Why free ride? The role of feedback in the public goods game[1]

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Abstract

We study a public goods game where subjects get feedback either continually or intermittently. We find that the latter helps to mitigate problems of free riding because subjects focus on a string of choices rather than deciding on a case by case basis.

JEL Classification: C72, C91

Introduction

The free riding hypothesis in the private provision of public goods has been the subject of a large number of laboratory experiments.[3] A typical public goods experiment looks like this. A group of subjects, usually consisting of between 4 and 10 participants, is gathered. Each participant is given an endowment of tokens and has two investment choices; she may keep her tokens by placing them in a private account, or contribute the tokens to a public account. The total contributions to the public account are then doubled and the resulting amount distributed equally among all the players, regardless of who contributed. The game can end at this point, or it can continue with additional rounds of decision-making. The Nash equilibrium for this game is for each participant to free ride by contributing none of her endowment to the public account. This solution is Pareto-dominated by the socially efficient outcome, where each participant contributes his or her entire endowment to the private account.

Prior researchers have observed certain behavioral regularities in public goods experiments. First, there is no significant evidence of free riding in single-shot games. Rather contributions average around 40% to 60% of the Pareto efficient level. Second, when subjects play a repeated game, contributions "decay" over time towards the free-riding level, although total free-riding is seldom realized. So free-riding while not all pervasive, as theory suggests, is not completely non-existent either. See Isaac, Walker and Thomas (1984), Isaac McCue and Plott (1985), Isaac and Walker (1988a, 1988b) and Kim and Walker (1984). Ledyard (1995) provides a review of much of this literature.

[3] See Ledyard (1995) for a comprehensive review of prior works in the area.

This phenomenon of contributions starting at about halfway between the Pareto-efficient level and the free-riding level and then decaying towards the free-riding level has been the subject of voluminous research starting with Andreoni (1988). Andreoni (1988, p. 292) suggests that there are two possible explanations for this observed decay in contributions. First, the learning hypothesis holds that a single-shot play of the game is not sufficient for the subjects to learn the exact incentives and the dominant strategy. Repeated play allows such learning and so over time with repeated trials subjects learn to play to free ride. However, this test of learning as an explanation of decay is confounded by the fact that repetition allows subjects to signal future moves to each other as well to infer each other's strategies via contributions to the public account. See Andreoni (1988) for a detailed discussion. This is the basis of the alternative hypothesis – the strategies hypothesis - that says that contributions decline not because of learning (in the sense of figuring out the dominant strategy of free-riding) but rather due to strategic behavior on the part of the subjects.[4] Thus the learning hypothesis must incorporate feedback provided by the decisions made by group members besides figuring out the dominant strategy of free riding. That is subjects also learn that many subjects free ride and in turn those subjects start to free ride themselves. Andreoni (1988) examines the strategies and learning hypothesis and fails to come up with any definitive conclusions. Subsequently, this line of research has spawned a large number of papers. A review of this entire line of research is found in Andreoni and Croson (1998).

In this paper we propose to explore the phenomenon of contributions decay from a different perspective. The public goods game is really a variant of a repeated play

[4] See Andreoni (1988) for detailed discussions.

prisoner's dilemma with contributing being to cooperating and free riding analogous to defecting. Defection produces higher rewards on any trial but by inciting others into defecting, it lowers long-term rewards. Contribution, on the other hand, might not maximize rewards on each trial but has the potential to increase long-term rewards by sustaining cooperation by others. It has been pointed out that this repeated prisoner's dilemma in the social sphere is analogous to self-control in the personal sphere. As Silverstein et al (1998) point out (p. 125) "self-control is analogous to consistent cooperation while impulsiveness is analogous to momentary defection." In a prisoner's dilemma game, the subject's alternatives are identical to the alternatives provided in many studies of self-control – a smaller-sooner reinforcer (defection/impulsiveness) versus a larger-later reinforcer (cooperation/self-control). See Rachlin (1995a, 1995b).

It has also been suggested that a temporal patterning of trials (a string of rapid trials followed by a relatively long inter-trial interval, followed by another string (and so forth) increases cooperation by encouraging subjects to choose, not on a case-by-case basis, but for the whole string at once. This tendency is further strengthened by the absence of feedback during the string. In everyday self-control tasks, such global decision making tends to reduce impulsiveness and increase self-control (cooperation).[5]

We design an experiment to test the conjecture that such patterning of trials will lead to higher cooperation. Two groups of subjects are randomly assigned to (a) a *continuous feedback* treatment and (b) an *intermittent feedback* treatment. In the continuous feedback treatment, a control group of 20 players play the conventional public goods game for 10 periods and receive feedback about total contributions to the public

account and their earnings at the end of the every round. In the intermittent feedback treatment, a second experimental group plays the same exact game with the same parameters, but receive feedback about contributions to the public account and their earnings intermittently. More specifically this group receives feedback at the end of period 3 (about periods 1 to 3), period 6 (about periods 4 to 6) and finally at the end of period 10 (about periods 7 to 10). It is predicted that the intermittent feedback group would exhibit lower rates of decay than the continuous feedback group.

Our conjecture is validated by the experimental results. What we find is that while the continuous feedback group exhibits patterns of decay similar to those reported in previous experimental work, the intermittent feedback group does not. More importantly, for the latter group there is hardly any decay in contributions with no significant difference in average contributions between period 1 and period 10. Moreover we find that there is a strong positive correlation between what a subject contributes and what he expects other group members to contribute. To our surprise though, contribution by the continuous feedback group is higher initially. Also general levels of contributions in both treatments are higher than those reported previously. We will proceed as follows. In the next section we describe the exact design of the experiments. Section 3 presents the results (Section 3.1) and discusses our findings (Section 3.2). Section 4 concludes.

2. Experimental Design

The study uses non-computerized classroom experiments with 40 subjects in 10 four-person groups. 5 of those groups (20 subjects) take part in the continuous feedback

[5] McReynold et al. (1983) show, for instance, that dieters who plan their meals for the day in the morning (i.e. choose a string of meals) eat less than those who decide on a meal-by-meal basis. Kudadjie-Gyamfi and Rachlin (1996) also find that such temporal patterning of trials increase self-control.

treatment while the other 5 (another 20 subjects) take part in the intermittent feedback treatment. Each group takes part in one session of the experiment with each session consists of 10 rounds. The subjects were recruited from among the staff and students of Wellesley College. Monetary rewards were emphasized at the time of recruitment. Subjects were randomly selected to participate in the continuous treatment or the intermittent treatment. The public goods game used in this paper is similar to other public goods experiments. The subjects were given a copy of the instructions to read and the instructions were also read aloud.[6] Before round one, the subjects were then asked to predict what each of the other group members would contribute in the first round. Each round worked in the following way. Each subject is given a budget of ten tokens. Each token was worth one point. The tokens could be invested in either a private account or a public account. Tokens invested in the private account were worth exactly one point each. The total tokens invested in the public account were added, and the sum was then doubled and the resulting amount equally distributed among the four group members. The number of tokens invested in each account during every round was noted on a record sheet. The number of tokens invested in the public account was written on a slip of paper, which was handed to the experiment moderator to tally. In the continuous feedback treatment, after every round the subjects were told their return from the public account. In the intermittent feedback treatment subjects were told at the end of rounds 3, 6 and 10 what the contributions were to the public account in the preceding rounds. For example, in Round 7, participants were given feedback on contributions for Rounds 4, 5, and 6, respectively. Individual contributions are not revealed. At the end of the game, the

[6] A copy of the instructions is available from the corresponding author upon request.

number of tokens accumulated in each round were summed and exchanged for cash at the rate of $0.05 per point. The experiment lasted about 45 minutes and average earnings were $8.75.

3. Experiment Results and Discussions

3.1 Results

The basic insight of this paper is summed up in Figure 1, which shows the pattern of average contributions over 10 rounds in the continuous and intermittent feedback treatments. Several interesting results emerge from comparing the patterns of contributions between the two treatments.

<<Figure 1 about here>>

First, there is a significant difference between the first round and last round contribution in the continuous feedback treatment, whereas no such difference exists in the intermittent treatment. See Table 1 for a breakdown of contributions by round in each treatment. In the continuous treatment, mean contribution in the first round is 6.95 (69.5%), which drops to 4.55 (45.5%) by the tenth round. Using a t-test, we find that the first round and tenth round contributions are significantly different from one another at the .02 significance level ($t = 2.49$ p-value = 0.02). The non-parametric Wilcoxon test bears out this conclusion ($z = 2.20$, $p = 0.03$). In the intermittent feedback treatment, the mean contribution in the first round is 5.35 (53.5%), which only decays to 4.9 (49%) in the last round. This is not a significant difference using either a t-test or a Wilcoxon ($t = 0.6594$, p-value = 0.52; $z = 0.620$, p-value = 0.54 respectively). What is surprising is that round 1 contributions in the continuous treatment are significantly higher at 69.5%

compared to the intermittent treatment at 53.5% (t = 1.86, p-value = 0.07 on a t-test and z = 2, p-value = 0.045 on a Wilcoxon).

<<Table 1 about here>>

We also find that there is a significant difference in the rates of decay in the two treatments. That is if we look at the contributions in the two treatments then contributions drop off more sharply in the continuous treatment which has a greater negative slope. In order to test for differences in the slopes, we performed a regression of average contributions on three independent variables. These include (1) period (goes from 1 through 1), (2) group, a dummy variable that equals 0 for the continuous treatment and 1 for the intermittent and finally (3) group*period, an interaction term between group and period. A significant coefficient on group*period will demonstrate that the slopes for the two different treatments are indeed different. Table 2 shows the regression output. As can be seen from Table 2, the coefficient for the interaction term is significantly different from zero showing that the rates of decay are significantly different in the two treatments.

<<Table 2 about here>>

We find that there is a strong positive correlation between expectations and contributions.[7] The Spearman rank correlation coefficient between average expectations and average contributions is 0.597 with a corresponding p-value of 0.000. Generally we find that both groups of subjects exhibit high expectations. In the continuous feedback treatment subjects on average expect contributions of 60.8% while in the intermittent treatment expected contributions are 54.4%. Once again we find that average expectations are lower in the intermittent feedback treatment than in the continuous

[7] Croson (1995) also finds a strong positive correlation between subjects' contributions to a public good and their beliefs about how much others were contributing.

feedback treatment. However, this difference is not significant using a T-test (t = 1.014, p-value = 0.323) or a Wilcoxon (z = 1.027, p-value = 0.304). This result shows that a subject's contribution depends on her expectations of other subjects' contributions. Thus, contributions are not motivated by pure altruism. Instead, subjects seek to maximize their own payoff by contributing at a level similar to that of the other participants.[8]

We find that, because intermittent treatment subjects are only given feedback after rounds 3, 6, and 10, they are significantly more farsighted than continuous treatment subjects. F-test results reveal that, in deciding what to contribute in Round 10, intermittent treatment subjects consider the past 9 rounds, while continuous treatment subjects do not. In fact, continuous treatment subjects do not even consider the past 3 rounds when deciding what to contribute in Round 10 (see Table 3). This reinforces our argument that the intermittent feedback will lead to lower defection by forcing subjects to decide for an entire string rather than on a trial by trial basis.

<<Table 3 about here>>

3.2 Discussion of results

Most previous studies of the public goods game report a 40%-60% contribution rate on the first round. In our experiment, the average contribution rate for the continuous treatment is 69.5% in round 1 and 45.5% in round 1 while the corresponding figures for the intermittent treatment are 53.5% and 49%. The average levels of contribution in round 1 and especially at the end in round 10 are much higher than those reported in

[8] We believe that the critical role played by expectations may explain why contributions "jump up" when the game is "restarted" as in Andreoni (1988) or Croson (1996). In real life bitterly divided enemies long at war approach the negotiating table with renewed expectations after a cease-fire or long feuding spouses start anew after being separated. It seems that the relatively long inter-trial interval, between the end of the previous game and the start of the new one, is enough to create fresh expectations in the minds of the

previous studies.[9] Two facts may have contributed to this. This study was conducted at a small, close-knit, women's college, and the effects of participating in the game with others from the same small community may have caused contributions to increase. Second, the fact that there are only four members in a group might have led to higher contributions. Moreover a combination of the two factors – social closeness of the subjects as well as small group size - may have led to high average levels of investment.

The second curious fact is that round 1 contributions by subjects in the continuous feedback treatment are significantly higher than contributions by subjects in the intermittent treatment. We have already found that contributions are closely connected to expectations. Continuous feedback subjects expect higher contributions from the group (60.8%) than do intermittent feedback subjects, even though the difference is not significant. This might partly explain the higher initial contributions by the former group. Continuous feedback subjects may also have contributed more in Round 1 because they were signaling to their fellow group members that they intend to contribute heavily to the public account if others do the same. Since intermittent feedback subjects do not receive feedback on contributions to the public account until Round 3, they are not able to signal to the other participants at the beginning of the game. This might have led to more circumspect behavior on the part of the intermittent feedback subjects resulting in lower initial contributions.

We believe that subjects approach the public goods game expecting high contributions from other group members and respond by contributing themselves. As

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subjects. They feel that this next time around they will succeed in keeping contributions high and therefore they start with high contributions.

[9] The overall average contribution in our study is 61% in the continuous treatment and 52.2% in the intermittent treatment. Compare this to the overall average of 16.6% in the partners treatment and 20.7% in

Rabin (1998, p. 21) points out, "…reciprocal altruism essentially turns public goods situations into "coordination games" where high contributions are efficient equilibria and low contributions are inefficient equilibria". But the continuous feedback treatment (which is the usual design of all previous studies), by asking subjects to decide on a trial by trial basis, leads to greater free riding (defection). Subjects here focus more on winning each trial than focusing on long-term rewards. As subjects defect, others revise their expectations downwards and in turn themselves defect. Thus the continuous feedback treatment provides more opportunities for learning the bad lesson that others will free ride and therefore you should too. The intermittent feedback treatment, by forcing subjects to decide on a string on investments, forces them to focus on long-term rewards and hence retard defection and the subsequent decay in contributions

4. Concluding remarks

In this experiment we have shown that the problem of decaying contributions in public goods game can be mitigated by forcing subjects to commit to a string of investments rather than have them decide on a case by case basis. In the continuous feedback treatment, subjects have more opportunities to observe that their fellow group members are not giving at a consistently high level, and they begin to focus myopically on "winning" the current round instead of thinking about the game as a whole. We find that contributions to the public good are driven by subjects' expectations of group members. Subjects, who expect others to contribute, themselves contribute to the public good. So in some sense the subjects turn the prisoner's dilemma of the standard public goods game into a coordination game with expectations. Subjects provided with

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the strangers treatment in Andreoni (1988). In Croson (1996) also, by round 10 contributions have declined

intermittent feedback are significantly more farsighted than those who receive continuous feedback.

One may be able to apply this result to public fundraisers. Instead of having a constantly updated billboard of donations for millions to see, a better strategy could be to have updates given at intervals, so that potential donors focus on their own value from giving and the long-term benefits of their choice instead of concentrating on the actions of others.

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to less than 25% in both the partners and strangers treatment.

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Table 1: Average Contributions in the Two Treatments by Round

Round	Avg. Contributions: Continuous Feedback	Std. Deviation: Continuous Feedback	Average Contributions: Intermittent Feedback	Std. Deviation: Intermittent Feedback
1	6.95	2.67	5.35	2.60
2	6.85	2.94	5.5	2.80
3	6.95	2.95	5.2	2.73
4	7.15	2.76	6.15	1.87
5	6.75	3.08	5	3.08
6	5.85	3.47	5.3	3.15
7	5.9	2.61	5	3.13
8	5.05	2.93	4.85	3.13
9	4.95	2.74	4.95	3.46
10	4.55	3.58	4.9	3.42
All	6.095	2.973	5.22	2.937

Table 2: Testing for Differences in the slopes. Dependent Variable = Average Contributions

Variable	Coeff.	Std. Error	t-stat	p-value
Period	-0.2972	0.0394	-7.54	0.000
Group	-2.0833	0.346	-6.02	0.000
Group*period	0.2197	0.0557	3.94	0.001
Constant	7.73	0.2446	31.6	0.000
Adjusted-R^2	0.82			

Table 3: F-Test Results

Continuous Feedback Treatment

Y-Variable	**X-Variables**	**F-Statistic**	**Prob>F**
Round 10	Rounds 7,8,9	2.349269	0.111025
Round 10	Rounds 1-9	0.852971	0.589549

Intermittent Feedback Treatment

Y-Variable	**X-Variables**	**F-Statistic**	**Prob>F**
Round 10	Rounds 7,8,9	11.35857	0.000307
Round 10	Rounds 1-9	2.842051	0.059623

Figure 1: Average Contributions by Treatment

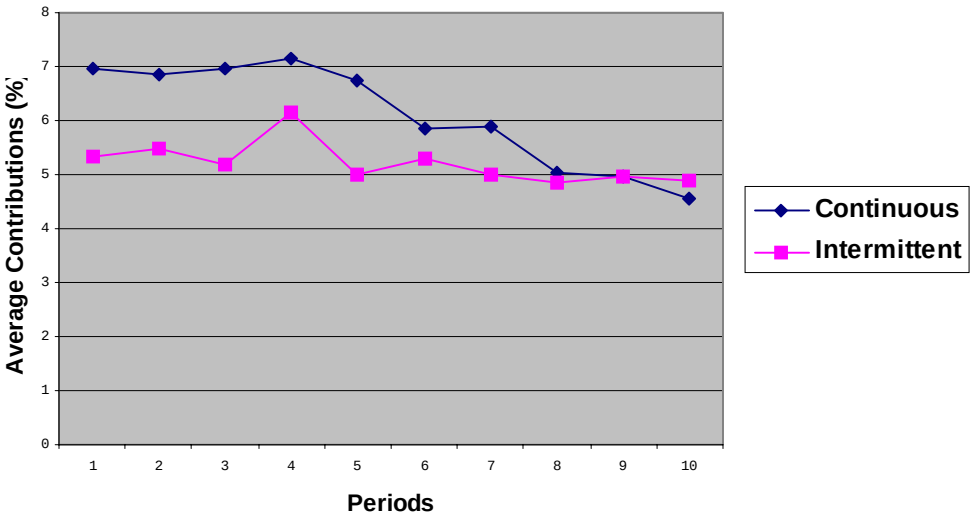

Figure 2: Expectations and Contributions