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Robust Systems of Cooperation in the Presence of Rankings: How Displaying Prosocial Contributions Can Offset the Disruptive Effects of Performance Rankings

Cassandra R. Chambers,[a] Wayne E. Baker[b]

[a] Department of Management and Technology, Bocconi University, 20136 Milan, Italy; [b] Stephen M. Ross School of Business, University of Michigan, Ann Arbor, Michigan 48109

Contact: cassandra.chambers@unibocconi.it, http://orcid.org/0000-0001-6222-0920 (CRC); wayneb@umich.edu (WEB)

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Abstract. Sustaining systems of cooperation in the face of strong self-interest is a subject of long-standing inquiry in the social sciences. Much of this work has focused on understanding the antecedents and outcomes associated with cooperation, noting that the inertial properties of a system should sustain cooperation over time. This paper shifts the focus toward examining how cooperation is maintained in the face of potentially disruptive forces. To advance theory, research, and practice on how to maintain cooperation over time, we examine how systems of cooperation interact with, withstand, or succumb to a potentially disruptive force that is commonplace in organizational contexts: rankings. Using a longitudinal, no-deception, between-groups experimental design, we assess how systems of cooperation respond to the introduction of performance rankings. Examining data from more than 11,000 rounds of decision making from 592 participants clustered in 74 teams, we find that cooperation plummets when performance-rank information is introduced. However, the addition of reputation information—individuals' histories of prosocial contributions—enables a system of cooperation to withstand the disruptive effects of performance rankings. Actors use reputation information to make decisions that reduce perceived inequity. Our study contributes to theories of cooperation, performance feedback, macrolevel prosocial behavior, and management practice.

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Introduction

Cooperation is essential for nearly every organizational endeavor. From complex international agreements to address global climate change (Ostrom et al. 1999, Wijen and Ansari 2007, Ostrom 2010, Barrett 2016) to daily teamwork and the pursuit of organizational goals (Barnard 1938, Tjosvold 1984, Jones and George 1998), organizations and communities depend on the maintenance of cooperation. However, to maintain cooperation, at least some members must limit self-interest in favor of collective interest (Hardin 1982; Kollock 1993, 1998; Cook and Rice 2003). This classic social dilemma has inspired a large interdisciplinary body of work that seeks to understand how cooperation is sustained over time (Fehr and Gintis 2007, Salvato et al. 2017).

One well-known type of cooperation is *generalized reciprocity*. Colloquially known as "paying it forward," generalized reciprocity exists when "an individual feels obliged to reciprocate another's actions, not by directly rewarding his [or her] benefactor, but by benefiting another actor" (Ekeh 1974, p. 48). Systems of generalized reciprocity are a type of social system (Asch 1959, Weick and Roberts 1993) where helping behaviors are linked over time through ongoing, regular interactions. Actors' past cooperative behaviors trigger future cooperative behaviors in others. These systems help resolve the social dilemma of self-interest versus group interest by relaxing the need for immediate reciprocity (Molm 1997; Molm et al. 2006, 2007; Nowak 2006). As Putnam (2000, p. 134) put it, "I'll do this for you now, without expecting anything immediately in return and perhaps without even knowing you, confident down the road that you or someone else will return the favor." Once established, a system of generalized reciprocity tends to be self-sustaining—the inertial properties of the system should maintain it over time by continually drawing actors into the interlocking chain of cooperative behaviors (Lévi-Strauss 1969, Molm 1997). Because of this inertial property, research on generalized reciprocity tends to focus on when and why generalized reciprocity occurs rather than examining how it is maintained over time in the face of potentially disruptive forces.

Performance rank is one potentially disruptive force that may undermine systems of generalized reciprocity. A performance ranking is a form of social hierarchy—a rank ordering of occupants on a valued social dimension (Magee and Galinsky 2008)—that confers differential benefits. Rankings are a dominant feature of social life. *U.S. News & World Report* displays a ranked list of the best universities to attend. J.D. Power ranks products across a wide set of industries. Academic journals are ranked by impact factors. Even national governments are utilizing rankings to organize their citizens and social services. China has designed a social-credit system that will launch in the year 2020 that rates individuals by their past citizenship behaviors such as smoking in public places, considerate driving practices, and social media activities (Ma 2018). Performance rankings are also commonplace inside firms (Greenberg 1987) and have been associated with many benefits (Anderson and Brown 2010). For example, rankings can help attract and retain top talent, reduce biases in performance evaluations, and streamline decision making (Moon et al. 2016). However, the presence of performance rankings may be detrimental to the maintenance of cooperation if it heightens pressures associated with performance comparisons (Garcia et al. 2006)—and triggers negative behaviors. Performance-comparison pressures have been linked to decreases in members' desires to maximize joint gains (Armstrong and Collopy 1996), unhealthy levels of competition (Garcia et al. 2006), elevated levels of cheating (Pettit et al. 2016, Vriend et al. 2016), and the sabotage of others (Tesser and Smith 1980, Poortvliet 2013)—all of which could be detrimental to the maintenance of cooperation. For example, many organizations feature sales teams that benefit from passing leads among each other but also rank sales professionals based on their individual levels of sales (Zoltners et al. 2008, 2011). These rankings may introduce negative dynamics that could weaken the lead-sharing system.

An established system of generalized reciprocity may nonetheless be able to withstand such disruptions. For example, at the industrial design firm IDEO, strong norms of generalized reciprocity supported by organizational routines and practices maintain cooperation among product designers despite a compensation system based on performance rankings (Hargadon and Sutton 1997, Hargadon 2003, Amabile et al. 2014). The ability of IDEO to maintain a system of cooperation in the presence of performance rankings suggests that system-level properties exist to withstand everyday pressures that arise with performance rankings. However, despite broad interest in the study of cooperation and the recommendation of these systems to managers (Cross and Parker 2004), social scientists have not examined how systems of generalized reciprocity interact with, withstand, or succumb to potentially disruptive forces such as performance rankings. Hence, we explore the following research question: *How do systems of generalized reciprocity perform in the presence of performance rankings and withstand potentially disruptive forces?* We examine whether they are naturally able to withstand the pressures that performance rankings create or whether they are vulnerable to disruption, and the mechanisms that may make systems more robust to potentially disruptive pressures. Of the mechanisms that are known to promote cooperation in these systems (see Baker and Bulkley 2014, Simpson et al. 2018), we pay particular attention to the role that rewarding the reputations of cooperative actors may play in allowing systems of generalized reciprocity to withstand the potentially detrimental effects of rankings.

Using a longitudinal, between-groups, no-deception experimental design that includes 74 groups, 592 participants, and more than 11,000 costly decisions to give or not give, we examine how systems of generalized reciprocity fare in the presence of performance rankings. We first establish a group norm of cooperation through 40+ rounds of decision making. Then, in one experimental condition, we interrupt the system by introducing information about an individual's performance rank after the first stage, providing participants with information about their relative standing in the group and informing them that the top third will receive a higher bonus at the end of the experiment. We then run the experiment for another 40+ rounds of decision making in the second stage. As hypothesized, cooperation plummeted in the second stage (look ahead to Figure 3). In another condition, at the end of the first stage, we introduce reputational information in addition to performance rankings. *Reputation* refers to a potential receiver's history of giving to others. We find that reputation enables a system of cooperation to withstand the disruptive effects of performance rank. Despite an initial decline in cooperation, systems that receive information about performance rankings *and* reputation information over time return to levels of cooperation that were established prior to the disruption.

Previous studies have assumed that established systems of generalized reciprocity are self-sustaining. We take this assumption as problematic. By examining the operation of these systems in the face of potentially disruptive forces, we document both the disruptive effects of performance rankings on systems of generalized reciprocity and provide an explanation for why some systems can be robust. Without displaying prosocial contributions (reputation), performance rankings are detrimental, causing an established system of cooperation to collapse. Displaying reputation is a remedy. Prior research

shows that reputation helps to explain the emergence and maintenance of generalized reciprocity (Alexander 1987; Nowak and Sigmund 1998a, b); here we show that reputation also enhances robustness.

This study makes several contributions. First, we make a general contribution to theories of cooperation by introducing a theoretical robustness lens (Jen 2003, 2005) to the study of cooperation (Smith et al. 1995, Baker and Bulkley 2014, Tjosvold et al. 2014, Simpson et al. 2018). A robustness lens explicitly focuses on the maintenance of a system's performance (e.g., cooperation levels) in the face of perturbations (e.g., performance rankings) that could disrupt a social system.[1] By identifying what creates robust systems of cooperation, we can help shape strategies capable of achieving long-term cooperation despite the occurrence of system-wide failure, environmental uncertainty, and increasing complexity. Second, we contribute to research that examines rankings as tools for performance feedback (Moon et al. 2016), showing that they can adversely affect systems of cooperation that have built-in inertial, normative pressures to continue cooperating, which may undercut their purported performance-enhancing effects. Third, we contribute to macrolevel theories of prosocial behavior, which focus on the benefits of systems of generalized reciprocity for groups and organizations (Penner et al. 2005, Baker and Dutton 2007). Our research shows that because of performance rankings, these systems may be more difficult to maintain than previously thought. However, we show and explain how introducing reputation information can reduce the negative consequences of performance rankings, permitting organizations to continue extracting benefits from these systems despite the presence of potentially disruptive pressures. Finally, we contribute to management practice with the implications of our findings: (1) leaders who desire a prosocial culture must pay careful attention to the disruptive effects of performance rankings, and (2) it may be possible to sustain a system of cooperation *without* changing competitive performance-appraisal systems by displaying employees' prosocial contributions and offering recognition for prosocial activities.

Theoretical Framework

Cooperation occurs when actors make expected contributions to jointly held goals (Gulati et al. 2012). These social conditions often arise in contexts that have a mixture of conflicting and complementary interests (Axelrod and Keohane 1985, p. 2226). Generalized reciprocity is one well-known form of cooperation with competing individual and collective interests. In contrast to direct reciprocity between two actors (A helps B and B helps A; Gouldner 1960), generalized reciprocity involves at least three actors, where a recipient of a benefit *pays it forward* to a third party, rather than returning the favor to the original benefactor (A helps B, who then helps C) (Ekeh 1974). Systems of generalized reciprocity consist of interlocking helping behaviors that become linked over time through ongoing, regular interactions. This regularity delays expectations for immediate reciprocity, which helps to resolve the dilemma of self-interest versus group interest (Molm 1997, Molm et al. 2007). Actors forgo immediate opportunities to maximize self-interest in favor of contributing to group interest, expecting to receive benefits in the future. Hence, a system of generalized reciprocity is considered a stable form of cooperation that can balance collective and individual interests (Blau 1968, Nowak 2006).

Prior research on generalized reciprocity has mainly focused on its antecedents or its outcomes. Antecedents include, for example, group size (Pfeiffer et al. 2005), the spatial structure of relationships (Nowak and Roch 2007), similarity among actors (Queller 1985, Axelrod et al. 2004, Santos et al. 2006), and the frequency and diversity of actors' interactions (Rankin and Taborsky 2009). Outcomes include social solidarity (Molm et al. 2007), social capital (Putnam 2000, Baker and Dutton 2007), organizational commitment (Adler and Kwon 2002), prosocial organizational cultures (Penner et al. 2005), and organizational performance (Cross and Parker 2004). Our research fits between antecedents and outcomes. We focus on the mechanisms that sustain generalized reciprocity and the extent to which they may enable a system of generalized reciprocity to withstand disruptions.

Mechanisms of Generalized Reciprocity

Reputation is widely recognized as a key mechanism that drives cooperation in systems of generalized reciprocity (Alexander 1987; Nowak and Sigmund 1998a, b; Wedekind and Milinski 2000; Nowak and Sigmund 2005; Seinen and Schram 2006). Reputations are actors' personal histories of actions toward others within a social system. Evolutionary theorists refer to reputations as *image scores* (Nowak and Sigmund 1998b) and argue that they are essential for fostering cooperative behavior among self-interested actors (Sigmund et al. 2001). Rewarding reputation occurs when actors provide help to those who have been cooperative in the past. Multiple economic experiments document actors' tendencies to reward positive image scores—actors preferentially help those who are perceived as being cooperative members of the social system (Milinski et al. 2002, Seinen and Schram 2006, Wedekind and Milinski 2000)—even at the expense of their own personal resources (Rabin 1993). For instance, in a laboratory experiment modeling generalized reciprocity, Wedekind and Milinski (2000) found that donations were more frequent to

receivers who had been generous in earlier rounds of the experiment; even those who rarely gave were more likely to transfer when paired with a participant with a high image score. Actors, aware of this contingent access to future benefits, may strategically construct their reputations. Cooperation implies that actors are "good citizens," although they may only be "good actors" engaging in impression management (Bolino 1999). Either way, those with positive reputations are more likely to be rewarded in the future than those with negative reputations.

Alternatively, systems of generalized reciprocity can be maintained by actors paying received help forward (Baker and Bulkley 2014). Paying it forward occurs when an actor receives help, but rather than repaying the benefactor, the actor helps a third person. Paying it forward could be driven by feelings of obligation (Ekeh 1974) but may also be driven by positive emotions such as gratitude (Bartlett and DeSteno 2006, McCullough et al. 2008, DeSteno et al. 2010). Gratitude motivates future prosocial behaviors. For example, Emmons and McCullough (2003) found that individuals who wrote daily about things they were grateful for were more likely to report that they provided tangible help to others in a future period. Economic experiments document the cooperation-enhancing effects of paying-it-forward behaviors (Dufwenberg et al. 2001, Greiner and Vittoria Levati 2005, Pfeiffer et al. 2005). By paying it forward, actors may help maintain generalized reciprocity, while disregarding any strategic effects from their actions.

A system of generalized reciprocity may be supported by the self-generating nature of such systems (Lévi-Strauss 1969, Molm 1997, Molm et al. 2007). For example, using computer simulations, evolutionary theorists propose that systems of generalized reciprocity should be stable over time (Nowak and Sigmund 1998a, b). However, scholars also recognize that systems of generalized reciprocity feature a well-known vulnerability that could threaten their continued maintenance (Lévi-Strauss 1969, Molm 1997). Each member does not depend on a specific actor (as with direct reciprocity) but rather on multiple, often unspecified others to maintain the system (Molm et al. 2007). Benefactors are not guaranteed repayment. Imbalances may occur (e.g., helpers do not receive help when it is needed), triggering a cascade of defections that undermine the system.

The Disruption of Cooperation

A social system may be disrupted by exogenous or endogenous forces. We focus on the introduction of information about performance rank as a potential exogenous disruption. Performance rankings are a form of social hierarchy—the implicit or explicit ranking of individuals on a valued social dimension (Magee and Galinsky 2008). There are many contexts in which performance rankings are used to produce benefits for groups and organizations. Organizations, for example, often employ incentive systems based on individuals' performance rank, such as bonuses, promotions, or other rewards for higher levels of performance (Greenberg 1987). Rankings can help streamline decision making, improve intragroup coordination, and heighten performance (Anderson and Brown 2010). A contextually similar, yet controversial, example is the use of forced distribution ratings systems (FDRS)—colloquially known as "rank and yank"—in which those at the bottom are often fired (Mulligan and Bull Schaefer 2011). FDRS can produce beneficial organizational outcomes, such as the cultivation of talent and more accurate, less biased evaluations (Moon et al. 2016). In general, there is a large body of work that demonstrates both the prevalence and benefits of rankings in social groups (Anderson and Brown 2010).

Despite potential benefits, rankings may impede cooperation. Performance rankings can intensify competition among group members. Competition raises the personal costs of cooperation (Deutsch 1949, Alexander 1987, Axelrod 1997). Evolutionary biologists argue that natural selection favors *cheaters*, or those that can benefit from a community without paying the personal costs of cooperation (West et al. 2007a, b). Factors that increase competition will increase the perceived benefits of defection and decrease the benefits of cooperation. For example, individuals at upper levels of a ranking may experience loss aversion (Tversky and Kahneman 1991) and decrease cooperation to preserve the superior benefits associated with their high rank. Those in lower ranks may decrease cooperation if they perceive outcomes to be inequitable or unfair. Believing that some members of the system are experiencing unfair outcomes may undermine members' trust that others will continue to cooperate in a system, thereby weakening the perceived strength of the norm of cooperation (Ring and van de Ven 1994, Salvato et al. 2017). Indeed, economic experiments find that even small perceptions of inequity can trigger defections (Fehr and Schmidt 1999). Furthermore, low-rank individuals may experience relative deprivation and negative emotions, even when they receive benefits from the system (Martin 1981, Greenberg 1987). Ultimately, these lines of research suggest that the introduction of performance rankings with differential benefits will disrupt these systems by reducing rates of continued cooperation. Therefore, as a baseline hypothesis, we expect the following.

Hypothesis 1. *The introduction of performance rankings tied to differential rewards reduces cooperation in systems of generalized reciprocity (ceteris paribus).*

Withstanding Disruptions

How might systems of generalized reciprocity withstand disruptions? An answer, we argue, lies in the principle of inequity aversion and the mechanism of rewarding reputation. Performance rankings can become problematic when they reveal differential benefits that are perceived to be inequitable or unfair. Rankings engender calculations of fairness. Individuals regularly reflect on whether their position in a ranking is commensurate with their contributions to a system (Thibault and Kelley 1959). When individual performance is affected by others' cooperative behaviors, it may lead to a sense of inequity—a suspicion that some actors are paying the costs to cooperate but are not receiving enough benefits to outweigh these costs. Inequity aversion occurs when an individual resists instances of inequity—when someone receives too much or too little compared with someone else (Walster et al. 1978, Fehr and Schmidt 1999). Compelled by inequity aversion, actors may adjust their behavior to reduce inequity (Walster et al. 1978, Fehr and Schmidt 1999).

The willingness of actors to "sacrifice their own material well-being to help those who are being kind" is well documented (Rabin 1993, p. 1283). Economic experiments show that participants in cooperative games will incur personal costs in order to adjust others' incomes, and this behavior is associated with enhanced levels of cooperation (Fehr and Gächter 2002, Andreoni et al. 2003). Actors often practice a form of *reciprocal fairness*—rewarding kindness with kindness and harm with harm (Rabin 1993, Falk and Fischbacher 2006). Dawes et al. (2007) find that this behavior is driven by egalitarian motives, whereby actors will punish or reward alters to reduce inequity and restore fairness. In a series of laboratory experiments, they show that subjects experienced negative emotional reactions to top earners—even when earnings were randomly generated—and that these emotional reactions were associated with costly redistribution behaviors.

Rewarding reputation occurs when one actor makes costly decisions to give to another actor who has been generous in the past or does not give to an actor who has been stingy. Hence, the presence of reputation information may reduce temptations to defect that arise from the presence of performance rankings because it permits actors to respond to inequity. Instead of defecting in response to increased costs of cooperation and perceptions that a system of generalized reciprocity is unfair, actors may continue to cooperate to seize opportunities to reward the cooperative citizens of a system. Correspondingly, systems of generalized reciprocity that introduce reputation information alongside performance-rank information should be more cooperative than those that only introduce performance-rank information.

Hypothesis 2. *The introduction of performance rank tied to differential rewards* and *reputation information increases cooperation compared with the introduction of just performance-rank information (ceteris paribus).*

Although all actors, regardless of their rank, could experience inequity aversion and hence exhibit efforts to correct for inequity, this behavior may be more visible among actors who are more at risk for perceiving inequity. Inequity is typically more salient for actors who are on the disadvantageous end of inequity (Fehr and Schmidt 1999). For example, Tannenbaum (1962) shows that individuals in lower ranks disproportionately feel that they should be receiving more than actors in higher ranks. In contrast, actors on the advantageous end of inequity are more prone to attribution biases, causing them to view their ranking positions as legitimate, fair outcomes (Major 1994, Flynn 2003). Therefore, we expect that participants that gave at high levels but ended up in the bottom of the ranking will be more at risk for perceiving inequity. Correspondingly, these actors will be more likely to transfer to actors with high reputations to reduce levels of inequity.[2]

Hypothesis 3. *Actors with a high risk of perceiving inequity will be more likely to reward participants with higher reputations for cooperating than actors with a lower risk of perceiving inequity (ceteris paribus).*

Research Design, Data, and Methods

We designed a laboratory experiment based on the *indirect helping game* (Wedekind and Milinski 2000, Engelmann and Fischbacher 2009). The indirect helping game is a no-deception, repeated decision-making game programmed in zTree (Fischbacher 2007) that allows actors to give and receive points within the same group of anonymous actors. Points convert to money at the end of the game. The indirect helping game simulates the classic social dilemma wherein actors incur a personal cost for helping the collective, but if all members of the collective pursued the same action, all would benefit from the collective's success. We modify this experiment by introducing different sets of information to actors at the midpoint of the experiment. Performance-rank information is introduced as a potentially disruptive force, and reputation information is introduced alongside rank information to offset this potentially disruptive force.

Our experimental design reflects organizational forms that benefit from widespread reciprocal, continued cooperation among their members but also include some form of comparative assessments or rankings. For example, a member of a project team may take time away from his or her own tasks—from which he or she is individually evaluated—to help another team member complete a task. In academia,

junior professors may be asked to complete a friendly review of a paper for an individual with whom they may eventually be compared in a decision for tenure. In each of these cases, cooperative behaviors are not explicitly rewarded yet are highly valuable for the collective as a whole. The continuation of these cooperative behaviors over time may be negatively impacted by the comparative assessments that also occur in these contexts. By using a generalized reciprocity game and introducing the presence of a performance ranking, our experimental design can help determine organizational structures that facilitate the continuation of cooperation over time in the presence of competitive pressures. This experimental design is well suited to the analysis of systems of generalized reciprocity because it does not include deception, and it allows groups of actors to interact regularly over multiple periods. Accordingly, each group organically develops a norm of generalized reciprocity, generating its own, unique system-level dynamics that may not be as reliably manipulated in shorter-term experimental settings that include deception.

Experimental Procedures

A total sample of 592 actors consisting of students, staff, and community members was recruited at a large university in the American Midwest. Upon arrival at the laboratory, actors were randomly assigned to 1 of 16 cubicles with a laptop. The laptop was randomly assigned to a networked group of eight laptops and one of four experimental conditions. The appearance of a larger group limits the perception of opportunities to engage in direct reciprocity. Actors were not permitted to communicate with each other during the experimental session. Before the experiment began, a laboratory instructor distributed and read aloud a set of instructions that included the decision-making roles and rules. It was also stated that the information on the actors' screens reflected their own and others' actual behaviors during the experiment. After the instructions were presented, each participant took a comprehension test.

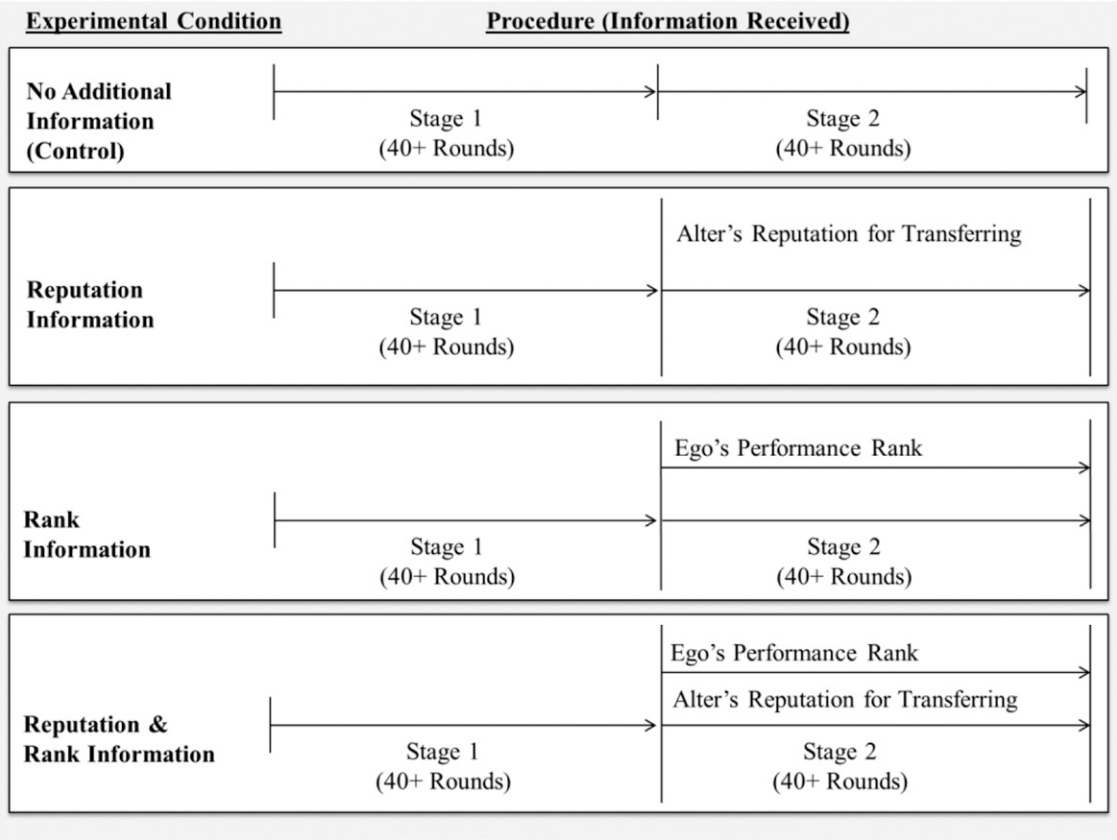
The game consisted of multiple decision-making rounds, where actors could choose to transfer points to other actors in their group. At the start of the game, each actor received an initial endowment of 33 points and was told that his or her final point balance, earned across all stages of the experiment, would be converted into a cash bonus of 2 cents per point.[3] This cash bonus is on top of a base pay for participation. The experiment consisted of two stages of 40+ decision-making rounds.[4] During each decision-making round, actors were paired randomly and anonymously. Within each pair, actors were randomly assigned roles: role A or role B. The participant in role A makes the decision of whether to "transfer" points to the participant in role B. The participant in role B does not make any decisions. Consistent with prior generalized reciprocity research in which benefits (b) received are greater than the cost (c) of providing benefits ($b > c$) (e.g., Engelmann and Fischbacher 2009, Greiner and Vittoria Levati 2005), if role A decided to transfer, the participant's balance *decreased* by two points and role B's balance *increased* by five points. A decision to not transfer resulted in no change to role A's balance. Although the roles were always referred to as role A and role B in the experiment to avoid a social-desirability bias, for ease of interpretation, we will henceforth refer to them as the *ego*—the person who is able to make the decision to transfer points—and the *alter*—the person who is not able to make a decision to transfer points.

Experimental Conditions

In stage 1, all actors, regardless of their experimental condition, experience the same decision-making game of 40+ rounds with no additional information. This allows groups to establish norms of generalized reciprocity that can then be affected by the introduction of new information. All manipulations occur at the start of the second set of 40+ rounds of decision making (stage 2; see Figure 1 for an illustration). A 2×2 factorial design crossed access to information about an ego's performance rank for total performance in points earned across stage 1 (no performance rank information versus performance rank information) and access to an alter's reputation for transferring in stage 1[5] (no reputation information versus reputation information), resulting in four conditions.

The first condition, labeled the "No Additional Information Condition," repeats the same procedure that occurs in stage 1 and does not provide any additional information. The second condition, labeled the "Reputation Condition," displays information about the alter's reputation for past cooperative behaviors: the percentage of times the alter transferred when in role A. With this information, the donor can infer the receiver's level of generosity (e.g., "The person I am randomly matched with in this round has been stingy in the past"). The third condition, labeled the "Rank Condition," includes information about an ego's performance rank in the group. This is an individual ranking. Before beginning stage 2, all actors who receive rank information are told that the bonus structure will change. Actors are ranked by total points, and those in the top third receive a bonus of 7 cents per point, whereas the middle and bottom thirds receive the standard payment of 2 cents per point. During each decision-making round, a reminder is displayed on the bottom of the screen that shows the ego's rank at the end of stage 1. Actors are told that they will receive information about whether they fell into the top, middle, or bottom third of the ranking.

Figure 1. Illustration of the Two-Stage Experimental Design



Notes. Interruption (treatment) occurs after stage 1, before stage 2 begins. (1) The ego is the decision maker in the current round (the participant with the ability to transfer points). The alter is the receiver in the current round (cannot transfer points). (2) All groups in stage 1 follow the same procedure: 40+ rounds of decision making without any additional information. In stage 2, decision makers have access to different types of information, depending on which condition they are in. (3) The first condition, labeled the "No Additional Information Condition," repeats the same procedure as in stage 1 without participants receiving any additional information. (4) The second condition, labeled the "Reputation Information Condition," makes available information about the alter's reputation for cooperative behaviors: the percent of times the alter transferred points when she was in role A. (5) The third condition, labeled the "Rank Information Condition," includes information about the ego's performance rank in the group. Before beginning stage 2, all actors in the Rank Information Condition are told that the bonus structure is changing. Actors that rank in the top third of total points receive a higher bonus of 7 cents per point, whereas the middle and bottom third receive the standard payment of 2 cents per point. During each decision-making round, a reminder is displayed on the bottom of the screen that shows the ego's rank at the end of stage 1. (6) The fourth condition, labeled the "Reputation and Rank Information Condition," includes both information about the ego's own performance rank and alter's reputation for cooperative behaviors.

From information about rank, egos can infer whether they are in general benefiting from this system as much as their peers (e.g., "I'm in the bottom third, and most of the others are earning more than me"). The fourth condition, labeled the "Reputation and Rank Condition," includes both information about an ego's own performance rank in the system and the alter's reputation for cooperating. This experimental design resulted in 11,833 postinterruption decision-making observations by 592 individuals clustered into 74 groups.

Measures

Dependent Variable. Cooperative behavior is modeled as a binary variable, where 1 = ego transferred and 0 = ego did not transfer. All models examine transfer decisions in stage 2 only.

Independent Variables. The four experimental conditions were noted by indicator variables that reflected the type of information the actor received (e.g., *No Additional Information*, *Reputation Only*, *Rank Only*, and *Reputation and Rank)*. Each variable is dichotomous, where 1 = received the type of information specified, and 0 = did not receive the type of information specified. No additional information is the default comparison group.

High risk of perceiving inequity is denoted by a dichotomous variable, where 1 = the actor was one standard deviation above the mean rate of transferring in stage 1 *and* was ranked in the bottom of the ranking in stage 1. In other words, high risk of perceiving inequity occurs when an actor has put a great deal of inputs into a system but received the least in outputs from the system relative to other actors.

Individual-Level Control Variables. Recent research shows that gratitude is a powerful mechanism of cooperation (Baker and Bulkley 2014). Actors feel positive affect after receiving help, which motivates paying help forward to others. Consistent with past research (Nowak and Roch 2007, Baker and Bulkley 2014), we measure *gratitude* with a proxy variable: the percent of times an actor received points when he or she was in role B prior to a given decision-making round. This proxy variable is interpreted to mean that the more help a person receives, the more grateful he or she feels. In addition, actors may feel grateful when they perceive that they are benefiting from the group's adherence to a norm of cooperation.

Prior giving may predict future giving. For instance, research on charitable giving shows that past donors are more likely to be donors in the future and in general tend to give more (Lindahl and Winship 1994, Sudhir et al. 2016). We measure *generosity* as the percent of times an actor gave when he or she was in role A prior to a given decision-making round.

We include demographic characteristics typically measured in studies of cooperative behavior: age, gender, and formal education. Prior research shows that age can be associated with decreases in levels of generosity (Murnighan and Saxon 1998). Although levels of generosity often grow in childhood (Bryan and London 1970), adulthood is generally associated with more strategic and less generous behavior (Murnighan and Saxon 1998). *Age* is measured in years.

Prior research finds inconsistent effects of gender on levels of generosity (Eckel and Grossman 1998, 2008, Grossman et al. 2008). In their review of economic experiments related to prosociality, Eckel and Grossman (2008) observed that exposure to risk of financial loss, exploitation, or the judgment of others was associated with no significant differences between men's and women's rates of generosity. It was only in studies where actors were not exposed to these pressures that women exhibited more prosocial tendencies than men (e.g., Eckel and Grossman 1998). Therefore, gender is included as a control variable, where *male* = 1 if the actor specifies male and 0 if the actor specifies female.

Education is a commonly measured control variable in studies that use cooperative games (Rand et al. 2014). Cooperative games include elements of strategy. Education could serve as a proxy for task-performance ability in strategic games, such as problem solving and critical thinking. *Education level* is an indicator variable for levels of education, which include high school, some college, associate's degree, bachelor's degree, and postdoctoral degree. High school is the default comparison category.

Reflective and deliberative cognitive style may also impact cooperative decision making. On average, actors with higher reflective cognitive styles exhibit more calculated decision making and higher rates of selfishness (Rand et al. 2014). We employ Frederick's (2005) widely used cognitive reflection test (CRT) to create a measure of reflective cognitive style. The CRT includes three problem-solving tasks that appear to have obvious, simple answers but require more reflective thinking. We ask participants to answer these three questions in a questionnaire that follows the experiment. Results from the CRT are averaged to create a measure of reflective cognitive style. A higher value for the variable *short-term thinking* indicates lower average performance on the CRT and a higher tendency toward short-term thinking.

Group-Level Controls. An alternative explanation for the likelihood that an actor will cooperate is that it depends on his or her unique normative climate. Specifically, if actors reside in a highly generous community, they may be more likely to cooperate than those who reside in a stingy one. We measure the group's normative climate as the group's average transfer rate before the interruption: *group percent transfers in stage 1*. Because actors are nested in closed groups and others' decisions may affect a focal actor's decision-making climate, we included two measures that aggregate individual-level controls at the group level: *group's average short-term thinking tendency* and the *percent of group that is male*.

This experiment necessitated many decision-making rounds both to establish a group norm of generalized reciprocity and to judge responses to events that may disrupt this norm. In past studies with economic games, cooperation tends to decline over time with many repeated interactions (Ledyard 1995). The concern with these cases is that actors will expect that their defections will have less of an impact on others' rates of cooperation because others have observed trends of behavior (Axelrod 1984). Similarly, because of the long duration of the experiment (45 minutes) and the repeated nature of the task (80+ decision-making rounds), concerns of decision fatigue may exist. Vohs et al. (2009) report that multiple rounds of decision making may impair actors' self-regulation abilities—the ability to substitute one action for another that better conforms to a norm or fits with a specific goal. *Increasing time* is modeled as a linear effect of increasing decision-making rounds. Table 1 reports descriptive statistics.

Analytical Strategy

Two model specifications were used. First, given the nested structure of the data, we employed a multilevel mixed-effects logistic regression model to assess whether systems of generalized reciprocity were disrupted with the introduction of various types of

Table 1. Summary Statistics

Variable	Mean	Standard deviation	Minimum	Maximum
Level 1: Postinterruption decisions (n = 11,833)				
Transferred	0.52	0.50	0	1
Ego's percent gratitude	0.60	0.20	0.06	1
Ego's percent generosity	0.60	0.32	0	1
Level 2: Ego (n = 592)				
Gender	0.36	0.48	0	1
Age	21.82	6.58	18	75
Education	2.27	1.24	1	5
Short-term thinking	0.53	0.37	0	1
Level 3: Groups (n = 74)				
No additional information (control)	0.25	0.43	0	1
Reputation information condition	0.24	0.42	0	1
Rank information condition	0.26	0.44	0	1
Reputation and rank information condition	0.26	0.44	0	1
Group's percent of short-term thinkers	0.53	0.15	0.17	1
Percent of group that is male	0.36	0.23	0	1
Group's percent transfers in stage 1	0.63	0.23	0.28	0.93

Notes. The ego is the decision maker in the current round (the participant with the ability to transfer points). The alter is the receiver in the current round (cannot transfer points).

information (Hypotheses 1 [H1], 2, and 3). Multilevel models allow us to rule out alternative explanations at the decision-making round, individual, and group levels of analysis. Second, we conducted an interrupted time-series analysis to further examine whether reputation information could help systems withstand the potentially disruptive effects of rank information (H2). Instead of focusing on mean-level differences, this analysis allows us to examine differences in trends between conditions as well as to account for the autocorrelated nature of the data, ensure that comparison groups are appropriate counterfactuals, and explore both initial and long-term effects of interruptions.

Multilevel Mixed-Effects Logistic Regression. Our design yields clustered longitudinal data with a binary dependent variable. This design creates a three-level hierarchy: 11,833 binary transfer decisions in stage 2 of the experiment (level 1), nested within 592 actors (level 2), nested within 74 groups of eight actors (level 3). Given this nested structure, we used a multilevel mixed-effects logistic regression for longitudinal data (Rabe-Hesketh and Skrondal 2008). Fixed effects are specified as regression parameters, and random effects are specified for the individual and group levels, with a maximum-likelihood estimation. This type of model allows us to assess the variation within individuals and between groups over time. Traditional methods for analysis of experimental data (e.g., an analysis of variance (ANOVA) or repeated-measures multivariate ANOVA) are not able to control for multiple levels of analysis.

Our first model includes the level 1 covariates of gratitude and generosity as controls, as well as the linear effect of increasing rounds of decision making. The second model introduces the level 2 covariates age, gender, education, and propensity toward short-term thinking as controls.[6] The third model includes the level 1, level 2, and level 3 covariates: indicator variables for information conditions and group-level controls for the group's gender and short-term thinking composition and the group's overall transfer rate in stage 1. We include post hoc analyses of the interaction between group's transfer rates in stage 1 and condition in model 4.[7] A final model tests whether a high risk of perceiving inequity is associated with higher levels of cooperation in the presence of alters with good reputations for transferring. The final multilevel mixed-effects logistic regression model solely examines the Reputation and Rank Condition because it is the only condition with both sets of information (see Table 4).

Interrupted Time-Series Analysis. An interrupted time-series analysis examines the impact of an intervention that is expected to interrupt a data trend (Shadish et al. 2002, Glass et al. 2008). This method has been used to examine the impact of population-based health interventions, media campaigns, and public-policy changes such as the introduction of new laws or taxes (Linden 2015). An interrupted time-series analysis evaluates the impact of an intervention by examining whether the treatment group deviates from a baseline mean by a greater amount than the comparison group and examines differences in trends between the two groups at multiple time periods. Using the ITSA package in Stata, we examine the immediate effects of the interruption (i.e., what happens in the first few rounds of stage 2), as well as the long-term effects of the interruption (e.g., overall

differences in trends in stage 2; Linden and Adams 2011, Linden 2015). The ITSA package also features a method for comparing conditions prior to the interruption to ensure that they do not vary on either baseline means or trends, indicating that they are appropriate counterfactuals. This analytical approach is particularly useful for our purposes because it highlights both the presence and duration of a disruption. We examine interruption effects for two of the four conditions, the Rank Information Condition and the Reputation and Rank Condition, because these are the two groups that had access to information about individuals' rank. This permits us to explore whether having access to reputation information can offset the disruptive effects of rank. We use ordinary least squares regression with Newey–West standard errors to account for autocorrelation and heteroskedasticity (Linden 2015).

Results

Table 2 reports log odds coefficients from four models. Predicted probabilities and odds ratios are reported in the text. Model 1 introduces controls at the decision-making round (level 1). Consistent with prior research (Baker and Bulkley 2014), gratitude and generosity were associated with an increased likelihood of transferring postinterruption. These findings confirm that both the act of receiving help and an ego's prosocial tendencies are drivers of cooperation. We consider gratitude and generosity as control variables, but these findings add validity to our design and model because they are consistent with previous empirical work. Model 2 introduces controls at the individual level (level 2). Although gratitude and generosity remain strongly associated with the likelihood of exhibiting cooperative behavior, the individual-level controls of age, gender, education level, and short-term thinking tendencies are not statistically associated with our outcome of interest. Model 3 introduces group-level controls (level 3) for the group's percentage of transfers in stage 1 (preinterruption), the percentage of the group that is male, and the percentage of the group that exhibits short-term thinking tendencies. These controls are not significantly associated with the likelihood that an individual will transfer.

Model 3 includes indicator variables for the experimental conditions with the No Additional Information Condition as the comparison group. Compared with groups that received no additional information, an interruption that revealed performance-rank information was associated with a sharp decrease in the likelihood of a transfer, controlling for many factors. Given the estimated random effects for a unique individual and his or her respective group, and all other factors held at their means, the odds of transferring for an ego in the Rank Condition are only 0.360 times as great as those of an individual in the No Additional Information Condition. This disruption is higher in generous groups. Post hoc analyses (model 4) reveal a relationship between group generosity in stage 1 and an individual's predicted probability of a transfer in stage 2. The higher a group's generosity in stage 1, the lower is an individual's predicted probability of a transfer in stage 2 for groups in the Rank Information Condition. For all other conditions, a participant's likelihood of transferring is not influenced by the group's level of generosity in stage 1 (see Figure 2).[8] We theorized that this disruption would be due to either concerns about losing one's rank position (i.e., loss aversion) or perceptions of unfairness. Participants' open-ended responses to questions about their strategies in the experiment were consistent with these two themes. For example, those in the Rank Condition said that they transferred less in stage 2 because they wanted to preserve their position. As one put it,

> after I was ranked in the top third, I transferred only a couple of times because I was not sure if I was helping someone else achieve the top third ranking and extra bonus or if I was helping someone already in the top third and possible [*sic*] booting myself out.

Similarly, another participant said the following:

> After I saw that I was in the top third of the activity, I started to give less points away. I would still give points away but it would [be] less often because I wanted to secure my spot in the top third.

Other participants in the Rank Condition perceived unfairness and adjusted their transferring strategies because they were not receiving benefits in proportion to their levels of generosity:

> [Stage] 2 showed me I was in the bottom third. As [stage] 2 started I noticed I was rarely gaining points when I was [in] role B and I realized most people were clicking no, so I started clicking no every time because I knew having faith in others was pointless at this point and I was just going to be losing money by clicking yes.

Similarly, another participant said the following:

> I tried to maximize total economic surplus in the first part of the activity but then when I found out I was in the middle third I became more selfish and stopped transferring points.

These results provide strong support of Hypothesis 1. Transferring declines in systems that are interrupted by the introduction of information about performance rank. Furthermore, this decline is heightened by the strength of the norm of reciprocity established in stage 1. This suggests that participants in highly generous groups may react more negatively to the introduction of performance rankings compared with participants in groups with lower baseline levels of cooperation.

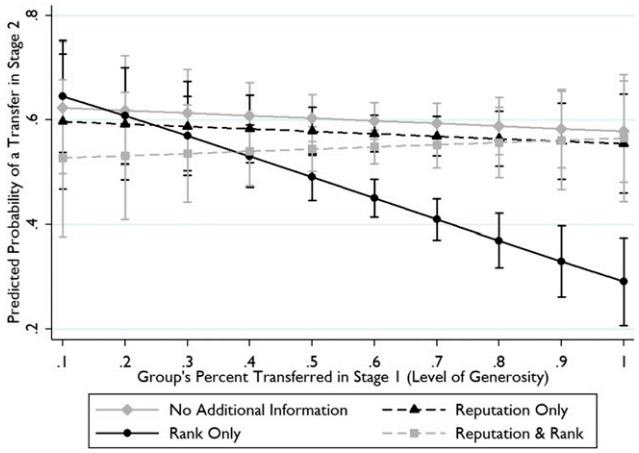
Table 2. Mixed-Effects Logistic Regression: The Likelihood of Transferring in Stage 2

Variable	Model 1	Model 2	Model 3	Model 4
Fixed effects				
Level 1: Decision rounds postinterruption				
Ego's percent gratitude	0.017***	0.017***	0.019***	0.019***
	(0.003)	(0.003)	(0.005)	(0.005)
Ego's percent generosity	0.049***	0.049***	0.049***	0.049***
	(0.002)	(0.002)	(0.002)	(0.002)
Increasing decision rounds	0.000	−0.000	−0.000	−0.000
	(0.002)	(0.002)	(0.002)	(0.002)
Level 2: Individual (ego)				
Male		−0.075	−0.059	−0.059
		(0.116)	(0.121)	(0.121)
Age (mean-centered)		−0.004	−0.009	−0.007
		(0.011)	(0.011)	(0.011)
Education: Some college (dummy)		−0.045	0.008	0.006
		(0.125)	(0.123)	(0.123)
Education: Associate's degree (dummy)		0.180	0.357	0.289
		(0.573)	(0.567)	(0.564)
Education: Bachelor's degree (dummy)		−0.122	−0.085	−0.128
		(0.167)	(0.165)	(0.164)
Education: Postdoc (dummy)		0.173	0.270	0.204
		(0.284)	(0.279)	(0.278)
Short-term thinking tendency (CRT)		−0.002	−0.001	−0.001
		(0.116)	(0.002)	(0.002)
Level 3: Groups				
Group's average short-term thinking tendency			−0.004	−0.005
			(0.005)	(0.005)
Group's percent transfers in stage 1			−0.010	−0.004
			(0.006)	(0.009)
Percent of group that is male			−0.002	−0.002
			(0.003)	(0.003)
Reputation information condition			−0.171	−0.190
			(0.180)	(0.656)
Rank information condition			−1.020***	0.392
			(0.181)	(0.602)
Reputation and rank information condition			−0.396*	−0.734
			(0.178)	(0.710)
Reputation condition × group's percent transfers in stage 1				0.000
				(0.010)
Rank condition × group's percent transfers in stage 1				−0.023*
				(0.009)
Reputation and rank condition × group's percent transfers in stage 1				0.006
				(0.011)
Random effects				
Standard deviation individual	0.505***	0.507***	0.303***	0.240***
	(0.073)	(0.076)	(0.083)	(0.091)
Standard deviation group	0.951***	0.959***	0.954***	0.954***
	(0.055)	(0.057)	(0.056)	(0.057)
Intraclass correlation	0.264	0.264	0.233	0.227
Number of observations (postinterruption decisions)	11,833	11,496	11,496	11,496
Number of individuals (ego)	592	574	574	574
Number of groups	74	74	74	74

Notes. (1) Standard errors are in parentheses. (2) Omitted categories for comparison: High school degree (level 2), No Additional Information Condition (level 3).
*$p < 0.05$; ***$p < 0.001$.

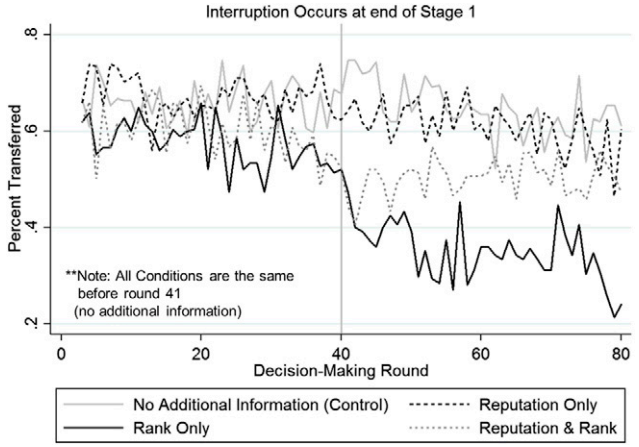
To test our hypothesis that reputation information can offset the disruption of performance rankings (Hypothesis 2), we examined the effects of simultaneously introducing both reputation and performance-rank information. We find that the disruptive effect of performance rank is substantially reduced when reputation

Figure 2. Predicted Probability of a Transfer in Stage 2 by Condition and Group's Level of Generosity in Stage 1



Note. All groups experienced the same decision-making conditions in stage 1 (no additional information), regardless of the conditions in which they were placed in stage 2.

Figure 3. Percent Transfers for Conditions at Each Round, Preinterruption and Postinterruption



Notes. (1) In stage 2, decision makers (those in role A in the current round—participants who can transfer points) that are in the Reputation Information Condition have access to alters' (those in role B in the current round—participants who cannot transfer points) reputations for generosity (percent of times they transferred when they were in role A). (2) In stage 2, decision makers (those in role A) that are in the Rank Information Condition have access to information about their own performance rank after stage 1 (relative rank is derived from the total points they earned in stage 1). (3) Before beginning stage 2, all actors in the Rank Information Condition and the Reputation and Rank Information Condition are told that the bonus structure is changing. Actors that rank in the top third of total points receive a higher bonus of 7 cents per point, whereas the middle and bottom third receive the standard payment of 2 cents per point. During each decision-making round, a reminder is displayed on the bottom of the screen that shows the ego's rank at the end of stage 1. (4) In stage 2, decision makers in the Reputation and Rank Information Condition have access to both information about their own performance rank and alters' past transferring behaviors.

information is also provided (model 3, Table 2). Given the estimated random effects for a unique individual and his or her respective group, and all other factors held at their means, the odds of transferring for an individual in the Reputation and Rank Information Condition are 1.865 times that of an individual in the Rank Information Condition.[9] Consistent with Hypothesis 2, these results suggest that reputation information can offset the negative effects of performance rankings.

We next considered the short- and long-term effects of an interruption. Figure 3 presents a line graph of the average transfer rate by condition for each decision-making round. Recall that in stage 1, all participants experience the same decision-making conditions (the absence of any additional information). The patterns in stage 1 are similar for each condition. Clear differences appear in stage 2. Both the Rank Information Condition and the Reputation and Rank Information Condition show immediate drops in average transfer rates; however, the Rank Condition continues to decline over time, whereas the Reputation and Rank Information Condition eventually returns to transfer rates on par with the No Additional Information Condition and the Reputation Only Condition.

An interrupted time-series analysis (Linden 2015) adds statistical support to our visual interpretation of the patterns in Figure 3. In this analysis, we compare the Rank Condition and the Reputation and Rank Condition to assess how having access to reputation information affects individuals who also have access to rank information. As shown in Table 3, preinterruption intercepts and trends are not significant, supporting our interpretation of Figure 3 that there are no significant differences between the Rank Condition and the Reputation and Rank Condition in stage 1 (preinterruption). There is no statistically significant difference in the intercepts for these two conditions in the period immediately after the interruption, suggesting that groups in both conditions experienced *the same* initial negative impact of the interruption. However, there is a significant overall postinterruption trend. For every additional 10 rounds, the model predicts a difference of 8.7 points between the conditions' average transfer rates (see Figure 4). Both conditions exhibited the same initial negative impact, but then transfer rates in the Reputation and Rank Condition increase steadily over time, whereas transfer rates in the Rank Condition steadily decrease over time. These results support Hypothesis 2, demonstrating that reputation information can help systems of cooperation withstand the presence of performance rankings.

We theorized that a system's ability to withstand the potentially disruptive effects of performance rankings would occur because actors reduce inequity by rewarding prosocial contributions. Correspondingly, we hypothesized that this behavior would be most pronounced in individuals who are at risk for perceiving inequity (i.e., those who gave the most to others in stage 1 but received the least—placing them in the

Table 3. Interrupted Time-Series Analysis of Postinterruption Effects on Transfer Rates

Variable	Model 1: Rank Information Condition vs. Reputation and Rank Information Condition
Preinterruption difference in intercepts	–0.065
	(0.043)
Preinterruption difference in trends	–0.001
	(0.002)
Postinterruption difference in intercepts	0.0167
	(0.063)
Postinterruption difference in trends	–0.009***
	(0.003)
Postinterruption rank condition trend	–0.004***
	(0.002)
Postinterruption reputation and rank condition trend	0.004***
	(0.001)
Observations	158

Notes. (1) Standard errors are in parentheses. (2) Nonsignificance in the preinterruption difference in intercepts and trends (i.e., slopes) indicates that the control group (Rank Information Condition) and treatment group (Reputation and Rank Information Condition) are appropriate counterfactuals (Linden 2015).
***$p < 0.001$.

bottom of the ranking: d). We find that the higher an alter's reputation for transferring, the more likely an individual will transfer and that this effect is even higher when actors are at risk for perceiving inequity. Table 4 reports coefficients in log odds. Given the estimated random effects for a unique individual and his or her respective group, and all other factors held at their means, when an individual is paired with an alter that has a 90% transfer rate, the predicted probability of transferring is 0.92 for individuals at risk for perceiving inequity and 0.71 for all others (see Table 4 and Figure 5).

Participants' open-ended responses to questions about their strategies in the experiment reflected sentiments in line with inequity aversion. For example, many participants in the Reputation and Rank Condition viewed their rank positions as a consequence of others' behaviors and sought to reward and punish reputations accordingly. As one said,

> During [stage] two of the experiment I changed my strategy so that I could try to punish those who were not liberal enough in their transferring of points in the first [stage] because I was in the bottom third of the group and I felt that my actions in [stage] one were not reciprocated by my fellow participants.

Another participant put it the following way:

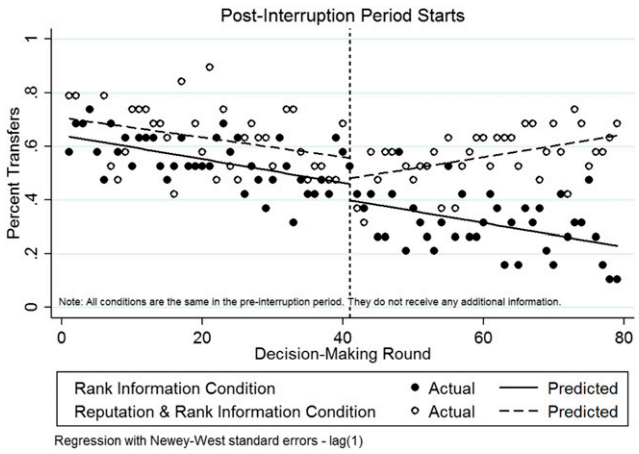
> When I knew that others had not transferred, I did not transfer to them, especially knowing that I was in the bottom third. However, even if I was worried about the amount of money I had left, I continued to give to those who had transferred, as I wanted to in a way reward them.

Jointly, these results suggest that reputation information can offset the negative effects of performance rankings because it permits actors to respond to inequity aversion.

Discussion

Generalized reciprocity is a powerful form of cooperation. By relaxing the need for immediate reciprocity, these systems can sustain cooperation among self-interested actors, making complex, higher-level organization possible (Nowak 2006). Systems of generalized reciprocity are thought to be inherently stable as a result of inertial self-generating properties that attract new participants and encourage costly

Figure 4. Illustration of Interrupted Time-Series Analysis Comparing Rank Information and Reputation and Rank Information Conditions Before and After an Interruption



Notes. (1) All groups experience the same decision-making context in stage 1 (no additional information), regardless of the conditions in which they were placed in stage 2. (2) The first round of decision making after the interruption is the beginning of stage 2.

Table 4. Mixed-Effects Logistic Regression: The Likelihood of Transferring in Stage 2 (Reputation and Rank Condition Only)

Variable	Model 1
Fixed effects	
Level 1: Decision rounds postinterruption (n = 2,942)	
Alter's reputation for transferring	0.045*** (0.002)
High risk of perceiving inequity × alter's reputation	0.040*** (0.010)
Ego's percent gratitude	0.032*** (0.010)
Ego's percent generosity	0.056*** (0.005)
Increasing decision rounds	0.015** (0.005)
Level 2: Individual (ego) (n = 147)	
High risk of perceiving inequity	−1.181* (0.518)
Male	−0.194 (0.259)
Age (mean-centered)	0.440 (0.029)
Education: Some college (dummy)	−0.181 (0.272)
Education: Associate's degree (dummy)	0.244 (0.831)
Education: Bachelor's degree (dummy)	−0.423 (0.404)
Education: Postdoc (dummy)	−0.459 (0.709)
Short-term thinking tendency (CRT)	−0.006 (0.029)
Level 3: Groups (n = 19)	
Group's average short-term thinking tendency	0.002 (0.013)
Group's percent transfers in stage 1	−0.056*** (0.015)
Percent of group that is male	0.005 (0.007)
Random effects	
Standard deviation individual	1.081*** (0.124)
Standard deviation group	0.300*** (0.195)
Intraclass correlation	0.277

Notes. (1) Standard errors are in parentheses. (2) Omitted categories for comparison: High school degree (level 2).
*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

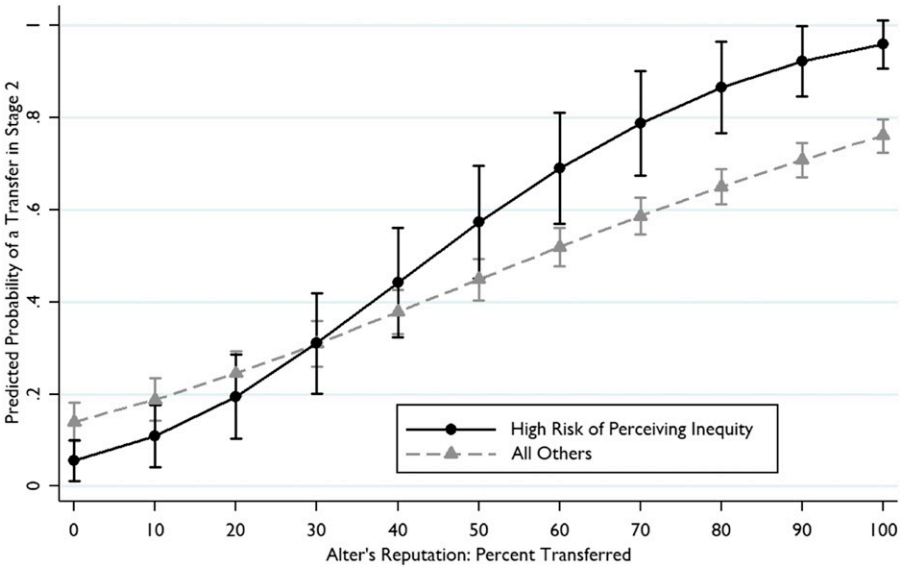
contributions without immediate benefits in return (Lévi-Strauss 1969, Molm 1997, Nowak and Sigmund 1998a, b). We explored how robust these systems are in the presence of a potentially disruptive force that is commonplace in organizational contexts: performance rankings. Performance rankings can impede cooperation by intensifying competition among members, revealing inequities in valued outcomes, and reducing motivations to cooperate. Determining when and under what conditions a system of generalized reciprocity can withstand potentially disruptive forces can make significant contributions to theories of cooperation and provide guidelines to specific practices that promote continued cooperation over time.

We find that performance rankings are highly disruptive for systems of cooperation. Not one group that received performance-rank information maintained the level of cooperation it had achieved prior to the interruption. The negative impact of rankings, especially for the most generous groups, may serve as a warning to organizations that rely on performance rankings as a management strategy. Performance-ranking systems are controversial (Rock and Jones 2015) yet commonplace in many different types of organizations, including for-profit corporations and educational and governmental organizations (Dooren et al. 2015, Cappelli and Tavis 2016). Our findings imply that rankings could impair the ability to build social capital (Baker and Dutton 2007) or establish prosocial cultures (Penner et al. 2005). Belmi and Pfeffer's (2015) argument that norms of reciprocity are weaker in organizational contexts lends credence to our findings. They found that organizational, as opposed to personal, contexts elicited more self-interested, calculative decision-making frames, which reduced willingness to cooperate. If true, then the introduction of rankings would exacerbate this tendency toward self-interested action.

Our key finding is that displaying reputation is a mechanism that helps systems of cooperation withstand disruptive forces created by performance rankings. Participants who received either rank information or reputation and rank information displayed similar initial drops in cooperation rates. However, cooperation continued to fall for those with rank information, whereas the trajectory reversed for those with reputation and rank information. We attribute this difference to actors having the ability to correct for inequity aversion and find evidence that actors who are at high risk of perceiving inequity are indeed more likely to cooperate with highly cooperative alters.

At one level, our key finding underscores the importance of reputation for systems of generalized reciprocity, adding to the stream of research about the positive effects of reputational incentives on cooperation (Wedekind and Milinski 2000, Seinen and Schram 2006, Baker and Bulkley 2014). At a deeper level, however, our key finding implies that reputation is a source of system robustness. In contrast, the mechanism of gratitude—cooperating owing to gratefulness for help received—may not be. Prior empirical work (Baker and Bulkley 2014) found that the gratitude effect was stronger than the reputation effect in a system that did not include performance rankings. Although we found significant gratitude effects in all

Figure 5. Predicted Probability of a Transfer in Stage 2 by Risk of Perceiving Inequity and Alter's Reputation



Notes. (1) Analysis of observations in the Reputation and Rank Condition only. (2) *High Risk of Perceiving Inequity* is indicated by an actor being among the system's highest givers (e.g., one standard deviation above others in transferring) *and* among the system's lowest receivers (e.g., in the bottom rank).

four conditions, the gratitude mechanism was unable to withstand the negative impact of the introduction of performance rankings (see Table 2). Reputation, by contrast, enables a system of cooperation to withstand forces that would otherwise destroy it.

Our study makes several contributions. Broadly, we contribute to theory on the maintenance of systems of cooperation (Marwell and Ames 1979, 1980; Nowak and Sigmund 1998a, b; Penner et al. 2005; Nowak 2006; Boyd et al. 2010; Baker and Bulkley 2014). Most work in this area focuses on the origins and outcomes of these systems. We introduce a robustness lens (Jen 2003, 2005) to the discussion of systems of cooperation by explicitly examining how these systems are maintained in the presence of perturbations. Here we focused on the introduction of performance rankings as an exogenous perturbation. However, perturbations can be endogenous—disruptions can emerge from the everyday actions that, on their face, should maintain these systems. For example, acts that increase the mutual benefits associated with cooperation may unintentionally pave the way for a system's collapse by making the payouts associated with defection larger (Stewart and Plotkin 2014). Rankings or reward systems could become an endogenous perturbation when they are used to incentivize cooperative contributions. The online encyclopedia Wikipedia seeks to incentivize activities such as posting and editing by rewarding participants for complying with site norms (Jan Piskorski and Gorbatai 2017). In such cases, members' past prosocial behaviors comprise their rank or level of success in a reward system, which may incite both cooperative and uncooperative dynamics such as cheating to get ahead in a ranking. A robustness lens shifts the conversation from "system maintenance" to "system maintenance in the presence of disruptive forces." In so doing, it provides insights into how and when systems of cooperation are robust to anticipated and unanticipated perturbations.

In examining the effects of performance rankings on cooperative systems, we contribute to research that examines the use of rankings to manage the performance of organizational members (Anderson and Brown 2010, Rock and Jones 2015, Moon et al. 2016). Evidence is mixed regarding whether rankings are beneficial or harmful for organizations (Anderson and Brown 2010). Although there is some evidence that rankings help to attract and retain high performers, rankings may reduce motivations to perform cooperative, prosocial behaviors (Moon et al. 2016). Because citizenship behaviors directly affect the ability of an organization to catalyze task activities and processes (Borman and Motowidlo 1993), performance rankings may ultimately undercut their expected performance gains. Our findings provide empirical support for these concerns. We find that performance rankings negatively impact actors' willingness to continue to cooperate over time—even in the presence of strong norms of cooperation.

Finally, we contribute to research on prosocial behavior at the macro level (Cross and Parker 2004, Penner et al. 2005, Baker and Dutton 2007, Baker and Bulkley 2014). To date, this research has focused on

the benefits that systems of generalized reciprocity create in organizations (Bolino and Grant 2016). Because of these perceived benefits, practitioners often recommend these systems to leaders (Cross and Parker 2004). Our research suggests that these systems may be more difficult to implement and maintain than previously thought, especially in the presence of performance rankings, but that recognizing and rewarding the prosocial contributions of organizational members might reduce the negative effects of performance rankings. We find evidence that reputation information permits actors to respond to perceptions of inequity by rewarding the cooperative behaviors of others.

Managerial Implications

One clear implication of our findings is that if managers seek to develop a pay-it-forward culture of helping or other types of cooperative systems, they must pay careful attention to the potentially disruptive effects of performance rankings. Despite their inertial properties, these systems are likely to collapse in the presence of performance rankings and other conditions that result in an increase in competition or perceived inequity (e.g., gamification programs and ratings systems). To motivate more geographically dispersed workforces, managers are enlisting performance rankings, gamification tools, and ratings systems at increasing rates (Cappelli 2009, Mollick and Rothbard 2014, Webster and Wing-Fai 2017). Relatedly, increased availability of information technology is enabling organizations to continuously monitor employees' activities and report back transparent performance data that are often in the form of rankings (Bernstein and Li 2017). Together with this research, our findings suggest that systems of cooperation will likely be subject to increasing amounts of potentially disruptive forces and that the maintenance of prosocial organizational cultures may become more difficult in the near future.

However, our findings also point to a way that managers can offset these disruptive forces. Our findings suggest that managers can maintain or restore cooperation, *without* changing the underlying performance-appraisal system by displaying and offering recognition for employees' prosocial contributions. For example, so-called peer-to-peer bonus systems enable employees to recognize and reward other employees' cooperative behaviors (Erez et al. 2015). Other examples include organizational routines in which members publicly express appreciations of helpfulness, acknowledgments in company newsletters of those who go the "extra mile," service awards, and formal performance reviews that explicitly include measures of cooperation (Weinzweig 2010). Employing these strategies may permit organizations to retain the benefits of using comparative performance-appraisal systems such as enhanced employee effort, task performance (Moon et al. 2016), and self-policing to avoid unproductive behaviors (Bernstein and Li 2017) without undercutting cooperation.

Of course, performance rankings are not the only type of potentially disruptive force. For example, excessive turnover in an organization may disrupt a system of cooperation. When organizational members leave, their reputations for paying forward help go with them. They are replaced with new actors who have not yet experienced help and who do not know who has been helpful in the past. Therefore, turnover may prematurely shut down chains of helping behaviors. Similarly, organizational restructurings or mergers can disrupt the social network inside an organization (e.g., Totterdell et al. 2004). Reputation may be a restorative mechanism under conditions of high turnover or organizational change because it provides actors with information to direct future help to those who are most deserving—ensuring that the system of cooperation remains fair.

Boundary Conditions

Different organizational features may shape the generalizability of these results. Individuals may possess different cooperation strategies that shape their responses to alters' rates of cooperation (Axelrod 1984, Nowak 2006). Studying groups' composition of cooperation strategies may reveal insights for creating more robust systems of cooperation that respond less negatively to disruptions. Alternatively, other forms of cooperation may give rise to different robustness dynamics. For example, organizations comprising temporary workers may not contain opportunities for continued cooperation among a similar set of members. They may only create intermittent opportunities for cooperation, making it difficult for a system of generalized reciprocity to get up and running. As a result of their brief tenure in an organization, temporary workers typically assert less control over organizational outcomes, are less likely to be the beneficiaries of extrarole helping behaviors from others, and arguably do not need to strategically manage a reputation for being a cooperator in any one, single organization. Consequently, it is less likely that temporary workers will be drawn into a system of generalized reciprocity, and it is unclear whether these systems can emerge or be maintained in this type of work environment. Furthermore, it is unclear whether rankings would be as disruptive. The disruptive effects of performance rankings and the ability of reputation information to help withstand them are mechanisms that exist because of the compilation of information over

time. Counterintuitively, the disruptive effects of performance rankings may be lessened with other forms of cooperation.

Additionally, our study invokes a specific type of performance-appraisal system, which may not generalize to other types of systems. Similar to the types of performance rankings that are commonly employed to manage sales forces (Zoltners et al. 2008, 2011) and the widely used forced distribution ratings (Moon et al. 2016), we use a type of zero-sum ranking in our experiment. Zero-sum rankings dictate that actors who are higher in the rankings will have access to benefits at the expense of actors who are lower in the rankings. We used this type of ranking because it maps onto performance-comparison pressures that are prevalent in organizational contexts. Even organizations that do not explicitly use a zero-sum performance-ranking system often feature some zero-sum competitive elements. For example, if we assume that an organization has a pool of equally talented employees, it is likely that only a select few will be promoted to leadership positions. Furthermore, in the absence of explicit performance rankings, individuals will often infer implicit rankings, which may elicit similar dynamics (Magee and Galinsky 2008, Willer 2009). In our experiment, a zero-sum ranking encapsulates these competitive pressures. Yet organizations may actively seek to avoid zero-sum performance structures. For example, a hybrid type of performance-appraisal system, which combines individual and team performance metrics, may produce less competitive dynamics and hence attenuate the potentially disruptive effects of rankings. Likewise, organizations can introduce other mechanisms that reduce competitive pressures associated with individual performance and gains. For example, superordinate goals have been shown to decrease intragroup competitive pressures and enhance levels of cooperation (Sherif 1958, Sherif et al. 1961). It is conceivable that the presence of superordinate goals or other mechanisms that emphasize the benefits associated with joint gains may also attenuate the disruptive effects of rankings.

Last, in our experimental design, actors had access to perfect information about others' cooperative behaviors (i.e., reputations were accurate and complete). Although prior research shows that group members often create accurate evaluations of others' prosocial contributions (Willer 2009), actors could conceivably have access to more or less accurate information about others' cooperative behavior. The larger the group, the more difficult it is to keep track of accurate assessments of others' reputations (Tennie et al. 2010, Baker and Bulkley 2014). Additionally, other biases may affect the accuracy of these assessments. For example, compared with men, women may receive less credit for prosocial behaviors because they are assumed to be altruistic in nature (Flynn 2005). Inaccurate reputations may mean that more deserving employees (highly prosocial employees) will not be on the receiving end of efforts to reward reputation and reduce inequity. Future research should explore whether high givers continue to exhibit efforts to reward others when they themselves are not recognized for their contributions.

Conclusion

Cooperation is essential for social systems ranging from small groups to organizations to international relations. Indeed, complex society would be impossible without it. As Nowak (2006, p. 1560) put it, "[h]umans are the champions of cooperation: From hunter-gather societies to nation-states, cooperation is the decisive organizing principle of human society." Accordingly, identifying how cooperation is maintained among self-interested actors is "one of the fundamental problems in biology and the social sciences" (Egas and Riedl 2008, p. 871). We contribute to research and theory on cooperation by explicitly examining how systems of cooperation fare in the presence of a potentially disruptive force commonly found in organizational contexts: performance rankings.

Using a longitudinal between-groups experimental design that included more than 80 rounds of decision making, we analyzed how the introduction of performance rankings affects systems of cooperation. We found that established systems of cooperation could not withstand the introduction of performance rankings. Despite the development of a group norm of generalized reciprocity during a lengthy period of decision making, participants who received information about rankings were less likely to cooperate. In contrast, participants who *also* received reputation information—information about the relative generosity (stinginess) of others in the past—were more likely to cooperate, despite the presence of performance rankings. Our research opens a new avenue of inquiry: the robustness of systems of cooperation. We considered robustness in the presence of one common potentially disruptive force (rankings), but other exogenous and endogenous forces or "shocks" can imperil a system of cooperation. We analyzed the effects of the restorative mechanism of reputation, but other restorative mechanisms likely exist. Future research may identify additional disruptive forces and mechanisms that offset them, broadening and deepening our understanding of robust systems of cooperation. Finally, our research supports a growing chorus of concern regarding rankings as performance-appraisal systems and suggests that organizations should find ways to recognize and reward the prosocial contributions of their members.

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Endnotes

[1] Robustness is related to, but distinct from, the concept of stability. In complexity theory (stemming from control theory and stability theory in engineering fields), a system is said to be stable when it can remain at an "equilibrium state" over time (Jen 2003). This includes returning to this equilibrium state after experiencing small changes in the environment, such as a change in levels of external inputs. Hence, stability and robustness both feature the common element of featured persistence over time, but robustness differs in two key ways: (1) robustness explicitly examines persistence in the face of perturbations, whereas stability can exist without considering perturbations, and (2) robustness can be achieved without returning to an equilibrium state where all previous system-level conditions remain the same—the social system can change in fundamental ways, so long as the performance of a social system is maintained. In contrast, stability cannot occur with fundamental changes to a social system's core dynamics. Hence, robustness is a wider construct than stability.

[2] The effect of having a high risk of perceiving inequity on rewarding alters' reputations can only be evaluated for participants who have information about their own rank and alters' reputations. Therefore, Hypothesis 3 can only be evaluated in the Reputation and Rank Condition.

[3] Points were used instead of dollars and cents to avoid any biases associated with money. However, actors knew that points would be converted at the rate of 2 cents per point, which they would receive as a bonus in addition to their participation fee ($10.00) at the end of the experiment. They were also told that their bonus amount may or may not change throughout the experiment. With 33 points, the initial endowment was equivalent to $0.66. This amount was set by considering rates used by past reciprocity studies and in consultation with the Institutional Review Board.

[4] All actors participated in a minimum of 40 rounds of decision making in each stage. To avoid end-game effects, each participant faced a 10% probability that he or she would participate in additional decision-making rounds. Participants were told of this probability in the instruction period and were asked about it during the comprehension test. These rounds are not included in the analysis.

[5] Because of a programming error, participants in stage 2 saw the track record of alters to date instead of at the end of stage 1. This correlated at 0.997 with the track record at the end of stage 1, and supplementary analyses indicate that this did not affect the experiment, results, or interpretation. Details regarding these supplemental analyses are available in the online appendix.

[6] In models 2 and 3, the number of individuals decreases to 574, and the number of observations decreases to 11,496 owing to missing values. Sixteen individuals did not report their age, one chose to not declare a gender, and one did not report an education level. Only one group featured more than one individual with missing data. As a robustness check, we examined our results with and without this group. The elimination of this group does not have a material effect on our results or interpretations. We also examined our results with and without the covariates of age, gender, and education. The elimination of these covariates does not have a material effect on our results or interpretations.

[7] As a robustness check, we follow Heisig et al. (2017) and include random slopes for level 2 (ego level) covariates in our model 3 specifications to examine whether there are cross-cluster differences in the effects of controls. The inclusion of these random slopes does not have a material effect on our results or interpretations. These analyses are not shown here but are available on request.

[8] Reputation is typically associated with an increase in cooperative behavior (Nowak and Sigmund 1998a, b), but we did not find a statistically significant difference between the Reputation Information Condition and the No Additional Information Condition. However, supplemental analyses reveal that there are significant reputation effects that vary with the group's level of generosity in stage 1 (models are available on request).

[9] Results with the Rank Information Condition as the comparison group are available on request.

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Cassandra R. Chambers is an assistant professor in the Department of Management and Technology at Bocconi University. She received her PhD from the Stephen M. Ross School of Business at the University of Michigan. Her research examines topics in cooperation, robust performance, social hierarchy, social influence, and online communities.

Wayne E. Baker is the Robert P. Thome Professor of Business Administration and faculty director of the Center for Positive Organizations at the Stephen M. Ross School of Business at the University of Michigan. He received his PhD from Northwestern University. His research interests include networks and social capital, reciprocity, culture and values, and positive organizational scholarship.