a subject who contributed more than the group average are unaffected by the exact amount that such a subject contributed.

[25]The Mann-Whitney test statistic for a comparison of the total dollar value of reductions in the two periods is U=102.5, and the corresponding p-value for the two-tailed test is 0.341.

Turning to the combined treatment, Figure 4 shows that the average group contribution tends to be about the same as in the reduction treatment in periods 1 through 6 and higher than all other treatments in periods 7 through 20. Table 2 shows the average contribution, average earnings and efficiency by treatment, over all twenty periods in the four experimental sessions. The table shows that the combined treatment with both regrouping and reductions has the highest average level of contributions over sessions. With the cost of reductions included, however, the combined treatment has a little lower level of earnings and efficiency than the treatment with regrouping only. We did not find significant differences, either for earnings or contributions, in pairwise comparisons between the combined, reduction, and regrouping treatments, in Mann-Whitney tests. However, like the regrouping treatment, both earnings and contributions are significantly higher in the combined treatment than in the baseline treatment.

Insert Table 2 Here

In the combined treatment, both ranking and reduction behaviors resemble those in the regrouping and reduction treatments separately. For example, in the combined treatment many subjects engage in reducing others' earnings, even in the last period, with reductions mainly aimed at low contributors. Also, most subjects engage in ranking and ranks are significantly correlated with past contributions, high contributors being given preferred ranks.[26] Sorting and signaling effects similar to those of the regrouping treatment are also found in the combined treatment, with less within-group

[26]Subjects were given no information about one another's reduction behavior, so this behavior does not directly affect ranking. We did two pilot experimental sessions with a

variance of contributions following endogenous group formation, and with first-formed groups sustaining higher contributions than those formed second, second higher than the third, and third higher than the fourth.

6 Incentives and a Possible Evolutionary Interpretation

Despite the theoretical prediction of free riding, people are often observed to cooperate more or less effectively in work groups, in local public goods provision, and in other settings. Preference structures including reciprocity, and the possibility of punishing free riders by social disapproval or other sanctions, may go some way towards explaining these outcomes.

The fact that people are often free to decide which groups to join and who to include in their groups offers another tool for building cooperation. The ability to exclude free riders allows more cooperative individuals to sustain cooperation more effectively. And because it is in everyone's interest to include cooperative individuals in and to exclude free riders from their groups (everyone's interest except for the excluded free riders), the ability to decide with whom to interact creates an incentive to act cooperatively to gain a reputation as a desirable partner. Our findings may also illustrate the idea that non-altruistic types don't always overwhelm altruistic ones

treatment in which subjects learned both of one another's past contributions and of one another's past reductions (including the degree to which these were targeted at high versus low contributors). We found that this increased contributions, but not efficiency, because the increase in contributions did not offset the costly increase in punishment activity.

by successfully invading their groups. Henrich (forthcoming) argues that group selection must have played an important role in order for altruistic tendencies to have emerged in human evolution, and that group selection can play such a role only when differences between groups are preserved by some means. Henrich emphasizes cultural mechanisms, and the ability of the group to control who is in or out could be among them.

Furthermore, the evolutionary payoff from increased cooperation might be enhanced by the combined opportunities to punish and regroup. Interpreting earnings as a measure of "fitness," we regressed individual average earnings on individual average contributions for the regrouping treatment, and compared this regression coefficient with the one for a regression of individual average earnings on individual average contributions for the combined treatment. The latter regression coefficient is higher, (mildly) suggesting that contributions are more highly rewarded with increased fitness in an environment of both regrouping and punishment than with regrouping alone.

Earlier experiments as well as this one have found punishment to be a powerful incentive toward cooperation. But punishment is not always a well-targeted incentive. The experimental design allows subjects to reduce the earnings of high as well as low contributors, and up to 20% of reductions are aimed at high contributors.[27] Analyzing the reduction treatment in an otherwise identical 10-period experiment, regressions in which the change in contributions is the dependent variable show that each dollar of punishment

[27]Such reductions of high contributors or cooperators are also found by Ostrom et al. (1992), Fehr and Gächter (2000a), and Falk, Fehr and Fischbacher (2001).

induces roughly a 50 cent increase in the contribution of a group's lowest contributor and a 33 cent increase in that of the next lowest contributor, but reduces the contribution of a high contributor by about 50 cents. It appears that "perverse punishment" can be a powerful incentive against cooperation.

Possibly, in the evolutionary context, the combination of regrouping and punishment might explain the development of cooperation and reciprocity better than either the opportunities for regrouping or punishing alone, as it did in our experiment. At the end of each session, we asked the subjects to write a debriefing statement. We found that subjects in the combined treatment were more likely than those in the other treatments to write remarks such as "it pays to cooperate."[28]

Suggestively, the experimental results relate to an old question in so-

[28]These debriefings can be colorful. A subject wrote: "When I started out, I was going to donate 10 every time to the group earnings. At first I thought I would soon be disappointed and get walked all over, but when I saw that others were joining me in the communal way of thinking, I got excited. And I saw that it benefited us because we sought each other out in the ranking process." In the same combined treatment session, another wrote: "after the first three rounds, I realized that colluding with a "10" was the best thing to do. There was a major incentive to do so. Not only are you being nice to people, but you are afforded the opportunity to work with those who also put 10. Ranking and providing reductions was crucial to the success of the experiment, as you were able to dictate to someone what kind of money they should be putting into the group account." In another combined treatment session, a subject wrote: "It does not pay to screw people. At the beginning, I thought I would give all ten dollars to the group in the first 2 phases of a round in order to gain trust, and then I would give nothing to the group in the last phase. However, the reductions that you incur by pursuing this strategy outweigh the benefits."

cial philosophy: does an increase in freedom, such as that associated with the rise of the market and the decline of traditional social relationships, reduce, increase, or leave unchanged the prevalence of moral behavior?[29] Our experiment suggests that sometimes freedom of association allows "virtue to be rewarded." The incentives of regrouping also increase the value of a good memory, the value of establishing a good reputation, and the payoff to narrowly self-interested agents for becoming skillful mimickers.

[29]The impact of social arrangements on people's moral preferences is discussed by contributors to Ben-Ner and Putterman, eds. (1998) and by Bowles (1998).

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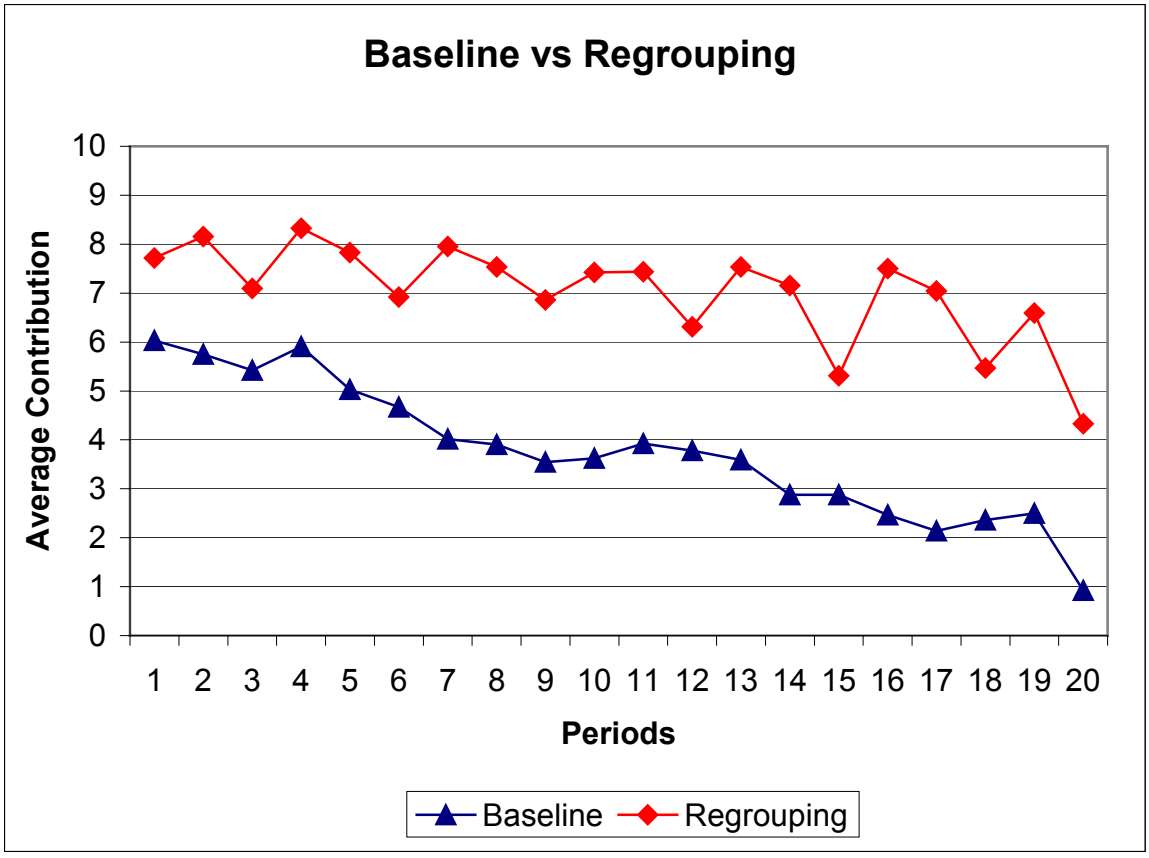

Figure 1. Average contribution by period in baseline and regrouping treatments.

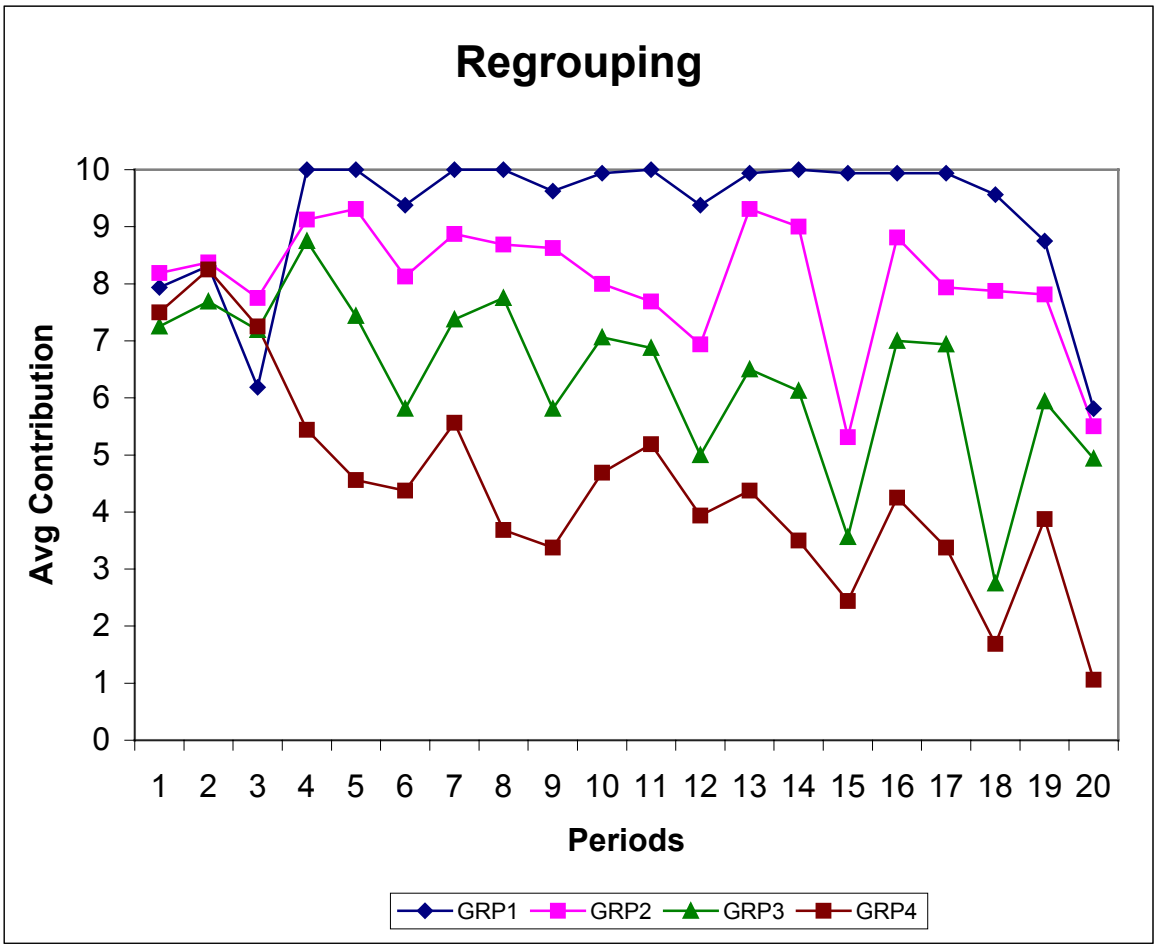

Figure 2. Average contribution disaggregated by group in regrouping treatment.

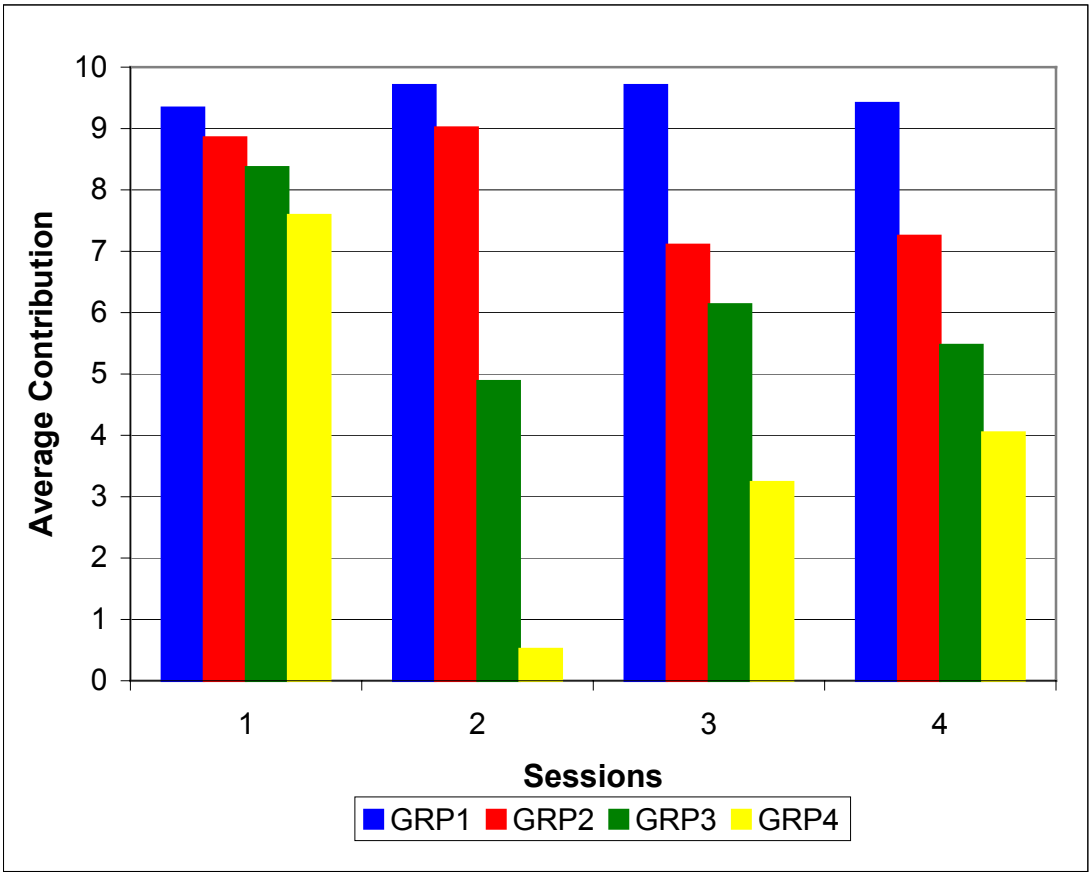

Figure 3. Average contribution by group formation order, grouped by session.

		ENDOGENOUS GROUPING	
		NO	**YES**
REDUCTION	**NO**	**Baseline** (4 sessions, 64 subjects)	**Regrouping** (4 sessions, 64 subjects)
	YES	**Reduction** (4 sessions, 64 subjects)	**Combined** (4 sessions, 64 subjects)

Table 1: Summary of the experimental design with all four treatments

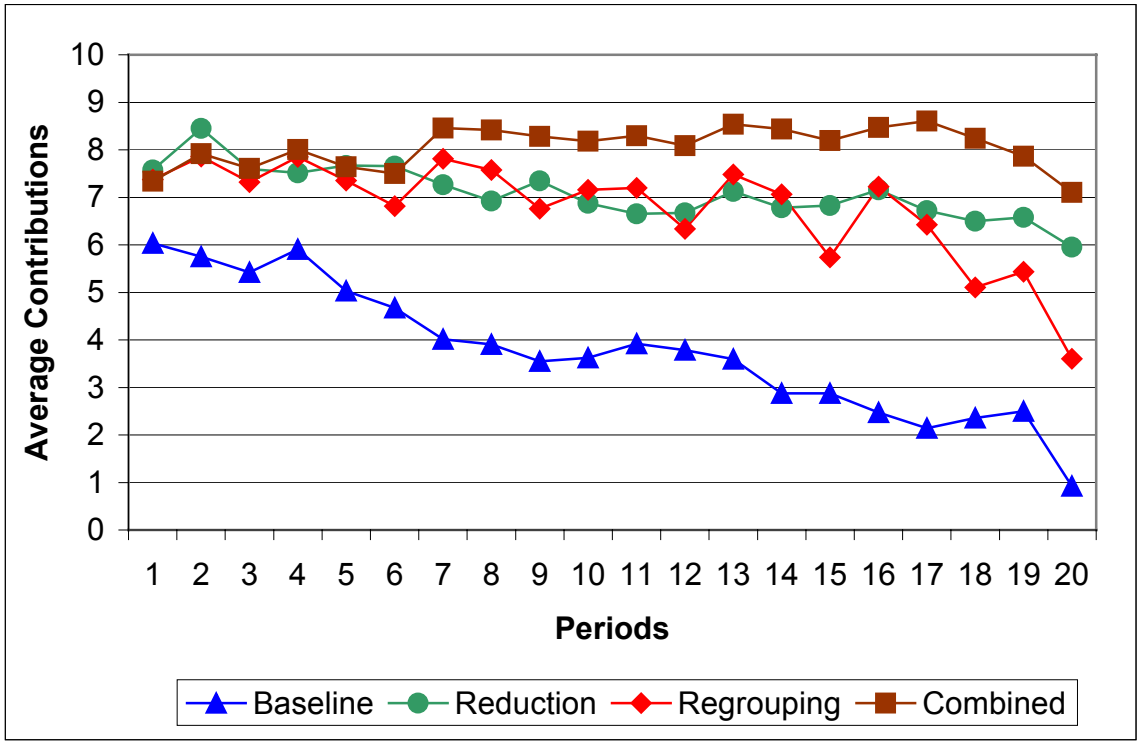

Figure 4. Average contribution by period in baseline, reduction, regrouping, and combined treatments

	Baseline	Regrouping	Reduction	Combined
Average Contribution	3.8	7.0	7.1	8.1
Average Earning	12.3	14.1	12.9	13.8
Efficiency	77%	88%	81%	86%

Table 2: Summary of the average contribution, earnings, and efficiency by treatment. Efficiency is defined as the proportion of the maximum attainable earnings that groups of subjects attained on average.

Appendix: Instructions for Combined Treatment

(For other treatments, delete the appropriate screens[1])

[Screen 1]

This is an experiment, funded by a research foundation, to study decision making. You will be earning money in "experimental dollars" during the experiment. At the end of the experiment you will be paid in cash in real dollars (each experimental dollar is worth real $0.07, i.e. seven cents). The amount you will earn will depend on your and others' decisions. The maximum possible earning is $27 (real dollars) and the minimum possible is $5. You are likely to earn an amount in between. Please make sure you understand the decision process.

[Screen 2]

Your Group

You will be placed in a group of four. The people in your group will not change during the experiment, but you will not know the identity of who is in your group, during the experiment or afterwards. The other three people in your group will have "screen names" of B, C, and D. You will be identified on your own screen as "You," but your name on others' screens will vary.

There will be 20 rounds in the experiment. Although the real identity of each of the other people in your group is unknown to you, each screen name will refer to the same person during a round. (But at the end of each round the screen names will be randomly switched, and then fixed for the next round.)

[Screen 3]

Earnings

Each round is like the others, so we will describe how your earnings for the first round are determined.

At the beginning of the round each member of your group will receive $10 (experimental dollars). Each of you must decide how to divide this amount between a group account and a personal account.

The money you assign to your personal account goes into your earnings.

An amount equal to 0.4 times the sum of all four assignments to the group account goes into your earnings.

[1] Treatments without regrouping delete screen 7 of the main instructions and screens 1 – 8, Regrouping Instructions. Treatments without reductions delete screen 5, Practice 5, and on screen 6 the last two lines of the earnings formula and the sentence following that formula.

Earnings = (amount in personal account) + (0.4)(total in group account)

[Screen 4]
The next four screens are designed to help you test your understanding of the experiment so far. The screens are set up in the manner of the actual decision screens of the experiment, but the numbers you will be asked to enter on them are for practice, and do not affect your earnings.

Corresponding to each screen, there is a paper worksheet on your desk which you should fill in first before typing the numbers onto the screen itself, as instructed.

[Practice 1]
Fill out the section below for the following situation. The four members of your group each have $10. Every member of your group has assigned $10 to the group account and $0 to their personal account.

1. Amount you assigned to group account: _____

2. Amount you assigned to your personal account: _____

   (= $10 - group account assignment on line 1)

3. Total number of dollars assigned to your group account: _____

4. Income from the group account for a member of your group _____

   (.4 x group account total in line 3)

5. Your earnings so far: _____

   (group account income in line 4 + personal account income in line 2)

Now, go back to the practice screen. Type in your assignment to the group account in the window according to the scenario above and submit it to make sure your calculations are correct.

[Practice 2]
Fill out the section below for the following situation. The four members of your group each have $10. Every member of your group has assigned $0 to the group account and $10 to their personal account.

1. Amount you assigned to group account: _____

2. Amount you assigned to your personal account: _____

   (= $10 - group account assignment on line 1)

3. Total number of dollars assigned to your group account: _____

4. Income from the group account for a member of your group _____

   (.4 x group account total in line 3)

5. Your earnings so far: _____

   (group account income in line 4 + personal account in line 2)

Now, go back to the practice screen. Type in your assignment to the group account in the window according to the scenario above and submit it to make sure your calculations are correct.

[Practice 3]

Person B assigned $10 to the group account and $0 to his or her personal account, person C assigned $5 to the group account and $5 to his or her personal account, and person D assigned $0 to the group account and $10 to his or her personal account.

Fill out the section below for the above situation assuming that you assign $5 to the group account.

1. Amount you assigned to group account: _____

2. Amount you assigned to your personal account: _____

   (= $10 - group account assignment on line 1)

3. Total number of dollars assigned to your group account: _____

4. Income from the group account for a member of your group _____

   (.4 x group account total in line 3)

5. Your earnings so far: _____

   (group account income in line 4 + personal account in line 2)

Now, go back to the practice screen. Type in your assignment to the group account in the window according to the scenario above and submit it to make sure your calculations are correct.

[Practice 4]
As in Practice 3, person B assigned $10 to the group account and $0 to his or her personal account, person C assigned $5 to the group account and $5 to his or her personal account, and person D assigned $0 to the group account and $10 to his or her personal account.

Fill out the section below for the above situation assuming that you assign $6 (rather than $5) to the group account.

1. Amount you assigned to group account: _____

2. Amount you assigned to your personal account: _____

(= $10 - group account assignment on line 1)

3. Total number of dollars assigned to your group account: _____

4. Income from the group account for a member of your group _____

(.4 x group account total in line 3)

5. Your earnings so far: _____

(group account income in line 4 + personal account in line 2)

How does the change in your assignment to the group account from $5 to $6 affect your earnings?

How does it affect the earnings of other members of your group?

Now, go back to the practice screen. Type in your assignment to the group account in the window according to the scenario above and submit it to make sure your calculations are correct.

[Screen 5]

Reductions

There is another decision that affects your earnings. Once you learn the

others' assignments to the group account, you have a chance to reduce others' earnings, and others have a chance to reduce your earnings.

The next screen and your last paper worksheet take you through an example of the earnings reduction process. As before, first fill out the worksheet, then enter the information onto the screen to check your work.

[Practice 5]
It costs you $0.25 to reduce the income of another person by $1.00. Fill out the section below for the following situation:

You assigned $5 to the group account and $5 to your personal account, person B assigned $10 to the group account and $0 to his or her personal account, person C assigned $5 to the group account and $5 to his or her personal account, and person D assigned $0 to the group account and $10 to his or her personal account. You reduce person B's earnings by $2, person C's by $3 and person D's by $4. You receive a total of $1 in reductions from other members of your group.

Fill out the section below based on the above assumptions:

1. Amount you assigned to group account: _____

2. Amount you assigned to your personal account: _____

   (= $10 - group account assignment on line 1)

3. Total number of dollars assigned to your group account: _____

4. Income from the group account for a member of your group _____

   (.4 x group account total in line 3)

5. Your earnings so far: _____

   (group account income in line 4 + personal account in line 2)

6. You reduced the earnings of others in your group by a total of _____

7. This cost you _____

(0.25 x the sum of your reductions from line 6)

8. Other members of your group reduced your earnings by: _____

9. The total change in your earnings due to reductions - _____
(line 7 + line 8)

10. Your total earnings for this period would be:
_____

Now, go back to the practice screen. Enter and submit your reductions according to the scenario above and check that your calculations are correct. This will complete the practice portion of the instructions.

[Screen 6]

Your Net Earnings

Your net earnings for a round will be:

Amount in personal account +
(0.4)(Total in group account) -
(0.25)(Total of your reductions of others) -
Total of reductions of your earnings made by others.

If your net earnings are negative in any round, they will be set to zero for that round.

At the end of the experiment, the net earnings for the 20 rounds will be totaled and converted from experimental dollars to real dollars. Then $5 will be added for your participation.

[Screen 7]

Regrouping

At the end of rounds 3, 6, 9, 12, 15 and 18, new groups will be chosen, based on rankings that each person gives to the others. The more favorably you rank some other person and the more favorably he or she ranks you, the more likely you and that person are to be grouped together.

At the time that you do the ranking, you will learn the average amount assigned to the group account by each person.

To rank the others, you type a number in each box (from 1 to 15). It will cost you $0.25 (experimental dollars) for the first ranking and $0.05 for

each additional ranking that is not a tie (ties happen when you type in the same number for two or more individuals). You can choose not to rank anyone, in which case there is no cost of ranking for you.

Further details about the mechanics of ranking will be given before the first ranking stage.

[Screen 8]

During the experiment, you are asked to be as quiet as possible. The only communication that is permitted is that resulting from the inputting of your decisions into your computer terminal. It is important that you understand how the experiment works before we begin. Are there any questions?

_ _ _ _ _ _

Additional instructions before first ranking and regrouping stage

[**Screen 1, Regrouping Instruction**]
You will now have a chance to rank the other individuals and new groups will be formed. These new groups will be fixed for the next 3 rounds, after which the process will be repeated following rounds 6, 9, 12 and 15. Let's see how you can make your rankings and then we'll see how all the the rankings are combined to form the new groups.

[**Screen 2, Regrouping Instruction**]
How the Regrouping Process Works

Following these instructions, you will see on your screen the average contribution level of each of the other individuals in the room for all of the previous rounds.

The computer orders the individuals and their information randomly. Click the box beside each subject and type in your ranking (a number between 1 and 15, for the 15 other persons in the experiment). Your highest or most favorable rank is "1," and your least favorable rank is "15." If you want to rank two or more individuals the same, just type in the same number for each.

[**Screen 3, Regrouping Instruction**]
Examples

If you choose to give a distinct ranking to each individual, your goal is to give a different whole number to each of them. To make the process easier, the computer allows you to assign to individuals decimal numbers between the whole numbers, and then it re-scales the numbers for you.

To see more about how the process works, consider some examples.

[**Screen 4, Regrouping Instruction**]
Example A.

You select the individual you most want to be grouped with and type in "1" in the box by that person. You select the individual you next most want to be grouped with and type in "2" by that person. But then you find a third individual that you would like to rank in between these two individuals. Just type a decimal number between "1" and "2" in that individual's box, for example "1.5" or "1.7".

[**Screen 5, Regrouping Instruction**]
Example B.

You decide you want to rank two (or more) people the same. Just type in the same number for each.

[**Screen 6, Regrouping Instruction**]
Example C.

You change your mind and want to rank someone differently. Click on the box and overtype your previous ranking.

[**Screen 7, Regrouping Instruction**]
Scaling

Once you have typed ranking numbers for each individual, click in the box labeled "Scale." The computer will keep your ordering but will re-scale the ranking numbers. You will notice that when you have ties the ranking numbers will be reset to the mid-point between your next higher and next lower rankings. If this mid-point is not a whole number, a decimal number will appear.

After the computer has re-scaled, you will have a chance to either approve this ranking, or to make further changes. To modify your rankings, just click in a box and overtype your previous rankings. Remember that you can use decimal numbers in making your adjustments, and that the computer will return decimal numbers to you in certain cases involving tied rankings. After making any changes, press "Scale" again. Once you are satisfied with your rankings, click the box labeled "Submit."

[**Screen 8, Regrouping Instruction**]
Cost

You will pay a cost of $0.25 (25 experimental cents) for your first ranking and $0.05 (5 experimental cents) for each additional ranking. Any group of rankings that are tied will be charged as a single ranking.

If you don't want to rank anyone, press the button labeled "Don't rank." There is no cost if you don't rank anyone.

Please note that once you type in some ranks, it is important to complete the job and not leave any blank ranking spaces on your screen (ties must be indicated by assigning a common number, not blanks).

[Screen 9, Regrouping Instruction]
We will resume the experiment with the ranking stage when everyone is satisfied that they have understood the instructions. Are there any questions?