Dynamic indirect reciprocity: When is indirect reciprocity bounded by group membership?

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ABSTRACT

Indirect reciprocity is a strong driver of reputation-based cooperation and previous studies have offered ample evidence as to when and how it guides cooperation towards others. However, the current empirical literature suffers from mixed evidence about the realm of indirect reciprocity; some studies showed that people assume that in-group members, but not out-group members, belong to the same system of indirect reciprocity and they, thus, display reputation-based cooperation only towards in-group members (i.e., bounded indirect reciprocity). Other studies found that people display reputation-based cooperation towards out-group members as well (i.e., un-bounded indirect reciprocity). It thus remains unclear when indirect reciprocity is bounded by group membership. We argue that the realm of indirect reciprocity is conditional to the presence of cues of reputational consequences (i.e., consequences of immediate cooperation). We further propose a new perspective, the dynamic indirect reciprocity perspective, which integrates the bounded and unbounded indirect reciprocity perspectives. We conducted a preregistered study ($N = 1800$) and found partial evidence for the perspective. First, between-condition differences in cooperation were very small and were not in line with the perspective. However, exploratory analyses on psychological underpinnings of intergroup cooperation revealed that a reputation manipulation (i.e., group membership knowledge manipulation) increased cooperation via increased expected cooperation from an immediate partner regardless of their group membership when the cue of reputational consequences was present. Yet, when the immediate partner was an in-group member, this indirect effect was observed when the cue of reputational consequences was absent. Overall, our findings underscore a new general principle of indirect reciprocity: the cue of reputational consequences determines the perceived realm of indirect reciprocity and influences whether or not individuals condition their cooperation to the group membership of immediate interaction partners.

Individuals often display prosocial behavior such as cooperation, even at their expense (Penner, Dovidio, Piliavin, & Schroeder, 2005; Schroeder & Graziano, 2017), and the prevalence of such costly other-benefitting behavior among humans, especially towards nonkin, has been a theoretical conundrum in diverse scientific disciplines (Apicella & Silk, 2019; Rand & Nowak, 2013; Van Vugt, Roberts, & Hardy, 2012; Wu, Balliet, & Van Lange, 2016a). One of the major theoretical frameworks to explain the evolution of cooperation is indirect reciprocity, a principle that one's cooperative behavior towards others depends on the reputation of others (e.g., Fehr & Fischbacher, 2003; Nowak & Sigmund, 1998, 2005; Ohtsuki & Iwasa, 2006; Sommerfeld, Krambeck, Semmann, & Milinski, 2007). More specifically, indirect reciprocity refers to a

process by which cooperation results in establishing a positive reputation and this increases a chance to receive cooperation from another individual in the future. In other words, immediate costs associated with cooperation are paid off in the long run. Previous studies have shown that indirect reciprocity can help us explain why people cooperate with unrelated individuals even when there is no chance for others to directly reciprocate cooperation (for reviews, see Van Vugt et al., 2012; Wu et al., 2016a).

While previous studies have yielded an abundance of empirical and simulation-based findings on how and when indirect reciprocity guides cooperative behavior (Milinski, Semmann, Bakker, & Krambeck, 2001; Nowak & Sigmund, 2005; Ohtsuki & Iwasa, 2006; Okada, 2020;

Wedekind & Milinski, 2000), current theoretical models do not clarify whether its benefits are limited to in-group members, or they extend to both in-group and out-group members. Previous studies on intergroup cooperation have collated mixed evidence regarding whether people display reputation-based cooperation towards in-group or out-group members. One possibility is that indirect reciprocity is dynamic and there might be conditions that define situations under which indirect reciprocity is bounded or unbounded by group membership. Hence, there remains an important puzzle in one of the crucial tenets of the indirect reciprocity framework. In the present article, we propose and test a new framework to understand when indirect reciprocity is bounded by group membership, the dynamic indirect reciprocity perspective.

1. Bounded indirect reciprocity

Previous studies have consistently documented the tendency to favor in-group members over out-group members (i.e., in-group favoritism) in various domains of human prosociality including cooperation (Aaldering, Ten Velden, van Kleef, & De Dreu, 2018; Ahmed, 2007; Balliet, Wu, & De Dreu, 2014; Goette, Huffman, Meier, & Sutter, 2012; Guala, Mittone, & Ploner, 2013; Koopmans & Rebers, 2009; Krupp, Debruine, & Barclay, 2008; Wit & Wilke, 1992). In-group favoritism has been observed among children (Dunham, 2018; Lazić, Purić, & Krstić, 2021) and adults (Balliet et al., 2014). Moreover, it has been observed in diverse cultures (Fiedler, Hellmann, Dorrough, & Glöckner, 2018; Romano, Balliet, Yamagishi, & Liu, 2017; Romano, Sutter, Liu, Yamagishi, & Balliet, 2021; Ruffle & Sosis, 2006; Yamagishi, Mifune, Liu, & Pauling, 2008) and in a wide range of intergroup contexts such as university affiliation (Hackel, Zaki, & Van Bavel, 2017; Ockenfels & Werner, 2014), political groups (Rand et al., 2009), morally conflicted groups (e.g., Imada, Codd, & Liu, 2021), and arbitrarily created experimental groups (e.g., Yamagishi, Jin, & Kiyonari, 1999). In-group favoritism is, thus, a robust phenomenon, and scholars of diverse disciplines have long investigated the evolutionary origin of such a tendency.

Building upon the empirical literature on indirect reciprocity, Yamagishi and colleagues proposed an evolutionary-rooted explanation for in-group favoritism: bounded generalized reciprocity (BGR: Yamagishi et al., 1999; Yamagishi & Kiyonari, 2000; Yamagishi & Mifune, 2008). Crucially, they argued that individuals intuitively and unconsciously assume that a system of generalized exchange (that can be understood as a system of indirect reciprocity), where favoring a member of the system is reciprocated by another person in the system, is bounded by group membership. More specifically, in this system, it is imperative that individuals establish a positive reputation such that they can remain in the system and enjoy indirect reciprocity (Mifune & Yamagishi, 2015; Yamagishi & Mifune, 2008). In other words, people typically assume that out-group members do not belong to the same system of indirect reciprocity and indirect reciprocity fails to promote cooperation towards out-group members. The assumption of group-bounded indirect reciprocity is referred to as the group heuristic (Yamagishi et al., 1999; Yamagishi & Kiyonari, 2000) and posits that intergroup contexts activate the heuristic and result in in-group favoritism.

Importantly, Yamagishi et al. (1999) posited that the group heuristic can be an evolutionary adaptive strategy. Previous studies have shown that the group heuristic can explain in-group favoritism in one-shot games, in which, reputation should not matter. Yamagishi and colleagues argued that the group heuristic helps individuals overlook the possibility of succeeding in freeriding. When individuals decide whether to cooperate with an in-group member, they can erroneously assume (1) that freeriding would be detected when it could not be detected and (2) that freeriding would not be detected when it could be detected. The cost associated with making the latter is much higher than that with the former, especially in demarcated and closed groups, as the second type of error may lead to devastating reputational consequences such as

ostracism. Overall, Yamagishi et al. (1999) claim that displaying in-group favoritism as a default strategy is more adaptive than not because individuals can benefit from the system of indirect reciprocity, which is ingrained in the in-group, in the long run.

To test BGR, Yamagishi and colleagues developed the group membership knowledge paradigm (Yamagishi et al., 1999). In the common knowledge condition, participants are informed of their partner's group membership and instructed that their partner also knows about their group membership. Thus, group membership of the two players is mutually known. Contrastingly, in the unilateral knowledge condition, participants are told that they know their partner's group membership, but their partner does not know their group membership. According to BGR, it is crucial whether or not an in-group interaction partner knows about the shared group membership. In the unilateral knowledge condition, their cooperation with in-group members loses its benefits; cooperation with the in-group member no longer helps them acquire indirect reciprocity, and they cannot either expect the in-group member to cooperate with them. Based on BGR, in-group favoritism should emerge in the common knowledge condition but not in the unilateral knowledge condition.

Several studies using the experimental procedure have yielded supporting evidence for BGR in minimal group contexts (e.g., Guala et al., 2013; Mifune, Hashimoto, & Yamagishi, 2010; Yamagishi et al., 1999; Yamagishi & Kiyonari, 2000; Yamagishi & Mifune, 2008) as well as in actual group contexts (e.g., Foddy, Platow, & Yamagishi, 2009; Nakagawa, Yokota, & Nakanishi, 2021; Platow, Foddy, Yamagishi, Lim, & Chow, 2012). Balliet et al. (2014) further provided robust meta-analytic evidence for BGR, revealing that in-group favoritism, overall, did not emerge under the unilateral knowledge condition. Mifune and colleagues further found that reputational concern plays a pivotal role in shaping in-group favoritism (Mifune et al., 2010; Mifune & Yamagishi, 2015; Yamagishi & Mifune, 2008). They showed that a fear of earning a negative reputation and concern about establishing a negative reputation were correlated with in-group cooperation (Mifune & Yamagishi, 2015) and in-group favoritism (Kajiwara, Myowa, & Mifune, 2022), respectively, under the common knowledge situation. These findings suggest that indirect reciprocity is by default, bounded by group membership and it does not guide cooperation when people face out-group members.

1.1. Unbounded indirect reciprocity

According to the other perspective, unbounded indirect reciprocity (UIR), benefits of indirect reciprocity are not limited to in-group members, but they can also extend to out-group members (Romano, Balliet, & Wu, 2017; but also see Everett, Faber, & Crockett, 2015). Proponents of the perspective claim that common knowledge studies cannot confirm that indirect reciprocity is bounded by group membership because experimental evidence was mostly based on one-shot interactions. This perspective suggests that people condition their behavior to several ecological cues that can lead to indirect benefits in the future, including gossip, and such cues have been shown to promote cooperation via increased reputational concern (Imada, Hopthrow, & Abrams, 2021; Wu, Balliet, & Van Lange, 2015a, 2016b). Importantly, such situations may lead to experience reputational concerns to both in-group and out-group members. While previous research on opportunities for indirect benefits found that indirect reciprocity promotes cooperation, they do not address whether indirect reciprocity is also effective with out-group members (Panchanathan & Boyd, 2004; Wu et al., 2015a; Wu, Balliet, & Van Lange, 2015b, Wu et al., 2016a, 2016b).

In a typical experimental procedure related to UIR, participants complete an economic game with an in-group (out-group) member and then another unrelated economic game with an in-group (out-group) member. Then, participants are informed that the recipient in the first economic game would gossip about their allocation behavior towards the recipient of the second economic game. Across a series of studies,

results show that prosocial behavior towards in-group members was larger when there were gossip opportunities towards the partner of the second economic game. Importantly, and in line with UIR, individuals displayed reputation-based prosocial behavior regardless of whether an immediate partner and a future partner belonged to the in-group or the out-group, suggesting that indirect reciprocity may be unbounded by group membership. These results were robust across a series of economic games, and independent of the group membership of the gossiper.

1.2. The dynamic indirect reciprocity perspective

Although recent studies found support for unbounded indirect reciprocity, such studies did not address why they found evidence for UIR while several other studies had provided support for BGR. Is indirect reciprocity unbounded by group membership? Or are there boundary conditions for bounded vs. unbounded indirect reciprocity? The current literature needs an explanation and empirical evidence disentangling the conditions under which indirect reciprocity is bounded or unbounded by group membership. Here, we offer a new perspective that helps us understand whether and when indirect reciprocity guides cooperation towards in-group members and out-group members. We argue that the presence of explicit cues of reputational consequences is crucial to understand the influence of the principle of indirect reciprocity on intergroup cooperation. We hereby define reputational consequences as rewards or punishments that individuals receive from a third party who knew about their previous behavior. Moreover, in line with previous research, we argue that individuals can experience reputational concern even when there are no explicit cues of reputational consequences, and a mere fact that their reputation is at stake is known to be sufficient to promote reputation-based cooperation (Andreoni & Petrie, 2004; Bradley, Lawrence, & Ferguson, 2018; Campbell & Slack, 2006).

We propose the dynamic indirect reciprocity perspective, which reconciles the conflicting previous findings as to whether indirect reciprocity guides cooperation towards out-group members. We posit that (1) group membership, by default, functions as a cue of bounded indirect reciprocity and (2) cues of reputational consequences lead to unbounded indirect reciprocity. According to our dynamic indirect reciprocity perspective, the realm of indirect reciprocity (i.e., whether indirect reciprocity is bounded or unbounded by group membership) is conditional to the presence of reputational consequences.

When no reputational consequences are implied as in one-shot economic games, individuals do not have a concrete expectation that their cooperation with an immediate partner would result in acquiring desirable reputational consequences such as receiving rewards and avoiding ostracism. In such a situation, we contend that the group membership of an immediate partner (i.e., the group heuristic triggered by group membership), together with a cue of reputational concern (i.e., the common knowledge treatment), provides particularly useful information for individuals to determine whether or not they should do reputation management; based on the group heuristic, individuals intuitively assume that indirect reciprocity is bounded by group membership. Accordingly, thus, when reputation is at stake without any cues of reputational consequences, individuals are particularly motivated to maintain a positive reputation from in-group members but not from out-group members, showing increased cooperation towards in-group members (Mifune et al., 2010; Yamagishi & Mifune, 2008).

In contrast, when individuals are aware that cooperation with an immediate partner would bring indirect benefits, individuals are compelled to do reputational management regardless of the group membership of the immediate interaction partner (Romano, Balliet, & Wu, 2017). In such situations, reputational consequences directly indicate that their immediate cooperation is subject to indirect reciprocity; people know that a third party will know their immediate behavior and base their action (i.e., reward and punishment) on it. Individuals, thus, no longer refer to the group heuristic as well as the membership of

immediate cooperation partners when judging whether they should cooperate and maintain a positive reputation. In other words, indirect reciprocity is perceived to be unbounded by group membership when there is a cue of reputational consequences. This process is analogous to when direct reciprocity overrides indirect reciprocity and dictates intergroup cooperation (Yamagishi & Kiyonari, 2000); given that a guaranteed future interaction is a more certain source of benefits, a cue of reputational consequences guides intergroup cooperation, diminishing the role of the group heuristics (BGR). Overall, we argue that the presence of explicit reputational consequences would play a pivotal role in determining the belief about indirect reciprocity and guiding reputation management behavior (i.e., cooperation).

1.3. The present research

The current literature seems to suffer from mixed evidence as to whether indirect reciprocity is bounded by group membership or not. Here, we argue that BGR (Yamagishi et al., 1999; Yamagishi & Kiyonari, 2000; Yamagishi & Mifune, 2008) and UIR (Romano, Balliet, & Wu, 2017) are not conflicted with each other, but these two perspectives account for intergroup cooperation across different ecologies. According to the dynamic indirect reciprocity perspective, indirect reciprocity guides cooperation towards out-group members when reputational concern is enhanced and a cue of reputational consequences is present. Contrastingly, when people do not perceive any cues of reputational consequences, the group heuristic dictates out-group cooperation and indirect reciprocity is bounded by group membership; people do not show reputation-based cooperation towards out-group members.

In the present research, we aim to experimentally test the key tenet of the dynamic indirect reciprocity perspective; the presence of reputational consequences determines whether indirect reciprocity is bounded or not. We have conducted a pilot study and obtained preliminary evidence for this hypothesis, and we propose a well-powered preregistered study to further validate it.

2. Pilot study

We conducted a pilot study in which we simultaneously manipulated the presence of cues of reputational concern and reputational consequences. More specifically, we had two experimental conditions varying in whether or not cooperation with an immediate interaction partner would influence future earnings. In the one-step game condition, participants completed a prisoners' dilemma game (PDG) either with an in-group or an out-group member. In the two-step game condition, participants were further instructed that they would complete a trust game (TG) with a newly paired participant who knew how they completed the first PDG. We also introduced the group membership knowledge manipulation in the PDG, and the study followed a 2 (group membership: in-group vs. out-group) × 2 (knowledge: common vs. unilateral) × 2 (game structure: one-step vs. two-step) between-subject design. The knowledge and game structure conditions were designed to manipulate the presence of cues of reputational concern and reputational consequence, respectively. We tested the preregistered hypothesis that indirect reciprocity is bounded by group membership (BGR) in the one-step condition, whereas it is not in the two-step condition. Thus, we expected a three-way interaction such that the interaction between group membership and knowledge would be significant in the one-step game condition but not in the two-step condition. We preregistered the study procedure, a target sample size, and the hypothesis at https://osf.io/4dpkt,[1] and study material, analysis code, and supplementary

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[1] When we conducted the study, we were interested in the emergence of in-group favoritism and did not think the realm of indirect reciprocity, which is now the central issue to the paper. Thus, our preregistered hypotheses were concerned about the presence of in-group favoritism.

results are available at https://osf.io/ukrax/.

2.1. Methods

2.1.1. Participants and design

The present study employed a 2 (group membership: in-group vs. out-group) × 2 (knowledge: common vs. unilateral) × 2 (game structure: one-step vs. two-step) between-subject design. As we could not expect an effect size of the hypothesized three-way interaction, we sought to be able to detect, at least, in-group favoritism ($d = 0.32$, Balliet et al., 2014). A priori power analysis revealed that 309 participants would be sufficient to detect an effect size of $d = 0.32$ with a statistical power of 80%[2] at alpha = 0.05. Thus, we recruited 340 participants via Amazon Mechanical Turk. We obtained 349 completed responses without duplicates.

2.1.2. Procedure

After giving consent, participants took part in an online survey that consisted of four main parts: minimal group induction, economic game instruction, a PDG, and a post-experiment questionnaire. As a cover story, they were informed that the study was concerned about the relationship between artistic preferences and economic decision making, and they were told that they would first complete an artistic preference task and then make economic decisions with another participant who would be matched online.

In the minimal group induction, they were presented with six pairs of drawings and asked to select the preferred one for each pair. They then received bogus feedback that people could be classified as one of the two artistic preference groups and based on their responses, they belonged to Group A. We provided a short script describing how people in Group A would typically behave and asked them to provide an example where their past behavior matched the description. The minimal group induction was adapted from previous research (see Everett et al., 2015). As this was bogus feedback, all participants were assigned to Group A irrespective of their responses to the artistic preference task. Participants then answered six questions measuring social identification with their group (Leonardelli & Brewer, 2001). It was measured with a 6-point scale ranging from *1 = Strongly disagree* to *6 = Strongly agree*.

Next, participants read instructions about the PDG. The rules of the PDG were as follows; two players were paired online, and each was given 300 cents. They should decide how much of the 300 cents they would like to transfer to their partner, knowing that each cent transferred to their partner would be doubled before it is given to the partner. The amount of money they sent was used as a measurement of cooperation. To incentivize them, we told them that one participant would be randomly selected to receive the actual payment of the money earned in the game. In the game, we manipulated group membership of their partner (in-group or out-group) and group membership knowledge. Following previous studies (Yamagishi et al., 1999), we instructed participants in the unilateral knowledge condition that their group membership was masked from their interaction partner. Contrastingly in the common knowledge condition, they were told that their partner knew their group membership.

Participants in the one-step condition did not receive further instructions. Those in the two-step condition were further told that they would subsequently play a TG with a newly paired participant and, importantly, their decision in the PDG would be communicated to the new partner in the TG. The TG consisted of two players: a trustor and a trustee. The trustor first received 300 cents from the researcher and was asked to decide how much they would like to transfer to the trustee. Importantly, each cent they decided to send would be tripled before it was given to the trustee, and the trustee could then have a chance to return any amount of the received money to the trustor. Participants

were told that they would play the TG as a trustee.[3] Therefore, their cooperation with an immediate partner in the PDG would influence their future earnings in the TG, and the TG acted as a cue of indirect benefits. After reading the instructions, participants answered comprehension check questions, and they completed the PDG. They were directed to the instruction again when they failed to correctly answer the comprehension check questions until they got them right.

Finally, they proceeded to the post-experimental questionnaire, which included a question asking them to indicate how much their partner in the PDG would send to them and four items measuring reputational concern (Wu et al., 2015b). The reputational concern items were measured with a 5-point scale from *1 = Strongly disagree* to *5 = Strongly agree* ($\alpha = 0.77$). We also measured how they would perceive a person who sends 300 and 0 cents to their partner for an exploratory purpose. Lastly, they provided demographic information (age, sex, nationality, and language) and were debriefed and dismissed. We have reported all measures, manipulations, and participants exclusions for the study.

3. Results and discussion

3.1. Cooperation

We conducted a 2 (group membership: in-group vs. out-group) x 2 (knowledge: common vs. unilateral) x 2 (game structure: one-step vs. two-step) between-subject ANOVA on cooperation (see Fig. 1). It yielded a significant three-way interaction, $F(1, 341) = 4.46$, $p = .04$, $\eta_p^2 = 0.01$. We conducted a sensitivity analysis and it revealed that the minimum detectable effect size given the sample size (alpha = 0.05, statistical power = 0.80) was $f = 0.15$ ($\eta_p^2 = 0.02$), suggesting that the pilot study was underpowered.

To follow-up the interaction effect, we first examined the group x knowledge interaction in each structure condition. In the one-step condition, the two-way interaction was marginally significant, $F(1, 172) = 3.77$, $p = .05$, $\eta_p^2 = 0.02$. Further simple effect analyses revealed that the main effect of group (i.e., in-group favoritism) was significant in the common knowledge condition ($F(1, 91) = 10.50$, $p = .002$, $\eta_p^2 = 0.10$), but not in the unilateral condition ($F(1, 81) = 0.13$, $p = .72$, $\eta_p^2 = 0.002$). Thus, in the one-step condition, in-group favoritism only emerged in the common knowledge condition, supporting BGR. In the two-step condition, the group x knowledge interaction was not significant, $F(1, 169) = 1.15$, $p = .29$, $\eta_p^2 = 0.007$. The main effect of knowledge was not significant in the two-step condition, $F(1, 169) = 0.73$, $p = .39$, $\eta_p^2 = 0.004$. The main effect of group was not significant either, $F(1, 169) = 0.83$, $p = .36$, $\eta_p^2 = 0.005$. In the two-step condition, in-group favoritism was not detected in both the common and unilateral condition, $F_s < 0.89$, $p_s > 0.35$, $\eta_p^2 < 0.01$.

3.2. Reputational concern

We conducted a 2 (group membership: in-group vs. out-group) x 2 (knowledge: common vs. unilateral) x 2 (game structure: one-step vs. two-step) between-subject ANOVA on reputational concern (see Fig. 2). We did not find any significant effects, $F_s < 2.23$, $p_s > 0.14$, $\eta_p^2 < 0.007$. Importantly, the main effect of knowledge was not significant, $F(1, 341) = 0.22$, $p = .64$, $\eta_p^2 = 0.001$. We compared the effect size with those of the reputation manipulation used in Studies 1 and 2 in Romano, Balliet, and Wu (2017). We converted η_p^2 to *Cohen's d* and compared the effect size of the knowledge manipulation in our study with those from

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[2] On the preregistration, we mistakenly wrote 0.08 (8%) instead of 80%.

[3] In Romano, Balliet, and Wu (2017) studies, participants played a TG as a trustor. We decided to assign participants to a trustee role because they could not earn any money if a trustor does not send any money and it is crucial that they earn a positive reputation using their cooperation in the PD and encourage the trustor to transfer money to them.
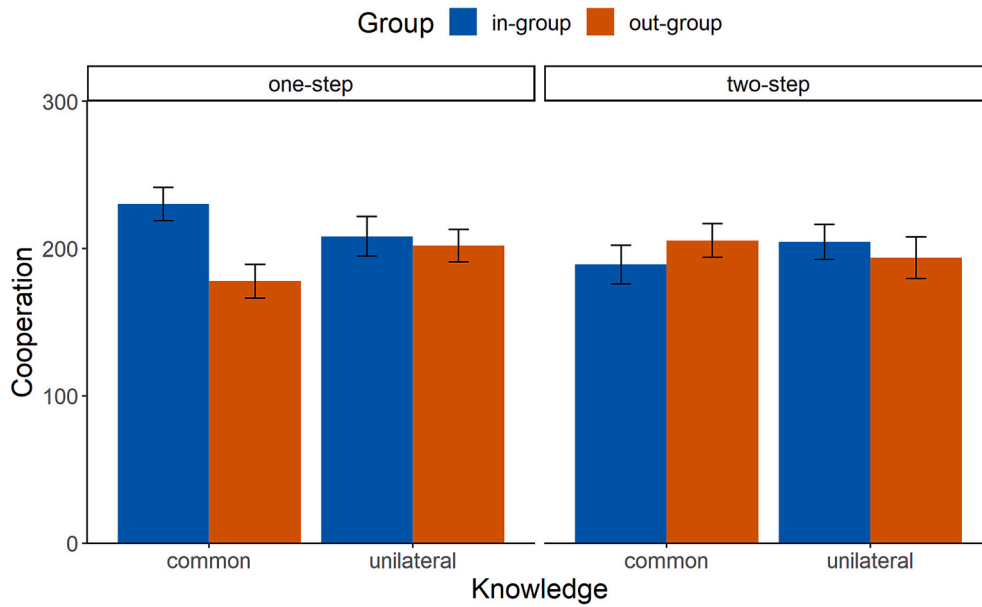
Fig. 1. Cooperation by condition.
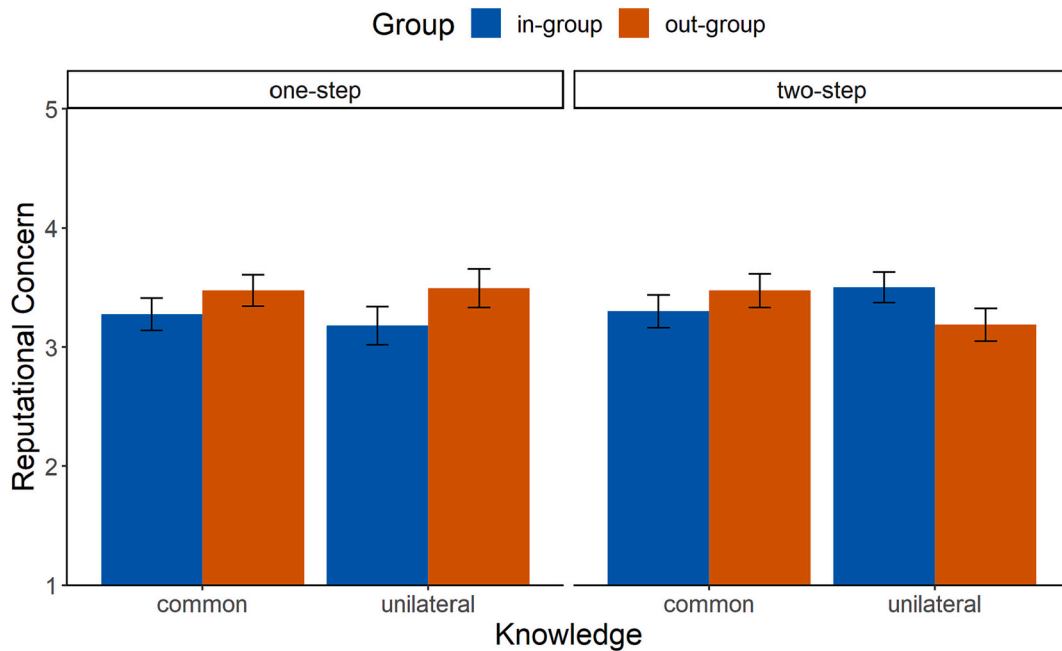Note: error bars represent standard errors.

Fig. 2. Reputational Concern by Condition.
Note: error bars represent standard errors.

Romano, Balliet, and Wu (2017): $d = 0.21$, 90% CI [-0.001, 0.42]; Study 1: $d = 0.30$, 90% CI [0.14, 0.46]; Study 2: $d = 0.22$, 90% CI [0.06, 0.38]. While our results suggested that the knowledge manipulation failed to influence reputational concern, the strength of the manipulation was rather comparable to the previous studies, especially Study 2 in Romano, Balliet, and Wu (2017).

Overall, the pilot study replicated the previous finding supporting the bounded indirect reciprocity perspective in the one-step condition; individuals displayed in-group favoritism in the common knowledge condition but not in the unilateral condition. However, the analyses focusing on the two-step condition revealed that the knowledge manipulation did not promote cooperation at all; we did not find support

for the unbounded indirect reciprocity perspective in the two-step condition. Thus, we obtained mixed evidence for the dynamic indirect reciprocity perspective, as indirect reciprocity did not seem to guide cooperation in the two-step condition in the first place. Yet, the effect size of the simple main effect of group membership knowledge in the two-step condition was $\eta_p^2 = 0.004$, 90% CI [0.00, 0.04]. In studies 1 and 2 of Romano, Balliet, and Wu (2017), the main effect of their reputation manipulation was reported to be $d = 0.30$ and $d = 0.20$, respectively. Using F statistics reported in the article, we converted them to η^2 and computed 90% CIs: Study 1: $\eta^2 = 0.02$, 90% CI [0.01, 0.04]; Study 2: $\eta^2 = 0.009$, 90% CI [0.00, 0.03]. Therefore, while our study revealed a nonsignificant effect of the knowledge manipulation on cooperation, its

effect size was similar to those reported in Romano, Balliet, and Wu (2017), and the apparent inconsistency could be attributed to statistical power. We admittedly based our a priori power analysis for the pilot study on an effect size for in-group favoritism (Balliet et al., 2014), which is larger than that for the previously observed effect size for reputation manipulations on cooperation (Romano, Balliet, & Wu, 2017). With a properly powered study, we expect to be able to find evidence for the dynamic indirect reciprocity perspective that indirect reciprocity (i.e., the common knowledge treatment) promotes cooperation regardless of group membership of an immediate partner in the two-step condition.

4. The preregistered main study

The pilot study has yielded partial evidence in support of our hypothesis that the presence of a cue of reputational consequences would explain whether indirect reciprocity would be bounded by group membership. We, thus, conducted a highly powered study to test the dynamic indirect reciprocity perspective with some modifications to the pilot study.

First, in the present study, we aimed to improve the manipulation of the presence of reputational consequences (i.e., the game structure manipulation). We had two newly named conditions: the two-step knowledge transfer and two-step no knowledge transfer conditions. In the two-step knowledge transfer condition, the instructions followed those we used in the two-step condition in the pilot study. In the two-step no knowledge transfer condition, contrastingly, we provided the same instruction as in the other condition except that participants were told that their cooperation in the PDG would *not* be communicated to a future interaction partner in the TG. In other words, both conditions had the two-step structure (PDG-TG), but they varied in whether their decision in the PDG would be known to a future partner in the TG. This manipulation allowed us to examine the effect of a cue of reputational consequences while excluding the potential effect of the number of games. We expected that the bounded indirect reciprocity perspective would be supported in the two-step no knowledge transfer condition, and the unbounded indirect reciprocity perspective would be supported in the other condition. We articulate operationalized hypotheses in the method section.

Second, in our pilot study and Romano, Balliet, and Wu (2017) studies, reputational concern was measured with items such as "during the decision-making task, I thought about how others would think about me." All items included the term "others." In other words, the measure could not distinguish between reputational concerns specifically from an immediate partner in the PDG and/or a future partner in the TG. Thus, we will include two separate reputational concern measures for a partner in the PDG and a future partner in the TG. We will simply replace "others" with another word that indicates a partner in the PDG and a partner in the TG. We have study material and analysis code available at https://osf.io/89c2e/.

4.1. Preregistered hypotheses

In the present study, we had a more elaborate set of hypotheses than we had in the pilot study.[4] Our preregistered hypotheses for cooperation were as follows; in the two-step no knowledge transfer condition, the knowledge manipulation increases cooperation with an in-group member (H1a) but not an out-group member (H1b): in the two-step

knowledge transfer condition, the knowledge manipulation increases cooperation with an in-group member (H2a) as well as an out-group member (H2b). H1 and H2 served to test the bounded and unbounded indirect reciprocity perspectives, respectively. Unlike the pilot study, in which our rough preregistered hypothesis focused on the presence of in-group favoritism, these hypotheses focused on the effect of the reputation manipulation allowing us to directly investigate the perceived realm of indirect reciprocity.

5. Methods

5.1. Participants and design

The present study followed a 2 (group membership: in-group vs. out-group) × 2 (knowledge: common vs. unilateral) × 2 (game structure: two-step no knowledge transfer vs. two-step knowledge transfer) between-subject design. In the present study, our hypotheses focused on the simple main effect of the knowledge manipulation in the following four conditions: in-group × two-step knowledge transfer: in-group × two-step knowledge transfer; out-group × two-step knowledge transfer: out-group × two-step knowledge transfer. Correspondingly, we aimed to have sufficient statistical power for these four analyses, as well as for the three-way interaction in a three-way ANOVA. We used the{superpower} R package to identify minimal sample sizes to have 80% statistical power with $\alpha = 0.05$ (Lakens & Caldwell, 2021). Using the package, we conducted simulation-based power analyses (the number of simulations for each analysis = 1000) with descriptive statistics from the pilot study and Study 4 of Romano, Balliet, and Wu (2017). Our power analyses revealed that $N = 219$ in each cell would be sufficient to ensure that we have 80% statistical power for the simple main effect of the knowledge manipulation in the in-group x no knowledge transfer condition. With this sample size, we had >90% power for other hypothesis tests. Thus, we recruited 1800 British participants whose first language was English via Prolific Academic, oversampling in anticipation of any data exclusions. To incentivize participants, we informed participants that 10% of the participants would be randomly selected to receive the actual payment of the money earned in the scenario.[5]

5.2. Procedure

The basic procedure of the study was identical to that of the pilot study with the two modifications indicated above and one change to the minimal group induction. We converted the one-step condition in the pilot study to the two-step no knowledge transfer condition. Thus, participants in this condition were instructed that a future partner in the TG was not aware of how they would complete the PDG. In the post-experimental questionnaire, we had two variants of the reputational concern scale in the pilot study: one measuring reputational concerns from a partner in the PDG and the other measuring reputational concern from a partner in the TG. In addition, while we assigned all participants to Group A in the pilot study, we randomly assigned participants to Group A and Group B in the present study.

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[4] When we conducted the pilot study, we were, in fact, primarily interested in the emergence of in-group favoritism. Thus, our preregistered hypotheses for the pilot study was about in-group favoritism. We conceived of the dynamic indirect reciprocity perspective and our predictions for the present study, after seeing and discussing the results of the pilot study. We decided to make this change during the peer review process.

[5] In the present study, we randomly assigned participants to Group A and Group B. When a participant who played the prisoners' dilemma game as a member of Group A with a hypothetical partner from Group B was selected to receive the bonus payment, we matched the participant with another participant who played the game as a member of Group B with another person from Group A. By doing so, we were able to determine the amount of bonus payment based on the actual decisions made by the participants. Participants were debriefed about the process and were also told that they were not in fact matched online while making their decision.

6. Results

We had 1800 participants (897 males, 892 females, M_{age} = 41.44, SD = 17.36) fully completing the study and none of them was excluded based on their completion time (Leys, Ley, Klein, Bernard, & Licata, 2013; Miller, 1991). The three scales showed satisfactory reliability (α_s > 0.83).

6.1. Preregistered hypothesis testing

As preregistered, we first conducted a 2 (group membership: in-group vs. out-group) × 2 (knowledge: common vs. unilateral) × 2 (game structure: two-step no knowledge transfer vs. two-step knowledge transfer) between-subject ANOVA on cooperation (see Fig. 3 for descriptive statistics). The main effect of the game structure was significant, suggesting that people in the knowledge transfer condition were more cooperative than those in the no-transfer condition, $F(1, 1792)$ = 6.96, p = .008, η_p^2 = 0.004. The main effect of knowledge was marginally significant, $F(1, 1792)$ = 0.91, p = .09, η_p^2 = 0.002. This partly supports UIR in that the reputation manipulation increases cooperation regardless of the group membership as well as the game structure. The other effects were not significant, F_s < 1.17, p_s > 0.28, η_{ps}^2 < 0.001. In the pilot study, we observed a significant three-way interaction, but we did not find it in the present study.

H1a and H1b served to test the bounded indirect reciprocity perspective. Following our preregistration, we carried out pairwise comparisons, examining the simple main effect of knowledge in the in-group × no transfer condition (H1a) and in the out-group × no transfer condition (H1b). In the no transfer condition (i.e., when there is no explicit cue of reputational consequences), participants in the common knowledge condition cooperated more with an in-group member (N = 228, M = 182.08, SD = 94.51) than those in the unilateral knowledge condition (N = 227, M = 168.31, SD = 89.20). However, the difference did not reach statistical significance, $F(1, 453)$ = 2.55, p = .11, η_p^2 = 0.006, d = 0.15 (95% CI [−0.03, 0.35]). As a non-preregistered analysis, we further computed a Bayes factor and it suggested that data offered anecdotal evidence of the null hypothesis (BF$_{10}$ = 0.36; Lee & Wagenmakers, 2014). Thus, we did not find support for H1a. In line with H1b, in the no transfer condition, participants in the common knowledge condition (N = 222, M = 178.11, SD = 86.68) did not cooperate significantly more with the out-group members than those in the unilateral knowledge condition (N = 220, M = 168.45, SD = 95.05), $F(1, 440)$ = 1.25, p = .27, η_p^2 = 0.003, d = 0.11 (95% CI [−0.09, 0.29]). Since H1b was a null hypothesis, we preregistered to follow up the analysis with a Bayes factor. The data provided moderate evidence of the null hypothesis (BF$_{10}$ = 0.19) and H1b was supported.

Next, we tested the unbounded indirect reciprocity perspective (H2a and H2b). Namely, we examined the simple main effect of knowledge in the in-group × transfer condition (H2a) and the out-group × transfer condition (H2b). We found that in the transfer condition, those in the common knowledge condition (N = 227, M = 203.35, SD = 82.37) were not significantly more cooperative towards an in-group member than those in the unilateral knowledge condition (N = 225, M = 201.94, SD = 77.39), $F(1, 450)$ = 0.04, p = .85, η_p^2 < 0.001, d = 0.02 (95% CI [−0.16, 0.20]). In the knowledge transfer condition, participants in the common knowledge condition (N = 225, M = 209.88, SD = 81.65) cooperated with an out-group member more than those in the unilateral knowledge condition (N = 226, M = 196.26, SD = 79.63), but the effect was only marginally significant, $F(1, 449)$ = 3.22, p = .07, η_p^2 = 0.007, d = 0.17 (95% CI [−0.02, 0.36]). Bayes factors indicated that the data offered moderate and anecdotal evidence of the null hypotheses for H2a and H2b, respectively. Overall, H2a and H2b were not supported.

6.2. Non-preregistered exploratory analyses

Using the measurements of expected cooperation from the

immediate partner and reputational concern, we aimed to elucidate psychological mechanisms underlying the results of the hypothesis testing. More specifically, following Romano, Balliet, & Wu, 2017, we built a moderated mediation model in which three psychological factors (reputational concern from an immediate partner, reputational concern from a future interaction partner, and expected cooperation from an immediate partner) mediate the relationship between the knowledge manipulation (common knowledge = 1: unilateral knowledge = −1) and cooperation. In addition, the group manipulation (in-group = 1: out-group = −1) moderates the paths between the knowledge manipulation and the mediators. See Fig. 4 for the visual representation. We fitted the model separately to each knowledge transfer condition and aimed to disentangle psychological processes behind intergroup cooperation. We bootstrap-tested the moderated mediation paths (5000 bootstrap samples).

In the knowledge no-transfer condition (i.e., no explicit cues of reputational consequences), there was only one significant mediation path: the knowledge manipulation led to an increased level of cooperation via expected cooperation when an immediate partner is an in-group member, B = 7.04, 95% CI [0.77, 13.57], p = .03. This is in line with the bounded indirect reciprocity perspective proposed by Yamagishi et al. (1999) in that the common knowledge treatment leads to in-group favoritism via increased expected cooperation from an in-group partner, which stems from the belief that indirect reciprocity is bounded by group membership. On the other hand, Mifune and colleagues (Kajiwara et al., 2022; Mifune et al., 2010; Mifune & Yamagishi, 2015; Yamagishi & Mifune, 2008) suggested that the common knowledge treatment shapes in-group favoritism via increased reputational concern. Given the absence of the significant moderated indirect effect of reputational concern in the model, our data overall suggest that the common knowledge treatment increases in-group cooperation via increased expected cooperation rather than reputational concern.

Next, we tested the moderated mediation model for those in the knowledge transfer condition. There was only one significant mediation effect; we found that expected cooperation mediated the relationship between knowledge manipulation and cooperation, B = 4.12, 95% CI [0.57, 7.71], p = .02. Yet, this path was not moderated by group membership. This suggests that when there is an explicit cue of reputational consequences, the knowledge manipulation increased cooperation via expected cooperation regardless of the group membership of the immediate interaction partner. This is consistent with the unbounded indirect reciprocity perspective. Romano, Balliet, and Wu (2017) tested a similar moderated mediation model in which there was only one mediation path via reputational concern,[6] and they found that their reputation manipulation (gossip) increased cooperation via reputational concern both for in-group and out-group immediate interaction partners. In our model, we added expected cooperation, and our result suggests that the proximal and psychological underpinning of the unbounded indirect reciprocity perspective may be expected cooperation rather than reputational concern.

Given that the main effect of knowledge manipulation was only marginally significant, we also fitted the moderated mediation model in which the path between knowledge manipulation and cooperation was removed. Yet, it did not change the results in any meaningful ways. See online supplementary results for more details of the reported moderated mediation analyses. Overall, while our preregistered analyses on cooperative behavior did not yield strong evidence of the dynamic indirect reciprocity perspective, our exploratory analyses on the indirect effects on cooperation offer support for the dynamic indirect reciprocity

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[6] They tested the model in three studies. In one of the studies, participants played a dictator game in which expected cooperation is structurally excluded. In the other two studies, participants played a prisoners' dilemma game but Romano, Balliet, and Wu (2017) did not test the moderated mediation path via expected cooperation.
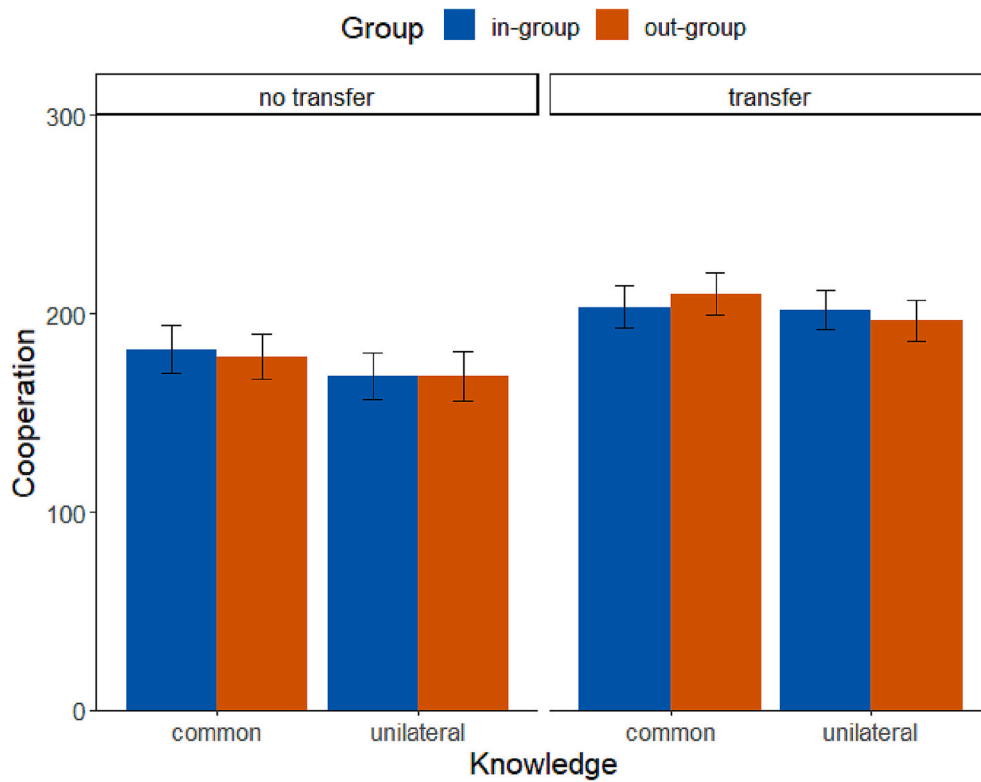
Fig. 3. Cooperation by Condition.
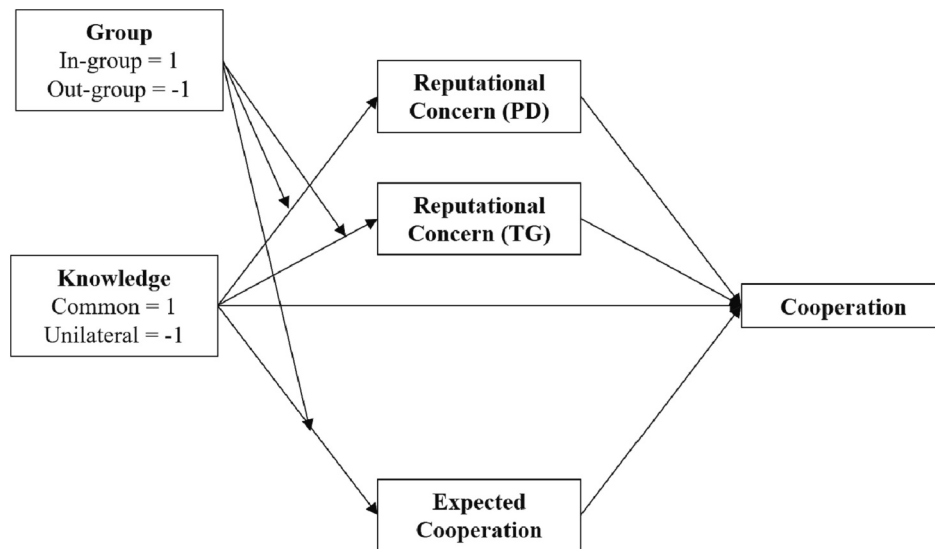Note: error bars represent standard errors.

Fig. 4. The Moderated Mediation Model.

perspective.

7. General discussion

According to the proposed dynamic indirect reciprocity perspective, the realm of indirect reciprocity depends on the presence of cues of reputational consequences. More specifically, we predicted that without such cues, indirect reciprocity is perceived to be bounded by group membership, and, thus, the common knowledge treatment increases in-group cooperation, but not out-group cooperation, as compared to the unilateral knowledge condition. While we did not find support for our

preregistered predictions derived from the dynamic indirect reciprocity perspective, we find supporting evidence from the exploratory analyses via indirect effects; when we took into account the psychological mechanisms underlying intergroup cooperation in the exploratory analyses, we found that the role of expected cooperation in shaping intergroup cooperation depended on the presence of the cue of reputational consequences. We summarize the predictions and empirical support obtained in the main study in Table 1.

Based on the dynamic indirect reciprocity perspective, we expected to find supporting evidence for BGR when there was no explicit cue of reputational consequences. While we found support in the pilot study,

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Table 1
Summary of Predictions from the Three Perspectives.

Perspective	Prediction	PR	Support
BGR	The CKM increases in-group cooperation, but not out-group cooperation	*	
	The CKM increases in-group cooperation via expected cooperation	*	
	The CKM increases in-group cooperation via reputational concern	*	
UIR	The CKM increases both in-group and out-group cooperation	*	
	The CKM increases in-group and out-group cooperation via expected cooperation		
	The CKM increases in-group and out-group cooperation via reputational concern	*	
DIR	The CKM increases in-group cooperation but not out-group cooperation in the no knowledge transfer condition	✓	
	The CKM increases both in-group and out-group cooperation in the knowledge transfer condition	✓	
	The CKM increases in-group cooperation via reputational concern in the no knowledge transfer condition		✓
	The CKM increases in-group and out-group cooperation via reputational concern in the knowledge transfer condition		✓

Note: CKM: common knowledge manipulation; PR: preregistration. * in the PR column indicats that the predictions were not preregistered-tested but were stated in our Stage 1 manuscript (in the introduction) prior to the data collection. We did not preregister-tested the predictions by BGR and UIR as our main goal was to test the dynamic indirect reciprocity perspective (i.e., the presence of cues of reputational consequences as a bondary condition).

we failed to do so in the main study. That is, we did not find that the knowledge manipulation increased in-group cooperation, but not out-group cooperation, in the no knowledge transfer condition. Given that the effect sizes in the main study were small, it may be due to statistical power, but we would like to discuss another explanation; we suspect that the mere presence of another one-shot game may explain why the bounded indirect reciprocity perspective was not supported in the main study. In our main study, the participants played two games. Yet, we would like to note that those in the two-step no knowledge transfer condition (i.e., when there was no explicit cue of reputational consequences) were explicitly told that two games (the PDG and the TG) were completely separated in that their decision in the PDG was completely hidden from their new partner in the TG.[7] Contrastingly, previous studies in favor of BGR, including our pilot study, mostly employed one-shot games (e.g., Mifune et al., 2010; Yamagishi et al., 1999; Yamagishi & Mifune, 2008). Yamagishi and colleagues argued that the expectation of bounded indirect reciprocity is an implicit strategy and other situational factors (e.g., cues of direct exchange; Yamagishi & Kiyonari, 2000) can override the expectation. Our results suggest that despite the fact that participants were aware of the independence of the two games, the mere presence of the second game may work against the influence of the expected bounded indirect reciprocity in the PDG, in a similar way cues of direct exchange did in Yamagishi and Kiyonari (2000).

If the mere awareness of future interactions that are completely independent of an immediate interaction can override the expectation of bounded indirect reciprocity, the role of BGR as a default strategy may be much more limited than previously expected. To put it the other way around, in line with a dynamic indirect reciprocity perspective, people may be much more flexible in utilizing different cues available in a given situation. BGR as a default strategy offers an explanation for in-group cooperation and in-group favoritism when group membership is the only information available, but group membership may become just one of the cues on which people can base their judgments (Pisor & Ross, 2022). Such flexibility in weighing the role of group membership may have helped individuals in the late Middle Pleistocene initiate intergroup trade (Glowacki, 2022; Pisor & Ross, 2022; Pisor & Surbeck, 2019); when people started perceiving the benefits of intergroup exchange, they may get rid of the expectation of the bounded indirect reciprocity but expected that out-group members would be willing to cooperate with them (see Gross et al., 2023).

Based on the dynamic indirect reciprocity, we expected to find support for UIR when people perceive cues of reputational consequences. However, we did not find robust experimental evidence that the common knowledge treatment (vs. the unilateral knowledge treatment) increased cooperation with in-group and out-group members. Yet, we would like to note that the common knowledge treatment slightly increased out-group cooperation in the knowledge transfer condition and this is partly consistent with UIR. In addition, we unexpectedly found partial support for UIR over the dynamic indirect reciprocity perspective. That is, we observed a trend that the common knowledge manipulation increased cooperation regardless of the group membership of the immediate partner as well as the game structure. We would like to note that the dynamic indirect reciprocity perspective is not in conflict with the claim by the proponent of UIR that people utilize diverse ecological cues of future indirect benefit. Unlike studies conducted by Romano, Balliet, and Wu (2017), our studies orthogonally manipulated reputational concern (with knowledge manipulation) and the presence of reputational consequences (with game structure manipulation). While knowledge manipulation did not influence cooperation in our main study, we did show that the game structure manipulations (two-step vs. one-step in the pilot study and knowledge transfer vs. no knowledge transfer in the main study) promoted cooperation.[8] Thus, our results can be treated as suggesting that people overall based their cooperation on the presence of future indirect benefits, which is consistent with the UIR perspective.

As discussed above, our preregistered analyses on cooperation behavior did not offer support for the dynamic indirect reciprocity. However, our exploratory analyses on psychological underpinnings offered partial evidence of the perspective and provided valuable insights into understanding proximal mechanisms of intergroup cooperation. BGR and UIR are both based on indirect reciprocity and the sensitivity to reputation cues is hypothesized to be an adaptation to indirect reciprocity. Yet, unlike UIR, BGR predicts that people have acquired the heuristic expectation of bounded generalized reciprocity, given that day-to-day interactions occurred mostly between group members in the ancestral past. Based on this functional explanation of reputation-based cooperation, previous studies identified two psychological causes: expected cooperation from an immediate partner (e.g., Yamagishi et al., 1999) and reputational concern (Mifune et al., 2010; Romano, Balliet, & Wu, 2017; Yamagishi & Mifune, 2008). In unidirectional games such as a dictator game, previous studies demonstrated that reputational concern can be a proximal explanation for both BGR (Mifune et al., 2010; Yamagishi & Mifune, 2008) and UIR (Romano, Balliet, & Wu, 2017). Nevertheless, the role of expected cooperation and reputational concern have been studied separately in a majority of previous studies, and it remained unclear how these together contribute to shaping intergroup cooperation.

Our moderated mediation models directly tested the issue and our results suggested that it is expected cooperation rather than reputational concern that influenced cooperation through the knowledge

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[7] We made it clear to participants in the knowledge no transfer condition that they would complete two completely different one-shot games. In addition, we had comprehension check questions explicitly asking participants whether their partners in the two games were identical and whether their decision in the PD would be known to a new partner in the TG.

[8] While not reported on the paper, we report in the online supplementary result that the three way ANOVA on cooperation did yield a significant main effect of game structure.

manipulation. Moreover, in line with our dynamic indirect reciprocity perspective, we found that the indirect effect of knowledge manipulation on cooperation via expected cooperation depends on the presence of cues of reputational consequences; when present, the effect holds regardless of the group membership of the immediate interaction partner. When absent, the effect holds only when interacting with the in-group immediate interaction partner. Therefore, our main study extended BGR and UIR and unified them with the dynamic indirect reciprocity, by elucidating the psychological mechanisms (reputation vs. expected cooperation).

We would like to reiterate, however, that our manipulations in the main study had much weaker effects on cooperation than those in the pilot and previous studies. Future research is needed to understand whether this was due to the nature of the design (between vs within subjects), the limited sample size, the nationality of the sample (UK), or the specific type of interdependent situation participants were in (online vs lab).

To conclude, we proposed and tested the dynamic indirect reciprocity perspective, which helps us better understand how the realm of indirect reciprocity is perceived and guides cooperation in intergroup contexts. Overall, we found partial support for the perspective and revealed that whether or not the influence of reputation manipulation is conditional to group membership depends on the presence of cues of reputational consequences. In intergroup contexts, individuals attend to a range of contextual cues (i.e., group membership, reputational concern, and reputational consequences), and our research calls for further investigation into how exactly people weigh different cues and make cooperative decisions.

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Conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Open practices

Preregistration, data, analysis codes, and study material for the pilot study are fully available at https://osf.io/ukrax/. All materials associated with the main study will be made to be available at https://osf.io/89c2e/. We also have an OSF project page that has all the materials associated with paper: https://osf.io/4nuwk/.

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