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Detecting Motives for Cooperation in Public Goods Experiments

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Abstract

This study clarifies the types of motives that are important as a source of cooperation in a linear public goods experiment. Our experimental design separates the contributions due to confusion, one-shot motives (which includes altruism, warm-glow, inequality aversion, and conditional cooperation), and multi-round motives (which includes a strategic motive under incomplete information, a failure of backward induction, and reciprocity). The experiment reveals that multi-round motives plays an important role in driving cooperative behavior. Confusion and one-shot motives play a minor role.

Keywords: Cooperation, Motives, Public goods

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1 Introduction

In real life, millions of people give to privately provided public goods such as charity. For decades, the question why people cooperate in social dilemma situation

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has been one of the most important research questions, not only for economics, but also for all of the social sciences. There may be many factors that induce the cooperative behavior such as altruism, warm-glow, reciprocity, other social and psychological motives, and even strategic motives.

Laboratory experiments on public goods game address this question. A large body of literatures find significant evidence that subjects are too cooperative to be consistent with the economic prediction under the self-interested assumption (see e.g., Ledyard 1995). Many studies have investigated subjects' preferences in public goods games, but there is no consensus on what explains the observed behavior. Andreoni (1989) and Andreoni (1990) suggest that subjects are altruistic toward other subjects or possibly that they get a warm-glow from giving to the public good. Palfrey and Prisbrey (1996) and Palfrey and Prisbrey (1997) find little or no pure altruism, but significant evidence of warm-glow and confusion. Goeree et al. (2002) find significant evidence, not only of warm-glow and confusion, but also of pure altruism. Croson (2007) suggests that a part of subjects' preferences may be to reciprocate or match the contributions of others in their groups.[1] Fischbacher et al. (2001) emphasize that many subjects are conditional cooperators. Andreoni (1995) and Houser and Kurzban (2002) argue the importance of both confusion and social motives. While Andreoni (1988b) does not support the hypothesis of strategic motives, Croson (1996) does do so using a similar design to Andreoni (1988b). Some studies also examine strategic motives, but there is no general agreement on their significance (Weimann 1994; Cooper et al. 1996; Palfrey and Prisbrey 1996; Sonnemans et al. 1999; Keser and van Winden 2000; Brandts and Schram 2001; Brandts et al. 2004; Yamakawa 2012).[2]

Andreoni (1995) provides an ingenious design to discriminate between cooperation due to social motives and that due to confusion. His experiments include three conditions. The first ("Regular" condition) is a standard public goods game. The second ("Rank" condition) is the same as the first, but subjects are paid based on their rank in the standard game, which generates a zero-sum payoff structure. In order to compare directly with the Rank condition, the third ("RegRank" condition) also provides feedback about rank, but subjects are paid according to

[1]Jacobson and Petrie (2014) find that a change in information provision increases contribution to the public good due to direct reciprocity by 14 percent.

[2]Some papers try to separate strategic motives from pro-social motives in indefinitely repeated games (e.g., Reuben and Suetens 2012; Cabral et al. 2014; Dreber et al. 2014).

the experimental earnings, just as under the Regular condition. Contributions in the Rank condition are considered to be due to confusion because the condition's zero-sum payoff structure left no incentive for cooperation. Contributions due to social factors are calculated by subtracting the contributions in the Rank condition from those in the RegRank condition. The difference in contributions between the Regular and RegRank conditions are due to either social motives or confusion. Andreoni (1995) reports that, on average, about half of all cooperative behavior can be classified as social motives. Confusion falls as time passes, while the importance of social motives fluctuate over time.

Houser and Kurzban (2002) also adopt the subtraction method to separate social motives from confusion. They place individual subjects into groups in which the other players are computers. The human player is told that the computers' contributions to the public good are independent of the subject's own play. Since subjects cannot benefit either himself/herself or other subjects, contributions in this condition are attributable to confusion. By subtracting contributions in this condition from those in the regular public goods experiment, they calculate the contributions due to social motives. Houser and Kurzban (2002) report that consistent with Andreoni (1995), on average, about half of all cooperation is due to social motives. In addition, confusion accounts for more cooperation in the early rounds than in the later rounds.[3]

By using the subtraction method, this study separates motives into three categories, namely confusion, one-shot motives, and multi-round motives. Our design adds one condition to the design of Houser and Kurzban (2002). We call the regular public goods game the *H* condition, and the computer condition the *C* condition. The additional condition (called the *HC* condition) is similar to the *C* condition, but the earnings from the computer are paid to a real subject. Since the subject can benefit the other member but not himself/herself with public contributions, cooperative behavior can be driven by motives such as altruism and warm-glow, as well as confusion. When the subject faces with positive contribution to the public good by the computer, cooperative behavior can be also driven

[3]Ferraro et al. (2003) also use computer players to separate out the motives for cooperation, and find that other-regarding behavior elevates contributions in public goods experiments. Cox (2004) discriminates between transfers due to trust or reciprocity and transfers due to other-regarding preferences that are not conditional on the behavior of others in trust game by comparing between different treatments.

by inequality aversion and conditional cooperation. The difference in contributions between the *HC* and *C* conditions is considered to be an estimate of these motives in the regular public goods game. We refer to these motives as "one-shot motives." The difference in contributions between the *H* and the *HC* conditions is an estimate of motives such as the strategic motive under incomplete information suggested in Kreps et al. (1982), failure of backward induction, and reciprocity. We refer to these motives as "multi-round motives."

Since our research focus is one-shot motives and multi-round motives, our experimental design attempts to remove confusion as much as possible, while keeping the important feature of public goods experiments, namely the social dilemma. Confusion is a subject's misinterpretation of instructions, unfamiliarity of the game, and so on, which are the effects specific to conducting the experiments. Hence, experimenters should eliminate subjects' confusion as much as possible in order to evaluate their behavior correctly. In particular, in linear public goods experiments with an equilibrium prediction of a zero contribution to the public good, there is only one way a confused subject can err, which is to contribute too much to the public good. Errors will not be averaged out of the aggregate data, and hence we might misinterpret the contributions that are really due to confusion as cooperative behavior. We use two devices to remove confusion in our experiment. First, we adopt a two-player game that generates a simple strategic environment. Second, subjects are provided with a detailed payoff table that lists the total payoffs gained from the private and public goods when their and their group member's investment units are determined. This makes the structure of the game clear.[4]

The results of our experiment are as follows. In aggregate, about 80 percent of cooperation is attributable to multi-round motives, while confusion and one-shot motives account for only 2 and 18 percent respectively. In addition, when

[4]Cason et al. (2002), Van Dijk et al. (2002), Cason et al. (2004), and Yamakawa (2012) also adopt a two-player public goods game and a detailed payoff table. Of these studies, Cason et al. (2002), Van Dijk et al. (2002), and Cason et al. (2004) examined non-linear public goods games with interior Nash or dominant strategy equilibrium. Yamakawa (2012) examined a linear public goods game. The data in Van Dijk et al. (2002) and Yamakawa (2012) have the similar pattern to our experiment. They observe stable or slightly increasing contributions over time, and sudden cooperative decay in the last round. Cason et al. (2002) and Cason et al. (2004) do not observe such pattern. Charness et al. (2004) conduct gift exchange experiments and show that the behavior is significantly sensitive to whether the subject is provided a detailed payoff table.

considering the round level data, multi-round motives is a dominant motive in all rounds but not the last, while confusion and one-shot motives are minor. In the last round, sudden cooperative decay is observed in the regular public goods game. This is consistent with a strategic motive under incomplete information about the player's rationality, failure of backward induction, and/or reciprocity. These results suggest that multi-round motives plays an important role in driving the cooperative behavior in our public goods game.

This paper is organized as follows. Section 2 describes our experimental design, which allows us to separate the motives into three categories, confusion, one-shot motives, and multi-round motives. Section 3 shows the experimental results. We will show that multi-round motives plays an important role in driving the cooperative behavior. Section 4 concludes.

2 Experimental Design

2.1 Separating Motives into Three Categories

There are three conditions in our experiment. The first condition, called the "*H* condition," is the standard linear public goods experiment with each group of two. Subjects are anonymously matched with a subject who remains fixed throughout the course of the experiment ("Partners" design). Subjects are told that their partner is in the same room. Each subject is given an endowment of 24 tokens in each of 20 rounds of play with which to invest in the public account. All subjects are provided with a detailed payoff table that lists the total payoffs gained from private and public goods when their and their group member's investment units have been determined. The marginal per capita return to public contribution is 0.7. Hence, investing nothing in the public good is the dominant strategy, while investing everything in the public good is Pareto efficient.

In the second condition, called the "*C* condition," each group consists of one human player and one computer player. The choices of the computers come from the *H* condition. Before the experiment begins, subjects are informed of the choice of the computer for all rounds, and hence reminded that these are unaffected by their decisions.[5] In addition, at the beginning of each round, the human subjects

[5]Subjects in the *C* condition are not informed that the choices of the computer are the data of the experimental session of human versus human held previously.

are informed on the computer screen about the number of tokens the computer will invest in that round.

The *C* condition is similar to the "computer condition" in Houser and Kurzban (2002). The difference is that they examined a four-player game and the aggregate computer contribution to the public good was three-fourths of the average aggregate contribution in the human condition, rounded to the nearest integer. If we follow their design, the choice of the computer should be half the average aggregate contribution in the *H* condition. However, we would like to see the behavior that is a response to the real choice of a subject. Another difference is that, in Houser and Kurzban's (2002) design, subjects were not told of the computer's choices before the experiment began. Rather, they were told each round's choice only at the beginning of that round. Our design leads subjects to believe strongly that their actions cannot influence the computer player's moves in later rounds.

The third condition, named the "*HC* condition," is similar to the *C* condition, but the experimental earnings of the computer are paid to a real subject. Subjects in a group are assigned player roles, as either *A* or *B*. While player *A* chooses his/her own investment units, player *B* does not. As in the *C* condition, the choices of player *B* come from the data in the *H* condition, and subjects are reminded that these are unaffected by player *A*'s actions. After reading the instructions and assigning the player roles, subjects assigned as player *A* are moved to the laboratory first, and then subjects assigned as player *B* follow. Hence, subjects assigned *A* know that their partner is in the same room during the experiment.

We refer to the motives (or causes) that induce cooperative behavior in the *C* condition as confusion. Since the human player in the *C* condition cannot benefit either himself/herself or the other subjects with public contributions, almost no social motives will lead subjects to contribute to the public account. Confusion includes the misinterpretation of instructions, unfamiliarity with game rules, and so on. It also includes the situation in which a subject understands the incentive structure of the game, but chooses cooperative behavior mistakenly, jokingly, or for some other reasons.

The *HC* condition is a situation in which player *A* can benefit player *B* but not himself/herself with public contributions. The motives that induce the cooperative behavior in the *HC* conditon, but not in the *C* condition are mainly one-shot-type social motives, such as altruism, warm-glow, inequality aversion, and conditional cooperation. The theory of altruism says that an individual's utility is increasing, not only in his/her own consumption, but also in the others' consumption (Andreoni 1988a; Andreoni 1989; Anderson et al. 1998). The theory of warm-glow says that the act of contributing, independent of how much it increases group payoffs, increases an individual's utility (Andreoni 1990).[6] As seen in the next section, on average, 43.28 percent of endowments are contributed to the public good in the *H* condition. When subject in the *HC* condition faces with the other player with these cooperation rate, cooperative behavior can be also driven by motives such as inequality aversion and conditional cooperation. The theory of inequality aversion says that an individual's utility is decreasing in the difference of their earnings compared with other people (Fehr and Schmidt 1999). A player is conditional cooperator if he/she is willing to contribute to a public good as long as others also contribute (Fischbacher et al. 2001). There may also be other effects on contributions such as an attempt to satisfy a social norm of not appearing too greedy to player *B*.

Since there will also be confusion in the *HC* condition, the difference in contributions between the *HC* and *C* conditions provides an estimate of one-shot motives to cooperation in the regular public goods game.

We refer to the motives that induce cooperative behavior in the *H* condition, but not in the *HC* condition, as "multi-round motives." An example of multi-round motives is a strategic motive under incomplete information, as suggested in Kreps et al. (1982). They show that, in the finitely repeated prisoner's dilemma with a sufficient number of repetitions, if one player (denoted by *X*) believes that the other player (denoted by *Y*) will play tit-for-tat strategy with small probability, cooperative behavior will occur for some periods in any sequential equilibrium. Player *Y* can get a larger payoff than under the free riding equilibrium, by concealing his/her rationality from player *X* for at least some periods. In the *HC* condition, since the actions of player *B* are fixed, player *A* need not conceal his/her rationality, leading him/her not to contribute to the public goods. Kreps et al. (1982) also show that cooperative behavior will diminish in the later rounds.

Another possible example for multi-round motives is also strategic, but is a failure of backward induction. Some previous experiments reveal that subjects seem not to use backward induction (Binmore et al. 2002; Johnson et al. 2002).

[6] One might think that contributions due to warm-glow may also occur in the *C* condition by its definition. However, if we interpret that warm-glow activates through the interaction with the other people, it does not work in the *C* condition.

The important logic of backward induction is that the choice at any stage cannot affect the outcome in the future stage, and hence the players choose the stage-game Nash equilibrium strategy. By failure of backward induction, we mean that players may think that their current choice can affect the other's choices in the later stages. Specifically, they may try to induce the other's cooperation by contributing to the public goods as a signal of their cooperative attitude to the other member. If so, cooperative behavior will occur in the *H* condition. On the other hand, since the choices of player *B* are predetermined in the *HC* condition, the subject easily feels certain that his/her current choice cannot affect the other's choices in the later stage. It also predicts that cooperative decay will occur in the later rounds in the *H* condition. As the remaining stages get shorter, the benefit from inducing the other's cooperation by sending a signal of cooperative attitude becomes smaller.

Reciprocity is also classified into multi-round motives. The theory of reciprocity incorporates the stylized fact that people are willing to sacrifice their own material well-being to help those who are being kind, and willing to sacrifice it to punish those who are being unkind.(Rabin 1993). Falk and Fischbacher (2006) emphasized that people evaluate the kindness of an action based on, not only the consequences of an action, but also the actor's underlying intention. In the *HC* condition, subjects assigned *A* cannot evaluate the intention of subject assigned *B* because he/she does nothing. If reciprocators interact with a subject with other motives, reciprocity can predict cooperative decay. Suppose that 50% of subjects are reciprocators, and 50% of subjects are strategic cooperators. Since strategic cooperators reduce contributions in later rounds, the reciprocators will respond by reducing.

A couple of comments are in order about the experimental design. First, the important assumption in the above argument is that contributions due to one-shot motives are similar between the *H* and *HC* conditions, and contributions due to confusion are similar among all conditions. This assumption allows us to conduct a clean analysis of the experimental data. If motives interact with context or condition, the differences netted out by subtraction between conditions might not be meaningful. For example, Houser and Kurzban (2002) pointed out that the *C* condition may underestimate confusion in the *H* condition since knowing how much the computer will invest before making a decision makes the game's incentives more transparent in the *C* condition. Another possibility is that, in the

HC condition, subjects assigned *A* may feel sorry for the other player because he/she cannot choose his/her own contribution, which can accelerate cooperation.

Second, since our focus is one-shot motives and multi-round motives, our design attempts to eliminate confusion as much as possible while keeping the structure of social dilemma. To do so, we adopt a two-player game that generates a simple strategic environment. We also provide a detailed payoff table, which makes the structure of the game clear. However, presenting a payoff table may have some problems. First, our payoff table is 25 by 25, which needs much time to read. Hence, it is doubtful whether presenting a payoff table makes the structure of the game clear. Second, it may force a subject's attention focus on his/her own payoff, which may cause the more self-interested behavior. As seen in the next section, these are not serious issues in our experiment because the contribution in the *C* condition (confusion) is very low and that in the *H* condition is high.

2.2 Experimental Procedures

Experimental sessions were conducted in November and December 2008 at Osaka University (80 subjects), and in October 2014 and January 2015 at Kochi University of Technology (76 subjects). The experiment was programmed and conducted using the software z-Tree (Fischbacher 2007). In total, 40, 38, and 78 students participated in the *H*, *C*, and *HC* conditions, respectively. The data of two subjects in the *H* condition were not used in the *C* condition (the data of one subject out of these two were also not used in the *HC* condition). In data analysis, in order to be comparable between conditions, we eliminated the data of these two subjects in the *H* condition, and the data of one subject in the *HC* condition. Hence, we have 38 independent observations in each of three conditions. No subject attended more than one session. Subjects were told that they would receive 750 yen at Osaka (500 yen at Kochi) for participating, and that they could expect to earn about 4000 yen for two hours.[7] Experimental sessions actually lasted slightly less than two hours.

Instructions were read aloud, offering participants the opportunity to ask private questions. Then, subjects practiced reading the payoff table and filling in the record sheet. Subjects also had an opportunity to review the payoff table for

[7] 1 US dollar was about 95 yen at the time experiment took place at Osaka, and about 118 yen at Kochi.

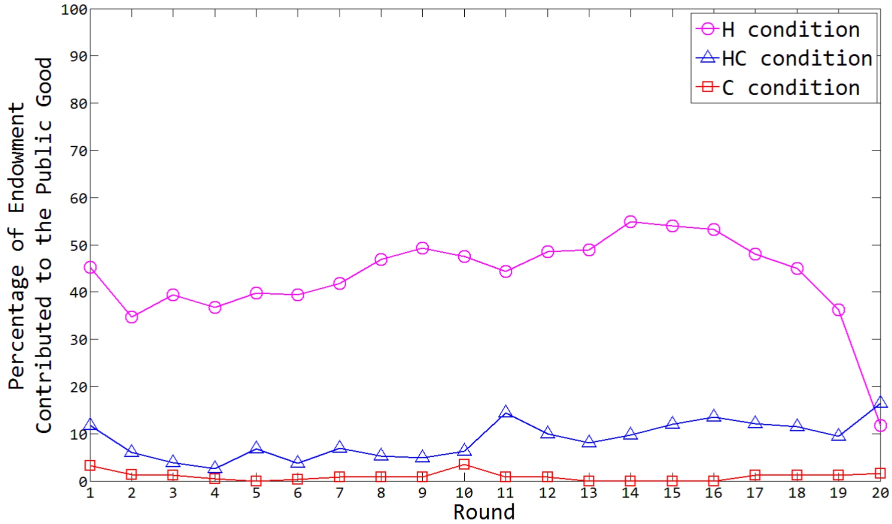

Figure 1: Percentages of Endowment Contributed to the Public Good Per Round

10 minutes before the experiment, but they were not forced to look at it. In the record sheet of subjects assigned *A* in the *HC* condition and all subjects in the *C* condition, their group member's choice in all rounds were written in advance.

Subjects were randomly paired with a fixed subject, and were not told the identity of the other subjects in their group. In making a decision in each round, subjects entered the value of their investment in the public good, and then clicked the "OK" button. The computer displayed the group member's choice for each round in the *HC* and *C* conditions. After all subjects made their decisions, the outcome was displayed, which included their own choice, their group member's choice and their payoff for that round. After the experiment, subjects received the payment in cash. The average earnings were 4673.3 yen in the *H* condition, 5086.2 yen for subjects assigned *A*, and 3710.1 yen for subjects assigned *B* in the *HC* condition, and 5179.0 yen in the *C* condition.

3 Results

Fig 1 reports the average percentages of subjects' endowments contributed to the public good. Basically, the average contributions are large in the order of the *H*, *HC* and *C* conditions in every round, as expected. The only exception is the contributions between the *H* and *HC* conditions in round 20.

Table 1: Average Contributions by Conditions and Percentage of Multi-round Motives, One-shot Motives, and Confusion

Condition	Average Contribution	Motives	Percentage	p-value
H	43.28	Multi-round Motives	79.80	0.000
	(9.50)			
HC	8.74	One-shot Motives	17.94	0.000
	(3.90)			
C	0.98	Confusion	2.27	0.011
	(0.97)			

Standard deviations in parentheses

Table 1 reports average contributions and resulting percentage of multi-round motives, one-shot motives, and confusion. When aggregating the data in all rounds, 43.28, 8.74, and 0.98 percent of all tokens are contributed to the public good in the *H*, *HC*, and *C* conditions, respectively. This indicates that multi-round motives, one-shot motives, and confusion account for 79.80, 17.94, and 2.27 percent of all cooperation, respectively. The last column in Table 1 reports p-values from the one-tailed Wilcoxon rank-sum tests for *H* versus *HC* conditions, for *HC* versus *C* conditions, and for *C* condition versus zero contributions.[8] It indicates that the existence of these motives are significant at the 5 percent level. With regard to the relative importance, cooperative behavior is mainly motivated by multi-round motives.

Round level data show that similar results hold until round 19. From rounds 1 to 19, 34.6-54.8, 2.6-14.4, and 0-3.5 percent of endowments are invested in the public goods in the *H*, *HC*, and *C* conditions, respectively. Multi-round motives account for about 80 percent of all cooperation. On the other hand, one-shot motives account for at most 30.4 percent, and confusion accounts for at most 7.3 percent. The one-tailed Wilcoxon rank-sum tests reveal that the differences in contributions between the *H* and *HC* conditions are significant at the 1 percent level in all rounds until round 19. The differences in contributions between the

[8] We first calculate the average contributions of each subject across all rounds and then calculate the test statistic using these to eliminate cross-period correlations.

HC and *C* conditions are nonsignificant at the 5 percent level in seven rounds.[9] The differences between the *C* and zero contributions are nonsignificant at the 5 percent level in all rounds until round 19.[10] Since the results of non-rejection may be partly caused by the small sample resulting in less power for the statistical test, we cannot deny the presence of confusion and one-shot motives. The rejection of the tests comparing the *H* and *HC* conditions indicates the significant presence of multi-round motives.

Though a gradual decay in cooperation is generally observed in previous experiments, we do not observe this tendency. Our results are slightly increasing over time from rounds 1 to 19 in the *H* condition. The Spearman's rank correlation coefficients indicate that the increasing trend of the average contribution is statistically significant in the *H* condition at the 5 percent level ($\rho = 0.484$, $p = 0.036$). This is also true in the *HC* condition ($\rho = 0.600$, $p = 0.008$), but the *C* condition does not have this tendency ($\rho = -0.195$, $p = 0.425$).

The relative importance of confusion is low and stable until round 19 ($\rho = -0.209$, $p = 0.391$). This is a clear contrast to the results in Andreoni (1995) and Houser and Kurzban (2002). In their studies, confusion tend to decrease across rounds. This difference may be caused by the adoption of the two-player game and detailed payoff table in our experiment, which generate a simpler strategic environment.

The relative importance of one-shot motives increases significantly as time passes ($\rho = 0.702$, $p = 0.001$), while that of multi-round motives decreases significantly ($\rho = -0.594$, $p = 0.007$). One interpretation for increasing trend of one-shot motives may be explained by the increase in inequality aversion and conditional cooperation in later rounds. As seen in Fig 1, the cooperation rate increased over time in the *H* condition. Inequality aversion and conditional cooperation accelerate the cooperative behavior of some subjects in the *HC* condition who face with these data. However, this cannot explain the increase in contribution in the last round. Another interpretation is guilty feeling of some subjects assigned *A* in the later rounds. In the first half of the experiment, cooperation rates are very low in the *HC* condition, which implies that subjects assigned *A* exploit the

[9] $p = 0.113$ in round 2, $p = 0.190$ in round 3, $p = 0.082$ in round 4, $p = 0.154$ in round 6, $p = 0.082$ in round 8, $p = 0.202$ in round 10, and $p = 0.063$ in round 19.

[10] $p = 0.080$ in rounds 1, 2, 3, 10, 17, 18, and 19, $p = 0.165$ in rounds 4, 6, 7, 8, 9, 11, and 12, $p = 1.000$ in rounds 5, 13, 14, 15, and 16.

other player. Such behavior make some subjects feel guilty, which increases the contribution, especially in the last round. However, the degree of increasing of one-shot motives is limited, and the multi-round motives are still dominant in these rounds.

In the *H* condition, sudden cooperative decay is observed from rounds 19 to 20. Contributions to the public good fall from 36.2 percent in round 19 to 11.7 percent in round 20, which is a statistically significant reduction. The Wilcoxon signed rank test rejects the null hypothesis that the mean of the contribution distribution in round 20 is the same as those until 19 ($p = 0.000$). This is consistent with a strategic motive under incomplete information, the failure of backward induction, and/or reciprocators facing with strategic players argued earlier. The relative importance of multi-round motives on cooperative behavior vanishes in round 20. On the other hand, the contribution distribution in round 20 is not significantly different from those until 19 in the *HC* and *C* conditions ($p = 0.784$ in the *HC* condition, $p = 0.906$ in the *C* condition).[11] This suggests that confusion and one-shot motives do not affect the cooperative decay in round 20 in the regular public goods game. The difference in contributions between the *H* and *HC* conditions is not statistically significant ($p = 0.801$, Wilcoxon rank-sum test). Therefore, cooperation in round 20 is attributable to one-shot motives and confusion. These results are not because the absolute importance of one-shot motives and confusion increases in the last round, but because the cooperation rate in the *H* condition decreases.

4 Discussion and Conclusion

This study proposed a design to separate motives for cooperation into three types in a public good experiment. The experiment revealed that multi-round motives, including the strategic motive under incomplete information, failure of backward induction, and reciprocity, plays an important role in driving cooperative behavior. On the other hand, one-shot motives, including altruism, warm-glow, inequality aversion, and conditional cooperation, does not explain cooperation as much as previous experiments have suggested. Although the relative importance

[11] The absence of decay in the *HC* and *C* conditions is partly because the contributions in the *HC* and *C* conditions are very low throughout the experiment, and hence there is little room to decay.

of one-shot motives has increasing trend over time, the degree of increasing is limited.

With regard to confusion, our experimental data suggest that it has less explanatory power on cooperation in all rounds. Andreoni (1995) reports that confusion is dominant in the first round of an experiment, accounting for 81 percent of all cooperation, and then declines to 13.6 percent in the last round. Houser and Kurzban (2002) report that confusion accounts for about half the tokens contributed to the public good. Hence, our experimental design was largely successful in removing confusion from the subjects' behavior. Adopting a two-player game and a detailed payoff table created a strategic environment simple for subjects to understand the structure of the game.

From a methodological viewpoint, it is important for experimental economists to construct an environment that adequately conveys the incentives to the subjects in order to evaluate subjects' behavior correctly. Our experimental design provides one example of a strategic environment in a public goods experiment that is simple enough for subjects to understand the structure of the game, while keeping the structure of the social dilemma.

Finally, note that our results about the relative importance of motives on cooperation cannot apply perfectly to the other social dilemma situations because it is possible that different motives are differentially important in different contexts. It would be interesting that subtraction method are applied to the other settings in which there are several competing theories that can explain observed behaviors in future study.

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