Chapter 5

When Generosity Is Hard to Communicate: The Asymmetric Role of Incompleteness of Information on Cooperation

In everyday life people face numerous situations in which self-interest and other people’s interests are in conflict. Acts of sharing (e.g., babysitting for a friend instead of going to a favorite football game) and making contributions to the group (e.g., effortful work for a group goal instead of an individual goal) are examples of cooperative behaviors in which people often act against their immediate self-interest. Some researchers have identified possible prosocial motives for cooperation such as altruism (e.g., Batson, 1991; Davis, 1996) and fairness (e.g., Deutsch, 1975; Lind & Tyler, 1988; Fehr & Schmidt, 1999). In contrast, other researchers believe that most or even all cooperative behaviors can be accounted for by self-interest (for discussions, see Batson, 1991; Cialdini & Fultz, 1990; Dovidio, 1984).

Cooperation in social interactions is importantly shaped by the partner’s cooperation. Previous research shows that people exhibit a strong tendency to respond cooperatively to the partner’s cooperation and noncooperatively to the partner’s noncooperation (Axelrod, 1984; Gouldner, 1960; Klock, 1993; Komorita & Parks, 1995; Nowak & Sigmund, 1992, 2005; Trivers, 1971; Van Lange, Ouwerkerk, & Tazelaar, 2002). Such reciprocal cooperation is quite effective for sustaining and promoting cooperation. A case in point is the success of the tit-for-tat strategy, which begins with a cooperative choice and subsequently reciprocates the partner’s cooperative and noncooperative behavior in the next interaction (Axelrod, 1984; see also Komorita & Parks, 1995; Van Lange, 1999; Van Lange et al, 2002). In particular, this reciprocal strategy elicits cooperation with individuals who want to cooperate, but it also protects itself against noncooperative individuals.

The partner’s cooperation is a powerful determinant of cooperation in social interactions, but sometimes people cooperate somewhat more or less than the partner. For example, every now and then people may behave in slightly self-serving ways by giving a little less than what they have received so that they can obtain even greater outcomes for the self. This may, for example, happen if the person does not completely trust the other person (Fetchenhauer & Dunning, 2009, 2010), or when there is a strong desire to ensure better outcomes than the partner (e.g., competitive social value orientation; Messick & McClintock, 1968; Van Lange, 1999). At other times, people may slightly differ from reciprocity in that they give a little bit more than they have received. This may, for example, happen if one seeks to restore mutual trust and

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7 This chapter is based on Vuolevi and Van Lange (2011c)
cooperation after some fairly noncooperative interactions (Desmet, De Cremer, & Van Dijk, 2010). Or a person may act in a generous manner simply because the person thinks this may be wise: If I give even more than the other, I may receive also more the next time (Klapwijk & Van Lange, 2009; Van Lange et al, 2002). People may also be generous for reputational reasons (e.g., Iredale, Van Vugt, & Dunbar, 2008). Of course, there can also be social motives that are activated by the partner (such as generosity that is inspired by liking or empathy; Batson, 1991; Van Lange, 2008).

The major purpose of the present research is to examine cooperation under incompleteness of information. Previous research has concluded that people adjust their cooperation to the partner’s level of cooperation (i.e., they follow tit-for-tat), but this baseline is not explicitly given when people have only incomplete information on their partner’s cooperation. Instead, people must first infer their partner’s cooperation before tit-for-tat or other conditional strategies can be applied. Incompleteness of information can influence social interactions in three distinct ways: First, people may cooperate less if they underestimate their partner’s cooperation. Second, various interpersonal strategies (e.g., generous vs. stingy) might be more difficult to perceive under incompleteness of information, and some of them might be easier to communicate and to get reciprocated than some others. And third, incomplete information may influence the way in which the partner is perceived as a person: People have a tendency to attribute specific behaviors to dispositions (see fundamental attribution error; Ross 1977; correspondence bias; Jones, 1990). Therefore, any errors that people make in perceiving cooperation under incompleteness of information may influence general evaluations of the partner.

In the present research, we advance a model in which cooperation is explained by the partner’s cooperation under different levels of incompleteness of information. In particular, when people have complete information about one another’s behavior, they can develop cooperation through the effective use of tit-for-tat or related mechanism. When information is incomplete, by contrast, the level of cooperation is expected to decline. We advance the argument that this decline in cooperation is based on people’s tendency to overestimate other people’s tendencies to pursue self-interest. We refer to this phenomenon as the incompleteness effect, because erroneous self-interest beliefs are only possible in incomplete information situations that allow multiple interpretations. Also, we expect that incompleteness of information challenges the communication of generous strategies. Given that people apply their self-interest beliefs when they explain others’ behavior, stingy behaviors are more likely to get correctly perceived as such than generous behaviors as such. This is a notable difference to complete information situations in which all kinds of behaviors, ranging from stingy to generous, are always perceived at the right level of cooperation.
An Interdependence Approach to Incompleteness of Information

Our theoretical approach to understanding incompleteness of information is rooted in the principles of interdependence theory (Kelley & Thibaut, 1978; for an overview, see Rusbult & Van Lange, 2003; Van Lange et al., 2007). Originally the theory focused on different types of outcome interdependence (e.g., covariation of interest), but more recently incompleteness of information has been added to interdependence theory as one of its basic structural properties (Kelley et al., 2003; Van Lange & Rusbult, 2011). Here, we make a distinction between three types of information and posit that every interaction can be defined in terms of situational, behavioral, and transformational (or person-specific) information.

Situational information describes the way in which the interaction partners’ possible behaviors influence their own and others’ outcomes. In dyadic interactions, this is often represented as a matrix, where each row represents one behavioral option for one interaction partner, and each column for the other. If situational information is incomplete, some outcome information in the matrix is missing. For example, often people know the outcomes of different behavioral options for the self (e.g., I would prefer an Italian restaurant over a Chinese one) but not necessarily for the partner (e.g., would my partner prefer an Italian or a Chinese restaurant).

Behavioral information refers to the partner’s particular behavior (i.e., one row or column in the matrix) and incompleteness of behavioral information refers to uncertainty about the partner’s exact choice. For example, people may know what the partner could do (i.e., complete situational information), but they do not know for sure which one of these possible behaviors was or will be chosen. Future behaviors are always characterized by incompleteness of behavioral information (e.g., even the most reliable person sometimes misses a meeting because of an unexpected traffic jam), but also past behaviors are not always known with 100% accuracy (e.g., second-hand information or probabilistic information about the partner’s behavior).

A related theoretical account that describes behavioral and situational aspects of interdependence is game theory (Von Neumann & Morgenstern, 1944). Game theory would predict that people choose the behavior that provides the best personal outcomes. Interdependence theory, by contrast, posits that people do not necessarily make their decisions based on the game theoretical matrix alone, but that they transform their motives from immediate self-interest (i.e., the game theoretical, given situation) to broader motives that include, among others, long-term considerations, norms, equality, and reciprocity (for an overview, see Rusbult & Van Lange, 2003). For example, when self-interest and equality are at odds, people tend to choose more cooperative (i.e., fairer) behaviors that the game theoretical model would suggest (e.g., Bolton, Katok, & Zwink, 1998; Fehr & Schmidt, 1999; Deutsch, 1975; Lind & Tyler, 1988).
The fact that people do not necessarily act according to self-interest introduces the third informational aspect to social interactions, which we refer to as **transformational information**. Different individuals exhibit a wide range of behaviors from competition to cooperation (Balliet, Parks, & Joireman, 2009; see also Van Lange, 1999; Van Lange et al, 2007) and therefore people cannot rely on the assumption that their partner’s pursue self-interest. Instead, people must infer their partner’s transformations (e.g., interpersonal strategies) from the interactional context—based on behavior across social situations.

The way in which people infer their partner’s strategies (e.g., stingy or generous variants of tit-for-tat) may have a crucial impact on social interactions. People tend to apply conditional strategies and the extensive use of tit-for-tat demonstrates this principle: People cooperate more with others who they perceive as more cooperative and less with others who they perceive as less cooperative. Thus, people’s own strategy might be influenced by the perception of their partners’ strategy—which may subsequently be influenced by incompleteness of information. Partners’ strategies are more difficult to infer when information about the partner’s behavior is incomplete. If people perceive their partners’ as less cooperative under incompleteness of information—the topic that we will discuss in the next section—people may choose more self-interest strategies themselves. Thus, the mere misperception of the partner’s strategy may seriously undermine cooperation—not necessarily because people intentionally choose less cooperative strategies, but because they underestimate their partners’ cooperation and respond accordingly.

The effects of incompleteness of information are not limited to the way in which people perceive their partners’ strategies, but they can also influence the way in which people can communicate their own strategies. When information is complete, people can try to elicit higher or lower levels of cooperation, and the partner will easily notice this behavior and presumably adapt to it. By contrast, when information is incomplete, different strategies may be more difficult to detect, thereby reducing the possibility that the partner would adapt to higher or lower level of cooperation. In particular, if people assume too much self-interest from others, generous strategies may be more difficult to communicate than stingy strategies. As a result, generous strategies may not elicit as much more cooperation as they would under complete information.

**People as Self-Interest Theorists**

How people interpret their partner’s specific behaviors and overall strategies when important pieces of information are missing? One interesting line of research examined people’s prediction about other people’s behaviors in the absence of any specific information. The 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. 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).

Another line of research demonstrated that dispositional attributions are also guided by self-interest. Research on interpersonal biases reveals a stable trait bias in that people think of others as more selfish and less fair than they think of themselves (Alicke, Dunning, & Kruger, 2005; Dunning & Cohen, 1992; Messick, Bloom, Boldizar, & Samuelson, 1985; Allison, Messick, & Goethals, 1989; Van Lange & Sedikides, 1998). Interestingly, this research reveals that in comparison to many other attributes (e.g., those linked to competence) such better-than-average (i.e., superiority) effects tend to be most pronounced for attributes that are strongly linked to social qualities (e.g., others are less honest, more unfair).

More recent research demonstrated that incomplete information on concrete behavior is also filtered through the belief in others’ self-interest (Vuolevi & Van Lange, 2010). In the so-called dice-rolling paradigm the participant observed another person assigning outcomes by rolling two dice and allocating one of them to the participant. Participants only had information about their own die, and they were asked to estimate the value of the die the other person allocated to himself or herself. The results revealed that people indeed overestimate the value of the die the other allocates to oneself. Thus, these findings indicate that the belief in others’ self-interest guides judgments of overt behavior even when there is incomplete information suggesting that the behavior is actually fair. Indeed, people do not seem to extrapolate from the given information, but seem to color their judgments based on the general belief that most other people are self-interested.

Research Overview and Hypotheses
Taken together, previous research shows that social judgments about unknown people in general (e.g., is she a nice person) and predictions about unknown people’s behavior (e.g., does she donate blood only if a financial incentive is given) tend to be driven by a belief in other people’s self-interest. Previous research also shows that specific judgments about unknown people’s overt behavior also tend to be driven by self-interest. However, to the best of our knowledge, no research has examined whether or not these self-interest beliefs translate into self-interest behavior. Building on the idea that incompleteness of information forces people to include factors beyond strategy consideration (such as tit-for-tat) into their decision-making, such as the belief in others self-interest, we advanced the basic incompleteness effect hypothesis that with greater incompleteness of information, participants would cooperate less with their partner (Hypothesis 5.1).
Furthermore, we examined whether incompleteness of information might have somewhat different effects on those who behave in a generous versus stingy manner. Given our assumption that people tend to rely on beliefs in other people’s self-interest, the observation of generosity is more conflicting with the observer’s a priori beliefs than the observation of stinginess. People might fill in the blanks (i.e., the lacking information) with self-interest, and people need more instances of generous behaviors to believe that the other is indeed generous than they need instances of stingy behaviors to believe that the other is indeed stingy. Thus, we hypothesized that the more cooperation the partner seeks to attain, the more incompleteness of information reduces participants’ cooperation (Hypothesis 5.2).

The second set of hypotheses tested the idea that general evaluations about the partner, referred to as the impressions of benign intent, are also influenced by incompleteness of information. Prior research has demonstrated that people explain other people’s behavior too much by personality traits, while underestimating the role of situational variables (see fundamental attribution error; Ross 1977; correspondence bias; Jones, 1990). Therefore, people may explain partners’ behavior (e.g., noncooperation) by means of their traits (e.g., a stingy person) while overlooking the possibility that behavior might be influenced merely by incompleteness of information (e.g., noncooperation triggered by the situation as much as the person). Because behavior and benign impression should be influenced by incompleteness of information in a corresponded manner, we advanced similar incompleteness effect hypotheses also for benign impressions. We predicted that with greater incompleteness of information, participants would form less benign impression of their partner (Hypothesis 5.3). And finally, we predicted that the more cooperation the partner seeks to attain, the more incompleteness of information reduces participants’ impressions on their partner’s benign intent (Hypothesis 5.4).

The hypotheses were tested in two different paradigms in which incompleteness versus completeness of information was manipulated in different ways. The first paradigm—the dice paradigm—is a dyadic resource allocation task in which the participant and another person (referred to as the other) take turns in rolling two dice and allocating them between the two (see Vuolevi & Van Lange, 2010). Participants are provided with either partial or full information about the other’s dice allocations that produce points for both the participant and the other. The second paradigm—the coin paradigm—is a new paradigm involving an allocation task in which incompleteness of information is manipulated by providing a smaller or a larger sample of information about the other’s actual allocation of coins. Thus, in the first paradigm participants have complete information about the outcomes they receive (i.e., behavior), but only incomplete information about the partner’s choice options (i.e., the situation). In the second paradigm participants have complete information about the partner’s choice options (i.e., the situation), but incomplete information about which of
these known options the partner had actually chosen (i.e., the behavior). Thus, the present research seeks to demonstrate that the effects of incomplete information on cooperation are quite general and largely independent of the way in which incomplete information is manipulated.

**Experiment 5.1**

**Method**

**Participants and design.** The participants were 280 North American students (97 men, 183 women) with an average age of 24.5 years ($SD = 7.12$). The computerized experiment was administered over the internet and all materials were displayed on participants’ web-browsers. The experiment was a 3 (partner’s strategy: stingy vs. fair vs. generous) × 3 (type of information provided: both outcomes vs. own outcome vs. vs. the other’s outcome shown) × 6 (blocks of trials) design with the latter being a within-participant variable.

**Procedure.** The dice rolling paradigm was an interaction-based, turn-taking task between the participant and another person—the other—who was described as another participant, but whose behavior was in fact controlled by a computer. The dice-rolling paradigm consisted of six rounds of rollings of two dice, each six-sided with values ranging from 1 to 6. The dice values produced points for both the participant and the other, and the participants were told that these points have value: “The more points you accumulate the better for you and the more points the other accumulates, the better for him or her”. Participants were first displayed that the other would roll two dice and allocate one of them to himself or herself, and another one to the participant. After each allocation, the participant would only see the value of the die the other allocated to the participant, the value of the die the other allocated to himself or herself, or the values of both dice—a variable that was manipulated between-participants. After the participant was presented with either incomplete or complete information about the other’s dice allocation, the participant in turn rolled and allocated the two dice—one of them to himself or herself, and another one to the other.

The interaction sequence was repeated six times. Each round the participant first observed the other’s dice rollings and allocations, followed by the participant’s own dice rollings and allocations. We controlled for the other’s rollings and allocations in that the shown dice values averages were 2.67 (consisting of values 1, 2, 2, 3, 4 and 4), 3.5 (consisting of values 1, 2, 3, 4, 5 and 6) and 4.33 (consisting of values 3, 3, 4, 5, 5 and 6). For example, participants in the stingy-and-own information condition received the dice values of 2.67 on average (i.e., the other allocated lower outcomes to the participant), and the other in the stingy-and-other’s information condition received the dice values of 4.33 on average (i.e., the other allocated higher outcomes to oneself). The dice values the other allocated to the participant and himself or herself across nine
experimental conditions are presented in Table 5.1. To make sure that all participants faced the very same allocation decisions, we also controlled for participants’ own dice rollings. Six rollings produced the following pairs of dice values in a random order: 1 & 2, 1 & 3, 2 & 3, 4 & 5, 4 & 6, and 5 & 6. As a dependent measure, we calculated the mean value of the die the participant allocated to the other and normalized this value between 0 and 1. This normalized measure of cooperation gets the value of zero if the participant always allocates the lower-valued of the two dice to the other. Likewise, if the participant always allocates the higher-valued die to the other, the normalized cooperation gets the value of one.

Table 5.1: The average outcome the other allocated to the participant (Self) and oneself (Other) across nine experimental conditions, in Experiment 5.1

<table>
<thead>
<tr>
<th>Information manipulation:</th>
<th>Both dice shown</th>
<th>Own dice shown</th>
<th>Other's dice shown</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stingy</td>
<td>Self: 2.67 points</td>
<td>Self: 2.67 points</td>
<td>Self: not shown</td>
</tr>
<tr>
<td></td>
<td>Other: 4.33 points</td>
<td>Other: not shown</td>
<td>Other: 4.33 points</td>
</tr>
<tr>
<td>Fair</td>
<td>Self: 3.5 points</td>
<td>Self: 3.5 points</td>
<td>Self: not shown</td>
</tr>
<tr>
<td></td>
<td>Other: 3.5 points</td>
<td>Other: not shown</td>
<td>Other: 3.5 points</td>
</tr>
<tr>
<td>Generous</td>
<td>Self: 4.33 points</td>
<td>Self: 4.33 points</td>
<td>Self: not shown</td>
</tr>
<tr>
<td></td>
<td>Other: 2.67 points</td>
<td>Other: not shown</td>
<td>Other: 2.67 points</td>
</tr>
</tbody>
</table>

After completing the dice task, the participants filled out 10 items assessing impressions of benign intent during the dice task (Van Lange et al., 2002). Positive items were “The other was...generous, nice, forgiving, kind, trustworthy,” and negative items were “The other was...self-centered, greedy, competitive, stingy, revengeful, selfish” (Cronbach’s α = .883). Participants could indicate how much they agreed with these statements on scales ranging from 1 (not at all) to 7 (very much).

Results

Cooperation. Based on six trials we calculated the mean value of the die the participant allocated to the other and normalized its value between 0 and 1. Normalized cooperation was analyzed in a 3 (the other’s strategy: stingy vs. fair vs. generous) × 3 (information: own die vs. other’s die vs. both dice shown) analysis of variance. The analysis revealed a main effect of strategy, indicating that, consistent with the tit-for-tat
principle, participants who were paired with the generous interaction partner cooperated more ($M = 0.41, SD = 0.39$) than participants who were paired with the fair interaction partner ($M = 0.27, SD = 0.29$), or with the stingy interaction partner ($M = 0.20, SD = 0.29$), $F(2, 271) = 9.24, p < .001, \eta^2 = .064$. The analysis revealed a main effect of information, indicating that participants who were given information on their own and the other’s outcomes exhibited greater cooperation ($M = 0.43, SD = 0.39$) than did participants who were only given information on their own outcome ($M = 0.25, SD = 0.29$), or the other’s outcome ($M = 0.19, SD = 0.27$), $F(2, 271) = 14.52, p < .001, \eta^2 = .097$. This supports the incompleteness effect hypothesis predicting that with greater incompleteness of information, participants would cooperate less with their partner (Hypothesis 5.1).

Figure 5.1: Cooperation as a function of the other’s strategy (stingy vs. fair vs. generous allocations) and the information manipulation (own dice shown vs. both dice shown vs. the other’s dice shown), in Experiment 5.1. The 95% confidence intervals are presented in line-graphs.

The analysis also revealed a two-way interaction between the other’s strategy and the information manipulation $F(4, 271) = 2.70, p = .031, \eta^2 = .038$. The pattern
presented in Figure 5.1 reveals that the difference in cooperation between the complete information condition (i.e., both dice shown) and the incomplete information conditions (i.e., own dice shown or the other's dice shown) is greater to the degree that the partner behaves a more generous (vs. stingy) manner. This supports the hypothesis that the more cooperation the partner seeks to attain, the more incompleteness of information reduces participants' cooperation (Hypothesis 5.2).

**Impressions of benign intent.** Impressions of the other’s benign intent were analyzed in 3 (the other’s strategy: stingy vs. fair vs. generous) × 3 (information: own die vs. other’s die vs. both dice shown) analysis of variance. The analysis revealed a main effect of strategy, indicating that participants who were paired with the generous interaction partner judged their partner’s intentions as more benign \( (M = 4.78, SD = 1.17) \) than participants who were paired with the fair interaction partner \( (M = 4.24, SD = 0.70) \), or with the stingy interaction partner \( (M = 3.88, SD = 0.87) \), \( F(2, 271) = 24.65, p < .001, \eta^2 = .154 \). The analysis revealed a main effect of information, indicating that participants who were given information about their own outcomes and other’s outcomes judged their partner’s intentions as more benign \( (M = 4.86, SD = 1.13) \) than participants who were only given information about their own outcome \( (M = 4.10, SD = 0.69) \) or the other’s outcome \( (M = 3.80, SD = 0.83) \) \( F(2, 271) = 35.78, p < .001, \eta^2 = .209 \). This supports the hypothesis that with greater incompleteness of information, participants would form less benign impression of their partner (Hypothesis 5.3).

Finally, the analysis revealed a two-way interaction between the other’s strategy and the information manipulation \( F(4, 271) = 12.70, p < .001, \eta^2 = .158 \). The pattern presented in Figure 5.2 reveals that the difference in benign impressions between the complete information condition (i.e., both dice shown) and the incomplete information condition (i.e., own dice shown or the other’s dice shown) is greater the more generous versus stingy the partner really is. This supports the hypothesis that the more cooperation the partner seeks to attain, the more incompleteness of information reduces participants’ impressions of their partner’s benign intent (Hypothesis 5.4).
Figure 5.2: Benign impressions as a function of the other’s strategy (stingy vs. fair vs. generous) and the information manipulation (own dice shown vs. both dice shown vs. the other’s dice shown), in Experiment 5.1. The 95% confidence intervals are presented in line-graphs.

Mediation by benign impressions. The above analyses revealed similar main and interaction effects for cooperation and for impressions of benign intent. Moreover, we found a significant correlation between cooperation and impressions of benign intent ($r = .48, p < .001$). These findings support our goal to explore whether impressions of benign intent might plausibly serve as a mediator for the determinants of cooperation (i.e., the main effect of incompleteness of information and the interaction effect of information and the other’s strategy). At the outset, we should note that this analysis can only provide preliminary evidence, because the mediator (i.e., benign impressions) was assessed after the dependent variable (i.e., cooperation).

Hence, we examined whether impressions of benign intent would reduce the effects of the strategy and information manipulations on cooperation. For this analysis, we coded the other’s strategy as -1, 0, and +1 for the stingy, fair, and generous conditions, respectively. For the information manipulation we computed a contrast between complete and incomplete information. Thus, we coded the complete
information condition (in which both dice were shown) as +2, and the own dice and the other’s dice conditions both as -1. We found that when benign impression were added as a predictor, the main effect of information dropped from $B = 0.067, t(278) = 5.13, p < .001$ to $B = 0.033, t(278) = 2.41, p = .017$. The main effect of strategy dropped from $B = 0.099, t(278) =4.28, p < .001$ to $B = 0.047, t(278) = 1.97, p = .050$. Finally, the interaction effect dropped from $B = 0.046, t(278) = 2.85, p = .005$ to $B = 0.011, t(278) = 0.64, ns$. Sobel tests revealed that all these three effects were mediated by benign intentions: The main effect of information on cooperation, $Z = 5.66, p < .001$, the main effect of strategy on cooperation, $Z = 6.13, p < .001$, and their interaction on cooperation, $Z = 5.55, p < .001$, were mediated by benign impressions.

Experiment 5.2

Experiment 5.1 provided good support for the hypothesized incompleteness effect—that with greater incompleteness of information, individuals cooperate less with their partner (Hypothesis 5.1). We also found, consistent with Hypothesis 5.2, that the detrimental effects of incompleteness of information were most pronounced for the generous partner, followed by the tit-for-tat partner, and least pronounced for the stingy partner. Finally, the experiment demonstrated that impressions of the partners’ intent were judged as less benign under incompleteness of information, and that this effect was more pronounced for partners who apply generous strategies (evidence in support of Hypotheses 5.3 and 5.4).

Experiment 5.2 extended Experiment 5.1 in several important respects. First, we designed a new paradigm (the coin paradigm) in which we could measure the effects of incomplete behavioral information. That is, in contrast to the dice-rolling paradigm, participants in Experiment 5.2 had complete information about the partner’s choice options (i.e., the situation), but incomplete information about which of these known options the partner had actually chosen (i.e., the behavior). Each turn, the partner allocated between 0 and 16 coins to the participant, who only got to see a subset of the overall allocation (e.g., that the partner allocated 3 coins to the participant and 5 to the self, and 8 coins were unknown). Thus, the fewer coins the participant sees, the more the partner’s overall allocation of 16 coins is characterized by incompleteness of information.

The coins the participant and the partner allocated were more valuable for the interaction partner than for the person who allocated the coins. Hence, we provided an incentive for mutual cooperation, but at the same time, noncooperation would provide better personal short-term outcomes. These characteristics—conflicting interest but high enough interdependence that mutual cooperation is promoted—are identical to the prisoner’s dilemma, which is the best-known dilemma in social and behavioral sciences (Rapoport & Chammah, 1965; Tucker, 1950). In fact, the coin paradigm is a game of
16 prisoner’s dilemma games played in parallel: Cooperation is the number of cooperative choices in 16 games and incompleteness of information is manipulated by means of unknown vs. known outcomes in those individual games.

Second, Experiment 5.2 used more realistic strategies for the interaction partner than did Experiment 5.1, in which the partner was programmed to pursue a stingy, fair, or a generous strategy in a perfectly unconditional manner—independent of the participant’s behavior. In Experiment 5.2, the partner’s behavior was anchored to the participant’s behavior, and the partner was programmed to pursue a variant of tit-for-tat, a strategy that makes a little less cooperative (i.e., stingy tit-for-tat), equally cooperative (i.e., tit-for-tat), or a little more cooperative (i.e., generous tit-for-tat) 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 (approximately 60% of the participants tend to follow tit-for-tat; see Klapwijk & Van Lange, 2009; Van Lange, 1999). Thus, when people make inferences about the tit-for-tat partner they make inferences about another person that is not only very realistic but also quite similar to the self.

Method

Participants and design. The participants of the computerized, laboratory experiment were 116 VU University students in the Netherlands (70 women, 46 men) with an average age of 20.47 years ($SD = 2.92$). The experiment was a 3 (the other’s strategy: TFT-2, TFT, TFT+2) × 2 (amount of information provided: low vs. high information) × 16 (blocks of trials) design with the latter being a within-participant variable. After completing the experiment, the participants were debriefed and paid €3.5.

Procedure. The coin paradigm was a dyadic coin allocation task between the participant and another person, who was described as another participant, but whose behavior was in fact controlled by a computer. In the present experiment, the task consisted of 16 rounds of allocations of coins. In each round, first the participant and then the other allocated 16 coins between the two. The coins that the other allocated were square-shaped coins that were worth of two points for the participant, but only one point for the other. The coins that the participant allocated were round-shaped coins that were worth of two points for the other, but only one point for the participant. This way, the situation supported mutual exchange of square and round coins (i.e., mutual cooperation).

Each round started with the participant’s allocation of 16 coins. Following the tit-for-tat principle, the other’s allocation was anchored to the participant’s allocation in that round. Three different versions of TFT were used: The other allocated two coins less than the participant (TFT-2), the same number of coins than the participant (TFT),
or two coins more than the participant (TFT+2). Participants were provided with incomplete information about the partner’s allocation of coins. Out of 16 coins in total the partner allocated each round, the participant was able to see a subset of 2 or 14 coins—a variable that was manipulated between-participants. After each allocation, the participants were presented with 16 blank coins, and they could click any coin they wanted. After clicking a coin the text “Your Coin” or “The Other’s Coin” appeared on the coin, indicating that the other had allocated that particular coin either to himself or herself, or to the participant. After clicking and observing the allocation of 2 or 14 coins, the interaction proceeded to the next round and to the participant’s allocation.

After the coin task, the participants filled out 10 items assessing the impressions of the partner’s benign intent (Cronbach’s $\alpha = .853$). This scale is described in detail in Experiment 5.1.

**Results**

**Cooperation.** Based on 16 trials we calculated the mean number of coins the participant allocated to the other and analyzed it in a 3 (the other’s strategy: TFT-2 vs. TFT vs. TFT+2) × 2 (amount of information provided: low vs. high information) analysis of variance. The analysis revealed a main effect of strategy, indicating that, consistent with the tit-for-tat principle, participants in the TFT+2 condition cooperated more ($M = 8.44$, $SD = 3.00$) than participants in the TFT ($M = 7.70$, $SD = 3.22$) or the TFT-2 conditions ($M = 6.13$, $SD = 2.64$), $F(2, 110) = 7.92$, $p = .001$, $\eta^2 = .126$. The analysis revealed a main effect of information, indicating that participants in the high information condition cooperated more ($M = 8.20$, $SD = 3.23$) than participants in the low information ($M = 6.68$, $SD = 2.84$), $F(1, 110) = 8.62$, $p = .004$, $\eta^2 = .073$. This supports the incompleteness effect hypothesis that with greater incompleteness of information, participants would cooperate less with their partner (Hypothesis 5.1).

Finally, the analysis revealed a two-way interaction between the other’s strategy and the information manipulation $F(2, 110) = 3.31$, $p = .040$, $\eta^2 = .057$. The pattern presented in Figure 5.3 reveals that the difference in cooperation between the high information condition and the low information condition is greater the more generous (TFT+2) versus stingy (TFT-2) version of tit-for-tat the partner applies. This supports the hypothesis that the more cooperation the partner seeks to attain, the more incompleteness of information reduces participants’ cooperation (Hypothesis 5.2).
Impressions of benign intent. Impressions of the other’s benign intent were analyzed in a 3 (the other’s strategy: TFT-2 vs. TFT vs. TFT+2) × 2 (amount of information provided: low vs. high) analysis of variance. The analysis revealed a main effect of strategy, indicating that participants who were paired with the FTF+2 partner judged the other’s intentions as more benign ($M = 4.20$, $SD = 0.83$) than participants who were paired with the TFT partner ($M = 3.77$, $SD = 0.77$) or with the TFT-2 partner ($M = 3.00$, $SD = 0.91$), $F(2, 110) = 27.34$, $p < .001$, $\eta^2 = .332$. The analysis also revealed a main effect of information, indicating that participants in the high information condition judged the other’s intentions as more benign ($M = 3.94$, $SD = 1.19$) than participants in the low information condition ($M = 3.37$, $SD = 0.67$), $F(1, 110) = 16.01$, $p < .001$, $\eta^2 = .127$. This supports the hypothesis that with greater incompleteness of information, participants would form less benign impression of their partner (Hypothesis 5.3). Finally, the analysis revealed a two-way interaction between the other’s strategy and the information manipulation, $F(2, 110) = 7.93$, $p = .001$, $\eta^2 =$
The pattern presented in Figure 5.4 reveals that the difference in benign impressions between the high information condition and the low information condition is greater the more generous (TFT+2) versus stingy (TFT-2) version of tit-for-tat the partner applies. This supports the hypothesis that the more cooperative the partner is the more cooperation the partner seeks to attain, the more incompleteness of information reduces participants’ impressions of their partner’s benign intent (Hypothesis 5.4).

Figure 5.4: Benign impressions as a function of the other’s strategy (stingy tit-for-tat vs. tit-for-tat vs. generous tit-for-tat) and the information manipulation (low vs. high information), in Experiment 5.2. The 95% confidence intervals are presented in line-graphs.

Mediation by benign impressions. In the above analyses, similar main and interaction effects were observed both for cooperation and for impressions of benign intent. Moreover, we found a moderate correlation between cooperation and impressions of benign intent other ($r = .62, p < .001$). These findings support our goal to explore whether impressions of benign intent might plausibly serve as a mediator for
the determinants of cooperation (i.e., the main effect of incompleteness of information and the interaction effect of information and the other’s strategy). As in Experiment 5.1, we should note that this analysis can only provide preliminary evidence, because the mediator (i.e., benign impressions) was assessed after the dependent variable (i.e., cooperation).

Hence, we examined whether impressions of benign intent would reduce the effects of the strategy and information manipulations on cooperation. For this analysis, we coded the strategy manipulation as -1, 0, and +1 for the TFT-2, TFT, and TFT+2 conditions, respectively. We coded the information manipulation as –1 and +1 for the low and high information conditions, respectively. We found that when benign impression were added as a predictor, the main effect of information dropped from $B = 0.751, t(114) = 2.86, p = .005$ to $B = 0.254, t(114) = 1.04, ns$. The main effect of strategy dropped from $B = 1.198, t(114) = 3.88, p < .001$ to $B = 0.093, t(114) = 0.28, ns$. Finally, the interaction effect dropped from $B = 0.754, t(114) = 2.44, p = .016$ to $B = 0.187, t(114) = 0.65, ns$. Sobel tests revealed that all these three effects were mediated by impressions of benign intent: The main effect of information on cooperation, $Z = 3.50, p < .001$, the main effect of strategy on cooperation, $Z = 5.53, p < .001$, and their interaction on cooperation, $Z = 3.43, p < .001$, were mediated by impressions of benign intent.

**General Discussion**

In the present research we examined cooperation in dyadic interactions. We advanced a new framework which posits that cooperation is importantly affected by incompleteness of information about the partner’s previous cooperation. When people have complete information on one another’s behavior, people may develop cooperation through the effective use of tit-for-tat, as previous research has demonstrated (e.g., Axelrod, 1984; Gouldner, 1960; Klock, 1993; Komorita & Parks, 1995; Nowak & Sigmund, 1992, 2005; Trivers, 1971; Van Lange et al. 2002). When people have only incomplete information about one another’s behavior, tit-for-tat becomes accompanied by the incompleteness effect. The hypothesized incompleteness effect is based on people’s tendency to overestimate others’ self-interest, which has been reported in various literatures (see Miller & Ratner, 1996, 1998; Allison et al., 1989; Van Lange & Sedikides, 1998; Vuolevi & Van Lange, 2010), but which behavioral implications have not yet been examined. We posited that this general overestimation of others’ self-interest makes people attribute too much self-interest to partners’ specific behaviors and to respond less cooperatively than the tit-for-tat principle would dictate (i.e., cooperate less than the partner actually did).

Two experiments provided good support for the incompleteness effect—that with greater incompleteness of information, participants cooperate less with their partner
We also manipulated the interaction partner’s cooperation and found that the more cooperation the partner seeks to attain, the more incompleteness of information reduces participants’ cooperation (Hypotheses 5.2). Thus, detrimental effects of incomplete information were not compensated by generosity. Instead, the more cooperation one tries to communicate the more that behavior is filtered through self-interest beliefs, which effectively diminish the benefits generosity in social interactions with incomplete information.

These detrimental effects of incomplete information were found across two complementary manipulations of incompleteness of information: When participants had incomplete outcome information regarding one of the two outcomes (i.e., incomplete situational information, in Experiment 5.1), and when participants had complete situational information (i.e., choice options), but incomplete information about the partner’s exact behavior (incomplete behavioral information, Experiment 5.2). Moreover, these effects were found when the partner used stingy, fair, and generous strategies in an unconditional manner (Experiment 5.1), and when the partner’s behavior was anchored to the participant’s own behavior (stingy tit-for-tat vs. tit-for-tat vs. generous tit-for-tat, in Experiment 5.2).

Both experiments also revealed that with greater incompleteness of information, participants form less benign impression of their partner (Hypothesis 5.3). Similar to the findings observed for cooperation, the more cooperation the partner seeks to attain, the more incompleteness of information reduces participants’ impressions on their partner’s benign intent (Hypothesis 5.4). Supplementary analyses revealed that in both experiments, the detrimental effects of incomplete information on cooperation were mediated by benign impressions of the partner. As noted earlier, the evidence for mediation should be considered preliminary—one reason being that the presumed mediator was assessed after the presumed criterion measure. Nevertheless, these findings plausibly underscore the vulnerability of cooperation under incompleteness of information: If people erroneously perceive their partner’s behavior as noncooperation, and form their impressions accordingly (e.g., she is unkind), and act upon it (e.g., I do not cooperate), the mere presence of incomplete information in the beginning may have a long lasting detrimental effect on mutual cooperation.

The mediational model suggesting that incompleteness of information reduces cooperation because people underestimate their partners’ cooperation has important implications to social interactions. One could argue that the mechanism by which incompleteness of information influences cooperation is that uncertainty about the outcomes elicits self-protection motives (cf. prevention focus; see Higgins, 1997) and make people try to avoid bad outcomes rather than to obtain good ones (cf. prospect theory; see Kahneman & Tversky, 1979; see also Baumeister, Bratslavsky, Finkenauer, & Vohs, 2001). This line of reasoning would predict lower cooperation under incompleteness of information, but no impact on benign impression of the partner. The
second mechanism—supported by our data—is that incompleteness of information indirectly influences cooperation by changing the way in which people interpret their partner’s cooperation. Because perceived cooperation and impressions that people form on their partners are presumably interrelated, this line of reasoning would predict lower cooperation as well as less benign impressions under incompleteness of information. This pattern was indeed found in both experiments, including full mediation in Experiment 5.1 and partial mediation in Experiment 5.2, which suggests that that incompleteness of information does not necessarily make people more self-interested directly, but that people become more self-interested indirectly because they overestimate their partner’s self-interest.

Our findings have important implications to interdependence theory (Kelley & Thibaut, 1978). Incompleteness of information has been recently added to one of the basic structural properties of interdependence theory (Kelley et al., 2003; Rusbult & Van Lange, 2003), but the role of incompleteness of information has not been elaborated in detail. Here, we develop these ideas in two different ways. First, we make a distinction between behavioral and situational incompleteness of information and demonstrate that they have similar negative effects on cooperation in social interactions. Second, we demonstrate the importance of transformational information—information relevant general strategies that people use across social situations. Under incomplete behavioral or situational information, people make errors in inferring their partner’s transformations (e.g., view their partner’s as more stingy). This can have a crucial impact for future interactions, because erroneously perceived transformations may influence people’s own willingness for cooperative transformations.

To the authors’ knowledge, no prior research has assessed cooperation as a function of mere information availability. One novel aspect of our work is that incompleteness of information (e.g., the extent to which incoming information is reliable) is manipulated orthogonally from the valence of information (e.g., the extent to which the partner is cooperative vs. noncooperative). In previous research the two are often operating in concert. For example, a large body of evidence shows that communication with the interaction partner increases cooperation (for a review, see Balliet, 2010). The exact underlying mechanism for this effect is not known, yet it is quite plausible to think that in such first time meetings, people are more likely to display positive rather than negative information about them. Therefore, in our view, previous communication experiments demonstrate that the combined effect of more information and positive valence increase cooperation. Our research contributes to this body of literature the notion that the mere incompleteness of information, while keeping its valence constant, is enough to undermine cooperation.

A few studies have manipulated information in a binary manner and compared complete information to no information at all. In a classic experiment by Shafir and Tversky (1992), participants played a single-shot prisoner’s dilemma game while
knowing or not knowing the partner’s choice (i.e., no choice shown, vs. cooperation shown vs. defection shown). Participants cooperated more when the partner’s choice was not shown, compared to the average cooperation when the partner’s cooperation or defection was shown. Further research demonstrated that high cooperation without knowing the partner’s behavior might be caused by illusion of control. Indeed, the original results were replicated when participants thought that the partner would make the choice in the future, but not replicated when participants were told that the partner had already made the choice (Morris, Sim, & Girotto 1998). In our experiments participants were shown part of the partner’s behavior, thus it was clear that the behavior had already happened and could not be influenced. A special feature of incomplete information is that it anchors the event firmly in the past, whereas no-information allows more abstract and perhaps positively biased thought processes, such as the illusion of control. Thus, from the perspective of eliciting mutual cooperation, the condition of very little information might be more challenging than complete information or no information at all.

Our findings are related to previous work on noise, defined as the discrepancy between actual and intended outcomes (Klapwijk & Van Lange, 2009; Van Lange et al, 2002). This work has demonstrated that cooperation declines when the actual outcomes are altered from the intended ones, but also that generosity is quite effective at reducing or overcoming the detrimental effects of noise. This previous research is consistent with our research in that both noise and incomplete information undermine cooperation. However, there are intriguing differences as well. Generosity helps one to cope with noise in social interactions, but generosity is not effective as a communication tool for coping with incompleteness of information. How can we reconcile these seemingly inconsistent findings?

In the noise paradigms, participants were typically able to communicate their cooperation, and such communication was not challenged by incompleteness of information. Moreover, generosity was communicated at each interaction. These qualities serve the important function that generosity is communicated clearly and consistently (Van Lange et al., 2002; see also Rumble, Van Lange, & Parks, 2010). By contrast, the drawback of incompleteness of information, as we have seen in two experiments, is that people are not able to communicate their generosity in a persuasive manner—because there is so much missing information that people are likely to fall prey to their persistent belief in other people’s self-interest. A complementary explanation is that when noise is present, one knows the exact outcomes, but does not know the partner’s precise intentions. When incompleteness of information is present, one does not know the exact outcomes, or the partner’s intentions. Thus, incomplete information might have a more fundamental impact on cooperation because it influences the outcomes one observes and receives (e.g., did I receive good or bad outcomes), not just the intentions (e.g., is the partner generous or stingy). The
important lesson we learned from the present research is that the belief in self-interest can drastic implications for how well good intentions can be communicated.

We propose that future research could examine in detail the way in which incomplete information versus noise influence dyadic cooperation. Our reasoning, based on tit-for-tat principle and the incompleteness effect, would also be quite easy to incorporate into the evolutionary framework, which could hopefully shed more light on the functional side of self-interest assumptions. The development of different interpersonal relationships would also provide a very interesting avenue for future research. In the present research we examined interaction with strangers, but it is quite possible that in ongoing relationships, for instance, people do not necessarily assume self-interest (e.g., in communal relationships, Clark & Mills, 1993; Rusbult & Van Lange, 2003). Conversely, even more self-interest might be assumed 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, beliefs in different contexts (e.g., when to assume self-interest vs. when to give the benefit of the doubt), and their influence on behavior in various types of interpersonal relationships, would provide a more comprehensive picture on how beliefs and incomplete information operate in concert in dyadic interactions.