Revisiting Kindness and Confusion in Public Goods Experiments

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There has been substantial recent interest in determining why there is cooperation in public goods experiments even in environments that provide all subjects with the incentive to free ride (see e.g., John O. Ledyard, 1995). Theories used to explain such cooperation generally posit either that subjects are "confused" in the sense that they make errors or do not understand the game's incentives, or that subjects contribute due to social factors such as altruism and reciprocity. Although several authors have pointed out the importance of distinguishing between these alternatives,[1] the roles that confusion and social motives play in determining public contributions remain poorly understood. This paper provides new evidence on the way that confusion and social motives determine contributions in public goods games by reporting data from experiments that use a new design with the Voluntary Contribution Mechanism (VCM).

Two important and often replicated findings in the experimental public goods literature are (1) that subjects' public contributions are much greater than predicted by standard economic theories of free-riding and (2) that these contributions decay over the course of multiple-round games (see e.g., Douglas D. Davis and Charles A. Holt, 1993). Models that employ social factors to explain cooperation and its decay usually assume that subjects are motivated by altruism, reciprocity, or fairness (see e.g., Andreoni, 1990; Rachel T. A. Croson, 1998; Anna Gunthorsdottir et al., 2001). It has been argued, for instance, that subjects make contributions in order to elicit like contributions from reciprocators in subsequent rounds and that decay in public contributions might result from "frustrated attempts at kindness" (Andreoni, 1995 p. 892). Specifically, because there is generally heterogeneity in the willingness to contribute to the public good, initially cooperative players will likely reduce their public contributions after being grouped with relatively low contributors. In contrast, confusion theories postulate that players make public contributions either in error or because they do not understand how to pursue their self-interest.[2] These theories argue that high initial contributions decay primarily because subjects gradually come to understand the game's incentives.

Recently, Andreoni (1995) conducted an interesting series of experiments in the first and, to our knowledge, only effort to discriminate between these competing theories of cooperative play. He provides two reasons that doing this is important. The first is that knowing the relative importance of confusion and social motives in generating cooperative decay can provide a useful guide to future research. While Andreoni argues that such knowledge could be used to inform research on learning models, note also that to the extent confusion is found to be important, shedding light on the way different sorts of instructions affect confusion could help to improve pedagogics. A second compelling reason Andreoni gives is that the outcomes of experiments designed to test theories of social giving are difficult to interpret if confusion is a primary source of cooperation.

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[1] See, for example, James Andreoni (1995), Martin Sefton and Richard Steinberg (1996), and Thomas R. Palfrey and Jeffrey E. Prisbrey (1997).

[2] This paper focuses on only standard linear games in which to contribute zero to the public good is the dominant strategy.

A reasonable characterization of Andreoni's results is that "[social motives] and confusion are equally important in generating cooperative moves in public-goods experiments" (Andreoni, 1995 p. 900).[3] However, Andreoni's design provides only bounds on the amount of confusion, and these bounds are rather loose in the final rounds of his experiments. For instance, he reports that about 38 percent of all cooperation between rounds six and ten of his regular public goods game could be due either to confusion or to social motives.[4] In addition, Andreoni points out that his design lends upward bias to his estimates of confusion's bounds. Hence, the relative importance of confusion and social motives in public goods experiments, particularly with regard to their respective roles in cooperative decay, remains an important open question.

This paper presents results from an easily replicated design that provides new evidence with respect to the roles of social motives and confusion in generating cooperation and cooperative decay in VCM experiments. Our design compares contributions in a standard public goods game to contributions in treatments where social factors have been largely eliminated. To remove social motives we place individual subjects into groups in which the other "players" are computers. The human player is aware that the other group members are computers and is told that the computers' contributions to the public good are independent of the subject's own play. Under these conditions players have no opportunity to benefit either themselves or other subjects by cooperating. Hence, we are comfortable in asserting that contributions in this condition are due to confusion. It is worthwhile to point out, however, that because contributions in the computer condition decrease total monetary rewards, subjects in this condition could contribute altruistically in order to benefit the experimenter (or perhaps future subjects) by extending the subject-payments budget.

Consistent with Andreoni (1995), our results suggest that about half of all cooperation in our standard public goods game is due to confusion. Our data also provide evidence that confusion accounts for more cooperation in early rounds of the experiment than in later rounds. We find that reductions in confusion can explain all of the cooperative decay in our standard VCM experiment.

I. Andreoni's Design

Because our work complements Andreoni's (1995) initial research, it is worthwhile to describe his work briefly here. Andreoni's experiments included three conditions. The first was a standard ten-round public goods game with five players and a marginal per capita return (MPCR) to the public good of 0.5. In a second condition (the "Rank" condition), subjects played a game that was similar to a public goods game, but with a fixed pool of payoffs. Subjects in this condition were paid fixed amounts according to their ranking in terms of the contribution to the public good, with the player contributing the least receiving the highest payoff ($0.95), the person who contributed the second least given a slightly lower payoff ($0.87), and so forth. In this condition, contributions to the "public good" did not increase aggregate benefits, but merely cost the contributor and benefited other group members.[5] A third condition ("RegRank") was included that was identical to the first but added feedback about where one's contribution to the public good ranked with respect to other players' contributions. This generated a control condition that enabled meaningful comparisons to the Rank condition.

Andreoni argued that contributions in the Rank condition were due to confusion because the condition's zero-sum payoff structure left no incentive for cooperation. Then he assumed that one could use the contributions in this condition as an index of his regular game's subjects' confusion and, therefore, that the difference between contributions in the Rank and RegRank conditions could be considered an index of social motives in his regular public goods game.

An important feature of Andreoni's design is that the Rank condition is not directly comparable

[3] Within any round, a subject who contributes any positive amount to the public good is said to have made a single "cooperative move."

[4] See Andreoni (1995), Table 2, p. 896.

[5] An advantage of the rank condition is that, because it is a zero-sum game, it is not possible for a subject to behave altruistically toward the experimenter, whereas our computer condition admits this possibility.

to the regular public goods game. This is unfortunate because the regular game is the condition of primary interest. Moreover, the RegRank condition cannot be compared to the regular game as the information structure in the two experiments differs. The result, as Andreoni clearly points out, is that many of the contributions in the regular public goods game are classified ambiguously as due either to confusion or to social motives. This problem becomes rather severe in latter rounds of the experiment: more than half of all contributions in the regular public goods game cannot be classified between rounds six and ten. Hence, Andreoni is restricted to describing bounds on the number of moves due to confusion and social motives and is prevented from drawing convincing inferences about the importance of reduced confusion in relation to social factors in generating cooperative decay.

Andreoni (1995) also points out that this design is biased in favor of finding evidence of confusion. One reason is that any contribution in the Rank condition that is due to altruism is necessarily misclassified as due to confusion. A second reason is that the Rank condition adds complexity to the experiment's instructions, and this may lead to more confusion in the Rank treatment than in the regular public goods game. Hence, Andreoni's bounds on the roles of confusion and social motives in generating public contributions seem open to question (see also Kurzban, 1998).

II. Experimental Design

There were two conditions in our experiment and both were played entirely on computers. The first condition, the "human condition," was a standard linear public goods game. In this condition there were four players per group and each player was given an endowment of 50 tokens in each of ten rounds of play to divide between the Individual and Group Exchanges. A table was provided to assist players in determining the payoff from the Group Exchange, and a table of the history of play was also provided. This table indicated the number of tokens contributed by the subject to each Exchange, the total number of tokens contributed to the Group Exchange by the other three players, and the subject's payoff for each round. Tokens placed in the Individual Exchange returned one cent to the player making the investment, while tokens placed in the Group Exchange generated a return of half of one cent to each group member. Therefore, the marginal per capital return (MPCR) to public contributions was 0.5.[6]

The second condition, the "computer condition," was identical to the first except that each group consisted of one human player and three computer "players." We ran the computer condition reported here subsequent to the human condition. Each round, the aggregate computer contribution to the group exchange was three-fourths of the average aggregate contribution observed for that round in the human condition, rounded to the nearest token.[7] For example, the average aggregate contribution in round one in the human condition was 124 tokens, so the aggregate computer contribution was 93 tokens in that condition's first round.

At the beginning of each round in the computer condition, subjects were reminded that the three computer players' contributions were predetermined and would be unaffected by the subject's own decision. In addition, before their own contribution decision, the human subject was told the aggregate number of tokens that the computers would contribute that round. We provided subjects with this information to limit the possibility that they would falsely interpret the nonconstant path of computer contributions as a response to their own actions. If players believed that their decisions could influence the computer players' moves, our inferences about confusion effects would be confounded since contributions based on this false belief would be attributed to confusion.

Because our focus is confusion, exercising strong control over what subjects know and believe about the experiment is, in our view, crucial. However, this control leaves the computer and human conditions imperfectly compa-

[6] Recall that Andreoni (1995) also uses an MPCR of 0.5, as have many others in the experimental VCM literature.

[7] We thank an anonymous referee for suggesting this approach. An earlier version of this paper reported data from a computer condition in which the computers' contributions were fixed at the same value each period. These data resemble the data reported here very closely and are available from the authors on request.

rable. In particular, since the game's incentives might be relatively more transparent in the computer condition, confusion in the computer treatment might be systematically less than confusion in the human treatment. That is, our design might bias downwards our inferences about confusion's importance in the human treatment.

We report here the data from 52 undergraduates at the University of Arizona who were recruited with the recruitment system in place at the Economic Science Laboratory. Subjects were told that they would receive $5 for participating in addition to whatever they earned during the course of the experiment and that the experiment would last no more than one hour. Subjects' earnings were paid to them privately at the end of the experiment. On average, subjects earned an additional $7.75 and were in the laboratory for about 30 minutes.

We ran nine experimental sessions each of which included between four and 12 individuals. In six sessions, subjects were randomly assigned either to the human condition or a computer condition under the constraint that a multiple of four subjects be assigned to the human condition (the data from this computer condition is not reported here; see footnote 7). In three sessions, run subsequent to the initial six sessions, all subjects were assigned to the computer condition. To maintain comparability of the treatments, everything, including the instructions provided to the subjects, was left unchanged in these latter sessions. We obtained data from 20 subjects (five groups) in the human condition and 32 players in the latter computer condition. Players were not told the identity of the other subjects in their group and were seated so that they could not see other players.

Once all participants had arrived and were seated at a computer terminal, they were provided verbal and written instructions as detailed in the Appendix. Our instructions follow those of Andreoni (1995) closely but differ in that we added an explanation of our computer interface (Andreoni's experiments were hand run). The instructions describe the return to investments in the public and private accounts and they indicate that subjects' experimental earnings are the sum of their earnings over all ten rounds in the game. It is worthwhile to reiterate that all subjects were informed as to whether their group members were humans or computers.

III. Results

Theories of social contributions may or may not link a subject's play to the history of their group's contributions. For example, theories of other regarding preferences can explain cooperation without reference to group contributions while reciprocity theories explicitly incorporate group behavior. We are not aware of any theory of the relationship between confusion contributions and group play, and it seems difficult to provide for such a dependence in a way that cannot be interpreted as reciprocity. Throughout the analysis of our experimental data, therefore, we maintain the assumption that confusion contributions in both of our conditions are independent of the history of group contributions.[8] This assumption is convenient in that it allows for a clean analysis of the experimental data. In particular, since our treatments differ only in the way subjects are grouped, an implication of this assumption is that the distribution of confusion contributions in the human condition should be similar to the distribution of confusion contributions revealed in the computer condition.[9]

Because a human player in the computer condition can benefit neither themselves nor other subjects with public contributions, we attribute all "cooperation" in this condition to confusion. This attribution assumes that several potential confounds have a negligible effect on contributions. One of these, as pointed out above, is altruism towards the experimenter. Also, because we knew which subjects were in the computer condition (see footnote 7), contributions could have stemmed from an attempt to satisfy a social norm such as not appearing too greedy. Another potential confound is that subjects might have understood yet not believed the experiment's instructions.

[8] The amount of confusion might somehow be influenced by group play. Since we are not aware of any evidence on the nature of this effect, and because we suspect any such effect is small, we abstract from it in our experimental analysis.

[9] Andreoni (1995) needs a similar assumption to justify comparisons across his conditions.

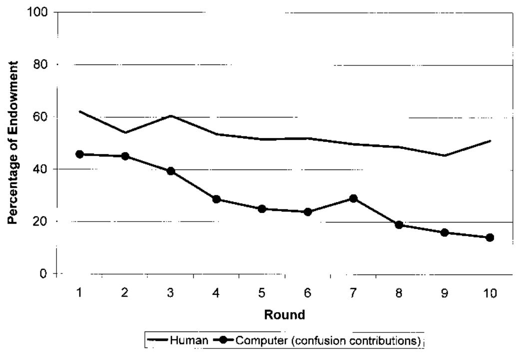

FIGURE 1. MEAN CONTRIBUTION BY ROUND IN COMPUTER AND HUMAN CONDITIONS

In the human condition there will be confusion as well as social contributions. Accordingly, we expect that the mean contribution in the human condition will be larger than that in the computer condition in every round. Because we assume confusion is the same in both conditions, the difference in mean contributions between the human and computer treatments provides an estimate of the importance of social motives to cooperation in the human condition.

Figure 1 plots the mean percentages of subjects' endowments contributed in each round in both conditions. The mean contribution in the human condition is statistically significantly larger than the mean contribution in the computer condition in every round except the second, where the means are statistically indistinguishable.[10] Overall, 28.6 percent and 52.8 percent of all tokens are contributed to the public good in the computer and human conditions, respectively. This suggests that confusion accounts for about half, 54 percent, of all tokens contributed to the public good in our standard public goods game.

Both conditions exhibit statistically significant decay in cooperation over the ten rounds of the game. However, Figure 1 shows that the amount of decay is greater in the computer condition than in the human condition: contributions fall from 46 percent in the first round to 14 percent in the final round in the former condition, and from 62 percent to 51 percent in the latter.[11] Because we assume that cooperation due to confusion is similar in the human and computer conditions, it follows that all of the cooperative decay in our standard public goods game can be explained by reductions in confusion. Consequently, it does not seem that cooperation due to social motives decays much with rounds.

Andreoni (1995) suggested that part of cooperative decay might be due to a reduced propensity of socially motivated subjects to contribute as they become frustrated by lack of sufficient reciprocity by their fellow group members. We find little evidence of this effect in our experiments. However, the overall rate of cooperation in our experiment is greater than in Andreoni's, and indeed is on the high end of what is usually found in experiments with similar parameter values. Moreover, the cooperative decay in our human condition is not as great as Andreoni reported for his standard public goods game. In his experiments contributions fell by about 50 percent over ten rounds while ours fell by about 20 percent. This might indicate that our subjects were slightly more willing to cooperate than Andreoni's and that the difference between our rate of decay and his can perhaps be attributed to differences in the frequencies of frustrated attempts at reciprocity.[12]

[10] Standard t-tests based on individual contributions (allowing for unequal variances) reject the hypothesis that the means of the contribution distributions are the same, against the alternative that the mean of the computer condition's contribution distribution is lower, at the 5-percent significance level in all but the second round. The null is rejected at the 1-percent significance level in all rounds except the first, second, third, and seventh.

[11] We ran an ordinary least-squares regression of the amount of cooperation on an intercept, a dummy for the condition (which took value one in the computer condition), the round, and the product of the condition dummy and the round. The results indicate that cooperative decay in the human condition is significant at the 10-percent level, decay is statistically significantly faster in the computer condition at the 5-percent significance level, and cooperative decay in the computer condition is statistically significant at the 1-percent significance level. Further details are available from the authors on request.

[12] The fact that groups in our human condition were fixed over ten rounds while Andreoni's were randomly rematched every round might be a source of the difference in our rates of cooperative decay. Rematching subjects has been found to decrease (see e.g., Croson, 1996; Joep Sonnemans et al., 1999; Claudia Keser and Frans van Winden, 2000), increase (see e.g., Andreoni, 1988), and have no effect on (see e.g., Joachim Weimann, 1994; Palfrey and Prisbrey, 1996) mean contribution rates.

IV. Conclusion

This paper revisited the roles of social motives and confusion in driving contributions in public goods experiments. We designed our analysis to complement earlier work by Andreoni (1995). His work focused on social motives and used a design that was biased against finding evidence of social motives. This research focused on the way confusion changes over time and used a design that was biased against finding evidence of confusion. We found that confusion is responsible for about half of all cooperation in our standard public goods game. However, confusion was found to be responsible for more contributions in earlier rounds than in later rounds. In particular, our findings suggested that all of the cooperative decay in our standard voluntary contribution mechanism game can be explained by reductions in confusion.[13] Our results together with those of Andreoni (1995) seem to make a compelling case for the importance of confusion and changes in confusion in many public goods experiments.

Appendix

Details of Instructions Provided for the Human and Computer Conditions

The following instructions were read aloud by the experimenter in each session:

> Hello, and thank you for coming. By coming here today, you have already earned five dollars. In a few moments, you will be given the opportunity to add to these earnings. Note that decisions you make in the coming experiment and your earnings will be kept confidential. Note that in the game you are about to play, some of you will be playing with other people in this room, and some of you will be playing only with computers. The instructions will tell you if you are playing with actual people or not.

The following is a transcript of the written instructions provided to our subjects. A lowercase "a" represents instructions unique to the "human" condition and a lowercase "b" represents instructions unique to the "computer" condition:

(1) Welcome. Instructions and messages will appear in this part of the screen. Since we have now begun, please keep your attention on your own computer screen and stay silent throughout this experiment unless otherwise instructed. To go to the next instruction screen, click on the "forward" button below.

(2) This experiment is a study of group and individual investment behavior. The instructions are simple. If you follow them carefully and make good investment decisions you may earn a considerable amount of money. The money you earn will be paid to you, in cash, at the end of the experiment. A research foundation has provided the funds for this study.

(3a) You will be in a group consisting of four players. The other players in your group will be actual people sitting in this room.

(3b) You will be in a group consisting of four "players." The other players in your group will be "robots"—players simulated by the computer. These computer players will play the game according to pre-set instructions. Your decisions will have no effect on how computer players play.

(4a) Each player in your group will be given an investment account with a specific number of tokens in it. These tokens are then invested to turn into cash. All tokens must be invested to earn cash from them. You will be choosing how to divide your tokens between two investment opportunities: the Individual Exchange and the Group Exchange.

(4b) Each player in your group (including computer players) will be given an investment account with a specific number of tokens in it. These tokens are then invested to turn into cash. All tokens must be invested to earn cash from them. You will be choosing how to divide your tokens between two investment opportunities: the Individual Exchange and the Group Exchange.

(5) THE INDIVIDUAL EXCHANGE: Every token you invest in the Individual Exchange will earn you a return of one cent. (Examples are given to the right.)

Example: Suppose you invested 28 tokens in the Individual Exchange. Then you would earn $0.28 from this exchange.
Example: Suppose you invested 42 tokens in the Individual Exchange. Then you would earn $0.42 from this exchange.
Example: Suppose you invested 0 tokens in the Individual Exchange. Then you would earn nothing from this exchange.

(6) THE GROUP EXCHANGE: The return you earn from the Group Exchange is a little more difficult to determine. What you earn from the Group Exchange will depend on the TOTAL NUMBER OF TOKENS that you and the other three members of your group invest in the Group Exchange. The more the GROUP invests in the Group Exchange, the more

[13] It is worthwhile to mention that we administered anonymous questionnaires after our experiments. Responses to a question asking how the subject made their contribution decisions included, "I received a larger payoff by investing in the group exchange," and, "I basically allocated some of the tokens to the group exchange because of [the] 'sure' return." One subject claimed that to make their contribution decisions they "followed the feeling." Such responses indicate that confusion likely has different sources in different subjects.

EACH MEMBER OF THE GROUP earns. The process is best explained by a number of examples, again given to the right.

Example: Suppose that you decided to invest no tokens in the Group Exchange, but that the three other members invested a total of 50 tokens. Then your earnings from the Group Exchange would be $0.25. Everyone else in your group would also earn $0.25.

Example: Suppose that you decided to invest 20 tokens in the Group Exchange, and the three other members invested a total of 40 tokens. This makes a total of 60 tokens. Then your earnings from the Group Exchange would be $0.30. Everyone else in your group would also earn $0.30.
Example: Suppose that you decided to invest 30 tokens in the Group Exchange, but that the three other members invest nothing. Then you, and everyone else in the group, would get a return from the Group Exchange of $0.15.

(7) THE GROUP EXCHANGE (continued): As you can see, every token invested in the Group Exchange will earn one half of a cent for EVERY member of the group, not just the person who invested it. IT DOES NOT MATTER WHO INVESTS TOKENS IN THE GROUP EXCHANGE. EVERYONE WILL GET A RETURN FROM EVERY TOKEN INVESTED—WHETHER THEY INVEST IN THE GROUP EXCHANGE OR NOT. The table below has been provided for your reference during the experiment. The table lists what your payoff would be from the Group Exchange given the number of tokens in the exchange.

(8) THE INVESTMENT DECISION: Your task is to decide how many of your tokens to invest in the Group Exchange. You are free to put some tokens into the Individual Exchange and some into the Group Exchange. Alternatively, you can put all of them into the Group Exchange or all of them into the Individual Exchange.

(9) STAGES OF INVESTMENT: There will be ten decision rounds in which you will be asked to make investment decisions. After the last round you will be paid the total of your payoffs from all ten rounds.

(10) Remember that your earnings in a decision period are the sum of the returns from the tokens you placed in your Individual Exchange plus the return from the total number of tokens placed in the Group Exchange.

(11) At the beginning of each round you will be given an Endowment of 50 tokens. You are to indicate by filling in the blank below your investment in each account. You simply enter the number of tokens you want to place in the Group Exchange. The number of tokens in the Individual Exchange will automatically be entered so that the sum of your investments equals your endowment, 50 tokens. The other players in your group will also have 50 tokens to invest. You must make your investment decisions WITHOUT knowing what the other human players (if any) in your group are deciding. When you have made your investment decisions, you will click on the red "submit" button.

(12) When all players have submitted their investment decisions, you will be told the total number of tokens invested in the Group Exchange that round as well as your earnings from that round. The table to the right will provide the history for each round, including a record of your contribution to the Individual and Group Exchanges, the Contribution to the Group Exchange of all players other than you, the Total Contribution to the Group Exchange, and your Payoff for that round.

(13) You have now completed the instructions. If you have any questions, raise your hand and ask the experimenter. Otherwise, click on the large green "start" button. When you do so, you will exit the instructions. Please be sure that you have understood the instructions before continuing.

Between rounds the instructions were:

(a) There are four players in your group—four human players (including you) and zero computer players.

Please enter your investment in the Group Exchange (your investment in the Individual Exchange will be automatically calculated). Remember that the sum of your investments must equal your endowment, 50 tokens. When you are done, click on the red "submit" button.

(b) There are four players in your group—one human player (you) and three computer players. Your play does not affect how the computers play. This period, regardless of what you do, the computers will contribute [AVERAGE FROM THE HUMAN CONDITION FOR THIS ROUND] tokens to the group account.

Please enter your investment in the Group Exchange (your investment in the Individual Exchange will be automatically calculated). Remember that the sum of your investments must equal your endowment, 50 tokens. When you are done, click on the red "submit" button.

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