Experimental Evidence of Magical Thinking in Public Goods Experiments

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Abstract

Consistent behavior in public goods games is well documented. Typically, participants begin with large contributions to the public good, but contribution rates decline as more iterations of the game are played. However, the impact of magical thinking on contributions to a public goods game has yet to be examined. We hypothesize that, when participants erroneously believe they can use their contribution to set a social norm, contribution rates will be higher. To test this hypothesis, we had participants play a public goods game, and gave them either no additional information or told them that there is a real probability that their contribution would be recorded first. We found no significant difference in contributions between the treatment and control groups. However, magical thinking was ubiquitous across groups, suggesting that magical thinking is a normative feature of behavior in public goods games that is robust to certain manipulations.

Introduction

A public good is a good or service that is both non-rival and non-excludable in consumption, meaning it can be consumed by multiple people simultaneously and it is difficult to prevent any one person from consuming it (Samuelson, 1954). Public parks, clean air, and streetlights are all examples of public goods. Standard economic theory predicts that a public good that is voluntarily funded will be undersupplied (Bergstrom, Blume, & Varian, 1986). This is a result of the free rider problem, which is broadly defined as a phenomenon that occurs when individuals use a public resource more than they choose to pay for it. Brubaker (1975) bifurcates this into a *strong* and *weak* free rider problem: the strong free rider scenario proposes that the public good will not be provided because virtually nobody contributes to it, and the weak free

rider scenario posits that the allocation of resources made to the public good will not reach Pareto optimality.

Experimental economists examine contributions to a public good by having participants play public goods games, in which they are given an endowment and asked to decide how much of it they wish to put into a public fund and how much they wish to keep in a private fund (Brock, 1991). In this scenario, economics and game theoretic approaches tend to favor the strong free rider hypothesis, since in this game contributing nothing to a public good when everyone else contributes nothing is a Nash equilibrium (Szabo & Hauert, 2002). Thus, if a public goods game were played, it would be reasonable to conclude from economic and game theoretic reasoning alone that the public good will receive virtually no contributions.

Experimental evidence for behavior in public goods games diverges from theoretical predictions. Contributions tend to be greater than zero, but not 100% of the endowment (Marwell & Ames, 1981). This gives credence to the weak, but not strong, free rider hypothesis, meaning that people tend to contribute some, but not all, of their endowment to the public good. In repeated public goods games in which subjects are asked to play the game several times, contributions begin high but decrease as more iterations are played (Smith, 2015). Thus, a natural question of interest is to determine factors that influence the divergence between contributions to a public good in an experimental setting and theoretical predictions concerning public goods contributions.

Research has shown that framing can influence contributions in public goods games (Cookson, 2000). Specifically, when participants were asked to delineate the benefits of collective action, contributions were higher; conversely, when they were asked to describe their own benefits, contributions were lower. That is, when participants were primed to think of the

benefits of individualistic behavior they contributed less, and when they were primed to think of the benefits of collective action they contributed more. Critically, the nature of the game was unchanged across frames, showing that seemingly arbitrary changes in perception can influence contribution rates. Therefore, it seems prudent to further investigate the impact of other perceptual factors on decision-making in public goods games.

Magical thinking is an important psychological phenomenon that has not been explored in the context of repeated public goods experiments. It has to do with a concept psychologists call the illusion of control, where an individual overestimates their ability to control an event (Langer, 1975). Shafir and Tversky (1992) defined magical thinking as "…the erroneous belief that one can influence an outcome (e.g., the role of a die) by some symbolic or other indirect act (e.g., imagining a particular number) even though the act has no causal link to the outcome." They also defined quasi-magical thinking as an instance of magical thinking in which the individual does not believe that their action can influence the desired outcome, yet nonetheless act in accordance with the notion that it does (Shafir & Tversky, 1992). St. James et al (2011) gave a slightly different definition of magical thinking, positing that it occurs when individuals employ supernatural beliefs to deal with stressful or uncertain situations. In our paper, we will adhere to Shafir and Tversky's (1992) definition of magical thinking, which can occur either when an individual invokes a superstitious belief or simply believes they have more control over a situation than they actually do. Quattrone and Tversky (1984) demonstrated an instance of magical thinking by showing that people are more tolerant of certain physical discomfort when they are told that said tolerance is indicative of longer life expectancy, and less tolerant when they are told that said tolerance predicts shorter life expectancy. This example shows that

individuals at times act to promote a desired outcome even when no causal link between the action and the outcome exists.

It may be the case that magical thinking impacts contributions in a public goods game. Specifically, leading people to believe they may be able to set a social norm in a simultaneous move game may impact contributions. We hypothesize that individuals who exhibit magical thinking will contribute more on average than individuals who exhibit less or no magical thinking, because they erroneously believe that a higher contribution will somehow cause others to raise their contributions.

Literature Review

In a public goods experiment, participants are assigned to groups consisting of three or more members. They are then endowed with a certain number of tokens that they can either contribute to the public fund or the private fund. Total contributions in the public fund are summed, multiplied by a number greater than one but less than the number of members in the group, and distributed evenly amongst the group members. A participants' earnings consist of what they earn from the public fund as well as what they keep in the private fund (Brock, 1991).

A series of experiments conducted by Marwell and Ames (1981) describe critical findings of public goods experiments. Specifically, they show that average contributions are about 50% of the endowment. In their initial experiment, participants played a standard public goods game. The researchers found that the average contribution was about 42% of their endowment, which differs from the game theoretical prediction that everyone will contribute nothing. In a subsequent experiment, participants played a public goods game, except the amount of the endowment and the rate of return on contributions to the public good differed across participants. Additionally, a public goods game was played with a provision point, where the

return on investment to the public good only rose above zero after contributions passed a threshold. Neither of these manipulations changed average contribution rates, reinforcing the notion that in public goods games the expected average contribution is somewhere around 50% of the endowment. The same results were observed when participants with previous experience with public goods games played, as well as when participants were allowed to gather information about other group members prior to playing. However, when group size was reduced to four players, higher contributions were observed. Contributions were also markedly lower than 50% of the endowment when participants consisted solely of economics graduate students. Though group size and the overwhelming presence of economics graduate students tended to shift results, most variations of public goods games deviate little from the trend of average contributions hovering around half of the endowment.

Despite the ostensible robustness of public goods behavior, research has shown that psychological manipulations can impact contributions. Specifically, Cookson (2000) found that framing effects can influence behavior in public goods games. In one experiment, he asked participants to either fill out a column identifying what earnings would be if everyone contributed (the ‘we’ frame) or to answer what earnings would be if the participant contributed various amounts individually holding other players’ contributions constant (the ‘I’ frame). The researcher found that participants in the ‘we’ frame condition were significantly more cooperative (meaning they contributed more to the public fund) than participants in the ‘I’ frame condition, suggesting that people are more generous when they focus on the collective benefits of strategies rather than on the individual benefits of strategies. In another experiment, Cookson framed the public good as a gift that would be distributed evenly amongst participants rather than a generic public good, and found that this framing raised contribution rates. Thus, it appears that

manipulation concerning individuals' perception of the public goods game can alter contribution rates even though the nature of the game remains unchanged, necessitating further investigation into psychological factors that may influence behavior in this setting.

A factor that may influence contributions in public goods games is magical thinking, which can be thought of as an attempt to influence the external world or promote an underlying internal disposition through one's actions when no causal link between the action and the desired outcome exists. Quattrone and Tversky (1984) experimentally demonstrated the existence of magical thinking. They had participants engage in physical activity, then place their hand in cold water. Participants were either told that tolerance to cold water after exercise increases or decreases life expectancy. When participants were told that it decreases life expectancy, they kept their hand in cold water for less time than if they were told that it increases life expectancy, despite the lack of a causal link between cold water tolerance and life expectancy. Thus, individuals can take actions in part because they wish to impact an outcome without a clear causal link between the action and the outcome.

Arad (2014) demonstrated another instance of magical thinking. He found that participants tended to forego a greedy option in a game in order to avoid 'tempting fate' and bringing about a bad outcome for themselves, even when the greedy option was the only rational choice in the game. In his study, participants were asked to write down a payoff between 16 and 23 euros. He then rolled a fair die, whose numbers either corresponded to a 5 euro show-up fee or to the amount the participant wrote down. Participants were paid based off the choice they made and the outcome of the die roll. He found that only 69% of participants wrote down the maximum amount, despite there being no logical reason to deviate from that strategy. A separate group of students were asked to analyze why 31% of participants chose a suboptimal strategy;

approximately half attributed this to magical thinking. Specifically, they believed participants chose less greedy options to avoid a sort of cosmic punishment, in which the outcome of the die roll was biased towards the 5 euro show-up fee rather than their response due to their greediness. Thus, magical thinking may cause people to deviate from optimal strategies in certain games.

A public goods game is a simultaneous move game, meaning no participant can use their move to set a social norm. However, if magical thinking is at play in public goods games, then people may be employing strategies typically reserved for sequential move games in which they use their contribution, at least in part, to influence the contributions of others. Or, per the logic of Arad's (2014) paper, it could be the case that participants contribute more to the public fund in order to avoid being punished for their greediness by a 'higher power.' Thus, two important questions emerge: is magical thinking present in public goods games, and, if so, does the presence of magical thinking influence average contributions? Our study seeks to add to this body of research by investigating these questions. Since both the optimal outcome and less greedy strategy in a public goods game is for everyone to contribute their entire endowment to the public fund, we hypothesize that magical thinking will increase average contributions.

Experimental Design

Our study adhered to a between-subjects design. Participants were randomly assigned to a control group or a treatment group to ensure that, on average, latent study-altering characteristics such as age, gender, and political beliefs were the same in the two groups. The treatment group was identical to the control group except that, at the end of the instructions, participants in the treatment group saw an additional sentence that read "please note that there is a real probability that your contribution will be recorded first." (See Appendix B). The goal of this sentence was to lead participants to believe that their behavior in the game could set a social

norm amongst other participants. There was a brief questionnaire at the end that assessed the extent to which participants felt they could use their contributions to set a social norm, as well as other broad demographics questions that include age, major, ethnicity, gender, and political orientation (See Appendix C).

Participants

Data were collected from human participants at UCSB's Experimental and Behavioral Economics Lab (EBEL). Forty-eight undergraduate students ages 18-31 were recruited from the University of California Santa Barbara's EBEL participant pool to participate in the study. Participants played the public goods game described above. They were paid a $5 show-up fee, and could earn more depending on their performance. They were paid with funding obtained from an Undergraduate Research and Creative Activities (URCA) grant. Participants spent no more than an hour in the laboratory. They received payment once they completed the experiment.

Procedure

After participants entered the laboratory, they were greeted by a researcher and asked to fill out an informed consent form. Once they consented, they participated in the experiment by playing a public goods game. The structure of the game was based on a public goods game described by Brock (1991). Participants were randomly assigned to groups of four, but did not know who was in their group. They were each endowed with twelve tokens, each of which were worth $0.05 in U.S. currency. Participants were told that they would play the public goods game for ten periods, and during each period they would decide how much of their endowment they wished to contribute to a public fund and how much they wished to keep in a private fund. For each group, contributions in the public fund were summed, multiplied by two, and distributed

evenly amongst group members. Before playing the game but after reading through the instructions, participants were asked to describe their hypothetical payoffs given various outcomes of the game to probe for comprehension (e.g., if everyone contributes nothing to the public fund, what will your payoff be?) (For detailed instructions, please see Appendix A).

The public goods game was played using pen and paper. At the beginning of each round, participants wrote down on a piece of paper how much of their endowment, if any, they wished to contribute to the public fund. Whatever was not contributed to the public fund was retained in their private fund. After two to three minutes, their responses were collected, recorded, and group averages were displayed. Critically, participants did not know what any other individual participant contributed, and they all made their contributions simultaneously in each period. This was repeated for the other nine trials.

After completing the game, participants were asked to rate the extent to which they felt their contributions influenced the contributions of others on a scale from one (not at all) to ten (a lot). In our analysis, we refer to their answer to this question as their *influence score*. They then completed a brief demographics questionnaire, received their payment, and exited the laboratory. Each session lasted no more than one hour.

Results

The dependent variable in a standard public goods experiments is contributions to the public good (Marwell & Ames, 1981); we adhered to that convention in our analysis. We first examined the influence of being in the treatment group on total contributions to the public good according to the following regression:

$$Y = \beta_0 + \beta_1 X_i + u_i$$

where Y, the dependent variable, represents total contributions to the public good, β_0 is a constant, X_i is a group indicator variable, and u_i is a random error term.

Results failed to achieve statistical significance. Surprisingly, contributions in the treatment group tended to be lower, but this coefficient is not statistically significant. Our results are shown in the table below.

Constant	76.25
	(5.98)
Group Indicator	-10.67
	(7.49)
R-squared	0.0422
Observations	48

We also looked to see if being in the treatment group predicted a significant difference in influence score. We analyzed these results according to the same regression above, except in this regression our dependent variable was influence score rather than total contributions to the public fund. Again, we found no statistically significant difference in average influence scores between the treatment and control groups, suggesting that our manipulation did not prompt changes in the extent to which participants engaged in magical thinking. Our results are shown in the table below. The sample size is reduced in this regression since we utilized a different question to measure the extent to which participants felt they could set a social norm with their contribution in the middle of running participants.

Constant	6.15
	(0.92)
Group Indicator	-1.49
	(1.08)
R-squared	0.0718
Observations	28

At the end of the game, participants were asked to rate the extent to which they felt their contributions could influence the contributions of others on a scale from 1 (not at all) to 10 (very much). We analyzed the extent to which participants' influence rating impacted total contributions to the public good according to the following regression:

$$Y = \beta_0 + \beta_1 X_i + u_i$$

where Y, the dependent variable, represents total contributions to the public good, β_0 is a constant, X_i is the influence rating, and u_i is a random error term. We found that influence score predicted total contributions at the ten percent significance level. Specifically, a one point increase in influence score is associated with a 3.919 token increase in total contributions to the public fund. However, participants were given a total of 120 tokens over ten periods, so this result, despite its statistical significance, carries little meaning since 3.919 tokens is such a small fraction of the total endowment. Our results are shown in the table below.

Constant	58.86
	(13.70)
Influence	3.919
	(1.98)
R-squared	0.1647
Observations	28

A surprising finding in our data was the mean and range of influence scores. The lowest influence score was a 1, and the highest was a 10; the average influence score was a 5.68 out of 10. Thus, on average, participants in both the treatment and control groups tended to believe that their contributions could influence the behavior of others in the public goods game, which is not possible in a simultaneous move game. Taken together, our results tell us that magical thinking

was ubiquitous amongst participants in our sample, and it was not impacted by our manipulation since average contributions and influence scores did not differ between the treatment and control groups.

Conclusion

Experimental evidence of behavior in public goods games is interesting because it does not strictly align with game theoretical predictions. In other words, on average participants contribute non-zero portions of their endowment to the public fund rather than contributing nothing, despite the fact that everyone contributing zero tokens is a Nash equilibrium. Behavior in public goods games is fairly robust to certain design manipulations: contributions begin at around half of the endowment and drop as more iterations of the game are played (Marwell & Ames, 1981). However, psychological factors such as framing effects seem to impact behavior in these games, necessitating the investigation of whether other psychological factors impact contributions to the public fund (Cookson, 2000). Our study seeks to add to this body of research by investigating the extent to which magical thinking influences contributions.

We failed to find statistically significant results confirming our hypothesis: it does not appear that magical thinking influences average contributions in a public goods game. It may be the case that magical thinking does not influence contributions, or it could be the case that our experimental manipulation was not strong enough to elicit significant differences in magical thinking between the two groups. A limitation of using experimental economics subject pools is the inability to utilize experimental deception. Perhaps, if we used a manipulation that included deception (e.g., ‘note that your contribution *will* be recorded first) then magical thinking would have been more prevalent in the treatment group.

Despite failing to find a statistically significant impact of being in the treatment group on either total contributions or engaging in magical thinking as measured by influence scores, it is interesting to note that magical thinking was ubiquitous, which may shed light on why contributions didn't differ significantly between the treatment and control groups. Our results suggest that engaging in magical thinking is a normative feature of behavior in public goods games. Thus, it may be more interesting to manipulate participants to *not* think that their contributions can set a social norm in any given period, and examine the extent to which this impacts their total contributions. This could be done by making it clear to participants that a public goods game is a simultaneous move game, and thus there is no first mover advantage that could influence the behavior of other players. It could be the case that behavior in public goods experiments deviates from the game theoretic prediction of zero contributions to the public good because of the prevalence of magical thinking. Future research may want to investigate this question further.

Future research may also want to further explore the mechanism behind magical thinking in public goods games. If it is the case that successfully manipulating participants to not engage in magical thinking lowers average influence scores, then it would be reasonable to conclude that the mechanism underlying this phenomenon is a lack of understanding of the simultaneous-move structure of public goods games. However, if influence scores do not change, even after it is explained to participants that social norms cannot be set in any given period in a simultaneous-move game, then it would appear that the mechanism underlying magical thinking in public goods games is more fundamental than a simple misunderstanding of the limitations of simultaneous-move games. For instance, Arad's (2014) supposition that magical thinking in certain games is a consequence of fear of punishment for greedy behavior may be more

explanatory in this context. Participants may initially contribute more to the public fund because they believe greed is coupled with a cosmic punishment, and this belief may persist irrespective of their understanding of simultaneous-move games. It has also been found that magical thinking decreases as individuals get older (Brashier & Multhaup), and thus would only go away if a public goods game were played with older participants. Either way, more research is required before a conclusion about the mechanism underlying magical thinking in public goods games can be drawn.

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Appendix A

Participant Instructions (Control)

Welcome to the experiment. You are guaranteed to earn at least $5 for showing up and will almost certainly earn more from the outcomes of the choices made. **Please do not speak to each other during the course of the experiment**.

This experiment involves multiple participants. Each participant is presented with the same series of choices. Your payoff depends on the decisions you make as well as the decisions of other participants.

You will be provided with 12 "tokens", called an **endowment**. Each token has a value of **$0.05** in U.S. currency.

You will be in a group of four participants. You will be given the choice of how much, if any, of this endowment to allocate to a **private fund** and how much to allocate to a **public fund**. Whatever you put in the private account, you keep. The remainder goes into the public fund. At the end of a round, the contributions to the public fund by all of the participants will be totaled and multiplied by 2. This doubled amount in the public fund will then be evenly distributed to all of the four participants.

There will be 10 rounds. Each round will take approximately 2-3 minutes. Your payoff in each round is determined by the amount you decide to allocate toward the public good, and the amount other participants decide to allocate to the public fund.

Example 1: You and all other participants contribute nothing to the public account. How much do you earn?

Example 2: You contribute nothing to the public account while all of the other participants contribute all of their tokens to the public account. How much do you earn?

Example 3: You contribute all 12 tokens to the public account while all of the other participants contribute none of their tokens to the public account. How much would you earn?

Example 4: You and all other participants contribute everything to the public account. How much would you earn?

You will repeat this round a number of times, finding out after each round how many tokens

were contributed by the group as a whole in that round.

Appendix B

Participant Instructions (Treatment)

Welcome to the experiment. You are guaranteed to earn at least $5 for showing up and will almost certainly earn more from the outcomes of the choices made. **Please do not speak to each other during the course of the experiment**.

This experiment involves multiple participants. Each participant is presented with the same series of choices. Your payoff depends on the decisions you make as well as the decisions of other participants.

You will be provided with 12 "tokens", called an **endowment**. Each token has a value of **$0.05** in U.S. currency.

You will be in a group of four participants. You will be given the choice of how much, if any, of this endowment to allocate to a **private fund** and how much to allocate to a **public fund**. Whatever you put in the private account, you keep. The remainder goes into the public fund. At the end of a round, the contributions to the public fund by all of the participants will be totaled and multiplied by 2. This doubled amount in the public fund will then be evenly distributed to all of the four participants.

There will be 10 rounds. Each round will take approximately 2-3 minutes. Your payoff in each round is determined by the amount you decide to allocate toward the public good, and the amount other participants decide to allocate to the public fund.

Example 1: You and all other participants contribute nothing to the public account. How much would you earn?

Example 2: You contribute nothing to the public account while all of the other participants contribute all of their tokens to the public account. How much would you earn?

Example 3: You contribute all 12 tokens to the public account while all of the other participants contribute none of their tokens to the public account. How much would you earn?

Example 4: You and all other participants contribute everything to the public account me. How much would you earn?

You will repeat this round a number of times, finding out after each round how many tokens

were contributed by the group as a whole in that round.

Please note that there is a real probability that you will be the first to contribute to the public good.

Appendix C

Subject ID: _____

Please rate the extent to which you feel that your contributions in a given period influenced a social norm **in that same period**. In other words, to what extent do you feel that your contributions in a given period influenced other contributions **in that same period**?

Not at all				Some					Very much
1	2	3	4	5	6	7	8	9	10

Major: _____

Age: _____

Gender: _____

Ethnicity: _____

Political Orientation: _____