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## The Robustness of Reciprocity: Experimental Evidence that Each Form of Reciprocity is Robust to the Presence of Other Forms of Reciprocity

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## SOCIAL SCIENCES

# The robustness of reciprocity: Experimental evidence that each form of reciprocity is robust to the presence of other forms of reciprocity

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Prosocial behavior is paradoxical because it often entails a cost to one's own welfare to benefit others. Theoretical models suggest that prosociality is driven by several forms of reciprocity. Although we know a great deal about how each of these forms operates in isolation, they are rarely isolated in the real world. Rather, the topological features of human social networks are such that people are often confronted with multiple types of reciprocity simultaneously. Does our current understanding of human prosociality break down if we account for the fact that the various forms of reciprocity tend to co-occur in nature? Results of a large experiment show that each basis of human reciprocity is remarkably robust to the presence of other bases. This lends strong support to existing models of prosociality and puts theory and research on firmer ground in explaining the high levels of prosociality observed in human social networks.

## INTRODUCTION

Prosocial behavior entails paying a cost for another agent to receive benefits. In such cases, prosociality undermines one's own fitness or welfare. As a result, the ubiquity of prosocial behavior in humans has long been a puzzle for the social and biological sciences. The main solution to this puzzle is humans' extensive embeddedness in social networks. In contrast to one-off interactions, relatively stable network structures promote prosociality (1–4) and alter evolutionary dynamics (5–6) via a range of mechanisms. Specifically, theoretical models and empirical tests show that we help those in our networks who have helped us (direct reciprocity; Fig. 1A) (7–9), pay forward help we have received from one person to another person in our network (generalized reciprocity; Fig. 1B) (10–12), give more in the presence of network members who can reward our giving (reputational giving; Fig. 1C) (13, 14), and relatedly, reward network members who have given to others (rewarding reputation; Fig. 1D) (15, 16).

While each of these forms of reciprocity is predicted to promote prosocial behavior, “surprising dynamics can arise when mechanisms are combined” (17). In nature, the mechanisms of reciprocity almost always overlap, since human social networks are characterized by basic properties, such as mutuality (9, 18, 19), clustering (20, 21), and short paths (21, 22), which provide the structural foundations for direct reciprocity, reputational giving, rewarding reputation, and generalized reciprocity (23). Furthermore, given the high levels of connectedness of human populations (24–26), any given person in a social network is generally embedded in multiple relation sets conducive to multiple bases and instances of reciprocity. In light of this complexity, we must understand how the embeddedness of multiple types of reciprocity affects prosocial behavior. While each of the forms of reciprocity predicts prosociality in isolation, it is possible—even likely—that some forms of reciprocity crowd out other forms. Only when we establish that the bases of reciprocity persist in the presence of other bases can we say with confidence whether theories and findings from controlled empirical tests apply

in contexts where our social networks implicate multiple forms of prosociality at once.

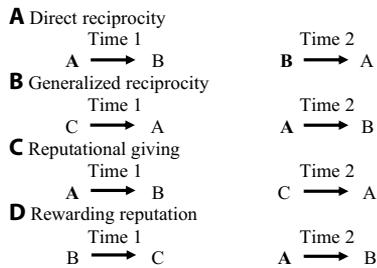
A few studies have examined the presence of multiple forms of reciprocity. Molleman, van den Broek, and Egas (27) examined direct reciprocity and rewarding reputation. They found that while both forms of reciprocity had positive effects on prosociality, when both were present, the effect of reputations was diminished. In addition, when motives for reciprocity in the two forms conflicted—e.g., when participants interacted with an alter with whom they had a positive direct experience but who had a negative reputation—direct reciprocity was a stronger determinant of behavior toward the alter. Similarly, Simpson and colleagues (28), building on two earlier studies (29, 30), studied both generalized reciprocity and reputational giving. They found that generalized exchange is more likely to initiate chains of prosociality and that each form of reciprocity holds in the presence of the other. While this work sheds light on how prosociality is affected by the presence of two forms of reciprocity, we do not know how each of the four bases of reciprocity identified above affect prosociality in tandem nor do we know how multiple instances of generalized reciprocity, reputational giving, or rewarding reputation shape prosociality. For instance, receiving from multiple others in a generalized reciprocity structure may increase the extent to which one pays it forward, by shaping perceived norms about behavior within a given setting. Here, we address these questions using a large crowd-sourced experiment.

There are reasons to doubt whether any given basis of prosociality is robust to the presence of other bases. For instance, explicitly strategic forms of reciprocity (e.g., giving solely to gain a positive reputation and reap the benefits of indirect reciprocity) may “crowd out” gratitude and other more “sincere” prosocial bases of giving via generalized reciprocity. Similarly, given the more explicit norms governing direct reciprocity (9, 18), the presence of direct reciprocal relations may lead people to be less apt to engage in other bases of reciprocity (e.g., paying it forward or rewarding others for their giving, as seen by research by Molleman and colleagues outlined above). Last, the greater informational demands on reputational giving and rewarding reputation (31) may simply lead to a narrowing focus on more immediate, direct forms of reciprocity when both are present. For

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**Fig. 1. Illustration of the four forms of reciprocity.** Within each form, the person's behavior being explained is in bold font. Direct reciprocity explains both A and B's behavior. A initially gives to B anticipating the norm of reciprocity. B gives back to A out of normative obligation.

instance, I may be less apt to indirectly reciprocate another's generosity toward a third party when focused on directly reciprocating help I have received. Similarly, rewarding reputation requires knowledge of the broader structure of relations beyond just the agent and the person to whom they are giving, and such information is not always known or salient when deciding to offer help. More generally, a greater number of instances of reciprocity embedded within a particular relation may diminish the effects of some or even all of the forms of reciprocity.

Of course, the copresence of multiple bases of reciprocity could potentially have positive or buttressing effects. For instance, there is evidence that feelings of gratitude, or elevation, from one form of reciprocity “spill over” to other types of relations, leading to higher overall levels of giving (32–34).

In short, we cannot know whether existing theoretical models and empirical results on prosociality apply to contexts where multiple bases of reciprocity and prosociality co-occur. Given that such contexts are ubiquitous in human social networks, we assessed the robustness of reciprocity with a large Web-based experiment in which participants interacted with ostensible others. This allowed us to carefully control both (i) the presence or absence of various types of relations and (ii) the behaviors of ostensible others in those relations. A controlled experiment is best suited to our research question since normative levels of giving may emerge in actual networks that would make it challenging to distinguish between various bases of reciprocity. This would be especially detrimental to our ability to draw causal inferences if the presence of any given basis of reciprocity affected giving in other bases. We therefore simulated others' decisions to isolate the effects of our manipulated factors from each other and from variation in others' giving behaviors. Further, it is difficult to use observational network data to infer the relational bases of prosociality since prosocial behaviors may flow through triads, but without extended time stamps, it is impossible to isolate the mechanism responsible for giving (31).

In our experiment, helping was costly to the giver and socially beneficial, i.e., it benefited the target of help more than it cost the helper. Specifically, for all decisions, participants (and ostensible others in the experiment) decided how much of a 10-point endowment to give to another. Any point given was multiplied by 2. Points had monetary values to participants.

We investigated direct reciprocity, generalized reciprocity and both phases or “components” of indirect reciprocity, which we will label “reputational giving” (35) and “rewarding reputation” (15). For simplicity, we refer to direct reciprocity, generalized reciprocity, reputational giving, and rewarding reputation as “four forms” of

reciprocity, while recognizing that reputational giving and rewarding reputation, although conceptually distinct, are part of the same chain of giving (31). To isolate the effects of each of the four forms of reciprocity on prosociality while enabling them to be embedded with one another, we fully crossed the four forms with three levels or instantiations of each type, yielding a total of 81 conditions. Table 1 presents a summary of the experimental design. For each type of reciprocity, we included a control (the first level of each factor or form of reciprocity) where participants were given no information about that type of reciprocity.

As shown in Table 1, the second level of the direct reciprocity manipulation entailed an ostensive other giving to the participant, and then the participant deciding how much, if any, to give back. The third level of this factor entailed the participant deciding how much to give to another participant, knowing that the participant would have the opportunity to reciprocate the participant's giving.

The other factors (generalized reciprocity, reputational giving, and rewarding reputation) have a similar structure to one another, as Table 1 shows. The second level of each of these factors enables exactly one other individual to engage in the respective form of reciprocity, while the third level of each of these factors enables two other individuals to engage in the respective form of reciprocity. For example, in the third level of reputational giving the participant (A) gives to another participant (B). Once A has given to B, C, and D each ostensibly decide how many points to give to A.

To illustrate, Fig. 2 shows a screenshot of the condition at the intersection of the second level of each factor. A participant in this condition would see (i) how many tokens H gave to the participant before the participant made his/her decision (direct reciprocity), (ii) how many tokens D gave to the participant before the participant decided how many points to give to H (generalized reciprocity), (iii) that P would observe the participant's giving and would have a chance to reward them (reputational giving), and (iv) how many tokens H gave to J before the participant decided how much to give H (rewarding reputation). To establish the robustness of our results across a wide range of alters' behaviors, we simulated others' giving based on random draws from a uniform distribution (see Materials and Methods). Thus, on the screen that followed the one depicted in Fig. 2, participants were told how many tokens H gave to J, how many tokens H gave to the participant, and how many tokens D gave to the participant. On that same screen, the participant was asked how many tokens he/she wanted to give to H. The participant was also reminded that P would learn how many tokens the participant gave to H, and then, P would have an opportunity to give the participant tokens.

Each participant completed six randomly selected conditions. For each decision, they were given the information corresponding to the condition and asked how many (if any) out of a possible 10 tokens they wanted to give (see the Supplementary Materials). Participants were told they would be paid on the basis of the number of tokens they earned in one randomly selected round. Across all conditions, there were a total of 709 participants, corresponding to 4254 participant responses.

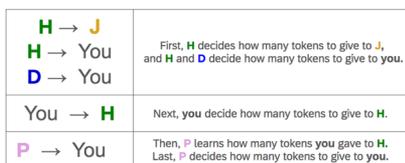
## RESULTS

### Direct reciprocity

Beginning with direct reciprocity, when participants knew that an alter would have the opportunity to directly reward their giving, they gave more (coeff = 0.51,  $P < 0.001$ ; table S2). This held across all

**Table 1. Summary of the experimental design.** Within each type of reciprocity, there were three levels of the factor. This was crossed by the four types of reciprocity. Note: The participant took the perspective of A. If something occurred “first,” he or she was given the information before making his or her decision. Similarly, if something occurred “then,” he or she was told that someone else would see his or her choice.

	Direct reciprocity	Generalized reciprocity	Reputational giving (event 1 in indirect reciprocity)	Rewarding reciprocity (event 2 in indirect reciprocity)
Level 1	A → B	A → B	A → B	A → B
Level 2				
First	B → A	C → A	A → B	B → C
Then	A → B	A → B	C → A	A → B
Level 3				
First	A → B	C → A D → A	A → B	B → C B → D
Then	B → A	A → B	C → A D → A	A → B



**Fig. 2. Example screen of what participants saw.** This screenshot illustrates the condition in which the participant goes second in direct reciprocity (H gives the participant before she decides how much to give H), there is one instance of generalized reciprocity (relation with D), there is one instance of reputational giving (relation with P), and there is one instance of rewarding reputations [H gives to someone else (J) before the participant decides how much to give H].

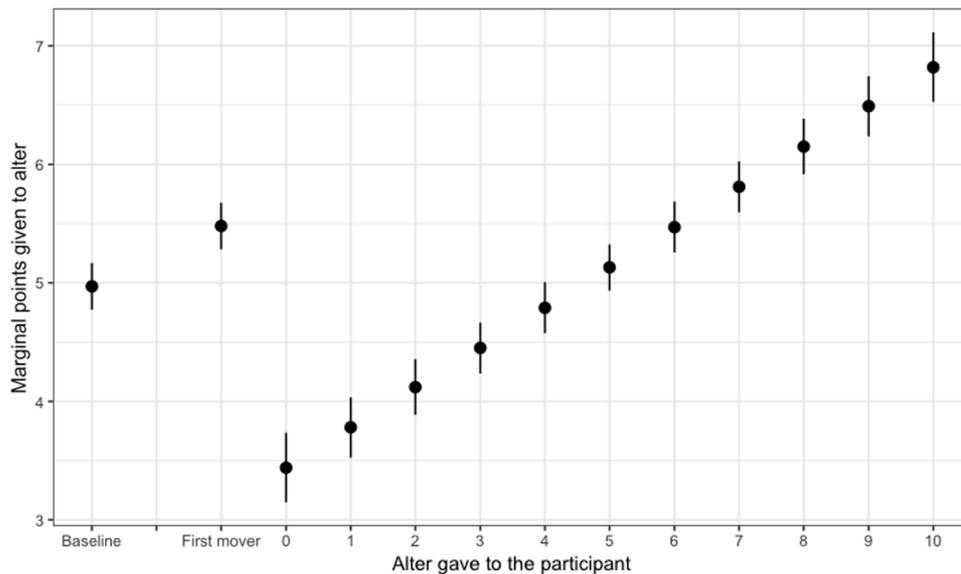
conditions, meaning that the presence of other forms of reciprocity did not affect initiating direct reciprocity (other forms of reciprocity were entered as categorical variables into the model; table S2, model 1). When an alter in a direct reciprocity relation gave to the participant, participant giving was contingent on how much they received. By design, the other’s giving was a randomly generated amount, and this amount affected the level of reciprocation (table S2, model 2). To illustrate, Fig. 3 plots the marginal means for the control condition, when the participant first decided how much to be given an alter who could directly reciprocate, and reciprocity amounts for each value that alter could give to the participant. When the alter gave the participant zero to four monetary units (MUs), the participant gave less than in the control condition. When the alter gave the participant five or more MUs, the participant gave more than in the control condition. Thus, we observe a “help enough or do not help at all” dynamic, with participants giving more when they had no reason to expect reciprocation from someone (i.e., in the control condition) than to others who had previously helped them but not very much. Tests of nested models show that none of the other forms of reciprocity moderates the effects of direct reciprocity on giving, meaning that direct reciprocity promotes prosocial behavior regardless of whether it is embedded with other bases of reciprocity (see the Supplementary Materials).

### Generalized reciprocity

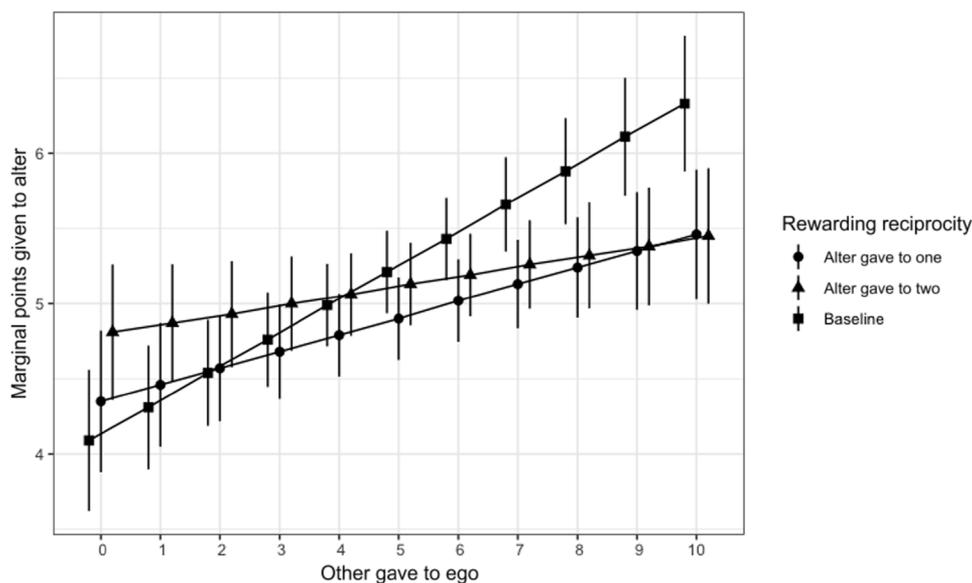
Generalized reciprocity presents participants with information about how much one or two others (depending on condition) gave to them, before the participant has the opportunity to give to someone else. The amount each alter gave to the participant was random, as detailed above. Hence, we include this as a continuous variable predicting how much the participant gave to someone else. We control for the other forms of reciprocity as factors and find that the more others gave to the participant, the more the participant paid forward (coeff = 0.13,  $P < 0.001$ ; table S3). These effects hold whether or not other forms of reciprocity were present (table S3, model 1), although the strength of the effect was moderated by the presence of rewarding reciprocity (table S3, model 2). Figure 4 illustrates that the effect of generalized reciprocity was strongest when rewarding reciprocity was not present (i.e., in the control condition). When the alter to whom the participant is giving gave to one or two others before the participant made his or her decision, the effect of generalized reciprocity was weaker but still positive. In terms of the presence of multiple others initiating generalized reciprocity (i.e., comparing levels 2 and 3 of the generalized reciprocity manipulation), we find that what matters most is the total amount of tokens the participant received, not the number of others who gave those tokens (table S3, model 3). Moreover, we find that generalized reciprocity has a linear effect on giving—participants do not give less the more they receive (table S3, model 4). Thus, prosociality is robust to multiple initiators, provided they are giving sufficiently, and does not appear to be characterized by diminishing returns.

### Reputational giving

For reputational giving, we focus on a mixed model with dummy variables for whether there was one or two others present to reward the participant’s giving. These effects are in contrast to the control condition, where there was no one present to reward giving. Other forms of reciprocity are controlled as factors. When either one or two others were present to indirectly reciprocate the participant’s giving, participants gave more (coeff = 0.41 and 0.52, both  $P < 0.001$ ; table S4). It is worth pointing out that the effect of reputational giving



**Fig. 3. Marginal means from models 1 and 2 in table S2 of points given for direct reciprocity conditions.** The y axis is the predicted or marginal values from the model. The control condition is the predicted or marginal value from model 1. The value for the first mover also comes from model 1. The other elements refer to how many points the other gave the participant before the participant decided how many to give. These estimates come from model 2.

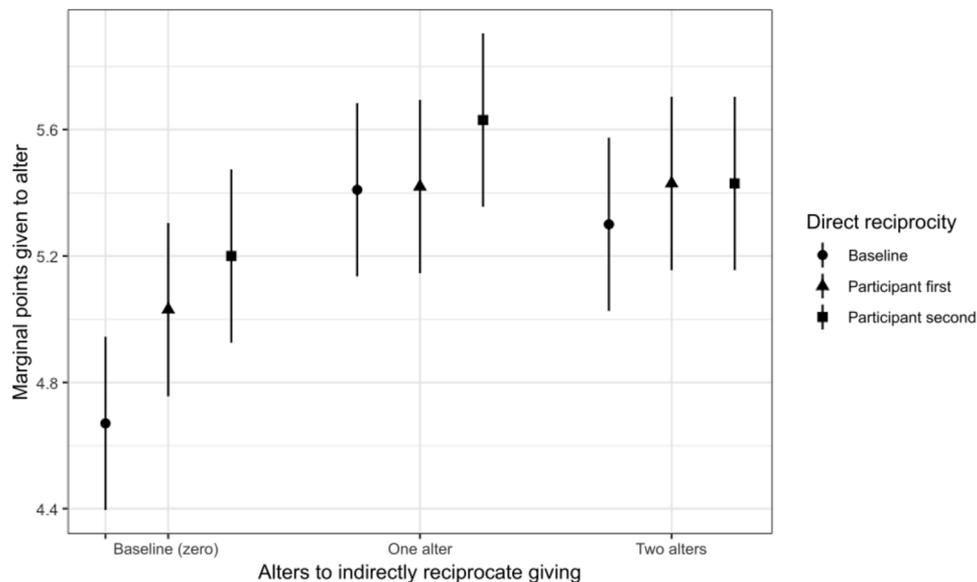


**Fig. 4. Marginal means from model 2 in table S3 of points given for generalized reciprocity conditions.** The y axis is the predicted or marginal values from the model. The x axis refers to how many points C gave to the participant before the participant decides how many points to give to B (Fig. 1B).

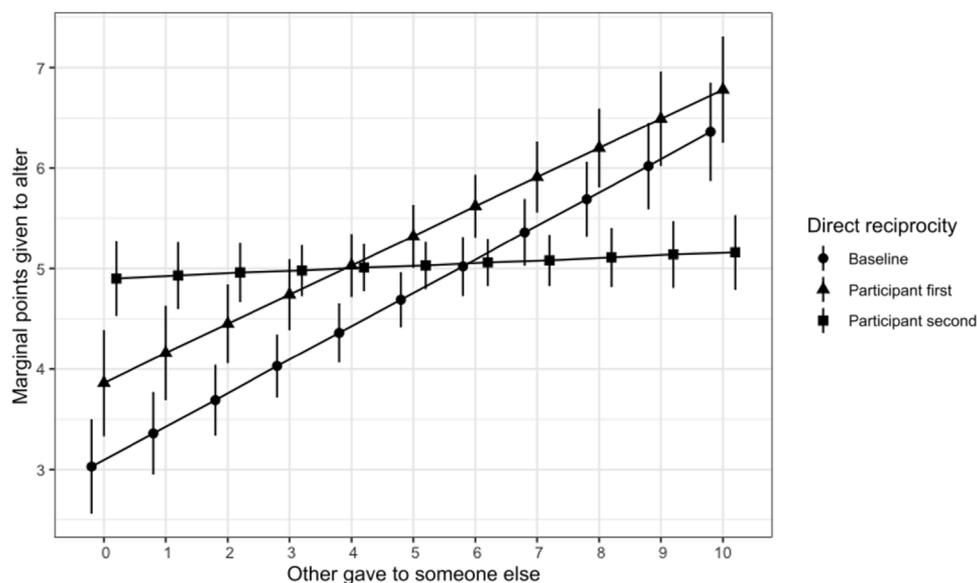
diminishes when multiple others are present: When one other is present, participants give 0.41 points more, but when two others are present participants give 0.52 points more. Thus, being embedded in a structure with multiple instances of reputational giving appears to result in diminished returns for additional others. This tendency to engage in reputation seeking via prosociality was robust to whether other forms of reciprocity were present, although we found some variation in giving for different levels of direct reciprocity (table S4, model 2), as shown in Fig. 5. In particular, reputational giving has a stronger effect when direct reciprocity is absent, although it still promotes giving even in the presence of either form of direct reciprocity.

### Rewarding reputation

Like generalized reciprocity, rewarding reputation presents participants with information about how much another gave before the participant decides whether and how much to give. Accordingly, we include how much the other (B) gave to one (C1) or two (C2) third parties before the participant (A) decides how much to give to B. We control for the other factors or forms of reciprocity. Here, we find that the more alter gave to third parties, the more the participant gave to alters (coeff = 0.18,  $P < 0.001$ ; table S5). This result holds across all other forms of reciprocity, although we find that the effect of rewarding reciprocity varies somewhat with direct reciprocity



**Fig. 5. Marginal means from model 2 in table S4 of points given for reputational giving conditions.** The y axis is the predicted or marginal values from the model. The x axis refers to which level of direct reciprocity the participant experienced.



**Fig. 6. Marginal means from model 2 in table S5 of points given for rewarding reciprocity conditions.** The y axis is the predicted or marginal values from the model. The x axis refers to how many points B gave to C before the participant decides how many points to give to B (Fig. 1D).

(table S5, model 2). Figure 6 shows that if the alter to whom the participant is giving has already given to them by way of direct reciprocity, then it does not matter how much that alter gave to others—only direct reciprocity matters, which is largely consistent with the findings from Molleman, van den Broek, and Egas (27) described earlier. This is the only instance where we find that one basis of reciprocity (direct reciprocity) reduces the tendency to engage in another type (rewarding reputation). Rewarding reputation has a positive effect in all other direct reciprocity conditions. As with generalized reciprocity, the alter could give to one or two others before the participant gives to alter. Also, as with the generalized reciprocity manipulation, we find that the number of others does not matter

but how many points the alter gave does (table S5, model 3). Further, the effect of rewarding reputation is linear, with no evidence of diminishing returns for alter's giving (table S5, model 4).

To summarize, with a single exception, all four forms of reciprocity positively predict giving, regardless of whether the other forms of reciprocity are present. That is, each form of reciprocity is robust to the presence of other forms. Specifically, the effects of direct reciprocity do not vary with other bases, and generalized reciprocity is strongest in the absence of rewarding reputation but is present across all conditions. Both components of indirect reciprocity—reputational giving and rewarding reputations—are moderated by direct reciprocity (Figs. 5 and 6) only. However, as shown in Fig. 5, reputational giving

relations continually promote giving across all conditions. Rewarding reputation relations fail to increase giving in only one condition: when the alter to whom the participant is giving has given to the participant in a previous interaction. Furthermore, for both generalized reciprocity and rewarding reciprocity, we find that it is not the number of relations that matter but rather the amount of prosociality that flows through them.

## DISCUSSION

We set out to answer a simple, but important, question: Are the conditions of reciprocity robust to the fact that they co-occur in human social networks? That is, the structure of human social networks is such that the relational bases of different forms of reciprocity rarely, if ever, occur in isolation. At any given point, a person's network may implicate them in deciding whether to (i) help a person who may (or may not) directly reciprocate that help in the future, (ii) directly reciprocate help from another network member, (iii) pay forward help received, (iv) give more to increase her reputation, and (v) help those that have helped others. Although our networks produce topologies that yield multiple bases of reciprocity, the bulk of past work treats them as occurring in isolation.

Here, we used a large Web-based experiment to isolate the bases of reciprocity to assess the extent to which the presence of one type attenuates prosociality effects in other types, as well as their conditional impacts on prosocial behavior. Fortunately for both our theories and human prosociality, our findings suggest that the forms of reciprocity are remarkably robust to the presence of other forms. That is, while we found some minor variation in how a given form of reciprocity might affect other forms, this variation was the exception, and robustness was the rule. This means that reciprocity, in its various forms, had a positive effect on participant giving under every condition we studied.

The robustness of reciprocity is, in many ways, remarkable. As noted earlier, there are clear reasons to expect the presence of one basis of reciprocity to alter generosity in other types of relations. But we did not find any strong detrimental moderating effects. This helps shed light on the remarkable quantity and diversity of prosociality observed in human populations.

## MATERIALS AND METHODS

The Institutional Review Board at the University of South Carolina reviewed and approved this research. The experiment was conducted using Amazon Mechanical Turk, an online crowd-sourcing platform that is used frequently for behavioral experiments in the social sciences (36–38). Turk workers read a brief description of the study, including a basic overview of the procedures and a summary of expected pay. If interested, they followed a link to an online survey that began with an online informed consent form. Those who completed the consent form read detailed instructions and completed comprehension check (see the Supplementary Materials). Data were collected in the Spring of 2018.

Participants decided how many points to give in six different conditions. The conditions were randomly drawn from a uniform distribution. When others made decisions before the participant decided how many points to give, the amounts others gave were randomly drawn from all possible amounts (0 to 10). It took participants approximately 10 min to complete the instructions and to make

decisions. At the end of the study, they were paid and debriefed. Participants were told that they would be paid on the basis of a randomly selected trial. But given that others' choices were simulated, all participants were paid \$2.00 at the conclusion of the experiment.

The data were modeled with linear mixed models, accounting for the nesting of conditions within participants (see the Supplementary Materials). More specifically, we estimated random intercept models that assume individual-level differences in giving, conditional on model parameters, are normally distributed. In the figures, we report marginal means drawn from the linear mixed models. SEs for the margins were computed using the delta method.

## SUPPLEMENTARY MATERIALS

Supplementary material for this article is available at <http://advances.sciencemag.org/cgi/content/full/6/23/eaba0504/DC1>

[View/request a protocol for this paper from Bio-protocol.](#)

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## The robustness of reciprocity: Experimental evidence that each form of reciprocity is robust to the presence of other forms of reciprocity

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