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Boundaries of reciprocity: Incompleteness of information undermines cooperation ☆

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ABSTRACT

Past research has revealed that people have a strong tendency to respond to others' cooperative behavior with cooperation and to others' noncooperative behavior with noncooperation. Yet it is unclear whether or not this tendency still holds when people have only incomplete information about their interaction partner's past behavior. To address this question, we designed a new paradigm – a coin allocation paradigm – in which participants were provided with incomplete information about another person's degree of cooperative behavior (i.e., coin allocations to the participant). Consistent with our hypotheses, two experiments revealed that incompleteness of information undermines both expectations about another person's cooperation as well as one's own cooperation. Moreover, complementary analyses indicated that the detrimental effects of incompleteness of information on cooperation were mediated by expectations of other's cooperation. We suggest that a relatively strong belief in self-interest serves to fill in the blanks when information is incomplete, which undermines expectations of other's cooperation as well as one's own cooperative behavior.

1. Introduction

What would you do when your colleague asks you to read her manuscript before submission? Would you *cooperate* and spend a fair amount of your free time to help her out? Or would you *not cooperate* and spend your spare hours with your favorite hobby instead? In everyday life, we encounter many situations in which we must make a choice that either benefits the self alone (i.e., noncooperation), or that benefits another person at some cost to the self (i.e., cooperation). What should one do in such situations to promote cooperation in one another, so that they both benefit? The basic lesson that the vast literature teaches us is quite simple: Start with making a cooperative choice, and then cooperate if the interaction partner cooperated in the previous interaction, and do not cooperate if the partner did not cooperate in the previous interaction. This strategy is called *Tit-For-Tat*, and computer simulations have shown that with this strategy, cooperation can emerge and sustain even among selfish agents (e.g., Axelrod, 1984; Gouldner, 1960; Trivers, 1971). Experimental findings with participants yield similar findings, and also show that most people adopt a version of Tit-For-Tat in their interactions (Klapwijk & Van Lange, 2009; Komorita & Parks, 1995; Van Lange, 1999).

Previous conclusions that cooperation elicits cooperation and that noncooperation elicits noncooperation are based on the assumption that people have complete information about their partner's past cooperation. In most programs of research – following the tradition in game theory – participants have complete information about the outcomes associated with different choice options.[1] In repeated interactions, participants often also have exact information about the partner's past choices (e.g., cooperation or noncooperation in the prisoner's dilemma). By contrast, the choice options and actual behaviors are far less clear cut in many real life situations: A colleague may or may not comment your manuscript, but she may also choose between spending hours for giving detailed comments, or just

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[1] In game theory, information is complete when participants have complete information about the precise consequences of own and other's choices, as well as their combinations, for one's own and the other's outcomes (e.g., Fudenberg & Tirole, 1991). Completeness versus incompleteness of information has received some theoretical and empirical attention in past research on negotiations (e.g., Hart & Moore, 1988), public good games (e.g., Marks & Croson, 1999), and asymmetric dyadic games such as the ultimatum game (e.g., Mitzkewitz & Nagel, 1993). However, there is little prior research on the question whether and how incompleteness of information might affect cooperation in repeated interactions with symmetric interdependence (i.e., equal power)—interactions in which people typically use Tit-For-Tat (for exceptions, see Camac, 1992; see also Interdependence Theory, Kelley et al., 2003).

correct a few typos in the introduction. And when the colleague asks a favor in the future, it is difficult to choose the level of cooperation that matches the colleague's past cooperation.

This example illustrates a very common situation in everyday life: information regarding the interaction partner's cooperation is incomplete and therefore subjected to interpretations. Because people need to ask themselves a question how much their interaction partner cooperated, incomplete information situations, compared to complete information situations, leave much more room for "psychology" in interpreting missing information, developing and updating beliefs, and forming impressions.

In the present work, we posit that cooperation in incomplete information situations is shaped by inferences about the partner's cooperation, and that such inferences tend to be driven by the assumption of other people's self-interest. Research on the "norm of self-interest" reveals that global judgments about unknown others are guided by a belief in self-interest (see Miller & Ratner, 1996, 1998). For instance, people overestimate the impact of financial rewards on their peers' willingness to donate blood. People also attribute responsibility in a self-serving way. For example, people think that their spouses are more responsible for negative than for positive events in their relationships, whereas people think of themselves being responsible for both positive and negative events (Kruger & Gilovich, 1999).

Further evidence shows that these cynical theories about other people are more pronounced and lead to more selfish behavior when people are encouraged to think more about others' thoughts (e.g., Epley, Caruso, & Bazerman, 2006; Vorauer & Sasaki, 2009). Also, research on interpersonal biases reveals the overestimation of others' self-interest is not only limited to specific interferences: There is a stable trait bias in that people think of others as more selfish and less fair than they think of themselves (Allison, Messick, & Goethals, 1989; Van Lange & Sedikides, 1998). And there is research revealing that people in general and self-oriented people in particular tend to overestimate the proportion of self-oriented individuals in the population (Iedema & Poppe, 1995). Thus, this finding too suggests that people overall tend to overestimate selfish, noncooperative motives in others.

1.1. The coin paradigm and hypotheses

In the present research, we examined whether incompleteness of information influences estimates about other's cooperation and own cooperation in a resource allocation task. Because people can no longer rely on what the other did, we expected that people use their global beliefs in other people's self-interest in general when making attributions about their behavior. Thus, we predicted that incompleteness of information leads people to underestimate others' cooperation. Further, we predicted that incompleteness of information undermines people's own cooperative behavior. And finally, we explored whether the predicted decline in estimated cooperation from the other through incompleteness of information mediates the predicted decline in own cooperative behavior. Such evidence would suggest that under incompleteness of information, people cooperate less than the partner because they tend to underestimate the partner's cooperation.

Our hypotheses were tested in a newly designed research paradigm referred to as the *coin paradigm*, which is a dyadic allocation task in which the participant and another person take turns in allocating resources between the two. Compared to classical paradigms used widely in behavioral economics and psychology, and their modern counterparts that capture some imperfections associated with real-life interactions such as noise (e.g., Klapwijk & Van Lange, 2009), the novel aspect of our paradigm is that each round participants are only provided with incomplete information about their interaction partner's allocation. That is, they are provided with 1, 2, 4, or 8 of a total of 16 pieces of information, each of which displays whether or not the other gave them a coin (cooperation) or kept it for himself or herself (noncooperation). Under those four conditions, we assessed participants' inferences regarding the total number of cooperative behaviors (i.e., inferred cooperation) and the number of coins the participant was willing to give to the other person (i.e., own cooperation). We predicted that with more incompleteness of information, participants would infer lower levels of cooperation from the other, and exhibit lower levels of cooperation.

2. Experiment 1

2.1. Method

2.1.1. Participants and design

The participants were 65 Dutch university students (53 women, 12 men) with an average age of 21.2 years ($SD = 2.56$). The computerized, laboratory experiment was a 4 (level of information provided) by 4 (blocks of trials) design with the latter variable being a within-participants variable. After completing the experiment, the participants were debriefed and paid 2.5 EUR.

2.1.2. Procedure

The coin paradigm is an interaction-based, turn-taking task between the participant and another person, who is described as another participant, but whose behavior is in fact controlled by a computer. In the present experiment, the task consisted of 4 rounds of allocations of coins. In each round, first the other and then the participant allocated 16 coins between the two. Participants were informed that coins have value: "the more coins you accumulate the better for you; the more coins the other accumulates the better for him or her."[2] Participants were first told that the other had allocated 16 coins between himself or herself and the participant, but the division of coins would not be displayed. Instead, participants were presented with 16 blank coins and they could click any coin they wanted, as illustrated in Fig. 1. After a click the text "Your Coin" or "The Other's Coin" appeared on the coin, indicating that the other had allocated that coin either to himself or herself or to the participant. The number of coins participants were able to click was 1, 2, 4, and 8, a variable that was manipulated between-participants. In the latter three conditions, equal number of coins was allocated to the other and the participant (a 50/50 split). In the condition where only one coin was clicked, its allocation was randomized for the first trial and alternated in subsequent trials. Thus, participants were presented with partial information that suggested fair allocations from the other. After participants had clicked the coins, as dependent variables, they estimated the total number of coins (out of 16) the other had allocated to the participant, and finally, allocated 16 coins in total to the other and themselves. After the participant's allocation, Round 2 started uninterruptedly with the other who, in turn, allocated 16 coins.

2.2. Results

Based on four trials we calculated the mean estimated number of coins the other allocated to the participant and the mean number of coins participants actually allocated to the other, and predicted them

[2] The interdependence structure of Experiment 1 can be best described as a sequential dictator game, in which the participant and the other alternate as dictators. The interdependence structure is borrowed from the dictator game, in that all coins (i.e., regardless of who allocates them) are equally valuable to the participant and the other. The key difference between the single-shot dictator game (e.g., Bolton, Katok, & Zwick, 1998) and the sequential game used here is that the sequential nature of the game provides opportunities for punishment and reward. Therefore, behavior is importantly shaped by the other's behavior in previous trials and the expected behavior in future trials, potentially increasing the base-rate cooperation compared to the single-shot game. Allocations that match the other's allocation would indicate that participants adhere to equality or mutual exchange of payoffs (i.e., Tit-For-Tat, see Experiment 2). Because fewer allocations than the other's allocation provide higher outcomes to the participant, this "less-than-matching" behavior would indicate that the equality principle is coupled with self-interest. Alternatively, in the case of incomplete information, less-than-matching behavior can also be caused solely by underestimation of the other's cooperation. Across both studies, we will present mediational evidence and discuss these two possible mechanisms.

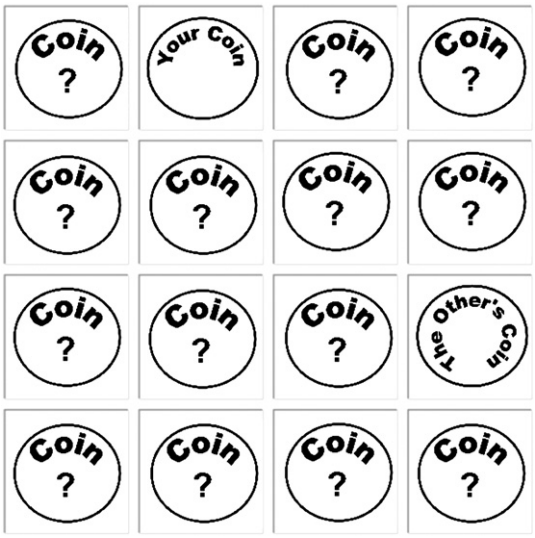

Fig. 1. Display of the other's allocation after the participant has seen two coins. In this situation, the other has allocated at least one coin to the participant and one coin to himself or herself. A JavaScript demonstration of the coin paradigm in Experiment 2 can be found from: http://webresearch.psy.vu.nl/coindemo/coinparadigm.htm.

with information availability, where 1, 2, 4 and 8 coin conditions were coded as −1, −1/3, +1/3, and +1, respectively. As predicted, a linear regression analysis revealed that with more incompleteness of information participants inferred lower levels of cooperation from the other, $B = 0.73$, $t(64) = 2.97$, $p = .004$, $\eta^2 = .12$. Indeed, the estimated numbers of coins the other allocated to the participant was the lowest in the 1 coin condition ($M = 5.87$, $SD = 2.23$), followed by the 2 coin condition ($M = 6.61$, $SD = 1.35$) and the 4 coin condition ($M = 6.84$, $SD = 1.21$), and finally, the highest in the 8 coin condition ($M = 7.41$, $SD = 0.81$). As predicted, another linear regression analysis revealed that with more incompleteness of information participants also exhibited lower levels of cooperation, $B = 1.07$, $t(64) = 3.24$, $p = .002$, $\eta^2 = .14$. The numbers of coins participants allocated to the other was the lowest in the 1 coin condition ($M = 5.13$, $SD = 1.94$), followed by the 2 coin condition ($M = 5.55$, $SD = 2.60$) and the 4 coin condition ($M = 6.73$, $SD = 1.78$), and finally, the highest in the 8 coin condition ($M = 7.13$, $SD = 1.65$). The means for estimated and actual cooperation across four experimental conditions are presented in Fig. 2.

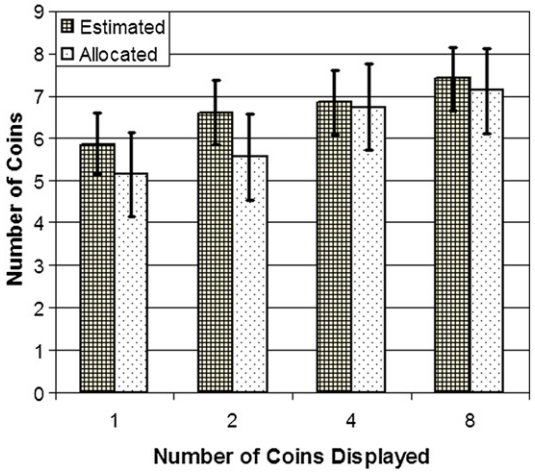

Fig. 2. The estimated number of coins (out of 16) the other allocated to the participant (left bars) and the number of coins (out of 16) participants allocated to the other (right bars) as a function of information availability in Experiment 1. Information availability refers to the experimental manipulation where 1, 2, 4, or 8 coins of the other's allocation were made visible to participants.

To test mediation we added coin estimations as a predictor for cooperation. As expected in the meditational analysis, the effect of the information manipulation on cooperation became weaker, $B = .56$, $t(64) = 1.77$, $p = .081$, and cooperation was strongly associated with coin estimations $B = .75$, $t(64) = 5.29$, $p < .001$. The Sobel test revealed the effect of information availability on cooperation was indeed mediated by coin estimations, $Z = 2.59$, $p = .010$ (two-tailed).

To conclude, consistent with our hypothesis, the findings of Experiment 1 revealed that incomplete information undermines inferred and actual cooperation, and that estimations regarding the other's cooperation mediate the detrimental effects of incomplete information on cooperation. This suggests that under incompleteness of information, people do not cooperate to the same extent that the other person actually did, but more to the extent that they *think* the other person did cooperate.

3. Experiment 2

Experiment 1 provided good support for the hypothesis that incompleteness of information undermines estimations regarding the other's cooperation, as well as one's own cooperation. These findings were observed in an exchange game that represents a conflict between self-interest and fairness. In this game, perfect equality in outcomes can only be maintained by allocating the same number of coins than the partner did in the previous round. At the same time, a person only interested in self-interest does not have any incentive to allocate any coins to the partner, because there is no direct or indirect benefit of cooperation.

In Experiment 2, we changed the outcome structure of the game in that the allocated coins were twice as valuable for the interaction partner as the self (for a similar outcome structure, see past research on the give-some dilemma, Van Lange, Ouwerkerk, & Tazelaar, 2002). This structure is identical to the Prisoner's Dilemma, in that it represents a conflict between individual rationality (outcomes for self are less good when one gives away more coins) and collective rationality (outcomes for self and the other are greater to the extent that both exchange a greater number of coins).

In Experiment 1 the interaction partner was programmed to pursue equality in an unconditional manner—independent of the participant's own behavior. While such a partner provides a good baseline against which to assess bias in estimated allocations, one might indeed argue that it is somewhat questionable whether many people would always pursue equality. Experiment 2 addressed this limitation by examining interactions with a partner who was programmed to pursue Tit-For-Tat, a strategy that makes exactly the same choice than the participant did in the previous trial (e.g., Axelrod, 1984; Kollock, 1993; Nowak & Sigmund, 1992; Van Lange et al., 2002). Prior research has shown that many people use a variant of Tit-For-Tat in their interactions in social dilemmas and related exchange situations (typically, at least 60% of the participants tend to follow Tit-For-Tat; see Klapwijk & Van Lange, 2009; Van Lange, 1999). This is one of the reasons why Tit-For-Tat is often used as a baseline or standard for conceptualizing differences from Tit-For-Tat (forgiving versus retaliatory versions of Tit-For-Tat , with Tit-For-Tat the "average" strategy; see Axelrod, 1984; Parks & Rumble, 2001) or for using it as the default strategy to resemble a realistic strategy (e.g., Parks, Sanna, & Berel, 2001).

There are two further reasons for examining a Tit-For-Tat partner. First, numerous studies have revealed support for the effectiveness of Tit-For-Tat to promote cooperation in social dilemmas. However, as far as we know, little effort has been devoted to examining the effectiveness of Tit-For-Tat under conditions of incompleteness of information. Second, with the exception of the first choice, Tit-For-Tat can be considered as providing a mirror image of the participant—and so, people are making inferences about another person who is not only very realistic but also quite similar to the self. This is also

interesting because Experiment 2 examined judgments of the other person's intentions. Given that people attribute too much self-interest to the other's behavior under incompleteness of information, participants should form less benign impressions of the other in the low information condition than in the high information condition.

3.0.1. Participants and design

The participants were 177 Americans (118 women, 59 men) with an average age of 33.8 years ($SD = 11.56$). The computerized, on-line experiment was a 2 (information provided: 2 or 8 coins) by 8 (blocks of trials) design with the latter being a within-participants variable. The experiment was conducted on Amazon Mechanical Turk, which is marketplace where workers can sign-up for on-line tasks for money. After completing the 4-minute experiment, the participants were debriefed and paid 30 cents.

3.0.2. Procedure

The coin task in Experiment 2 differed from the one in Experiment 1 in two major respects. Most importantly, we implemented benefit for mutual exchange by noting that the coins the participant allocated were worth of 2 points for the other but only 1 point for the participant. Likewise, the coins the other allocated were worth of 2 points for the participant but only 1 point for the partner. When coins were presented graphically on the screen, the values of different coins were displayed. The second difference was that the partner followed Tit-For-Tat strategy (rather than fairness). The interaction started with the other's fair allocation (50–50), and in subsequent trials the other's allocation was the same as the participant's previous allocation. When the participants were displayed a part of the other's allocation, they were presented with a random sample of the entire allocation. For example, if the other had allocated 8 coins to the participant in the 2 coin condition, they were most likely to see a 1–1 split of coins (i.e., 53.3%), but they could also see 0 or 2 of their coins, according to the binomial probability distribution (i.e., 23.3% for each).

Several minor modifications were made to the coin task in Experiment 2. First, it consisted of eight trials rather than four trials. Second, instead of letting participants click the coins they would like to see, the computer randomly displayed 2 or 8 coins of the other's allocation. Third, participants were displayed which coins the other would see of the participant's allocation. These coins were randomly selected from the participant's overall allocation of 16 coins.

After the coin task, we assessed participants' general impressions of benign intent of the other (Van Lange et al., 2002). Positive items were "The other was generous, nice, forgiving, kind, and trustworthy," and negative items were "The other was self-centered, greedy, competitive, stingy, vengeful, and selfish" (Cronbach's $\alpha = .83$). Participants indicated how much they agreed or disagreed with these statements on a scale ranging from 1 (*completely disagree*) to 7 (*completely agree*).

3.1. Results and discussion

3.1.1. Estimation and cooperation

Based on eight trials we calculated the mean estimated number of coins the other allocated to the participant and the mean number of coins participants actually allocated to the other, and predicted them with information availability, where low (=2 coins) and high (=8 coins) information conditions were coded as −1 and +1, respectively. As predicted, a linear regression analysis revealed that participants in the low information condition inferred lower levels of cooperation from the other ($M = 5.79$, $SD = 3.62$) than participants in the high information condition ($M = 8.24$, $SD = 3.33$), $B = 1.23$, $t(175) = 4.68$, $p < .001$, $\eta^2 = .11$. As predicted, another linear regression analysis revealed that participants in the low information condition exhibited lower levels of cooperation ($M = 6.96$, $SD = 3.69$) than participants in the high information condition ($M = 9.23$, $SD = 3.67$), $B = 1.13$, $t(175) = 4.08$, $p < .001$, $\eta^2 = .09$.

Next, we analyzed the change in coin estimations and allocations across trials. For that analysis, we first computed the linear least squares fit across 8 trials and for each participant separately (i.e., the mean change in estimations and allocations from Trial 1 to Trial 8). A linear regression analysis revealed that the estimated cooperation changed differently across trials in the low and high information conditions. Participants in the high information condition increased their estimated cooperation ($M = 1.55$, $SD = 4.07$) more than participants in the low information condition ($M = 0.04$, $SD = 5.18$), $B = 0.756$, $t(175) = 2.14$, $p = .034$. Another linear regression analysis revealed the same pattern for cooperation: Participants in the high information condition increased their cooperation ($M = 1.48$, $SD = 3.85$) more than participants in the low information condition ($M = 0.02$, $SD = 4.61$), $B = 0.732$, $t(175) = 2.27$, $p = .024$. This pattern presented in Fig. 3 indicates that the effect of incompleteness of information is more pronounced in later rounds of interaction, supporting the idea that Tit-For-Tat is an efficient strategy for eliciting and maintaining cooperation over repeated interactions under high rather than low information conditions.

To test mediation we added coin estimations as a predictor for cooperation. The effect of the information manipulation on cooperation became nonsignificant, $B = -0.03$, $t(175) = -0.28$, $p = .789$, and cooperation was strongly associated with coin estimations $B = 0.94$, $t(175) = 28.80$, $p < .001$. The Sobel test revealed the effect of information availability on cooperation was indeed mediated by coin estimations, $Z = 4.62$, $p < .001$ (two-tailed).

3.1.2. Benign intentions

Using the same model than in previous analyses, a linear regression analysis revealed that with more incompleteness of information participants formed less benign impressions on the other, $B = 0.52$, $t(175) = 5.46$, $p < .001$, $\eta^2 = .15$. This result indeed supports our hypothesis that participants would form less benign impressions of the other in the low information condition ($M = 3.75$, $SD = 1.33$), than in the high information condition ($M = 4.80$, $SD = 1.21$).

To conclude, consistent with our hypothesis, Experiment 2 revealed that incomplete information undermines inferred and actual cooperation, and that estimations regarding the other's cooperation mediate the detrimental effects of incomplete information on cooperation. What is remarkable in Experiment 2 is that this pattern generalizes to the coin paradigm in which the game theoretical structure is similar to the well-known prisoner's dilemma. Yet cooperation does not occur – to a large extent – when people have only a limited

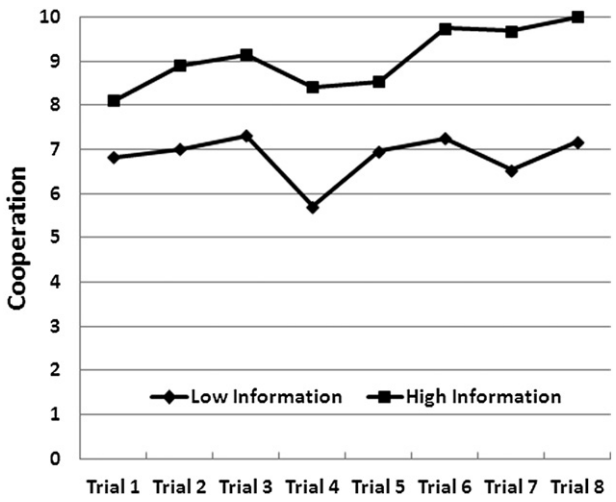

Fig. 3. Cooperation as a function of trials in the low information and in the high information conditions, in Experiment 2.

amount of information about the partner's behavior. The second important extension is that the findings observed in Experiment 1 were replicated in a situation in which the partner pursued Tit-For-Tat. Unlike the fairness strategy examined in Experiment 1, Tit-For-Tat strategy cooperates at the same level than the participant does, and still participants cooperate less in the low information condition.

Our explanation for this finding is that even Tit-For-Tat suffers from incomplete information because information about the other's cooperation is ambiguous. When people interact with a Tit-For-Tat other in complete information situations, they receive, by definition, clear information whether the other was equally cooperative or not. By contrast, when incomplete information is present, information about the other's cooperation is less clear, and the missing information may be subject to interpretations that are rooted in participants' (implicit) theories—such as the assumption of other people's self-interest. Finally, the findings also indicate that information availability may have consequences that go beyond a specific interaction. That is, people who had less information about the other's behavior developed less benign impression about that person, and that may potentially influence cooperation in future interactions.

4. General discussion

In the present research we examined the way in which incompleteness of information about the other's previous behavior influence estimated and actual cooperation in dyadic interactions. Using a new research paradigm – *the coin paradigm* – the results revealed that incompleteness of information leads to reduced estimations regarding the other's cooperation as well as lower level of own cooperation. These detrimental effects of incomplete information were found when the partner was programmed to behave in a fair manner (Experiment 1), and when the other followed Tit-For-Tat strategy (Experiment 2). The effects were found in an exchange game in which the allocated outcomes were equally valuable for both (Experiment 1), and in a prisoner's dilemma type of a game in which the allocated resources were more valuable for the partner than the self (Experiment 2).

Previous research has concluded that the prisoner's dilemma elicits a high degree of cooperation when both pursue Tit-For-Tat, yet this conclusion is valid only as long as interaction partners have enough information about each other's behaviors. Complementary analyses revealed an explanation for the finding that incomplete information reduces cooperation: the participant's actual cooperation was mediated by the other's estimated cooperation, indicating that under incomplete information, people do not allocate the number of coins they have received (simply because they do not have that information), but the number of coins they *believe* they have received (i.e., perceived cooperation). The implication of this mediation model that was supported in both experiments is that under incompleteness of information, responding *in kind* becomes responding *in mind*.

Our findings are consistent with research showing that global judgments about unknown others are guided by a belief in self-interest (see Miller & Ratner, 1996, 1998), and that people view others as more selfish than they view themselves (Allison et al., 1989; Van Lange & Sedikides, 1998). Our work extends these literatures in that the belief in others' self-interest guides not only *global* judgments about other people's dispositions, traits, and imagined behavior (for the above-average effects in general, see Alicke, Dunning, & Kruger, 2005; Kruger & Dunning, 1999), but it also distorts *specific* judgments about overt, proximal behavior.

Most importantly, a novel aspect of the present work is that the overestimation of others' self-interest has strong implications on cooperative behavior: under higher levels of incompleteness of information, people are likely to behave less cooperatively than the other did, thereby systematically deviating from matching cooperation in a self-protective or self-enhancing manner. This finding extends previous literature on reciprocity—the idea that people would respond to helpful and harmful acts in kind (e.g., Axelrod, 1984; Gouldner, 1960; Komorita & Parks, 1995; Trivers, 1971). The existing literature shows that reciprocity is a key determinant of behavior in social dilemmas and related monetary exchange situations (see Kollock, 1993; Nowak & Sigmund, 1992, 2005; Van Lange et al., 2002). However, the present work shows that when incompleteness of information is present, people tend to cooperate a bit less than the rule of reciprocity would dictate. This implies that in many real life situations that are covered by incompleteness of information by nature, such as returning favors for other types of favors, people fail to adhere to the rule of reciprocity. As a result, they perform a favor that may be a bit less other-regarding than the favor they received themselves in the past. Hence, incompleteness of information calls for greater latitude in interpreting one another's behavior, and it is likely, so we argue, that the global belief that people are self-interested is used as a theory for interpreting other's behavior. One interesting implication may be that because there is more incompleteness of information in exchange situations involving immaterial outcomes (e.g., favors, compliments) than in situation involving material and often quantifiable outcomes (e.g., money), cooperation should more of a challenge in the former rather than latter situations (for similar argument, see Zhang & Epley, 2009).

The findings also indicate that the effects of incomplete information may go beyond a specific interaction. Experiment 2 revealed that participants who had less information developed a less benign impression about their interaction partner (e.g., perceived the partner as less kind, less honest, and more selfish). Thus, incompleteness of information, which is a situational feature, has strong implications how one comes to think about another person's personal qualities—a finding which is consistent with classic insights of various attribution theories (e.g., Jones & Davis, 1965; Nisbett & Ross, 1980). Our finding also adds credence to the possibility that, if dispositional attributions influence cooperation in the future, mere information availability in the initial interaction may have a fairly pervasive influence on mutual cooperation over time.

Given that cooperation and incomplete information have received relatively little attention in the literature, it is important to outline some promising lines for future research. Clearly, one limitation of the current work is that all interactions examined in this paper were interactions with strangers. It is plausible and in fact quite possible that in some other types of interpersonal relationships, such as in ongoing relationships, people do not necessarily assume self-interest from their partner (e.g., in communal relationships, Clark & Mills, 1993; Rusbult & Van Lange, 2003). Instead, people may use specific knowledge about their partner whenever incompleteness of information leaves room for multiple interpretations (e.g., she is such a nice person that she wouldn't do anything harmful to me—even though at first sight it looks like she did). Conversely, people may assume more self-interest from groups, or from representatives of groups, as people think more positively about persons than about groups (e.g., Insko & Schopler, 1998; Sears, 1983). More generally, it would be interesting to examine beliefs as a determinant of behavior in a more systematic way by assessing or manipulating beliefs about the interaction partner, and measuring their influence on cooperation under different levels of incompleteness of information. Due to the dynamic nature of human interactions, it is plausible that relatively small differences in initial beliefs (i.e. giving the benefit of the doubt vs. assuming self-interest) may have quite a pronounced impact on cooperation as it develops over time after a series of repeated interaction.

5. Concluding remarks

We advanced the hypothesis that incompleteness of information undermines cooperation, and suggested that the main reason for this effect gleans from people's underestimations of others' cooperation. Under incompleteness of information, people can cooperate a

little bit less than the other person did in the previous interaction and still believe that they just cooperated as much as the other person did. This pattern forms a serious threat to the development of human cooperation, because through acting upon such self-created beliefs and expectations of self-interest, it is indeed likely to elicit self-interested behavior in others over the long run—indeed, a classic example of a self-fulfilling prophecy (see also Kelley & Stahelski, 1970; Miller, 1999). Therefore, to increase cooperation in interactions in which cooperation may be undermined by general beliefs in other people's self-interest, we need to understand more about how these erroneous beliefs develop and persist, and how they can be corrected. This is all the more important in social interactions in the real world, in which it seems to be the rule, rather than the exception, that we have less than complete information about the actions of others.

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