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How to Cope With "Noise" in Social Dilemmas: The Benefits of Communication

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Interactions in social life may be seriously affected by *negative noise*, whereby actual or perceived behavior is less cooperative than was intended (e.g., arriving late due to an unforeseen traffic jam). The present research examines whether negative noise exerts detrimental effects on impressions and cooperation and whether such effects could be reduced by communication. Consistent with hypotheses, Study 1 revealed that negative noise exerts detrimental effects on both impressions of partners' benign intent and cooperation and that these detrimental effects could be effectively reduced by communication about noise. Study 2 replicated both findings but only for individuals with low trust. Mediation analysis revealed that impressions of benign intent and prosocial interaction goals underlie the positive effects of communication on cooperation.

It is an inevitable fact from social life that one's behavior is not always perceived or experienced by others as intended, and sometimes one is simply not able to act according to his or her intentions. For example, even if people are strongly determined to arrive on time for a meeting, their actions may be subject to unintended errors (e.g., taking the wrong exit, being held up by an unexpected traffic jam) that cause them to arrive late. In the context of social dilemmas (i.e., conflicts between self-interest and collective interest) such unintended errors are referred to as *noise*, which is defined as "discrepancies between intended and actual outcomes for an interaction partner due to unintended errors" (e.g., Van Lange, Ouwerkerk, & Tazelaar, 2002, p. 768; cf. Kollock, 1993; Wu & Axelrod, 1995).

Of particular relevance to the present research is *negative noise*; that is, unintended errors that cause actual outcomes to be worse than intended. Relative to positive noise—that is, unintended errors that cause actual outcomes to be better than intended—negative noise is assumed to form a stronger challenge to trust and impressions of benign intent, as well as a stronger threat to cooperative interaction. For example, failure to respond to an e-mail message due to a computer network breakdown may cause misunderstanding, thereby exerting detrimental effects on impressions ("he always makes me wait") and future cooperation ("next time, I will make him wait as well"). Indeed, the concept of negative noise gives rise to several intriguing questions. Do incidents of negative noise always exert detrimental effects on impressions and cooperation? More important: What can people do to reduce such (assumed) detrimental effects? Is it possible to "undo" incidents of noise and, if so, how? Is it possible to undo noise by communication, informing the other when a particular interaction outcome was affected by noise ("I did not mean it that way")?

The present research addresses these questions, thereby pursuing two complementary goals. First, we wish to demonstrate that incidents of negative noise (henceforth, noise) exert detrimental effects on impressions of interpersonal intent and cooperative interaction. Second, we wish to present evidence relevant to the claim that communication about noise serves as an effective interpersonal means for reducing detrimental effects of noise. Such evidence would, among other extensions, complement extant research on noise—which consists almost exclusively of computer simulations—by illuminating a truly psychological and interpersonal mechanism for reducing detrimental effects of noise in social dilemmas. In pursuing these two goals, we advance a framework based on earlier research (Van Lange et al., 2002), which suggests that incidents of negative noise in social dilemmas challenge trust and impressions of benign intent. We argue that communication about noise primarily serves to restore trust and impressions of benign intent, which are both essential for establishing and maintaining cooperative interaction.

Does Noise Exert Detrimental Effects?

Although we do not know of any empirical research addressing this question, it is plausible that noise exerts detrimental effects on impressions and cooperation. Research using computer simulations reveals that noise tends to exert detrimental effects on cooperation, suggesting that even a few incidents of noise disrupt cooperative interaction (e.g., Bendor, Kramer, & Stout, 1991;

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Molander, 1985). Such detrimental effects are especially pronounced for strategies that are largely reciprocal in nature—which tend to be strategies that are also commonly observed in actual participants (e.g., Kelley & Stahelski, 1970; Van Lange, 1999; see also Komorita & Parks, 1995). Moreover, some anecdotal evidence suggests that noise may exert detrimental effects on both impressions and cooperation. The example of failure to respond to an e-mail message because of a computer network breakdown may serve as a useful illustration of the idea that unintended events may cause detrimental effects on impressions and on future cooperation. A more powerful illustration is the example of the South Korean airliner that mistakenly flew over the Soviet Union during the Cold War (see Wu & Axelrod, 1995). The plane was subsequently shot down by the Soviets, killing all 269 people on board, thereby causing a short but sharp escalation of Cold War tensions, as described by Goldstein (1991, p. 202).

The present research seeks to extend simulation studies and anecdotal evidence by providing a more stringent, experimental test of the detrimental effects of noise on both impressions of benign intent and cooperation. Moreover, we explore whether impressions of benign intent may mediate the detrimental effects on cooperation.

Coping With Noise: Past Research

What should one do to effectively reduce the (potential) detrimental effects of noise? To begin with, computer simulations suggest that reciprocity is not an effective means for reducing the detrimental effects of noise (e.g., Bendor et al., 1991; Nowak & Sigmund, 1992). Indeed, if a person were to behave in a completely reciprocal manner, as advocated by the tit-for-tat (TFT) strategy, partners would become trapped in cycles of noncooperative interaction, which is referred to as the *echo effect* or *negative reciprocity* (Axelrod, 1984; Van Lange, 1999). Because TFT does not initiate cooperation, it does not actively contribute to breaking out of the pattern of negative reciprocity; if anything, TFT supports negative reciprocity.

A more promising means of coping with noise is adding generosity to TFT. Issues relevant to generosity are not new. Indeed, generosity has been addressed in classic research by examining issues such as conditional and unconditional forms of cooperation (e.g., Kuhlman & Marshello, 1975), the benefits of increasing cooperative behavior over time (e.g., Harford & Solomon, 1967), and the verbal expression of conditional forms of cooperation along with some initiation of cooperative behavior after mutual noncooperation (e.g., Lindskold, 1978; Osgood, 1962; for an overview, see Komorita & Parks, 1995; Pruitt, 1998). However, these studies did not examine whether generosity may help reduce or overcome the detrimental effects of noise.

More recently, computer simulations (Bendor et al., 1991; Kollock, 1993) have suggested that, relative to strictly reciprocal strategies, strategies that respond a bit more cooperatively than the partner did in the previous trial appear to suffer less from incidents of noise. Recently, we extended computer simulations by comparing the responses of real participants, under conditions of noise and no noise, to TFT and a generous version of TFT (TFT + 1; a strategy that behaves always a bit more cooperatively than the interaction partner did in the previous trial; Van Lange et al., 2002). As have most simulation studies, results revealed that TFT suffered from noise, whereas TFT + 1 did not. In fact, under conditions of noise, TFT + 1 even elicited significantly higher levels of cooperation than did TFT. Also, the intentions of a partner pursuing TFT were judged as being less benign under noise than under no noise, whereas the intentions of partners pursuing TFT + 1 were evaluated as quite benign, with no significant differences between noise and no-noise conditions. Thus, this research provides some preliminary evidence for psychological mechanisms underlying the detrimental effects of noise, suggesting that generosity is effective in reducing detrimental effects of noise because generosity helps to maintain or improve impressions of benign intent.

At the same time, generosity should not be regarded as the only or most effective way for coping with noise, as there may be some limitations linked with implementing, or effectively communicating, generosity. To begin with, generosity by definition involves giving a bit more than one has received, and one may not always be able to do so. For example, one may simply lack the resources to act in a generous manner or features of the dilemma may not enable one to demonstrate such subtle generosity (e.g., one cannot do so in so-called binary social dilemmas, with only two options: cooperate or not). Moreover, generosity is a somewhat indirect means of coping with noise, because a partner cannot infer from generosity that, or when, outcomes are affected by noise. Thus, notwithstanding the benefits of generosity, it is important to examine the effectiveness of less costly and more direct means, such as communication, for coping with noise in social dilemmas.

Coping With Noise: Benefits of Communication

Previous research on social dilemmas has devoted a fair amount of empirical attention to the effects of verbal communication in social dilemmas (e.g., Caldwell, 1976; Dawes, McTavish, & Shaklee, 1977; Kerr & Kaufman-Gilliland, 1994). Although researchers expected that communication would promote cooperation, such effects were not always obtained. Moreover, various mechanisms have been proposed (e.g., promotion of trust, feelings of identity, possibilities for coordination), and there is some insight into the circumstances under which communication does—versus does not—promote cooperation (e.g., variations in the degree to which the message is binding, see Chen, 1996; Chen & Komorita, 1994; Orbell, Van de Kragt, & Dawes, 1988).

We propose that the presence of negative noise may be a situational factor that is essential to the functionality of communication, arguing that communication about noise can be an effective means of coping with noise in social dilemmas. Specifically, informing the interaction partner when a particular outcome was affected by noise may be helpful in reducing and perhaps overcoming the presumed detrimental effects of noise. Why should communication about noise be effective? We advance a line of reasoning that is based on two broad arguments. The first argument is that incidents of noise challenge impressions of benign intent. Noise evokes ambiguity or uncertainty regarding the partner's benign intentions because, due to noise, observed behavior can be perceived as intentional or unintentional. The second argument is that impressions of a partner's benign intentions are conditional for behaving cooperatively and that any violation of such "benign

impressions" will lead to diminished cooperation. For example, most people exhibit very low levels of cooperation with partners perceived as below average on trustworthiness, whereas they exhibit high levels of cooperation with partners perceived as above average on trustworthiness (Van Lange & Kuhlman, 1994; Van Lange & Semin-Goossens, 1998). Also, individuals who are prone to cooperate tend to switch rapidly to noncooperation after one noncooperative choice by the partner, suggesting that even a single failure to reciprocate cooperation may exert detrimental effects on cooperative interaction (e.g., Kelley & Stahelski, 1970; Kuhlman & Marshello, 1975).

In light of the detrimental effects of noise on impressions and cooperative interaction, it becomes important to ask: How can one "undo noise" in an effective manner? We suggest that communicating about noise may serve the function of undoing noise by clarifying when a particular outcome was affected by noise. As such, communication about noise is linked to *clarity* (Axelrod, 1984), in the sense that the partner can infer from communication when a particular outcome was affected by noise. Finally, communication about noise may serve as a general reminder of noise, making interaction partners aware of the fact that there may be discrepancies between intended and actual interaction outcomes. These lines of reasoning underscore the important function of communication as a means of maintaining or improving impressions of benign intent, which are assumed to be essential for coping with noise in social dilemmas.

Hypotheses and Research Overview

The preceding discussion provides a framework for understanding why noise may cause detrimental effects on cooperation and how such unfortunate effects may be effectively reduced. The present research is designed to test two central hypotheses derived from this framework. First, we predicted that noise would exert detrimental effects on levels of cooperation (Hypothesis 1a) and on benign impressions of a partner (Hypothesis 1b). Second, we predicted that communication about incidents of noise would reduce such effects for cooperation (Hypothesis 2a) and for benign impressions of a partner (Hypothesis 2b).

To test these hypotheses, the present research used a "gradual" social dilemma task adopted from previous research (Van Lange et al., 2002), which examined the degree of cooperation by asking participants to decide how many coins out of 10 (which were twice as valuable to the partner as to the participant) to give to the partner. We examined this gradual social dilemma (rather than the more frequently used binary social dilemma) for two reasons. First, the gradual social dilemma captures a broad domain of situations in real life (e.g., how much time or energy to devote to a particular collective goal). Second, the gradual social dilemma allows for behavior and strategies by which participants can communicate their intentions and goals much more profoundly (and perhaps more effectively) than they can in a social dilemma involving only a dichotomous choice (for further reasoning, see Van Lange et al., 2002).

Furthermore, as noted earlier, the present research focused on negative noise rather than positive noise because negative noise is arguably more prevalent in the real world, more likely to be noticed (or experienced) by the interaction partner, and more likely to have detrimental effects on cooperation by eliciting both misunderstanding and noncooperative interaction (i.e., the echo effect; cf. Signorino, 1996). Moreover, we assume that communication about noise—the major topic of the present research—in real life is more likely to occur when something negative happens than when something positive happens.

Study 1

The main goal of Study 1 was to test two central hypotheses: the predicting of detrimental effects of noise on cooperation and benign impressions (Hypotheses 1a and 1b) and the reducing of such effects by communication (Hypotheses 2a and 2b). Accordingly, we compared a condition without noise with a condition with noise (to demonstrate detrimental effects of noise) and compared these conditions with a condition with noise and with communication (to examine the benefits of communication). We examined an iterated social dilemma, involving 53 interaction trials, in which we varied partner's strategy. Specifically, we examined a partner who adopted TFT and a partner who adopted TFT + 1 (i.e., a generous TFT partner), who always gave one coin more than the partner gave in the previous interaction. The inclusion of these two strategies allows us to examine whether the benefits of communication are independent of any possible benefit of generosity (see also Kollock, 1993; Van Lange et al., 2002).

Method

Participants and experimental design. Participants were 134 undergraduate students (71 women, 63 men; average age 21 years). They were recruited at the campus of the Free University by written announcements inviting individuals to participate in a study of decision making. The experimental design was a 3 (condition of the task: noise absent vs. noise present without communication vs. noise present with communication) × 2 (strategy of the partner: TFT vs. TFT + 1) × 9 (blocks of trials) design, with the latter variable being a within-participant variable (this variable is discussed later). In the following, we refer to the noise-absent condition as the no-noise condition and to the two noise-present conditions as the communication and no-communication conditions. The primary dependent variables were level of cooperation and impressions of benign intent.

Procedure. From 6 to 14 participants attended each research session. Participants were welcomed and escorted to individual cubicles to prevent them from communicating with each other. Each cubicle contained a computer with a monitor and a keyboard. The instructions and the entire experiment were computerized. Participants were told that they could consult the experimenter if they had problems understanding the instructions. After answering some questionnaires from an unrelated study, participants took part in one of the six conditions of the experiment (randomly determined), which consisted of a social dilemma task and a postexperimental questionnaire. The studies lasted about 75 min, and on completion, participants were debriefed, thanked for their participation, and paid 15 Dutch Guilders (which equaled approximately $7 in American currency or Euro 7 in European currency).

Measuring cooperation in a social dilemma. The experiment started with an explanation to participants that the computers in the different cubicles were connected and that they would be randomly paired to interact by computer in a decision task for several trials. Next, participants read the instructions of the social dilemma task, which was adopted from previous research (Van Lange et al., 2002). Each trial of the social dilemma offered participants a choice among 11 options, varying systematically from least to most cooperative. The social dilemma was presented as a "give-some"

situation in which each participant received 10 coins at the beginning of every trial and could choose among giving no coins, 1 coin, 2 coins, up to maximally 10 coins to the other. Each coin had a value of NFL 0.50 to the person him- or herself and a value of NFL 1.00 (approximately US$0.48) to the partner. Similarly, each coin held by the partner had a value of NFL 0.50 to the partner and a value of NFL 1.00 to the participant him- or herself. Maximal cooperation is to give 10 coins (i.e., joint well-being is better served by exchanging more coins), and maximal noncooperation is to give no coins (i.e., personal well-being is better served by giving fewer coins to the partner).

The number of coins and the consequences of giving away coins were displayed on the participant's computer screen. Specifically, the computer screen displayed a "virtual table," divided into the participant's side on which 10 green coins for the participant were displayed ("you") and the partner's side on which 10 blue coins for the partner were displayed ("the other"). The coins that were given away by the participant literally moved from the participant's side to the partner's side of the table, and vice versa for the coins given away by the partner. The outcomes with which the participant and the partner preceded and ended an interaction were displayed at the right of the table. Finally, throughout the interactions, we used variable time intervals for displaying the coins given by the partner to mimic the variability in decision time that characterizes the choices of real people in social dilemmas.

The social dilemma task included eight equivalent blocks of six trials and a ninth block of five trials, as is discussed shortly. Participants were not informed about the total number of 53 trials, but they were informed that before proceeding to the next trial they would receive information about the partner's choice and the partner would receive information about the participant's choice. After explaining the social dilemma task, we administered 10 questions to check comprehension of the task, which revealed good comprehension by all participants (i.e., a mean score of 9.42 of 10).

Because the experimental task used coins, which represented hypothetical amounts of money, we sought to increase the value of the coins by noting that participants would increase the odds of receiving an extra reward of 25 Dutch Guilders (approximately $12 in American currency) as they accumulated a greater amount of money in the experimental task. That is, we stated that the amount of money (coins) accumulated for themselves corresponded to a number of tickets in a raffle for the extra reward, making clear that their changes would increase by the amount of money they accumulated for themselves, not by the amount of money they accumulated more than others (i.e., we used an absolute standard, and the number of certificates was not fixed). In the actual raffle, held after the entire experiment was completed, each participant had an equal chance of winning one of five extra rewards (for a comparable procedure, see Van Lange et al., 2002; Van Lange & Visser, 1999).

Manipulation of partner's strategy. Both TFT and TFT + 1 were programmed to begin by giving 6 coins. We decided to make both preprogrammed strategies start in Trial 1 by giving 6 coins (moderate cooperation) instead of 10 coins (maximal cooperation) because we know from previous research that hardly any real person gives 10 coins at the first trial (Van Lange et al., 2002). By starting with 6 coins, the behavior of the preprogrammed partner was realistic, whereas at the same time this partner showed good intentions (cooperation exceeded the midpoint of possible cooperation). In subsequent trials, TFT was programmed to give the same number of coins as the participant gave in the previous trial, and TFT + 1 was programmed to give the same number of coins as the participant gave in the previous trial plus 1 coin extra.

Because no more coins than the maximum of 10 coins could be given, TFT + 1 could not pursue adding 1 coin if the participant gave 10 coins in the previous trial. In these instances, TFT + 1 was programmed to give the maximum of 10 coins. It appeared that, on average, the 67 participants interacting with TFT + 1 gave 10 coins in about 17 of the 53 trials (M = 17.01), indicating that TFT + 1 actually gave 1 coin more than it received in 67.9% of the interaction trials.[1]

Manipulation of noise. Prior to making choices in the social dilemma task, participants in the two noise-present conditions were told that we were interested in examining situations in which there may be discrepancies between decisions intended by one person and the observation of this decision by another person. Next, we explained that, for this reason, the computer would change choices of one of the partners every now and then (for similar instructions, see Van Lange et al., 2002). The incidents of noise were illustrated by an example so that participants could see how the computer might change choices and how the computer would inform the actor about such changes. The instructions emphasized that, although the actor would receive information when his or her choice had been changed, the partner would not be informed about a change in actor's intended choice. So, participants could never be sure whether the number of coins given to them by the partner was the result of an intended choice or the result of a choice changed by computer. At the end of the noise instructions, which were obviously not included in the no-noise condition, participants were led to believe that the computer had randomly determined that the choices of their partner (and not their own choices) would be changed in some trials.[2]

As noted earlier, the social dilemma task included 53 interaction trials, consisting of eight structurally equivalent blocks of trials, in that each block began with 5 normal trials followed by a 6th trial involving noise, and a final ninth block of trials, which included only 5 normal trials. The final block of trials, Block 9, did not end with a trial involving noise because this trial could not affect subsequent levels of cooperation. In this way noise affected choices at every 6th trial (Trial 6, Trial 12, and so on) with a total of 8 out of the 53 trials, which makes the frequency of noise 15%.

Incidents of noise were operationalized by subtracting two or three coins from the "intended" choice of the preprogrammed partner. This intended choice was based on the former choice of the participant, following TFT or TFT + 1, as explained earlier. We alternated between subtractions of two and three coins to induce some randomness to the noise intensity, starting with an intensity of three coins in Trial 6, two coins in Trial 12, three coins in Trial 18, and so on. Whenever the preprogrammed partner intended to give fewer than two or three coins, noise involved the maximal number of coins that could be subtracted from the intended choice. Of course, when the partner intended to give zero coins, negative noise could not affect that intended choice. Indeed, it is impossible to completely prevent such "no-hits" (see Van Lange et al., 2002). Also, with an eye on everyday inter-

[1] On average, the 134 participants gave 10 coins in about 16 of the 53 trials (M = 16.19). There was no difference in this percentage of maximum cooperation (30.6%) between participants interacting with TFT or with TFT + 1. Further, a main effect of condition and planned comparisons revealed that this percentage was significantly lower in the no-communication condition (22.3%) than in both the no-noise condition (39.7%) and the communication condition (29.5%). Generally, these findings are not surprising because, as outlined earlier, noise without communication should exert detrimental effects on level of cooperation, including the frequency of maximal cooperation.

[2] We programmed noise in such a manner as to affect only choices of the preprogrammed partner (and not to affect choices of the participant). The primary reason was that we were interested in examining whether a manipulation at the partner's side (communication about noise) was sufficient to overcome detrimental effects of the actor's (i.e., participant's) cooperation. Moreover, an earlier study revealed that the effects of noise on cooperation are independent of whether noise affects a participant's choices, a partner's choices, or both of their choices (Van Lange et al., 2002).

actions, the prevention of no-hits would be unrealistic, because the presence of no-hits resembles situations in reality: Whenever someone decides not to cooperate at all, level of cooperation cannot become less by accidental feuds. No-hits cannot occur with TFT + 1, as this strategy will never intend to give zero coins. It appeared that with TFT, on average, noise did not influence choices in fewer than two of eight noise incidents (the mean number of no-hits was $M = 1.80$).[3]

Manipulation of communication. Prior to the social dilemma task, participants in the communication condition were told that one of both partners would be given the opportunity to send a maximum of 10 messages to the other person. Additionally, participants were informed that (a) this opportunity would only be given after some interaction trials, (b) messages could only be sent after outcomes of a trial had been displayed, (c) the messages could not exceed 30 words, and (d) the content of the messages had to be relevant to the interaction. The instructions also explained how to send and how to receive messages. Thereafter, we informed participants that a lottery would determine who would be able to send messages (and who not). The (actually bogus) result of the lottery was always that the partner, and not the participant, was able to send messages.

Because we were particularly interested in examining the ability of communication to reduce the detrimental effects of noise, we programmed the messages to be sent after trials that were affected by noise. More specifically, the messages were sent after Trial 6, Trial 12, Trial 24, Trial 30, Trial 36, and Trial 48 (i.e., six out of the eight noise trials).[4] The messages explained the former incident of noise, stated each time in slightly different words; for example "I wanted to give you six coins, but the computer changed my decision. I think you only received three coins." The first message (after Trial 6) and the fourth message (after Trial 30) ended with an apology such as "I'm sorry" to capture the everyday-life nature of communication and thus to prevent the messages from looking artificial. We reasoned that apologizing every now and then is something people often do quite naturally in case things go wrong, even when these situations are caused by external events.

Communication was only referring to actual noise (and no message was sent in case of a no-hit). It appeared that all 40 participants in the communication condition received at least two messages, whereas 32 of them received the maximum of six messages ($M = 5.58$).

Measuring impressions of benign intent. On completion of the social dilemma task, participants proceeded with a postexperimental questionnaire, including 11 items assessing impressions of benign intent during the interaction (cf. Van Lange et al., 2002). Positive items were "the other was" [stem] . . . "generous," "nice," "forgiving," "kind," and "trustworthy," and negative items were "the other was" [stem] . . . "self-centered," "greedy," "competitive," "stingy," "vengeful," and "selfish" (Cronbach's $\alpha = .85$). Participants could indicate how much they agreed with these statements on scales ranging from 1 (*not at all*) to 7 (*very much*).

Results and Discussion

In the following analyses, we examine level of cooperation in a 3 (condition: no noise vs. no communication vs. communication) × 2 (strategy: TFT vs. TFT + 1) × 9 (blocks of trials) analysis of variance, with the latter variable being a within-participant variable. We examine benign impressions in a 3 (condition: no noise vs. communication vs. no communication) × 2 (strategy: TFT vs. TFT + 1) analysis of variance. Because we hypothesized that noise exerts detrimental effects on cooperation (Hypothesis 1a) and benign impressions (Hypothesis 1b), and that these effects can be sufficiently reduced by communication (Hypotheses 2a and 2b), we argue that levels of cooperation and benign impressions are lower under conditions in which noise is presumed to exert detrimental effects (i.e., no communication) than under conditions in which either noise is absent (i.e., no noise) or communication could help reduce the detrimental effects of noise (i.e., communication). To test these hypotheses, we computed two hypothesis-relevant orthogonal contrasts for both dependent variables. One contrast, which we refer to as the *first contrast*, compares the no-communication condition with both the no-noise condition and the communication condition. The other contrast, to which we refer as the *second contrast*, allows us to test differences between the no-noise and communication conditions.

Level of cooperation. A 3 (condition) × 2 (strategy) × 9 (blocks of trials) analysis of variance revealed the hypothesized detrimental effect of noise and the positive effect of communication: Participants in the no-communication condition exhibited lower levels of cooperation ($M = 4.95$, $SD = 2.84$) than did participants in the no-noise condition ($M = 6.11$, $SD = 2.94$) and in the communication condition ($M = 5.81$, $SD = 2.63$). Although the main effect of condition failed to reach significance, $F(2, 128) = 2.24$, $p = .110$, planned comparisons indeed revealed that the first contrast was significant, $F(1, 128) = 4.31$, $p < .05$, whereas the second contrast revealed no significant effect, $F(1, 128) = 0.17$, *ns*. Thus, we found support for the hypotheses: Noise exerted detrimental effects on level of cooperation (Hypothesis 1a), and the presence of communication reduced these detrimental effects of noise to such extent that cooperation in the communication condition did not significantly differ from cooperation in the no-noise condition (Hypothesis 2a).

Of lesser importance, we also observed a main effect of strategy, $F(1, 128) = 5.68$, $p < .05$, indicating that independent of condition, participants who interacted with TFT exhibited lower levels of cooperation ($M = 5.05$, $SD = 2.85$) than did participants who interacted with TFT + 1 ($M = 6.18$, $SD = 2.73$). No interactions between condition and strategy or contrasts and strategy were found (all Fs $< .05$, all ps $> .84$). Moreover, we observed a main effect of blocks of trial, $F(8, 121) = 6.75$, $p < .001$, whereas there were no significant interaction effects involving blocks of trials. It appeared that, independent of condition and strategy, level of cooperation increased gradually over the first five blocks (Ms = 4.53, 5.38, 5.64, 5.78, 6.05, in Blocks 1 through 5, respectively), after which level of cooperation decreased somewhat in Block 6 ($M = 5.63$) and increased again over the last three blocks (Ms = 5.61, 5.82, 6.19, in Blocks 7 through 9, respectively). Pairwise

[3] The number of no-hits in the no-communication condition with TFT ($M = 2.26$) was somewhat higher than in the communication condition with TFT ($M = 1.29$). This is not surprising, because, as we show in the results section, level of cooperation was higher in the communication condition than in the no-communication condition.

[4] We decided not to program a message after each noise trial, because we reasoned that it would be more realistic if the partner used the messages somewhat sparingly: Participants were told that their partners could only send 10 messages and, just like themselves, did not know how many trials there would be in total. At the same time, we wanted to inform participants as completely as possible about incidents of noise. Hence, whenever noise actually affected the partner's choice at Trial 18 and Trial 42 (i.e., the noise trials after which no messages were sent), the next message (after Trial 24 and Trial 48) was extended with information about this former incident (e.g., "Some trials ago, the computer also gave you less than I intended. I didn't send you a message at that time.").

comparisons revealed significant differences between Blocks 1 and 2, 5 and 6, and 8 and 9 (all ts > 2.21, all ps $< .05$). [5]

Benign impressions. Benign impressions of the partner were analyzed in a 3 (condition: no noise vs. communication vs. no communication) $\times$ 2 (strategy of the partner: TFT vs. TFT + 1) analysis of variance, which revealed a main effect of condition, $F(2, 128) = 5.70$, $p < .01$. This main effect indicated that participants in the no-communication condition formed less-benign impressions of their partner ($M = 4.46$, $SD = 1.13$) than did participants in the no-noise condition ($M = 5.09$, $SD = 0.83$) and the communication condition ($M = 4.83$, $SD = 0.97$). Indeed, as for level of cooperation, planned comparisons revealed the hypothesized negative effect of noise and the positive effect of communication: The first contrast was significant, $F(1, 128) = 9.84$, $p < .01$, whereas the second contrast revealed no significant effect, $F(1, 128) = 1.56$, *ns*. Thus, noise exerted detrimental effects on benign impressions of the partner (Hypothesis 1b), and the presence of communication could overcome these detrimental effects of noise (Hypothesis 2b). Of lesser importance, as for level of cooperation, a main effect of strategy was found, $F(1, 128) = 17.15$, $p < .001$, which revealed that impressions of a TFT partner were less benign ($M = 4.45$, $SD = 1.06$) than were impressions of a TFT + 1 partner ($M = 5.12$, $SD = 0.84$). No interactions between condition and strategy or contrasts and strategy were found.

Mediation by benign impressions. Is there evidence that benign impressions might mediate the effects observed for level of cooperation? At the outset, we note that, conceptually, benign impressions should both (a) summarize the evaluations of past behavior and interactions and (b) guide behavior and interactions in future trials. However, benign impressions were assessed only after the social dilemma task because we did not want the measurement of impressions to affect behavior and interaction in the social dilemma task. Hence, from the perspective of testing mediation, this order of measurement can only yield preliminary evidence because the presumed mediator (i.e., benign impressions) was assessed after we measured the criterion variable (i.e., level of cooperation).

Nevertheless, these analyses revealed some interesting patterns relevant to the mediating role of benign impressions. First, recall that the first contrast (i.e., no communication vs. communication and no noise) was significant for both benign impressions (i.e., the presumed mediator) and cooperation (i.e., the presumed criterion). Second, as expected, benign impressions and cooperation were significantly correlated ($r = .34$, $p < .01$). Third, a regression analysis in which cooperation is regressed onto the first contrast, strategy, the interaction, and benign impressions revealed a significant effect for benign impressions ($\beta = .287$, $t(134) = 3.14$, $p < .01$). Fourth, we tested whether the reductions in the main effects and interaction effect were significant (Kenny, Kashy, & Bolger, 1998).[6] It appeared that the inclusion of benign impressions caused a decline in the variance accounted for by the first contrast (from $\beta = .175$, $t(134) = 2.07$, $p < .05$ to $\beta = .104$, $t(134) = 1.23$, *ns*), a significant reduction ($Z = 2.28$, $p < .05$).

Thus, the findings revealed evidence (albeit preliminary) in support of the argument that the "positive" effects of communication on cooperation are mediated by benign impressions. Of lesser relevance, benign impressions also appeared to mediate the main effect of strategy on cooperation—from $\beta = .197$, $t(134) = 2.23$, $p < .05$, to $\beta = .085$, $t(134) = 0.92$, *ns*; a significant reduction ($Z = 2.58$, $p < .01$). Although not hypothesis relevant, this finding suggests the importance of benign impressions as an explanatory variable of cooperation in social dilemmas.

To summarize, consistent with the hypotheses predicting detrimental effects of noise, noise exerted detrimental effects on cooperation levels toward a partner and on benign impressions of this partner (Hypotheses 1a and 1b). Moreover, consistent with the hypotheses predicting positive effects of communication, communication about noise appeared to reduce or even overcome these detrimental effects on cooperation and benign impressions (Hypotheses 2a and 2b). Both effects generalized across two different types of partner's strategy, in that TFT and TFT + 1 partners benefited from communication to roughly the same degree. Finally, Study 1 revealed preliminary evidence suggesting that benign impressions mediated the positive effects of communication on cooperation, adding credence to the argument that communication serves to maintain impressions of benign intent, which in turn are important to reducing or overcoming detrimental effects of noise on cooperation.

Study 2

Study 2 was designed to test Hypotheses 1a through 2b, thereby seeking to extend and complement Study 1 in two theoretically important respects. First, as noted earlier, our framework assumed that "negative noise challenges impressions of benign intent," in that negative outcomes, and the ambiguity regarding the intended action by the partner, should lead to uncertainty regarding the partner's benign intent. Therefore, prior to the social dilemma task, Study 2 assessed differences in dispositional trust, defined as differences in the general belief in human benevolence or the default expectation of the trustworthiness of people in general (Van Lange, Van Vugt, Meertens, & Ruiter, 1998; Yamagishi, 1986, 1988; Yamagishi & Kakiuchi, 2000). Previous research on

[5] Previous research has revealed that level of cooperation may exhibit an increase, a decrease, or no change at all over interaction trials. Generally, these different findings can be understood in terms of several differences among these studies, including differences in partner's strategy (e.g., TFT tends to generate increases in cooperation in social dilemmas without noise; see Van Lange & Visser, 1999), gradual versus binary social dilemmas, detail of instructions, whether the outcomes represent value, and differences in sample characteristics. It is interesting that the decline in Block 6 followed by a subsequent increase in cooperation is similar to the U-shaped pattern observed by Rapoport and Chammah (1965). This U-shaped pattern may reflect the idea that people learn from the actual experience of mutual noncooperation (e.g., see Pruitt & Kimmel, 1977). However, the meaning and robustness of the decline in cooperation in Block 6 awaits further research, because, as the reader will see, Study 2 did not replicate the decline in cooperation at any block of trials.

[6] We used a formula discussed at: http://nw3.nai.net/~dakenny/mediate.htm (see Kenny et al., 1998). This approach, which is more conservative than several alternative approaches toward testing mediation (e.g., see MacKinnon, Lockwood, Hoffman, West, & Sheets, 2002) was used in both Studies 1 and 2. Also, we note that an analysis of variance in which benign impressions was included as a covariate also rendered the first contrast nonsignificant.

social dilemmas without noise has revealed that individuals with high trust tend to exhibit greater cooperation than individuals with low trust, even though such differences do not tend to be large, are not consistently observed, and sometimes are only revealed in interaction with other variables (e.g., Brann & Foddy, 1987; Parks, 1994; Parks, Henager, & Scamahorn, 1996; Van Lange et al., 1998). Because our framework assumes that incidents of negative noise challenge impressions of benign intent, we argue that differences between individuals with low and high levels of trust should be more pronounced under conditions in which noise is presumed to exert detrimental effects (i.e., no communication) than under conditions in which noise is absent (i.e., no noise) or communication helps to reduce the detrimental effects of noise (i.e., communication). Thus, our general hypothesis states that differences between low and high trust on cooperation (Hypothesis 3a) and impressions (Hypothesis 3b) are greater in the no-communication condition than in the no-noise or the communication condition.

Second, Study 1 examined impressions of benign intent by assessing global judgments of the partner, as used in previous research (e.g., "trustworthy" and "generous" vs. "self-centered" and "vengeful"). However, such global impressions are likely to be rooted in perceptions of the specific interaction goals, which underlie behavior (i.e., perceived transformations; Kelley & Thibaut, 1978). In assessing such interaction goals, we examined three prosocial goals and two proself goals. Prosocial goals were tendencies toward enhancing joint outcomes (MaxJoint), minimizing (absolute) differences between own and partner's outcomes (MinDiff), and enhancing the partner's outcomes (MaxOther); and proself goals were tendencies toward enhancing relative advantage over partner's outcomes (MaxRel) and enhancing one's own outcomes (MaxOwn). Assessing these interaction goals allows us to test Hypotheses 1b, 2b, and 3b in a comprehensive and specific manner, thereby providing greater insight into the perception of specific interaction goals that are most strongly challenged by noise. Moreover, assessing these transformations allows us to illuminate the mediating role of perceptions of specific interaction goals in accounting for the detrimental effects of noise and the positive effects of communication in reducing such detrimental effects.

Method

Participants and experimental design. Participants were 94 undergraduate students (55 women, 39 men; average age 21 years). As in Study 1, they were recruited at the campus of the Free University. The experimental design was a 3 (condition of the task: noise absent vs. noise present without communication vs. noise present with communication) × 2 (interpersonal trust: high vs. low) × 9 (blocks of trials) design, with the latter variable being a within-participant variable. As in Study 1, we refer to the three task conditions as the no-noise, no-communication, and communication conditions. The dependent variables were level of cooperation and impressions of benign intent, including perceptions of specific interaction goals.

Procedure. The procedure of Study 2 was identical to the procedure of Study 1, except for three differences. First, in Study 2 participants only started reading the task instructions (which were comprehended well; i.e., a mean score of 9.55 correct answers out of 10 questions of the comprehension check) after assessing their interpersonal trust, followed by a 7-min filler task, which included perceptions and judgments of colors. Second, the postexperimental questionnaires on partner impressions included additional questions regarding three prosocial and two proself goals. Third, because the findings of TFT and TFT + 1 partners were similar for the three conditions in Study 1, we decided to examine only a partner pursuing TFT.

Measuring dispositional trust. Participants' level of trust was measured using a Dutch translation of Yamagishi's (1986, 1992) Interpersonal Trust Scale (e.g., Van Lange et al., 1998). Participants had to indicate how much they agree with eight different statements on scales ranging from 1 (*not at all*) to 7 (*very much*). Higher scores indicate lower trust (e.g., "You should not trust others, unless you know them very well."). This frequently used scale exhibited reasonable reliability in the present study ($\alpha = .73$). On the basis of a simple median split on the overall scale score, we labeled 48 participants as *high trusters* (participants with a mean score of 3.63 or lower) and 46 participants as *low trusters* (participants with a mean score higher than 3.63).[7]

Noise and communication. As in Study 1, we calculated whether all preprogrammed incidents of noise and communication actually occurred during the interaction. It appeared that in Study 2, on average, noise did not influence choices in about one of the eight noise incidents in total (no-hit $M = 1.34$).[8] As in Study 1, messages were only sent after noise actually affected a choice. It appeared that of the 29 participants in the communication condition, 18 participants received the maximum amount of six messages, whereas none of the participants received fewer than two messages ($M = 5.41$). Trust was not related to the number of received messages.

Measuring impressions of benign intent. On completion of the social dilemma task, participants proceeded with a postexperimental questionnaire. First, we assessed impressions of benign intent with the same 11 items used in Study 1 (Study 2, $\alpha = .84$). Second, 15 items assessed participants' impressions of the partner's prosocial and proself interaction goals. Each goal was indicated by 3 items, which exhibited good internal reliability: MaxJoint, $\alpha = .84$ (e.g., "the other person wanted to get the most outcomes for the two of us"); MinDiff, $\alpha = .85$ (e.g., "the other person wanted to minimize the differences in outcomes between me and him or her"); MaxOther, $\alpha = .74$ (e.g., "the other person wanted me to get the most outcomes"); MaxRel, $\alpha = .92$ (e.g., "the other person wanted to get more outcomes than I did"); MaxOwn, $\alpha = .85$ (e.g., "the other person wanted to get as many outcomes as possible for him- or herself").

Results and Discussion

As in Study 1, the social dilemma task involved 53 trials, consisting of eight equivalent blocks of 5 trials without noise and 1 trial with noise and of a ninth block of only 5 trials without noise.

[7] In determining our strategy of analyses, we considered both regression analysis and analysis of variance using median split for trust. Although regression analysis has clear advantages, we report the results obtained in analyses of variance (see also Parks et al., 1996; Van Lange et al., 1998; Yamagishi & Cook, 1993). The primary reason was that the data for trust revealed a rather substantial violation of normality in the distribution, with the scores for trust exhibiting a bimodal distribution in which two clusters of peak values were observed (one between scores of 2.25 and 2.75, and one between scores of 3.75 and 4.25). The scores of only 2 participants (2.1%) equaled the median value (3.625). Exclusion of these participants did not change the results.

[8] As in Study 1, the number of no-hits in the no-communication condition ($M = 1.80$) was somewhat higher than in the communication condition ($M = 0.79$). This is not surprising, because, as we show in the results section, level of cooperation was higher in the communication condition than in the no-communication condition. Trust was not related to the number of no-hits.

In the following analyses, we examine level of cooperation in a 3 (condition: no noise vs. communication vs. no communication) × 2 (interpersonal trust: high vs. low) × 9 (blocks of trials) analysis of variance, with the latter variable being a within-participant variable. We examined partner impressions by performing a 3 (condition: no noise vs. communication vs. no communication) × 2 (interpersonal trust: high vs. low) analysis of variance for each impression. To test the central hypotheses, we computed the same orthogonal contrasts as in Study 1 for each of the dependent variables: (a) the first contrast, which compares the no-communication condition with both the no-noise condition and the communication condition, and (b) the second contrast, which compares the no-noise condition with the communication condition.

Level of cooperation. A 3 (condition) × 2 (trust) × 9 (blocks of trials) analysis of variance revealed a main effect of condition, $F(2, 88) = 5.04$, $p < .01$, indicating that participants in the no-communication condition ($M = 4.51$, $SD = 3.00$) exhibited lower levels of cooperation than did participants in the no-noise condition ($M = 6.07$, $SD = 2.91$) and in the communication condition ($M = 6.32$, $SD = 2.44$). Indeed, planned comparisons revealed the hypothesized positive effect of communication: The first contrast was significant, $F(1, 88) = 9.83$, $p < .002$, whereas the second contrast revealed no significant effect, $F(1, 88) = 0.24$, *ns*. No main effect of trust was found, $F(1, 88) = 1.02$, *ns*. Thus, as did Study 1, Study 2 provides good support for the central hypotheses, in that noise exerted detrimental effects on level of cooperation (Hypothesis 1a), and communication was effective at reducing these detrimental effects (Hypothesis 2a).

More important, this main effect was qualified by an interaction between condition and trust, $F(2, 88) = 4.85$, $p < .01$. As can be seen in Table 1 (Level of cooperation section), high trusters exhibited about the same level of cooperation across all three conditions, whereas low trusters exhibited lower levels of cooperation in the no-communication condition than they did in both the no-noise and the communication conditions. Indeed, planned comparisons revealed a significant interaction between trust and the first contrast, $F(1, 88) = 7.62$, $p < .01$, whereas the interaction between trust and the second contrast was not significant, $F(1, 88) = 2.08$, *ns*.

Thus, we found support for the central hypothesis: Differences between high and low trusters in level of cooperation were more pronounced in the no-communication condition than in the no-noise condition or the communication condition (Hypothesis 3a). Specifically, noise exerted detrimental effects on cooperation only for low trusters and, as a result, only for these participants could the detrimental effects be overcome by communication.[9] Finally, a main effect of blocks of trials was found, $F(8, 81) = 3.82$, $p < .001$. It appeared that overall level of cooperation increased gradually over the first five blocks (Ms = 4.76, 5.28, 5.57, 5.36, 5.85, in Blocks 1 through 5, respectively—with significant or marginal differences between Blocks 1 and 2, 2 and 3, and 4 and 5; all ts > 1.87, all ps < .07), after which levels of cooperation remained essentially the same (Ms = 5.81, 5.86, 5.80, 5.85, in Blocks 6 through 9, respectively).[10]

Benign impressions. Benign impressions were analyzed in a 3 (condition) × 2 (trust) analysis of variance, which revealed effects that were similar to those observed for level of cooperation. First, a main effect of condition, $F(2, 88) = 10.91$, $p < .001$, revealed that impressions of partners in the no-communication condition were less benign ($M = 3.94$, $SD = 0.99$) than impressions of partners in the no-noise condition ($M = 4.85$, $SD = 0.89$) and in the communication condition ($M = 4.73$, $SD = 0.84$). Indeed, planned comparisons revealed the hypothesized detrimental effect of noise and the positive effect of communication: The first contrast was significant, $F(1, 88) = 21.73$, $p < .001$, whereas the second contrast was not significant, $F(1, 88) = 0.09$, *ns*. No main effect of trust was found, $F(1, 88) = 0.03$, *ns*. Thus, as for level of cooperation, noise exerted detrimental effects on benign impressions (Hypothesis 1b), and the presence of communication could reduce the detrimental effects of noise (Hypothesis 2b).

More important, the main effect of condition was again qualified by an interaction between condition and trust, $F(2, 88) = 7.83$, $p < .001$. As can be seen in Table 1 (Benign impressions section) the impressions held by high trusters were quite similar for the three conditions, whereas the impressions held by low trusters were quite different for the three conditions. Low trusters in the no-communication condition formed less-benign impressions of their partners than did low trusters in both the no-noise condition and the communication condition. As for level of cooperation, planned comparisons revealed a significant interaction between trust and

Table 1
Means (and Standard Deviations) for Level of Cooperation and Benign Impressions as a Function of Condition and Trust

	Condition		
Dependent variable/trust	No noise	Communication	No communication
Level of cooperation			
Low trusters	5.84 (3.13)	7.20 (1.73)	3.12 (2.21)
High trusters	6.38 (2.68)	5.70 (2.71)	5.82 (3.11)
Overall	6.07 (2.91)	6.32 (2.44)	4.51 (3.00)
Benign impressions			
Low trusters	5.14 (0.97)	4.84 (0.75)	3.44 (1.01)
High trusters	4.48 (0.64)	4.65 (0.91)	4.40 (0.72)
Overall	4.85 (0.89)	4.73 (0.84)	3.94 (0.99)

[9] Note that the interaction between trust and the second contrast was not significant. Hence, we regard further speculation about the seemingly high level of cooperation for low trusters in the communication condition ($M = 7.20$, $SD = 1.73$) irrelevant.

[10] The analysis also revealed a marginal interaction between condition, trust, and blocks of trials, $F(16, 162) = 1.58$, $p = .08$. Planned comparisons revealed a significant interaction between the first contrast with blocks of trials and trust, $F(8, 81) = 2.42$, $p < .05$, whereas the second contrast did not interact with blocks of trials and trust. The pattern of levels of cooperation over blocks of trials showed that high trusters, independent of condition, started with a reasonable level of cooperation, which remained rather stable over time. Low trusters started with lower levels of cooperation, but increased their level of cooperation over time in both the no-noise condition and the communication condition; whereas low trusters in the no-communication condition did not increase their level of cooperation over time. The means relevant to this interaction are available from the authors. There was no interaction between blocks of trials and trust, $F(8, 81) = 1.26$, *ns*.

the first contrast, $F(1, 88) = 14.55$, $p < .001$, whereas the interaction between trust and the second contrast was not significant, $F(1, 88) = 1.11$, *ns*. Thus, we found support for Hypothesis 3b, predicting that differences in low versus high trust would be more pronounced in the no-communication condition than in the no-noise condition or the communication condition.

Impressions of partner's interaction goals. Impressions of the partner's interaction goals were analyzed using 3 (condition) × 2 (trust) analyses of variance. For ease of interpretation, the *F* values of these main effects are presented in Table 2 (Simple main effects section) in the Condition column. As can be seen, the analysis revealed significant main effects of condition for each of the prosocial transformations (i.e., MaxJoint, MinDiff, and MaxOther) and both proself transformations (i.e., MaxOwn and MaxRel). The means relevant to these effects are summarized in Table 3 in the Overall rows and reveal that participants in the no-communication condition formed less-strong prosocial impressions as well as stronger proself impressions of their partner than did participants in the no-noise condition and the communication condition. Indeed, the first contrast was significant for all five interaction goals, as can be seen in the first part of Table 2 (First contrast column), indicating that communication could overcome detrimental effects of noise on impressions of prosocial goals and proself goals.[11] Thus, consistent with Hypothesis 1b, noise exerted detrimental effects on the impressions of the partner's goals (i.e., participants ascribed lower levels of prosocial goals and higher levels of proself goals to their partners). Consistent with Hypothesis 2b, communicating about noise significantly reduced the detrimental effects of noise on impressions of prosocial and proself goals.

Moreover, for two prosocial goals (i.e., MaxJoint and MinDiff) and one proself goal (i.e., MaxRel) the main effects were qualified by interactions between trust and condition. The *F* values of the interactions between trust and condition and between trust and the contrasts for all goals can be found in Table 2 (Interactions with trust section). More important, planned comparisons for MaxJoint, MinDiff, and MaxRel revealed significant interactions of trust and the first contrast, whereas the interactions between trust and the second contrast were not significant (see Table 2, First contrast and Second contrast sections). The means relevant to these interactions are summarized in Table 3 and reveal that, for high trusters, impressions of MaxJoint, MinDiff, and MaxRel of the partner were hardly affected by condition, whereas, for low trusters, impressions of MaxJoint and MinDiff were less strong and impressions of MaxRel were stronger in the no-communication condition than they were in both the no-noise and the communication condition. For impressions of MaxOther and MaxOwn, no interactions between trust and contrasts were found.

Mediation analyses. Complementing the mediation analyses in Study 1, we examined the ability of both impressions of benign intent and impressions of specific interaction goals to mediate both the detrimental effects of noise and the positive effects of communication in coping with noise. Also, as in Study 1, because we assessed these impressions after behavior and interactions in the social dilemma, the evidence should be regarded as preliminary.

Table 2
An Overview of F Values Associated With the Effects of Condition and Trust on Partner Impressions

Partner impression	Condition $F(2, 88)$	First contrast $F(1, 88)$	Second contrast $F(1, 88)$
Simple main effects			
MaxJoint	7.84***	15.66***	0.02
MinDiff	7.35***	13.69***	1.02
MaxOther	9.03***	12.55***	5.51*
MaxRel	5.21**	10.21**	0.21
MaxOwn	4.91**	9.79**	0.03
Interactions with trust			
MaxJoint	3.74*	7.40**	0.09
MinDiff	3.03†	6.05*	0.00
MaxOther	0.96	1.37	0.54
MaxRel	3.24*	6.40*	0.07
MaxOwn	1.62	1.65	1.59

Note. The first contrast compares the no-communication condition with both the no-noise condition and the communication condition. The second contrast compares the no-noise condition with the communication condition. MaxJoint = tendencies toward enhancing joint outcomes; MinDiff = minimizing (absolute) differences between own and partner's outcomes; MaxOther = enhancing the partner's outcome; MaxRel = tendencies toward enhancing relative advantage over partner's outcomes; MaxOwn = enhancing one's own outcomes.
† $p = .053$. * $p < .05$. ** $p < .01$. *** $p < .001$.

Table 3
Means (and Standard Deviations) for Partner Impressions as a Function of Condition and Trust

	Condition		
Dependent variable/trust	No noise	Communication	No communication
MaxJoint			
Low trusters	5.65 (1.32)	5.58 (1.28)	3.51 (1.66)
High trusters	5.10 (1.35)	5.28 (1.47)	4.80 (1.61)
Overall	5.41 (1.34)	5.40 (1.38)	4.17 (1.74)
MinDiff			
Low trusters	6.08 (1.35)	5.72 (1.54)	4.04 (1.70)
High trusters	5.85 (0.97)	5.45 (1.29)	5.28 (1.47)
Overall	5.98 (1.18)	5.56 (1.37)	4.68 (1.68)
MaxOther			
Low trusters	3.04 (1.09)	4.00 (1.29)	2.31 (1.13)
High trusters	2.95 (1.59)	3.45 (0.90)	2.59 (1.41)
Overall	3.00 (1.30)	3.68 (1.09)	2.46 (1.13)
MaxRel			
Low trusters	2.80 (1.47)	2.72 (1.28)	4.73 (1.71)
High trusters	3.39 (1.87)	3.08 (1.46)	3.46 (1.71)
Overall	3.06 (1.65)	2.93 (1.37)	4.08 (1.80)
MaxOwn			
Low trusters	3.08 (1.96)	2.61 (1.16)	4.41 (1.73)
High trusters	2.74 (1.53)	3.37 (1.61)	3.70 (1.65)
Overall	2.93 (1.76)	3.06 (1.47)	4.05 (1.70)

Note. MaxJoint = tendencies toward enhancing joint outcomes; MinDiff = minimizing (absolute) differences between own and partner's outcomes; MaxOther = enhancing the partner's outcome; MaxRel = tendencies toward enhancing relative advantage over partner's outcomes; MaxOwn = enhancing one's own outcomes.

[11] Additionally, for MaxOther, the second contrast was significant (see Table 2, Second contrast heading), indicating that the positive effect of communication was even stronger than hypothesized.

Before conducting mediation analyses, we examined the intercorrelations among the impressions, revealing that benign impressions exhibited significant, and descriptively strong, correlations with impressions of all three prosocial goals (rs = .70, .65, and .59; all ps $< .001$, for MaxJoint, MinDiff, and MaxOther, respectively), as well as with both proself goals (rs = $-.50$ and $-.66$, both ps $<$ .001, for MaxOwn and MaxRel, respectively). These findings are consistent with the theoretical argument that global impressions are rooted in perceived transformations, or impressions of specific interaction goals (cf. Kelley & Stahelski, 1970; Rusbult & Van Lange, 2003). Next, we began our analysis by examining the mediating role of the most global judgment (i.e., benign impressions) followed by examining the mediating role of impressions regarding a partner's specific interaction goals.

The analysis of mediation by benign impressions proceeded in four steps. First, recall that the first contrast (i.e., no communication vs. communication and no noise), and the interaction of the first contrast and trust, was significant for both benign impressions (i.e., the presumed mediator) and cooperation (i.e., the presumed criterion variable). Second, as would be expected, benign impressions and cooperation were significantly correlated ($r = .38$, $p <$ .01). Third, a regression analysis in which cooperation is regressed onto the first contrast, trust, the interaction, and benign impressions revealed a significant effect for benign impressions ($\beta =$ .238, $t(94) = 2.12$, $p < .05$). Fourth, the inclusion of benign impressions caused a decline in the variance accounted for by the first contrast (from $\beta = .290$, $t(94) = 3.01$, $p < .01$, to $\beta = .188$, $t(94) = 1.78$, *ns*), a significant reduction ($Z = 1.98$, $p < .05$). Also, the inclusion of benign impressions caused a decline in the variance accounted for by the interaction between the first contrast and trust (from $\beta = -.261$, $t(94) = -2.70$, $p < .01$, to $\beta = -.179$, $t(94) = -1.75$, *ns*), a marginal reduction ($Z = 1.91$, $p < .06$). Thus, the findings revealed evidence (albeit preliminary) in support of the argument that the positive effect of communication, and its interaction effect with trust, on cooperation would be mediated by benign impressions.[12]

As in the previous analysis, the analysis of mediation by impressions of interaction goals proceeded in four steps. First, recall that the first contrast (i.e., no communication vs. communication and no noise), and its interaction with trust, was significant for MaxJoint, MinDiff, and MaxRel transformations (and not significant for MaxOther and MaxOwn transformations). Second, MaxJoint, MinDiff, and MaxRel transformations exhibited significant correlations with level of cooperation (respective rs = .52, .48, and $-.24$; all ps $< .05$). Next, we performed three separate regression analyses in which we included each of the transformations (MaxJoint, MinDiff, and MaxRel) as a predictor variable.

The regression analysis in which cooperation is regressed onto the first contrast, trust, the interaction, and MaxJoint transformations revealed a significant effect for MaxJoint transformations ($\beta = .431$, $t(94) = 4.36$, $p < .001$). Moreover, the inclusion of MaxJoint transformations caused a decline in the variance accounted for by the first contrast (from $\beta = .290$, $t(94) = 3.01$, $p <$ .01, to $\beta = .126$, $t(94) = 1.32$, *ns*), a significant reduction ($Z =$ 3.01, $p < .01$). Also, the inclusion of MaxJoint transformations caused a decline in the variance accounted for by the interaction between the first contrast and trust (from $\beta = -.261$, $t(94) = -2.70$, $p < .01$ to $\beta = -.150$, $t(94) = -1.63$, *ns*), a significant reduction ($Z = 2.17$, $p < .05$).

The regression analysis in which cooperation is regressed onto the first contrast, trust, the interaction, and MinDiff transformations revealed a significant effect for MinDiff transformations ($\beta = .371$, $t(94) = 3.71$, $p < .001$). Moreover, the inclusion of MinDiff transformations caused a decline in the variance accounted for by the first contrast (from $\beta = .290$, $t(94) = 3.01$, $p <$ .01, to $\beta = .158$, $t(94) = 1.63$, *ns*), a significant reduction ($Z =$ 2.68, $p < .01$). Also, the inclusion of MinDiff transformations caused a decline in the variance accounted for by the interaction between the first contrast and trust (from $\beta = -.261$, $t(94) = -2.70$, $p < .01$, to $\beta = -.170$, $t(94) = -1.81$, *ns*), a significant reduction ($Z = 2.17$, $p < .05$).

The regression analysis in which cooperation is regressed onto the first contrast, trust, the interaction, and MaxRel transformations revealed no significant effect for MaxRel transformations ($\beta = .098$, $t(94) = -0.93$, *ns*). Moreover, the inclusion of MaxRel did not cause a significant decline in the first contrast (from $\beta =$ .290, $t(94) = 3.01$, $p < .01$, to $\beta = .259$, $t(94) = 2.54$, $p < .05$), a nonsignificant reduction ($Z = 0.94$, *ns*), or the interaction between the first contrast and trust (from $\beta = -.261$, $t(94) = -2.70$, $p < .01$, to $\beta = -.237$, $t(94) = -2.37$, $p < .05$), a nonsignificant reduction ($Z = 0.94$, *ns*). Thus, although judgments of partner's MaxJoint and MinDiff transformations—two prosocial transformations—mediated the effects of the first contrast and its interaction with trust, judgments of partner's MaxRel transformation did not qualify as a significant mediator.[13]

Finally, in a more exploratory vein, we conducted an analysis in which cooperation was regressed simultaneously onto the first contrast, trust, and the interaction of the contrast and trust, as well as on the three impressions that qualified as significant mediators (i.e., benign impressions, MaxJoint, and MinDiff). This analysis revealed that only MaxJoint continued to exhibit a significant association with cooperation ($\beta = .371$, $t(94) = 2.44$, $p < .05$). Benign impressions and MinDiff no longer accounted for significant variance in cooperation: For benign impressions $\beta = -.095$, $t(94) = -0.70$, *ns*, and for MinDiff $\beta = .160$, $t(94) = 1.11$, *ns*. These findings suggest that impressions about the degree to which a partner is judged as oriented toward enhancing joint outcomes (MaxJoint) is a relatively powerful mediator of both the detrimental effects of noise and the positive effects of communication.

To summarize, the findings revealed evidence (albeit preliminary) in support of the argument that positive effect of communication on cooperation, observed for individuals low in trust, is mediated by a global impression (i.e., benign impressions) and impressions of two specific interaction goals (i.e., MaxJoint and MinDiff transformations). Considering all three mediators, the impressions of the partner's goal toward enhancing joint outcome (MaxJoint) appears to be the most powerful mediator of both the

[12] An analysis of variance with benign impressions as a covariate yielded the same findings as the regression analysis.

[13] Again, three separate analyses of variance with MaxJoint, MinDiff, and MaxRel as covariates yielded the same findings as the regression analysis.

detrimental effects of noise and the positive effects of communication.

General Discussion

Two experimental studies provided good support for the present hypotheses. First, in support of the hypothesis predicting detrimental effects of noise, both studies revealed that levels of cooperation and benign impressions were lower when noise was present than when noise was absent (i.e., supporting Hypotheses 1a and 1b). Second, and more important, in support of the hypothesis that communication reduces such detrimental effects, both studies revealed that levels of cooperation and benign impressions were lower in the no-communication condition than in the communication condition and no-noise condition (i.e., supporting Hypotheses 2a and 2b). Third, Study 2 revealed that differences between low- and high-trust individuals were, as predicted, more pronounced in the condition in which noise challenged impressions of benign intent (i.e., no-communication condition) than in the condition in which noise was absent and in the condition in which noise was effectively reduced through communication (Hypotheses 3a and 3b). Finally, Studies 1 and 2 provided preliminary evidence in support of the mediating role of impressions of benign intent in accounting for the positive effects of communication; Study 2 revealed even support for mediation by concrete beliefs regarding the partner's goal to enhance joint outcomes and equality in outcomes. In the following, we discuss these findings in terms of the present framework, consider some implications of the findings, and outline some strengths and limitations of the present research, along with directions for future research.

Detrimental Effects of Noise

The present research revealed that participants' level of cooperation with a partner is significantly diminished when the partner's choices are every now and then negatively affected by noise. The instructions in these studies stated that "the computer may change intended choices" so as to make participants aware of the possible occurrence of noise in each interaction trial. It is interesting that, despite such instructions, incidents of negative noise exerted reliable detrimental effects on both impressions of benign intent and cooperation.

Study 2 complemented the findings of Study 1 by indicating that the detrimental effects of noise on partner impressions work in two directions. First, noise hampers the behavioral expression of prosocial interaction goals. That is, participants ascribed less concern with equality in outcomes (MinDiff), joint outcomes (MaxJoint), and other's outcomes (MaxOther) to the partner under noise than under no noise. Second, noise promotes the behavioral expression of proself interaction goals. That is, participants ascribed greater concern with own outcomes (MaxOwn) and relative advantage (MaxRel) to the partner under noise than under no noise. (The impressions of two prosocial transformations, MaxJoint and MinDiff, were found to mediate the detrimental effects of noise—an issue to which we return later).

Hence, even though participants were told beforehand that the partner's choices would be affected by noise, they still seemed to have problems in ascribing diminished cooperation to incidents of noise and, instead, seemed to hold the personality and interaction goals of the partner responsible for this diminished cooperation. This mechanism parallels attributional tendencies toward explaining behavior in terms of intentions and traits rather than external causes (Jones & Davis, 1965; Ross, 1977), especially negative behavior (cf. Coovert & Reeder, 1990; Reeder & Brewer, 1979). In interdependent situations, especially social dilemmas (Allison & Kerr, 1994), such attributional tendencies are problematic, because they cause people to lower their levels of cooperation with their partners. These low levels of cooperation in turn trigger subsequent diminished cooperation of the partners. In other words, incidents of negative noise may bring about relatively enduring echo effects, a process that has been assumed to underlie escalation of conflict and international tension (e.g., Axelrod, 1984).

Benefits of Communication

The present results also revealed that the detrimental effects of noise can be relatively easily overcome by communication. Partners who communicated in the form of sending messages after some incidents of noise (in which noise and original intentions were explained and apologies were made occasionally) were able to elicit levels of cooperation and impressions of benign intent that were as high as in the condition in which noise was absent. These positive effects of communication are consistent with our reasoning outlined earlier: By communicating about noise partners are able to psychologically undo noise, thereby maintaining impressions of benign intent, which are essential to cooperative behavior.

When partners communicate, individuals appear willing to give a partner another chance: They react to the messages of intent and keep behaving cooperatively, rather than reacting to diminished outcomes for self due to noise. There is increasing evidence that generosity and forgiveness are effective at coping with noise in social dilemmas, as suggested by computer simulations (e.g., Bendor et al., 1991; Kollock, 1993; Molander, 1985; Nowak & Sigmund, 1992), as well as by a follow-up study using real participants (Van Lange et al., 2002). The present findings complement this growing literature by showing that *people are actually willing to forgive* an incident of noise, as long as the partner communicates about noise and clarifies the actual (benign) intentions. Thus, the positive effects of communication may be interpreted in terms of maintenance of impressions of benign intent through providing clarity on intentions (e.g., psychologically undoing noise), which in turn seems to enhance tendencies toward forgiveness, which are crucial to effectively coping with noise.

Consistent with this line of reasoning, the present research provided good support (albeit preliminary) for the mediating role of benign impressions in accounting for the positive effects of communication. Similar effects were observed for judgments about the partner's goal of enhancing joint outcomes and equality in outcomes, suggesting that in the context of social dilemmas with noise "benign intent" may be a general label for the concrete pursuit of "joint outcomes" and "equality in outcomes." Such prosocial impressions or beliefs seem essential to giving the other "the benefit of the doubt" (Bendor et al., 1991; Kramer, 1999; Van Lange et al., 2002), thereby enhancing forgiveness of negative behavior as well as cooperative interaction. Indeed, findings revealed significant mediation for both benign impressions and two

specific "prosocial" impressions (MaxJoint and MinDiff transformations). Moreover, regressions analyses involving all three significant mediators revealed that impressions of MaxJoint contributed above and beyond the other two mediators in accounting for the detrimental effects of noise and the positive effects of communication. Generally, these findings are of great theoretical interest, in that they provide support for the notion that individuals in social dilemmas are inclined to form both global impressions *and* specific impressions in terms of outcome transformations, which appear to be important for understanding key psychological mechanisms underlying cooperation (cf. Kelley et al., 2003; Kelley & Thibaut, 1978). As such, the present research contributes to understanding *why* noise exerts detrimental effects on cooperation and *why* communication provides an effective means for reducing or overcoming the detrimental effects of noise on cooperation in social dilemmas.

Moreover, it is interesting to note that the impressions of MaxJoint and MinDiff tend to go together in the actor's mind just as these two (conceptually independent) goals tend to go together in the actual orientations of people. That is, individuals who are more strongly oriented toward enhancing joint outcomes are also more strongly oriented toward enhancing equality in outcomes—and both orientations are needed to explain why people do or do not exhibit cooperation in iterated social dilemmas (Kelley & Stahelski, 1970; Van Lange, 1999). Thus, the two prosocial impressions that are found to serve as a mediator are exactly the same as the actual orientations that only in combination account for cooperative behavior.

Beyond the contributions discussed earlier, the present findings are interesting from at least two additional perspectives. First, in his influential work Axelrod (1984) attributed the success of TFT to niceness, forgiveness, and retaliation, as well as to clarity—the fact that partners are able to understand a partner's primary interaction goals. Past research provides some support for the benefits of clarity, through verbal communication (e.g., Chen, 1996; Chen & Komorita, 1994; Orbell et al., 1988) or through behavior (Komorita, Hilty, & Parks, 1991; Komorita, Parks, & Hulbert, 1992; Parks & Komorita, 1997). However, we do not know of any published study that has examined clarity as means for coping with noise. Conversely, in computer simulations with noise much attention has been paid to improving TFT by changing some of its other beneficial properties—examples are comparisons among versions of TFT differing in niceness, forgiveness, and retaliation. Yet, one may argue that negative noise also challenges impressions of benign intention because of a lack of clarity. Hence, one might suggest two distinct ways of coping with noise, one by which individuals seek to maintain or improve clarity (e.g., by communicating about noise) and another by which individuals seek to convey prosocial intentions (e.g., by exhibiting generosity, forgiveness, and niceness).

Second, earlier work on communication in social dilemmas has typically (but not always) revealed that communication about the choices at hand enhances cooperation. Such encouraging findings have been explained in terms of enhancing trust, publicly displaying commitment (also through pledging), collective identity, or mechanisms by which one conveys promise or threat (e.g., Chen & Komorita, 1994; Dawes et al., 1977; Deutsch, 1958; Loomis, 1959; Kerr & Kaufman-Gilliland, 1994; Lindskold, Han, & Betz, 1986; Orbell et al., 1988). The present research contributes to this work by indicating that one important function of communication may flow from providing clarity regarding a past interaction—by communicating discrepancies between intended and actual outcomes for the partner (e.g., "I did not mean it this way"). Hence, a promising avenue for future research is to study communication when impressions of benign intent are most seriously challenged (e.g., in social dilemmas with noise).

Influence of Trust

Although we obtained good support for the primary hypotheses underlying this research, it is also true that these hypotheses were supported for low trusters but not for high trusters. More generally, the present findings provided evidence in support of the hypothesis that individual differences in trust should have more pronounced effects under conditions of noise than under conditions of no noise or conditions in which noise is communicated. We consider these findings important for at least three broad reasons.

To begin with, high trusters tend to harbor impressions of benign intent and high levels of cooperation even under conditions of noise without communication—indeed, the mean levels of cooperation and impressions were not higher under conditions in which there was no noise or noise was unlikely to matter a lot (communication condition). This finding suggests that high trusters may be less susceptible to exhibiting negativity effects or to inferring negative intentions and traits from diminished interaction outcomes. In other words, high trusters may be inclined to give others the benefit of doubt, emphasizing the role of external circumstances and forces in accounting for negative behavior (cf. Kramer, 1999). In contrast, low trusters are more likely to rely on a predominant heuristic that people cannot be fully trusted, a schema which readily allows them to interpret seemingly negative behavior (i.e., diminished cooperation) in terms of tendencies toward competition. Consistent with this reasoning, low trusters suspected their partners of having greater concern with advantage or competition (MaxRel) and lower concern with joint outcomes or equality in outcomes (MaxJoint and MinDiff). Future research may benefit from examining differential negativity effects for individuals with differing levels of trust.

Second, it is interesting to relate the present findings to the extant literature on dispositional trust, which reveals—somewhat surprisingly—that dispositional trust does not tend to influence cooperative behavior in two-person social dilemmas (e.g., Yamagishi, 2001; Yamagishi & Kakiuchi, 2000). In retrospect, this can be understood because these social dilemmas were not affected by noise, hence allowing for considerable clarity in the link between intention and behavior. In contrast, in "noisy" social dilemmas, impressions of benign intent are strongly challenged, and such uncertainty or ambiguity brings along a larger impact of personality differences that are linked to global beliefs regarding malignant or benign intentions of other people. In terms of Snyder and Ickes (1985), noisy social dilemmas may be conceptualized as "weak situations" in which personality differences are more likely to matter than in "strong situations," which provide strong guidelines for how to interpret the situation and the partner as well as for how to behave oneself. Hence, social dilemmas with noise (and related forms of ambiguity or uncertainty) may well be the types of

situation that are especially likely to activate differences in personality that are linked to trust.

Finally, the present results show that especially low trusters are at risk in developing noncooperative interactions, even with partners who may in fact pursue cooperative goals. This finding is consistent with some earlier studies revealing that high trusters react more strongly to messages expressing a cooperative intent, whereas low trusters react more strongly to messages expressing a competitive intent (Parks et al., 1996). According to Rotter (1980), high trusters will trust a person unless they have clear evidence that he or she cannot be trusted, whereas low trusters distrust a person unless there is clear evidence that he or she can be trusted. These differences in perspective between high and low trusters may eventually result in differences in behavior they elicit from their partners. Indeed, the present findings lend support to the notion that low trusters may in fact "create a social world" in which they are continuously confronted with self-centered behavior, which provides not only inferior outcomes but also confirmation that others cannot be trusted to cooperate (cf. Kelley & Stahelski, 1970).

Avenues for Future Research

We begin by noting that noise in social dilemmas represents a new topic that we regard as promising for generating novel avenues for future research. Most important, noise can be thought of as a situational feature that may activate various psychological processes (e.g., feelings of uncertainty, trust) and interactional processes (e.g., communication, misunderstanding). Such processes are relevant to various key constructs in, for example, evolutionary theory (e.g., cheater detection; Cosmides & Tooby, 1992), theories of trust (e.g., Kramer, 1999; Yamagishi, 2001), interdependence theory (e.g., transformations; Kelley & Thibaut, 1978), and communication theory (e.g., effective communication; Gottman, 1994). We suggest that new avenues of research can be located in these broad domains, addressing specific questions relevant to social interaction and relationships (e.g., is marital quality and stability predicted by communicating about noise? cf. Gottman, 1994) and group processes (e.g., are members categorized as out-group given less benefit of the doubt than members categorized as in-group members? cf. Marques, Abrams, & Serôdio, 2001).

We consider it appropriate to briefly discuss some limitations of the present research and concrete avenues for future research. First, although it is common to use TFT as the default strategy followed by an interaction partner in a social dilemma, this "convention" has the limitation that findings may not be directly generalized to environments that consist of strategies that are somewhat less reciprocal than TFT. Although Study 1 revealed no differences between at least two strategies (i.e., TFT and TFT + 1), we suggest that it would be useful to examine the benefits of communication in social environments involving a greater variety in strategies, including ones that every now and then deviate from strict reciprocity.

Second, although the present research did examine—and did provide evidence in support of—the mediating role of impressions of benign intent and judgments regarding the partner's transformations (MaxJoint and MinDiff), complementary mechanisms underlying the benefits of communication in this paradigm remain to be illuminated. For example, in addition to providing clarity as such, communication by a partner may to some degree serve as a reminder of noise, may decrease feelings of anonymity (e.g., the partner may be less of a "stranger" through communication), and the occasional apology, while common, may also have promoted impressions of benign intent and cooperation.

Last but not least, we can imagine that several readers consider the positive effects of communication as "to be expected" or at least "far from counterintuitive." However, we do not regard these positive effects as self-evident. In fact, from the perspective of rational self-interest—a prevalent assumption in theories about social interaction—one may argue that communication may also be used to misinform the partner about one's intentions, especially when the intentions are oriented toward pursuing own outcomes or relative advantage. In that sense, it may even be considered remarkable that individuals do not tend to distrust communication about noise—especially because the positive effects of communication were observed for individuals low in trust (Study 2). At the same time, it is possible that the experimental circumstances were quite trusting and congenial so that deliberate forms of misinformation were not anticipated. However, experimental games are not known to promote trusting or congenial circumstances; if anything, the opposite is more strongly believed (e.g., because the other is a stranger, the focus is on "outcomes," see Van Lange, 2000). Nevertheless, we can imagine that less-trusting circumstances (e.g., an incident of noise in the very first interaction, increasing the frequency of noise, presenting the other as an out-group member) may cause an individual to question or challenge the honesty of an interaction partner's messages. Such circumstances may perhaps show that communication yields positive effects that are less strong, no positive effects at all, or perhaps even negative effects. Thus, we suggest that several issues need to be explored in future research to understand the effectiveness, as well as the potential boundary conditions, of communication as a means of coping with noise in social dilemmas.

Concluding Remarks

It is important to acknowledge that noise in social interaction represents a truly *social* psychological topic in that it addresses impression formation, attributional activity, and behavior and social interaction. As such, it is ironic that the discussion and research about noise in social interaction tends to take place in disciplines other than social psychology, in particular theoretical biology, political science, economics, and sociology. Moreover, virtually all research focusing on noise in social interaction has relied on computer simulations as the dominant paradigm. Given that coping with noise is truly social psychological, it is important to consider intrinsic social psychological mechanisms for coping with noise. We hope that the study of communication, with a conceptual and empirical focus on impressions of benign intent and trust, serves as an important step toward understanding how real people actually cope as well as how they might have coped with noise in social dilemmas.

We close by illustrating the potentially far-reaching implications of research on noise and trust in social dilemmas. Returning to the anecdotes described earlier, incidents of negative noise are easily

interpreted in terms of malignant intent, especially during periods of international tension and distrust (e.g., during the Cold War). Such misunderstandings may have very unfortunate consequences, including international warfare, violence, and suffering. As such, the present findings provide suggestive evidence for the functionality of a direct phone connection between world leaders during such circumstances of tension. Indeed, a hot line allows for direct communication about noise and for clarifying of intentions, thereby enhancing possibilities for preventing long-lasting echo effects involving mutual loss, suffering, and pain.

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