

MAKING A LITTLE GO A LONG WAY: SCARCITY INCREASES COOPERATION
IN AN ITERATED PRISONER'S DILEMMA

By

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ABSTRACT OF THE THESIS

Making a Little Go a Long Way: Scarcity Increases Cooperation in an Iterated Prisoner's Dilemma

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An emerging explanation of poverty focuses on the attentional demands induced by a scarcity mindset and the effect of such demands on subsequent decision making. We build on this work by investigating the impact of resource scarcity on prosocial behavior. Specifically, we experimentally induce scarcity and then have agents play an indefinitely repeated prisoner's dilemma game in which individual and collective gains stand in conflict. Our findings suggest that relative to control participants, those experiencing scarcity are more likely to cooperate with each other and are more sensitive to reciprocity motivations. These results stand in direct conflict with the low levels of cooperation predicted by the existing bandwidth account of scarcity. We therefore propose an alternative account in which scarcity induces reciprocal altruism by altering an agent's expectations and beliefs about the behavior of others with whom they are interacting.

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1.0 Introduction

It is widely held in economics and psychology that we navigate a world of inherent scarcity and we do so with relatively limited cognitive resources. We aim to achieve maximum satisfaction yet have to constantly make trade-offs when deciding how to allocate our time or our money (e.g. Baron, 2000). Similarly, we are faced with trade-offs when directing our attention and cognitive capacities to problems or stimuli in the world at large (e.g. Kahneman, 1973). When resources are in relative abundance and cognitive constraints are minimal, navigating such a world is achieved with ease. Difficulty arises however when the scarcity of resources is instead extreme, and the world is one characterized by poverty. The aim of the current research is to examine how this poverty of resources impacts the decision making of those experiencing scarcity. Specifically, we seek to understand how scarcity changes the way in which people interact and specifically, how they cooperate.

Previous literature has approached the psychological consequences of scarcity by examining commonly observed, counterproductive, behaviors of the poor. For instance, it is widely observed that the poor are more myopic than the wealthy, and this myopia manifests itself in low engagement in long-term outcomes such as education and healthcare, and high engagement in aggressive borrowing behavior (e.g. Lawrance, 1991; Yesuf & Bluffstone, 2008; Guiso & Paiella, 2008). By the psychological account of poverty, these ostensibly counterproductive decisions are a direct result of the psychological consequences of experienced scarcity. More formally, when resources feel low

relative to an individual's needs, a scarcity mindset emerges which changes the way in which individuals experiencing scarcity make decisions (e.g. Shah *et al.*, 2012; Mani *et al.*, 2013). The myopic decisions made by those who are poor are not, by this account, due to circumstance or inherent personality traits, but are instead due to the effect their scarcity has on their decision making.

The aim of the present work is to add to this literature and to understand the effect of a scarcity mindset on cooperation behavior. In doing so we take an important step in expanding the conversation of scarcity beyond individual behavior. For if scarcity does indeed create its own mindset that has particular psychological consequences, these consequences should extend beyond valuation and individual decision making, and should affect how people interact. Understanding such an effect has both practical and theoretical implications. Poor people tend to live in proximity to others who are poor; so much so that extreme pockets of poverty persist all around the country. It is insightful then to examine how resource scarcity might affect how resource scarce individuals interact with their communities at large. Theoretically, our current work challenges the presumed mechanism underlying scarcity. To account for our present findings, we instead propose a new account, one by which scarcity changes the way individuals reason about the likely behavior of the people with whom they are interacting.

To elucidate the effect of scarcity on cooperation and provide support for our theoretical mechanism, we use a game from game theory that encapsulates the tension between individual and collective gain (Andreoni & Miller, 1993). In

the prisoner's dilemma, two agents make a simultaneous decision to either defect or cooperate with each other. While the temptation to defect is high, the average payoff is greatest when the two agents coordinate on cooperation. Because of this, if the agents interact only once, defection dominates. Cooperation can, however, be sustained as an equilibrium if the agents interact instead over several periods, and it is this iterated version of the game that we employ here (Axelrod, 1987; Nowak & Sigmund, 1993). This iterated game captures well the repeated nature of real world interactions. Furthermore, it will provide us with a precise way to look at how an individual in a scarcity mindset trades off individual and collective gain in a repeated setting.

1.1 Bandwidth Account of Scarcity

To understand how scarcity affects decision making, researchers have largely taken one of two approaches: experimentally inducing scarcity or dichotomizing participants based on reported real world income. Shah *et al.* (2012) for instance, manipulate experienced scarcity by allocating to participants either a large or a small endowment of resources. Armed with these resources, participants play a game in which they have to aim and shoot items at targets to accrue points. As compared to participants with an abundant arsenal to shoot, when participants had a small endowment they focused more on each shot and were more likely to borrow shots away from future rounds. A scarcity of resources thus led to greater engagement in areas where the shortfall was most salient. In a related manipulation, the authors allocated either a large or small number of

guesses to participants in a Wheel of Fortune game. Those who had only a small number of guesses showed impaired performance on subsequent tests of attention and cognitive control. As such, the shifting and narrowing of attention caused by scarcity seems to lead to subsequent cognitive load; attention is captured by areas of shortfall, leaving fewer attentional resources to be allocated to other problems.

Related work suggests that similar mechanisms underlie the myopic and risk averse behavior of the poor (Haushofer *et al.*, 2013; Zwane, 2012). By the above explanation, the attention and cognitive resources consumed by scarcity concerns renders the resource poor individual unable to plan for the future. Such a mechanism easily accounts for the findings described above - the attention of resource poor individuals is captured by immediate scarcity leading them to neglect the future costs of borrowing and depleting their cognitive resources.

In addition to scarcity preoccupying cognitive resources, it also forces consideration of difficult trade-offs. When money is scarce, purchasing one item means you must forgo something else; that is, scarcity increases the accessibility of opportunity costs. As a result, when the value of an item is ambiguous, individuals making decisions under scarcity are more likely to use internal, rather than external, cues to decide how much something is worth. In a classic effect of inconsistent valuation, people are found to be willing to pay more for a beer purchased at a beach resort than for the same beer bought at a corner convenience store (Thaler, 1985). Participants experiencing scarcity however, are less likely to fall prey to the irrelevant context information and more likely

than non-scarce individuals to value the beer consistently, regardless of where it is bought (Shah *et al.*, 2015).

While the above account primarily appeals to the way in which scarcity affects attention, it may also be that the central effect is one of cognitive load. By this account, preoccupation with concerns of scarcity consumes cognitive resources leaving fewer mental resources available for the efficient planning and solving of other problems. To this end, Mani *et al.* (2013) capture the intuition that when resources are scarce, people become preoccupied by the demands imposed by that scarcity and are less able to reason about other problems effectively. The authors demonstrate this causal relationship by asking participants with real world low and high incomes to answer scenario tasks in which, for example, participants had to detail how they would pay for an expensive or cheap car repair. Afterwards, participants completed Raven's Matrices to assess fluid intelligence and, similar to the study by Shah *et al.* (2012), completed a spatial incompatibility task to measure cognitive control. The results support the hypothesis that a causal relationship exists between poverty and cognitive function; when low income participants had to figure out how they would pay for an expensive repair, they scored lower than high income participants on tests of cognitive performance. The authors suggest that the effect of scarcity is thus to induce distraction and impede cognitive function; cognitive resources and working memory are limited resources and the preoccupation of the poor with concerns of their shortfall results in impaired cognitive function.

Together, the mechanism underlying scarcity is theorized to be one which serves to shift and narrow attention on areas of shortage and deplete cognitive resources. Previous research has explored the effects of scarcity on valuation and individual behavior, but of current interest is the effect a scarcity mindset might have on cooperation behavior. It is therefore informative to consider what behavior the bandwidth account of scarcity would predict should emerge when individuals in a scarcity mindset can act either to protect their individual resources, or work with others to increase resources collectively. In such a situation, the bandwidth account would predict that first and foremost, the individual's attention should be captured by information regarding possible earnings and opportunities to increase their own resources. Furthermore, the cognitive depletion wrought by their scarcity should render them unable to effectively reason about the likely behavior of the people with whom they are interacting. The bandwidth account would, therefore, predict that resource-scarce individuals will work together less than individuals who are under no such constraints. More specifically, it would predict low levels of cooperation among individuals in a scarcity mindset.

1.2 Scarcity Induced Reciprocal Altruism

While the prevailing bandwidth account of scarcity predicts low levels of cooperation among resource-scarce individuals, there are real world behaviors that suggest actually the opposite may occur. For instance, although the poor ostensibly have less, they consistently give more. Americans in the bottom

income brackets donate on average, proportionally more of their income than America's wealthiest. Moreover, poor Americans are more likely than wealthy Americans to donate to charities that support the poor or dispossessed and less likely to give to arts foundations and universities (Piff *et al.*, 2010; Stern, 2013). Other properties of poor communities provide further intuition that individuals experiencing scarcity may be likely to work with each other to increase collective resources. For example, in small scale societies, during times of food scarcity peaceful sharing is actively enforced while aggressive hoarding behavior is punished (Gurven, 2004). There are also many instances of informal partnerships emerging in scarce communities that are founded on principles of reputation building and reciprocity. The informal loan clubs of Caribbean islands exemplify this. In these clubs, participating members contribute a certain sum each month to a communal pot which is then allocated to a different member in turn (Kirton, 1996). The emergence and stability of such a partnership fundamentally relies on the desire of individuals to look beyond their personal resources and work with others to increase resources collectively.

In line with this observed behavior, resource-scarce participants also seem to be particularly attuned to reciprocity motivations. Participants reminded of their resource scarcity are, for example, more willing than control participants to spend money on a gift when future self-benefits are salient (Roux *et al.*, 2015). That is, individuals look past the immediate constraint their scarcity imposes and value instead the future benefits they are likely to receive from the recipient of their gift. These results suggest that while scarcity may not increase the generosity of

individuals per se, it may serve to increase their sensitivity to reciprocity and reputation building.

As exemplified by the above examples, when resources are scarce, those experiencing this scarcity are likely to eschew selfish resource protecting behaviors in favor of interactions that will increase collective resources. When money is tight, they donate to charities that support others who are poor; when there is opportunity to build relationships, they are generous. These examples motivate the following alternative account of scarcity.

By our proposed account, the effect scarcity has on the psychology of individuals is to alter their expectations and beliefs about the people with whom they are interacting, rendering them more able to make informed predictions about their likely behavior. Following from this, we suggest that a scarcity of resources increases the likelihood that an individual will be completely intolerant of defection. If the other agent in the interaction is also scarce, it would follow that this other individual would be similarly likely to adopt a policy of zero tolerance for defection. As such, cooperation is likely to be achieved.

We propose that several constructs are important for this outcome to hold. First of all, the agents must interact more than once; repeated interactions provide the critical opportunity for building reciprocity and reaping the benefits of cooperation. Additionally, the agents interacting must both be experiencing scarcity. An agent in a scarcity mindset cannot make the same inferences about the likely behavior of a non-scarce individual as they can about someone who is similarly scarce. By this account, we can therefore predict that when individuals

who are similarly scarce interact repeatedly, they are likely to achieve great rates of cooperation.

The remainder of the paper proceeds as follows. In section two we present empirical evidence supporting the cooperation behavior predicted by our account of scarcity. In section three we will discuss these results and suggest avenues for future research. Section four concludes.

2.0 Study

The primary objective of this study was to provide support for our hypothesis that scarcity increases the propensity to cooperate by changing the beliefs and expectations about other agents. We began by experimentally inducing a scarcity mindset by having participants complete a recall task as per Roux *et al.* (2015). Cooperation behavior was then observed in a hypothetical indefinitely iterated prisoner's dilemma (IPD) game. In accordance with our scarcity induced reciprocal altruism account, we predicted that participants in a scarcity mindset would be more likely than control participants to coordinate on cooperation.

2.1 Methods

2.1.1. Participants

An a priori power analysis was performed and determined that 632 subjects should be run to obtain 95% statistical power with an effect size of $d=0.3$. Effect size was estimated from the results of a pilot study. Six-hundred thirty-two participants from the United States (49.04% male, Male = 35.35, SD = 11.03) were therefore recruited via Amazon Mechanical Turk (MTurk). Each completed the online study in exchange for a small base payment of \$0.98. Six participant responses were excluded due to a technological glitch that erroneously allowed them to enter the study a second time so the results reported here contain responses from the remaining 626 participants. No other participants were excluded from the presented data. The study was pre-

registered at AsPredicted, a standardized tool in which researchers are asked to pre-commit to their dependent measures, data collection procedures, and analyses.

2.1.2. Materials

2.1.2.1. The game.

A simultaneous, indefinite IPD was used in which the participant, Player A, played against a hypothetical partner, Player B (see Figure 1 for payoffs). Unbeknownst to the participant, Player B was programmed to play a Tit-For-Tat (TFT) strategy such that it would cooperate in round one and then copy the move the participant played in the previous round. After the participant chose an option, the outcome of the interaction would be revealed and the next round would begin. Five rounds were completed and the payoff matrix was constant across all rounds.

		Player A	
		Cooperate	Defect
Player B	Cooperate	Player A: 50 Player B: 50	Player A: 75 Player B: 0
	Defect	Player A: 0 Player B: 75	Player A: 25 Player B: 25

Fig. 1. Payoff matrix presented to all participants. Participants made decisions as Player A and played against a hypothetical partner, Player B. Note that payoffs are in cents.

2.1.2.2. Scarcity Manipulation

To induce a scarcity mindset, we used a recall task from Roux *et al.* (2015). This task is self-contained and has been shown to have an effect on

prosocial behavior, making it a strong task to use here. In the recall task, all participants were asked to recall three or four episodes from their life and then to expand on two of these recalled scenarios. In the scarcity condition, participants recalled times when they felt like they “didn't have enough of something” or “when resources were scarce”. When expanding on two of those events, participants were asked to describe in detail what was lacking and what they experienced. Participants in the control condition were asked to recall things they had done during the past week and then to describe two of those events in detail.

2.1.3. Design

Participants were randomly assigned to either the Scarcity or Control condition. These conditions differed only in the recall task completed. All participants completed the IPD as Player A.

2.1.4. Procedure

We began by randomly assigning participants to either the scarcity condition ($n = 301$) or the control condition ($n = 325$). All participants then completed a task designed to introduce them to the IPD game. They read the instructions for the game, were presented with an example payoff matrix, and completed a set of comprehension questions. Upon successful completion of these questions they completed the scarcity manipulation recall task.

To test that recalling times of scarcity does indeed induce a scarcity mindset, we exposed a separate set of participants to this manipulation. Seventy-five MTurk participants from the United States (61.33% male, Mage = 34.45; SD

= 10.99) participated in this study in exchange for a small base payment. Participants were randomly allocated to either the scarcity ($n = 37$) or control ($n = 38$) condition and completed the recall task. All participants then completed a set of rating questions which served as a measure of experienced scarcity. They rated (scale: 1 = strongly disagree to 7 = strongly agree) the degree to which they agreed with the following: “My resources are scarce”, “I need to protect the resources I have”, “I don’t have enough resources”, and “I need to acquire more resources”. Responses to these four questions were averaged together to form a scarcity index, with a higher score indicating greater experienced scarcity and a lower score indicating less experienced scarcity. As predicted, scarcity index scores were higher for participants in the scarcity condition ($M = 4.64$, $SD = 1.07$) compared to participants in the control condition ($M = 3.72$, $SD = 1.41$; $t(73) = 3.16$, $p = 0.002$). That is, participants who recalled past experiences of scarcity subsequently reported feeling more scarce (see Figure 2). These results provide evidence for the effectiveness of this manipulation (for more details see *S1*).

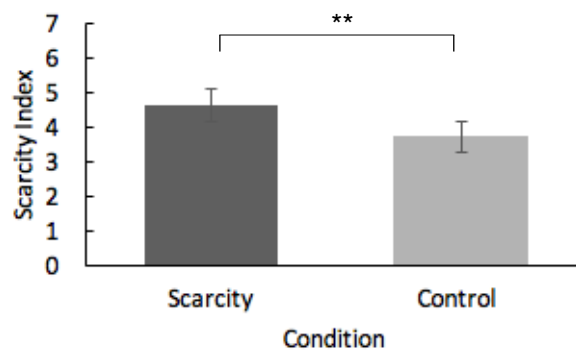


Fig. 2. Results from scarcity manipulation check study. Note that the scarcity index ranges from 1 (not scarce) to 7 (high experienced scarcity). Thus, higher ratings indicate higher experienced scarcity. Error bars represent ± 1 standard error.

Following completion of the scarcity manipulation recall task, participants proceeded to the five-round IPD. All participants were told they were going to interact with the same, hypothetical partner for an undetermined number of rounds of a task. We emphasized that they were to imagine that this partner had just completed the same writing task they had; that is, those in a scarcity mindset would imagine playing with a partner who had also written about times of scarcity. To increase the realism of this, we presented participants with an example episode written by a previous participant in the respective conditions. Scenarios were chosen from a pilot study and exemplified the recall task completed in each condition. The participant was informed of the outcome after each round and proceeded directly to the next round until five were completed.

Finally, all participants answered a set of follow up rating questions designed to elicit their beliefs about how people experiencing scarcity or abundance of resources should value acts such as returning favors, working together, or protecting their own resources. Following this they completed a 15 item SVO scale adapted from Murphy *et al.* (2011). This scale consists of a series of decomposed games that require the participant to choose between combinations of outcomes for herself and for an anonymous and hypothetical partner. These decisions form a measure that assess individual preferences for resource allocation between oneself and another (for more details on these secondary measures, see *S/*).

2.2 Results

Our primary prediction was that participants in the scarcity condition would be more likely to cooperate than participants in the control condition. We began by calculating the proportion of participants cooperating and defecting in each round and in each condition (Figure 3). We then specified a repeated measures logistic regression model which accounts for the correlation among observations from the same participant. In model 1, this regression was fit to the entire data set with cooperation (0 = defection, 1 = cooperation) as the response variable and condition (0 = control, 1 = scarcity) as the explanatory variable.

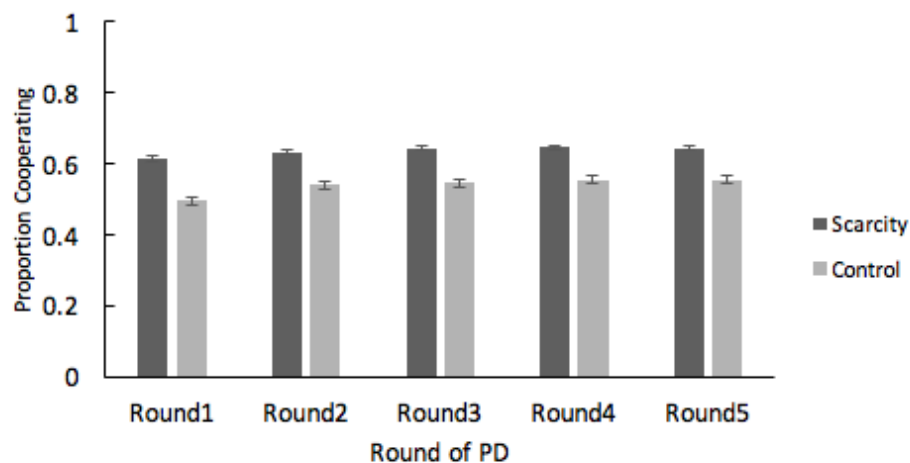


Fig. 3 Proportion of participants choosing to cooperate in each round of the iterated Prisoner's Dilemma game. Error bars represent ± 1 standard error.

As Table 1 shows, participants in the scarcity condition were significantly more likely than participants in the control condition to cooperate (OR = 1.50, SE = 0.21). Furthermore, this main effect of condition does not change significantly with the addition of other explanatory or control variables. In model 2, we account

for the significant effect of round on cooperation behavior. We find that cooperation rates were significantly higher in all rounds as compared to round 1. This effect does not however differ between condition; that is, there is no significant interaction between round and condition. In model 4, we include SVO as a covariate. Unsurprisingly, SVO is a significant predictor of cooperation, such that participants who are more prosocial, and thus have higher SVO scores, are more likely to cooperate than those who are more pro-self and have lower scores (OR = 1.07, SE = 0.11). Covarying out SVO does not however, significantly change our main effect of condition (OR = 1.59, SE = 0.23). In this model we also include an interaction between SVO and condition and find a marginally significant interaction between SVO and condition such that SVO predicts cooperation less for those in the scarcity condition (OR = 0.98, SE = 0.014). Model 4 shows that the addition of control variables does not significantly influence our effects. Neither gender nor age is a significant predictor of cooperation.

Table 1.
Repeated measures logistic regression models

	Model 1	Model 2	Model 3	Model 4
(Intercept)	1.170 (0.109)	1.509 (0.105)	0.996 (0.106)	0.666 (0.173)
Condition (0=Control, 1 = Scarcity)	1.505* (0.207)	1.509** (0.208)	1.593** (0.226)	1.605*** (0.229)
Round 2		1.148* (0.08)	1.164* (0.089)	1.157* (0.089)
3		1.187* (0.083)	1.207* (0.092)	1.210* (0.093)
4		1.211** (0.084)	1.234** (0.094)	1.237** (0.095)
5		1.203** (0.837)	1.223** (0.094)	1.123** (0.094)
SVO			1.077*** (0.011)	1.075*** (0.011)
SVO # Condition			0.977 (0.014)	0.977 (0.014)
Gender (1 = Female, 2 Male)				1.245 (0.177)
Age				1.007 (0.007)
Num. groups.	626	626	626	626
Obs. per group	5	5	5	5

*** p < 0.001, ** p < 0.01, * p < 0.05

Note: Odds ratios reported, standard error in parentheses

3.0 Discussion

The results of the present experiment demonstrate that a scarcity mindset increases the propensity to cooperate with individuals similarly experiencing scarcity. We demonstrate this effect using a hypothetical, indefinite IPD and show that across all rounds and robust to the addition of control variables, participants in the scarcity condition are more likely to cooperate than participants in the control condition. The significance of this finding is twofold.

First, it is the only work we know of that extends the research on scarcity beyond that of individual decision making to how individuals in a scarcity mindset interact. Our choice of the IPD as a paradigm allows us to examine behavior and situations that arise in the real world. Poor individuals often live in proximity to similarly poor individuals and they are likely to interact with each other on more than one occasion. Additionally, while we look only at the tension between individual and collective gain of monetary resources, material scarcity is a robust predictor of secondary features of poverty (Haushofer & Fehr, 2014).

Second, these findings challenge the existing bandwidth account of scarcity and lend initial support to our alternative account, scarcity induced reciprocal altruism. By the bandwidth account, scarcity serves to shift attention and deplete cognitive resources and would thus predict that the attention of those in a scarcity mindset should be captured by high individual payoffs. Subsequently, their cognitive depletion should render them unable to reason about the strategy of their partner. Thus, this account would predict high rates of

defection and low levels of cooperation in the scarcity condition. We observe, however, the exact opposite.

While not predicted by the bandwidth account of scarcity, the observed high levels of cooperation among individuals in a scarcity mindset is consistent with the scarcity induced reciprocal altruism account, in which scarcity serves to increase beliefs about the strategy likely to be played by the other agent. Due to the scarcity of resources that defines a scarcity mindset, individuals in this case should be less tolerant of defection and more likely to play a grim trigger strategy in which they exercise complete intolerance to defection (Axelrod, 1987). Game theory already assumes that each agent is reasoning about the behavior of their partner so the belief that a similarly scarce partner would also play a grim trigger strategy should increase and coordination on cooperation should thus be achieved. The results from the present experiment provide strong empirical support for the prediction made by our theoretical account

3.1 Limitations and Future Directions

Despite the robustness of the current finding, further research is needed to conclusively support our proposed account. Possible alternative explanations for our current results are as follows: First, it may be the case that scarcity serves only to increase social preferences; under this explanation, scarce participants cooperate because they wish to increase the resources of their partner. This account differs critically from our scarcity induced reciprocal altruism in that an agent driven by social preferences does not care about the possible benefits they themselves could reap from cooperation (Boyd & Richardson, 1988; Cox, 2004).

Similarly, resource-scarce participants may simply be cooperating because of empathy or sympathy they have for their partner. To distinguish between these social preferences explanations and our proposed account, cooperation behavior could be observed in a one-shot interaction compared to a repeated interaction. Our account predicts that the repetition of interaction and the opportunity that provides for reciprocity and reputation building is critical to the heightened cooperation. In contrast, a social preferences account would predict greater cooperation between scarce participants as compared to control participants in both a one-shot and a repeated interaction. Therefore, observing that an increase in cooperation among individuals experiencing scarcity occurs only when the interaction is repeated will strengthen support for our account.

Our results and proposed theoretical account will be further strengthened by observing behavior when interactions and monetary outcomes are non-hypothetical. While arguably the main disadvantage to a hypothetical study is an increase in choice variance, non-hypothetical interactions should be observed to confirm the validity of our results (Camerer & Hogarth, 1999). More critically, the hypothetical nature of the present study limits the set of strategies we can observe. If indeed the effect of scarcity is to change agent's expectations of strategies, this should emerge in observed patterns of response. In the present experiment, our programmed computer plays a strict TFT strategy and as a results, we cannot distinguish among strategies such as conditional or unconditional cooperation. Furthermore, due to this TFT strategy, we cannot observe how a participant in the scarcity condition would respond to defection on

the part of their partner; our program defects only if the participant is the first to deviate from cooperation. It would therefore be advantageous to observe either real partner interactions or participant's interactions with a hypothetical partner who has some probability of defecting each round. If, as we predict, scarcity changes the strategies played, scarce agents should be more likely to play a grim trigger strategy and less likely to play other more generous strategies such as unconditional cooperation or Tit-for-Tat.

4.0 Conclusion

In summary, the findings presented here are a novel first step to understanding how scarcity affects strategic interactions. Specifically, we propose an account of scarcity in which it affects the way in which individuals reason about other agents in their environment. Unlike the existing bandwidth account of scarcity, this account predicts that individuals in a scarcity mindset should be more likely to cooperate with each other than individuals who are under no such constraints. We present results from a study in which we experimentally induce a scarcity mindset and observe that participants experiencing scarcity are more likely than control participants to cooperate in an indefinitely iterated prisoner's dilemma. The results support our hypothesis that scarcity does indeed increase propensity for cooperation.

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SUPPLEMENTARY INFORMATION

Manipulation check study: In the manipulation check study we sought to evaluate evidence for the effectiveness of our scarcity manipulation. In addition to the main effect of the recall task on the scarcity index as reported in the main text, we also measured SVO and analyzed it per the procedure outlined in Murphy et al. (2011). The distribution of SVO values can be seen in Figure 4. As expected, the scarcity manipulation had no effect on SVO, such that SVO values did not differ significantly between the scarcity and the control condition ($t(73) = -0.71$, $p = 0.48$). This result is consistent with the conceptualization of SVO as a trait, not state, characteristic.

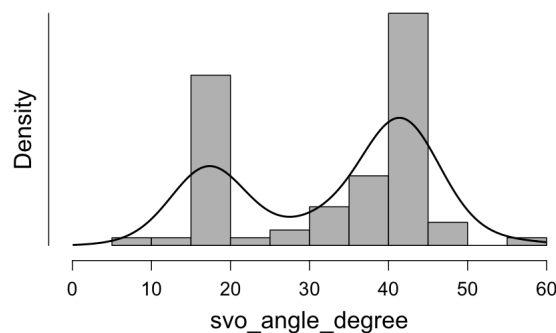


Fig. 4 Distribution of SVO scores. Groups of participants fall in the categories of individualistic ($-12.04 < \text{SVO} < 22.45$) and prosocial ($22.45 < \text{SVO} < 57.15$).

Main study: The primary aim of the study was to assess the effect of a scarcity mindset on cooperation behavior. In addition to the main results already reported, we pre-registered the following analyses. As it is possible that a scarcity state may have more of an effect on cooperation decisions in earlier rounds, we predicted a possible two-way interaction between state and round. A three-way interaction among round, state, and SVO was also explored, as it is possible that

Table 2. Repeated measures logistic regression results for secondary analyses

	Model 5	Model 6
(Intercept)	1.092 (0.165)	1.060 (0.172)
Condition (0=Control, 1 = Scarcity)	1.46* (0.240)	1.554 (0.270) **
Round 2	1.089 (0.111)	1.107 (0.125)
3	1.137 (0.116)	1.165 (0.132)
4	1.153 (0.118)	1.193 (0.137)
5	1.137 (0.116)	1.170 (0.134)
Condition # Round		
1	0.899 (0.126)	0.918 (0.141)
2	0.993 (0.139)	0.998 (0.154)
3	0.975 (0.137)	0.978 (0.152)
4	0.986 (0.138)	0.983 (0.153)
SVO		1.067 (0.013)***
Condition # SVO		0.977 (0.166)
Condition # Round # SVO		
Condition = 0 Round = 2		1.008 (0.015)
0 3		1.009 (0.012)
0 4		1.015 (0.012)
0 5		1.013 (0.012)
Condition = 1 Round = 2		1.010 (0.016)
1 3		1.000 (0.015)
1 4		0.989 (0.015)
1 5		0.997 (0.015)
Num. groups.	626	626
Obs. per group	5	5

*** p < 0.001, ** p < 0.01, * p < 0.05

Odds ratios reported, standard error in parentheses

any interaction between state and SVO would only be present during the first few rounds of the prisoner's dilemma game. Table 2 reports the results of these analyses. No significant interaction between state and round was found (Model 5), nor was there found to be a significant interaction between state, round, and SVO (Model 6). As was true in the manipulation check study, we also found that the scarcity manipulation had no effect on SVO ($t(624) = -0.24, p = 0.81$) (see Figure 5 for distribution of scores).

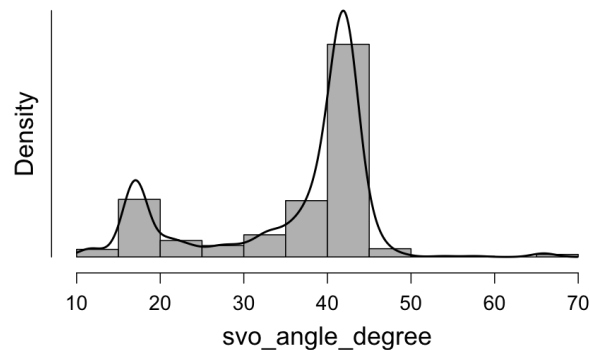


Fig. 5 Distribution of SVO scores. As in the manipulation check study, groups of participants fall in the categories of individualistic ($-12.04 < \text{SVO} < 22.45$) and prosocial ($22.45 < \text{SVO} < 57.15$).

In this study we also included a set of exploratory rating questions, designed to provide insight into the views of participants. All participants rated (scale: 1 = strongly disagree to 7 = strongly agree) the degree to which they agreed with the following statements: “People who always experience an abundance [scarcity] of resources should work together to expand the resources available for everyone” , “People who always experience an abundance [scarcity] of resources should work to protect their own resources”, and “People who always experience an abundance [scarcity] of resources should reciprocate

and pay back favors to others”. We expected participants to agree more that when resources are scarce, people should work together and reciprocate, than when resources are abundant. Conversely, we predicted that participants would agree less that when resources are scarce people should protect their own, as compared to when resources are abundant. Contrary to all of our predictions, participants indicated that compared to when resources are scarce, when resources are abundant, people should reciprocate ($t(624) = -14.97, p < 0.001$), work together ($t(624) = -9.88, p < 0.001$), and not selfishly protect their own resources ($t(624) = 11.82, p < 0.001$) (see Figure 6). These findings are in direct

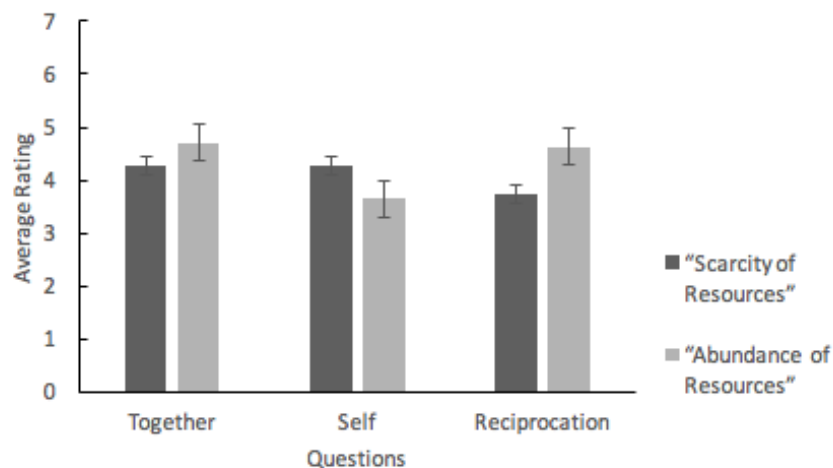


Fig. 6 Responses to the exploratory rating questions. Higher ratings indicate greater agreement with the statement.

contrast to what we observe in their behavior. While here participants indicate that people experiencing scarcity should not reciprocate and work together, this is exactly the behavior we observe in the indefinite IPD. This reversal of results

may be attributable to confusion about the questions or the rating scale used; no attention or comprehension checks were used during this section. Furthermore, our counterintuitive results may be due to lack of insight on the part of participants; the questions we posed may not have provided them with the best way to evaluate or express their opinions.