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Reading People's Minds From Emotion Expressions in Interdependent Decision Making

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How do people make inferences about other people's minds from their emotion displays? The ability to infer others' beliefs, desires, and intentions from their facial expressions should be especially important in interdependent decision making when people make decisions from beliefs about the others' intention to cooperate. Five experiments tested the general proposition that people follow principles of appraisal when making inferences from emotion displays, in context. Experiment 1 revealed that the same emotion display produced opposite effects depending on context: When the other was competitive, a smile on the other's face evoked a more negative response than when the other was cooperative. Experiment 2 revealed that the essential information from emotion displays was derived from appraisals (e.g., Is the current state of affairs conducive to my goals? Who is to blame for it?); facial displays of emotion had the same impact on people's decision making as textual expressions of the corresponding appraisals. Experiments 3, 4, and 5 used multiple mediation analyses and a causal-chain design: Results supported the proposition that beliefs about others' appraisals mediate the effects of emotion displays on expectations about others' intentions. We suggest a model based on appraisal theories of emotion that posits an inferential mechanism whereby people retrieve, from emotion expressions, information about others' appraisals, which then lead to inferences about others' mental states. This work has implications for the design of algorithms that drive agent behavior in human–agent strategic interaction, an emerging domain at the interface of computer science and social psychology.

Keywords: emotion expressions, appraisal theories, reverse appraisal, decision making, theory of mind

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The ability to attribute beliefs, desires, and intentions to others is invaluable in explaining and predicting other people's behavior (Sodian & Kristen, 2010). Nonverbal displays, notably facial expression of emotion, may contain critical cues for making inferences about other's mental states (Boone & Buck, 2003; Frank, 2004; Frijda & Mesquita, 1994; Keltner & Haidt, 1999; Keltner & Kring, 1998; Morris & Keltner, 2000; Nesse, 1990; Parkinson & Simons, 2009; Trivers, 1971). In line with this, in interdependent decision making—mixed-motive interaction where outcomes depend on decisions made by self and other (Pruitt & Kimmel, 1977)—emotion displays can impact negotiation (e.g., van Kleef, De Dreu, & Manstead, 2004, 2006), trust (e.g., Krumhuber et al., 2007), reactions to ultimatums (e.g., van Dijk, Van Kleef, Steinel, & Van Beest, 2008), cooperation in public goods dilemmas (e.g., Wubben, De Cremer, & van Dijk, 2009), and dispute resolution (Friedman et al., 2004). The mechanisms underlying such interpersonal effects of emotion have not been fully uncovered, and this leads us to ask: What information do people retrieve from emotion displays?

This question was also raised by Van Kleef, De Dreu, and Manstead (2010), and the answer, they suggested, was that "each discrete emotion has its own antecedents, appraisal components, relational themes, and action tendencies" (p. 48); thus, "observing a particular emotion in another person provides relatively differentiated information about how that person regards the situation" (p. 53). We posit, and test in five experiments reported here, that this differentiated information can be understood under the concise framework of appraisal theories. According to appraisal theories (Frijda, 1989; Ortony, Clore, & Collins, 1988; Roseman, 2001; Scherer, 2001; Smith & Ellsworth, 1985; for a review, see Ellsworth & Scherer, 2003), emotion displays arise from cognitive appraisal of events with respect to an agent's goals, desires, and beliefs (e.g., Is this event congruent with my goals? Who is responsible for this event?). According to the pattern of appraisals that occurs, different emotions are experienced and displayed. Thus, a specific event does not define by itself which emotion an individual should experience; it is the appraisal of the situation with respect to the individual's goals that defines which emotion

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will be experienced. Now, because displays reflect one's intentions through the appraisal process, it is plausible to ask whether people can infer from emotion displays the others' goals by reversing the appraisal mechanism. The intuition is that if appraisal, abstractly, is a function that maps from < event, mental state > to emotion, reverse appraisal is a function that maps from < event, emotion > to mental state (see Figure 1).

According to reverse appraisal, thus, people retrieve from emotion displays how others are appraising the ongoing interaction, and this information, in turn, leads to inferences about others' intentions. In this sense, Scherer and Grandjean (2008) showed that people are able to retrieve information about others' appraisals from photos of facial expression of emotion; however, their study did not show that this information could lead to inferences about others' mental states, in particular, others' intentions in an interdependent decision-making context. Hareli and Hess (2010) showed that people can, from expressed emotion, make inferences about the character of the person displaying emotion and that these inferences were mediated by perceived appraisals. For instance, a person who reacted with anger to blame was perceived as more aggressive and self-confident than a person who reacted with sadness. Hareli and Hess focused on how emotion expressions lead to inferences about people's personalities; here, we are interested in how emotion expressions lead to inferences about people's intentions in interdependent decision making.

Reverse appraisal can be viewed as an inferential mechanism for the social effects of emotion in decision making. According to this inferential pathway perspective, emotions communicate information that helps disambiguate the beliefs, desires, and intentions of one's counterpart in a decision-making setting (Van Kleef et al., 2010). For instance, van Kleef et al. (2004) have shown that people negotiating with angry counterparts tend to concede because they infer the counterparts to have high aspirations. According to reverse appraisal, such inferences about the counterpart's mental states, in this case, aspirations, are achieved via perceptions of how the counterpart is appraising the ongoing interaction. The claim is, thus, that a critical piece of information people retrieve from emotion expressions is about appraisals, and this information, in turn, leads to inferences about others' mental states.

The reverse appraisal pathway can be contrasted to the affective pathway (Parkinson & Simons, 2009; Van Kleef et al., 2010), where others' emotional expressions directly elicit emotion in observers, and these affective reactions, then, influence decision making. The prototypical example of an affective process is emotional contagion or mimicry (Hatfield, Cacioppo, & Rapson, 1994; Niedenthal, Mermillod, Maringer, & Hess, 2010), which is said to occur due to people's natural tendency to automatically mimic and synchronize with others' facial expressions, vocalizations, and postures; afferent feedback from mimicked behavior, then, leads to the experience of similar emotions. After catching others' emotions, people's decisions might be influenced, for instance, by (mis)attributing the current affective state to the current context (i.e., the affect-as-information heuristic; Schwarz & Clore, 1983; cf. Carnevale, 2008). Reverse appraisal, thus, does not explain or substitute the affective pathway; there are situations in which these mechanisms might co-occur and, perhaps, interfere with each other.

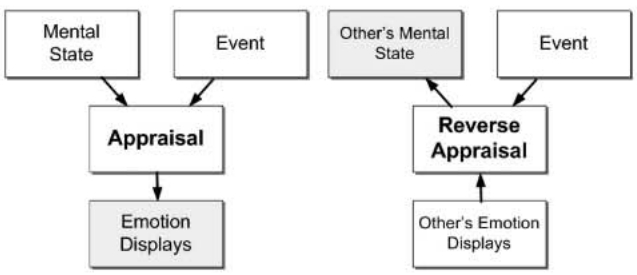

Figure 1. Appraisal theory and reverse appraisal.

A third pathway, which is related to but different than the affective pathway, is social appraisal (Manstead & Fischer, 2001). This perspective also concerns the impact of others' emotional expressions on one's own emotions. Social appraisal posits that other's emotions impact one's own appraisals of the situation, which, only then, elicit emotion. For instance, Fischer, Rotteveel, Evers, and Manstead (2004) found that participants' reacted more angrily to a poor grade given by an instructor when other students reacted with anger but more sadly when others reacted with sadness. Social appraisal acknowledges that other people can be the object of "regular" appraisals (e.g., regarding blameworthiness), but the point is that specific "social" appraisals occur because people care about how others react to situations. Both mechanisms claim people can retrieve appraisals from emotion displays, but social appraisal is distinct from reverse appraisal in, at least, two ways: First, social appraisal places the emphasis on own appraisals, whereas reverse appraisal emphasizes others' appraisals; second, social appraisal focuses on how others' emotional expressions lead to own emotions (via the impact of others' appraisals on own appraisals), whereas reverse appraisal focuses on how others' emotional expressions lead to inferences about others' mental states (i.e., theory of mind).

The five experiments reported in this article test the plausibility of reverse appraisal as an inferential mechanism for the social effects of emotion expression in decision making. The experiments reflect a causal model derived from reverse appraisal whereby people retrieve information from emotion expressions about how others appraise the interaction, and this information, in turn, leads to inferences about others' mental states. To test this model, we had participants engage in interdependent decision making in the prisoner's dilemma game, with emotional counterparts. Each experiment tested a specific prediction of reverse appraisal. Experiment 1 tested the prediction that what is critical for the social effects of emotion is the underlying information rather than the displays themselves. We tested whether the same displays could achieve opposite effects on emergence of cooperation in the prisoner's dilemma depending on the context in which they were shown. Experiment 2 tested the prediction that emotion displays achieve the same function as information about others' appraisals. We tested whether we could achieve the same effects on expectations of cooperation with facial displays of emotion as with corresponding textual expressions of appraisals. Experiments 3 and 4 tested the prediction, through multiple mediation analyses (Preacher & Hayes, 2008), that perception of others' appraisals mediate the social effects of emotion displays on, respectively, people's decision making and expectations about others' mental states. Finally, Experiment 5 presents complementary evidence,

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following a causal-chain design (Spencer, Zanna, & Fong, 2005), for the mediating role of perception of appraisals.

Experiment 1

Our model of reverse appraisal posits that the information people retrieve from emotion displays pertains to information about appraisals. For instance, from a display of joy, people infer that counterparts find the current state of affairs to be conducive to their goals (e.g., Ortony et al., 1988). Thus, the same display of joy is likely to lead to different reactions if it is shown in a competitive as opposed to a cooperative context. This experiment, therefore, tests whether the same emotion displays can have different, or even opposing, effects on people's decision making. To accomplish this, we had people engage in the iterated prisoner's dilemma with counterparts that, despite following the same strategy to choose their actions, showed displays that were compatible with either a cooperative or competitive goal orientation. The *expressively cooperative* counterpart expressed joy when mutual cooperation occurred, regret when it exploited the participant, and nothing otherwise. The *expressively competitive* counterpart expressed joy when it exploited the participant, regret when mutual cooperation occurred, and nothing otherwise. Our hypothesis was:

> *Hypothesis 1:* People cooperate more with an expressively cooperative counterpart than with an expressively competitive counterpart.

Method

Task. The prisoner's dilemma (Poundstone, 1993; Pruitt & Kimmel, 1977) is a two-person task in which the payoffs of each player depend on the simultaneous choice of both players. A standard payoff matrix for this task was used in this experiment and is shown in Table 1. The task represents a dilemma because the rational (i.e., utility-maximizing) choice for both players is to defect, which results in an outcome (mutual defection) that is worse than mutual cooperation. The form and labels of the task used here came from Kiesler, Waters, and Sproull (1996). Participants were told there would be no communication between the players before choosing an action and that the other player would make a decision without knowledge of the participant's choice. After the round was over, the action each chose was made available to both players, and the outcome of the round (i.e., the number of points each player got) was shown. Each participant played this task for 25 rounds. A tutorial was also presented to the participants before starting the task.

Table 1
Payoff Matrix for the Prisoner's Dilemma

	Other	
Participant	Cooperates	Defects
Cooperates	Other: 5 Participant: 5	Other: 7 Participant: 2
Defects	Other: 2 Participant: 7	Other: 4 Participant: 4

Conditions. Participants engaged in the prisoner's dilemma, in a between-participants design, with either the expressively cooperative or the expressively competitive counterpart (see Table 2). Counterparts always followed the same action strategy: tit for tat, but starting with a defection. The rationale for starting with a defection comes from previous research that shows that initial toughness, followed by cooperation, is more effective at eliciting cooperation than cooperation from the start (Bixenstine & Wilson, 1963; Harford & Solomon, 1967; Hilty & Carnevale, 1993).

We used virtual agents to implement the counterparts. Virtual agents are anthropomorphic computer characters that have virtual bodies and can express themselves through them in the same way people can (Gratch et al., 2002). Previous research has shown that people can treat virtual agents like people (Reeves & Nass, 1996) and be socially influenced by them (Blascovich & McCall, 2013). Moreover, virtual agents have been argued to be an appropriate tool for research in social psychology (Blascovich et al., 2002). In this experiment, the agent was referred to as Ethan. Figure 2 shows the agent and the corresponding facial displays. These facial displays were animated using a muscular model of the face that replicates prototypical emotional expressions (de Melo & Paiva, 2006) with blushing and wrinkles (de Melo, Kenny, & Gratch, 2010).

To validate the displays, we asked a (separate) sample of participants ($N = 29$) to rate each display according to perception of joy, sadness, anger, regret, and neutrality on a 7-point scale (from 1 [*not at all*] to 7 [*very much*]). Table 3 shows the means and standard deviations for this analysis. The results for the multivariate test showed a significant effect ($p < .01$, Pillai's trace). Analyses of variance (ANOVAs) confirmed significant differences for the emotion perception measures (see the last column of Table 3), and subsequent Bonferroni post hoc tests revealed that perception of joy was highest for the display of joy, perception of sadness was highest for the display of sadness, perception of anger was highest for the display of anger and, perception of regret was highest for the display of regret (all tests, $p < .01$). Thus, the emotion displays were interpreted as intended.

Dependent variable. The dependent variable was cooperation rate (i.e., the number of times the participant cooperated over the total number of rounds).

Participants. Forty participants were recruited at the USC Marshall School of Business. Regarding gender, 52.5% of the participants were males. Age distribution was as follows: *18 to 21 years*, 37.5%; *22 to 34 years*, 55.0%; *35 to 44 years*, 7.5%. Most participants were undergraduate (44.7%) or graduate (50.0%) students from different academic backgrounds. Most were originally from the United States (40.0%) and India (37.5%). The incentive to participate followed standard practice in experimental economics (Hertwig & Ortmann, 2001): First, participants were paid $10 for their participation in this experiment; second, with respect to their goal in the task, participants were instructed to earn as many points as possible, as the total amount of points would increase their chances of winning a lottery for $100.

Results

To compare cooperation rate between the expressively cooperative and competitive counterparts, we ran an independent t test. The results showed that people cooperated significantly more with

Table 2
Counterpart's Facial Displays in Experiment 1

Participant	Other: Cooperates	Other: Defects
	Expressively cooperative	
Cooperates	Joy	Regret
Defects	Neutral	Neutral
	Expressively competitive	
Cooperates	Regret	Joy
Defects	Neutral	Neutral

the cooperative counterpart ($M = .446$, $SD = .327$) than the competitive counterpart ($M = .238$, $SD = .257$), $t(38) = 2.238$, $p < .05$, $r = .390$.

Discussion

The results showed clear contextual effects of emotion displays on people's decision making. Even though both counterparts were expressing the same emotion displays, people cooperated significantly more with a counterpart who expressed joy after mutual cooperation and regret after exploiting the participant than one who expressed regret in mutual cooperation and joy after exploiting the participant. Hypothesis 1 was thus supported. These findings are consistent with previous literature on the importance of context for interpreting emotion expressions (Aviezer et al., 2008; Hareli & Hess, 2010; Lanzetta & Englis, 1989; Van Kleef et al., 2010) and are in line with reverse appraisal's prediction that the underlying information, not the displays themselves, is especially important for social effects of emotion expressions. Experiment 2 was designed to directly address the nature of information that people retrieve from others' emotion displays.

Experiment 2

Experiment 2 was designed to test the reverse appraisal prediction that information about others' appraisals is a critical component of the information people retrieve from emotion expressions. To achieve this, we compared the social effects of facial displays of emotions with the social effects of textual expression of the corresponding appraisals. Appraisal theorists (Frijda, 1989; Ortony et al., 1988; Roseman, 2001; Scherer, 2001; Smith & Ellsworth, 1985) tend to agree that goal conduciveness and blameworthiness are key appraisals for eliciting joy and regret: Joy is elicited if the event is appraised to be goal conducive, and regret is elicited if the event is appraised to be goal obstructive and the self is to blame. Appraisal theories thus suggest a systematic way of mapping emotion displays into textual expressions of appraisals. Accordingly, we mapped joy to "I like this outcome" and regret to "I do not like this outcome and I blame myself for it." The experiment itself consisted of scenarios in which participants imagined engaging in the prisoner's dilemma with an emotional counterpart. Participants were told a certain outcome of the dilemma occurred and then watched a video of the counterpart's reaction. This reaction consisted of a facial display of emotion, textual expression of appraisals, both, or none. We then measured people's expectation of how likely the counterpart was to cooperate in the future. Expectations of cooperation have been shown in the past to be correlated with people's decision to cooperate (Balliet & Van Lange, 2012). Following the previous experiment, we explored (facial and appraisal) expressions of joy and regret in the context of mutual cooperation and when the counterpart exploits the participant. For each pairing of emotion and outcome, we hypothesized a significant interaction between facial display and textual appraisals on expectations of cooperation:

Hypothesis 2a: Following mutual cooperation, people expect more cooperation when a counterpart expresses joy through facial displays, textual appraisals, or both, compared with no expression.

Hypothesis 2b: Following mutual cooperation, people expect less cooperation when a counterpart expresses regret through facial displays, textual appraisals, or both, compared with no expression.

Hypothesis 2c: Following exploitation by a counterpart, people expect less cooperation when the counterpart expresses joy through facial displays, textual appraisals, or both, compared with no expression.

Hypothesis 2d: Following exploitation by a counterpart, people expect more cooperation when the counterpart expresses regret through facial displays, textual appraisals, or both, compared with no expression.

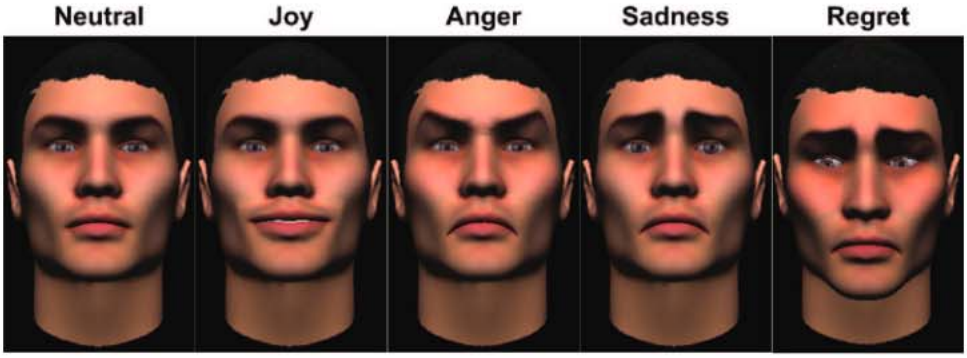

Figure 2. The emotion facial displays used in Experiments 1, 2, 3, and 4.

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Table 3
Perceived Emotion in the Facial Displays Used in Experiments 1, 2, 3, and 4 (Manipulation Check)

	Emotion display										
	Neutral		Joy		Sadness		Anger		Regret		
Perceived emotion	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*F*
Joy	1.93	1.49	5.59	1.90	1.48	1.18	1.38	0.94	1.41	1.24	49.69[p]
Sadness	1.24	0.51	1.14	0.58	5.10	1.66	2.45	1.94	3.59	1.84	47.56[p]
Anger	1.10	0.31	1.03	0.19	1.14	0.35	4.24	2.21	1.72	1.31	39.42[p]
Regret	1.24	0.64	1.31	0.97	3.28	2.14	2.52	1.79	3.97	2.13	15.28[p]
Neutral	6.10	1.57	2.24	1.75	1.41	0.78	1.72	1.16	1.52	0.99	67.72[p]

[p] $p < .05$.

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Method

Scenarios. Participants were told to imagine that they were engaging in a "decision making task" (the iterated prisoner's dilemma) with a counterpart named Ethan. The task was the same as in Experiment 1. The scenarios pertained to the first round of what was supposed to be a five-round task. The participant was told to imagine that a particular outcome of the task had occurred and, then, was shown a video of Ethan reacting to the outcome. This reaction was the experimental manipulation. The participant was then asked about how likely Ethan was to cooperate in the future. After answering this question, the study ended.

Conditions. For each combination of Outcome (Mutual Cooperation vs. Counterpart Exploits) and Emotion (Joy vs. Regret), we ran a Facial Displays (Emotional vs. No Display) × Textual Appraisals (Appraisals vs. No Appraisals) between-participants factorial design.

Dependent variable. We asked the participant one question about expectations of the counterpart's likelihood of cooperation (on a scale ranging from 1 [*not at all*] to 7 [*very much*]): How likely is Ethan to cooperate in the next round?

Participants. We recruited 926 participants online using Amazon Mechanical Turk. This resulted in approximately 230 participants for each pairing of emotion and outcome, or approximately 60 per condition. Regarding gender, 56.8% of the participants were males. Age distribution was as follows: *18 to 21 years*, 8.7%; *22 to 34 years*, 63.6%; *35 to 44 years*, 15.4%; *45 to 54 years*, 7.2%; *55 to 64 years*, 4.2%; *65 years and over*, 0.9%. Most were from the United States (44.3%) and India (42.0%). The education-level distribution was as follows (current or expected degrees): *basic*, 0.3%; *high school*, 15.3%; *college*, 56.6%; *master's*, 24.9%; *Ph.D. or above*, 2.9%. Education majors and profession were quite diverse. Participants were paid U. S. $0.50, and average participation time was 10 min.

Results

For each pairing of outcome and emotion, we ran a Facial Display × Textual Appraisals ANOVA on expectations of counterpart's cooperation. These results are shown in Figure 3. For joy in mutual cooperation, there was a significant interaction, $F(1, 236) = 8.350$, $p < .01$, partial $\eta^2 = .034$: Participants expected more cooperation when the counterpart conveyed facial displays ($M = 4.93$, $SD = 1.815$), textual appraisals ($M = 4.68$, $SD = 1.916$), or both ($M = 4.50$, $SD = 1.878$) than when nothing was shown ($M = 3.70$, $SD = 1.933$). For regret in mutual cooperation, there was a significant interaction, $F(1, 242) = 8.219$, $p < .01$, partial $\eta^2 = .033$: Participants expected less cooperation when the counterpart conveyed facial displays ($M = 2.90$, $SD = 1.535$), textual appraisals ($M = 2.44$, $SD = 1.666$), or both ($M = 2.65$, $SD = 1.812$) than when nothing was shown ($M = 3.98$, $SD = 2.036$). For joy when the counterpart exploits, there was no significant interaction, $F(1, 225) = .068$, *ns*: Participants expected similar levels of cooperation when the counterpart conveyed facial displays ($M = 2.67$, $SD = 1.480$), textual appraisals ($M = 2.98$, $SD = 1.732$), both ($M = 2.86$, $SD = 1.742$), or nothing ($M = 2.91$, $SD = 1.871$). Finally, for regret when the counterpart exploits, there was a significant interaction, $F(1, 222) = 6.919$, $p < .01$, partial $\eta^2 = .030$: Participants expected more cooperation when the counterpart conveyed facial displays ($M = 4.63$, $SD = 1.864$), textual appraisals ($M = 5.02$, $SD = 1.697$), or both ($M = 5.16$, $SD = 1.735$) than when nothing was shown ($M = 3.21$, $SD = 2.013$).

Discussion

The results showed that textual appraisals of emotion serve the same function as corresponding facial displays of emotion. The significant Facial Display × Textual Appraisals interactions for the cases of joy in mutual cooperation, regret in mutual cooperation, and regret when the counterpart exploits confirmed Hypotheses 2a, 2b, and 2d. In these cases, showing emotion in the face, expressing textual appraisals, or both led to similar effects on expectations of cooperation, when compared with the case in which nothing was expressed. The lack of support for Hypothesis 2c suggests the expression of joy, or the underlying appraisals, did not impact expectation of cooperation when the counterpart exploited the participant; perhaps, in this case, the expression of joy did not convey any information above and beyond that signaled by the counterpart's decision to defect.

Experiment 3

This experiment tests reverse appraisal's prediction that perception of appraisals mediates the social effects of emotion expressions on people's decision making. To accomplish this, we had participants engage in the iterated prisoner's dilemma with counterparts that, as in the previous experiments, displayed joy or regret in mutual cooperation or when the participant was exploited. After

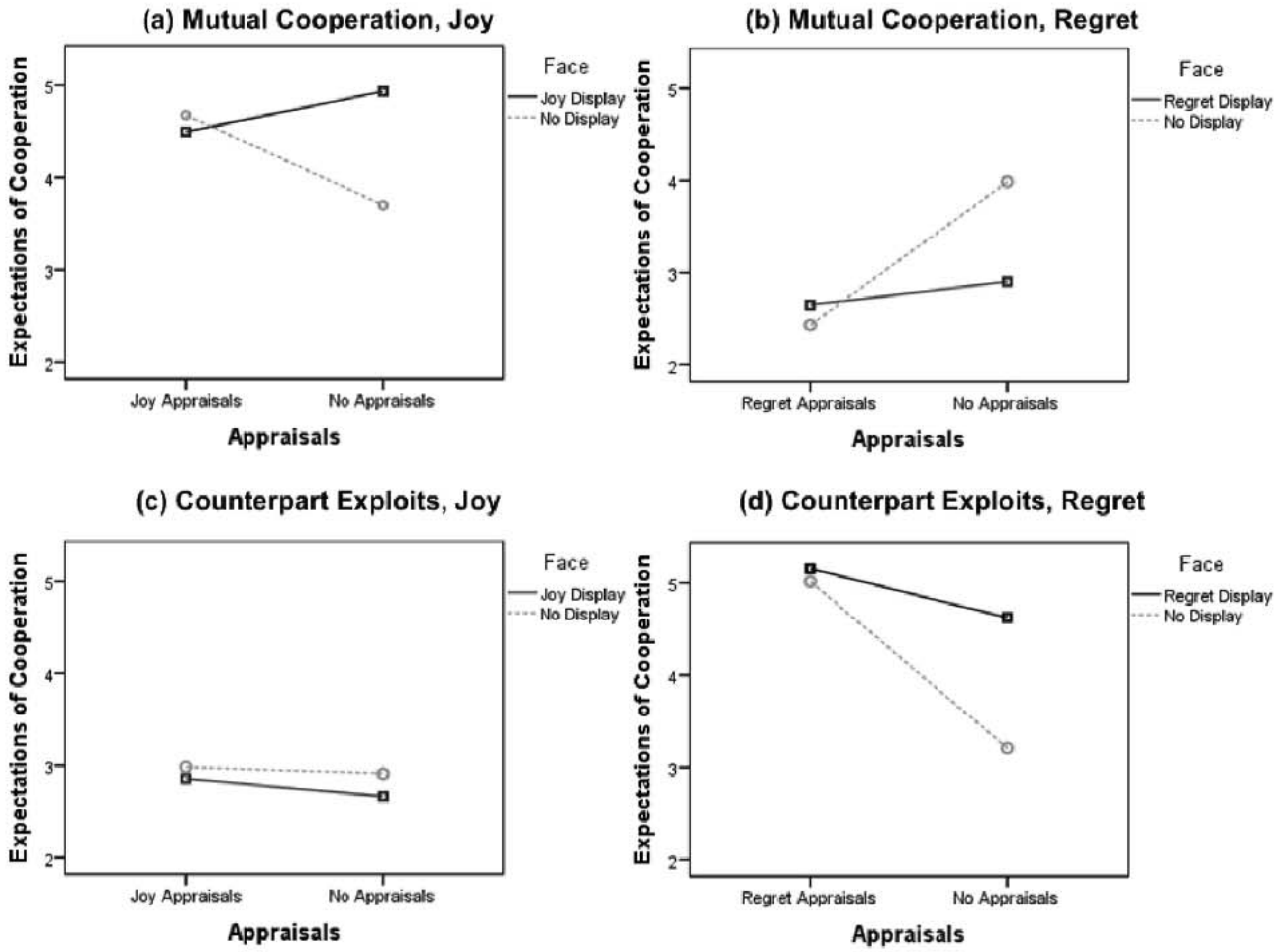

Figure 3. Expectations of the counterpart's likelihood of cooperation in Experiment 2.

the outcome was revealed to the players and the counterpart's facial reaction was shown but before asking for a decision for the following round, we asked participants about their perceptions of the counterpart's appraisals. As in Experiment 2, we focused on the appraisals of goal conduciveness and blameworthiness. Our hypothesis was the following:

> *Hypothesis 3:* Perceptions of appraisals mediate the effects of emotion expressions on people's decision to cooperate.

Method

Task. We used the same implementation of the prisoner's dilemma as in Experiment 1. In this case, however, participants only engaged in 15 rounds of the task.

Conditions. Participants engaged in the prisoner's dilemma, in a between-participants design, with one of four counterparts: a counterpart who expressed joy following mutual cooperation and nothing otherwise; a counterpart who expressed joy after exploiting the participant and nothing otherwise; a counterpart who expressed regret after mutual cooperation and nothing otherwise; and, a counterpart who expressed regret after exploiting the participant and nothing otherwise.

Measures. The dependent variable was the decision of whether to cooperate. The proposed mediators—that is, the perception of the counterpart's appraisals—were measured after the participant saw the counterpart's facial reaction but before making the decision for the next round. To measure perception of goal conduciveness, we asked four questions (on a scale ranging from 1 [*not at all*] to 7 [*very much*]): (a) How pleasant for Ethan was it to be in this situation? (Smith & Ellsworth, 1985); (b) At the time of experiencing the emotion, do you think Ethan perceived that the consequences of the event did or would bring about positive, desirable consequences for him (e.g., helping him reach a goal, or giving pleasure)? (Scherer, 2001); (c) Was the situation obstructive or conducive to Ethan's goals? (Frijda, 1989); (d) Was what happened something that Ethan regarded as unfair or fair? (Frijda, 1989). To measure blameworthiness we asked two questions: (e) At the time, how much did you think Ethan blamed himself for the event? (Smith & Ellsworth, 1985); (f) At the time, how much did you think Ethan blamed you for the event? (Smith & Ellsworth, 1985).

Participants. One hundred forty-five participants were recruited at the USC Marshall School of Business. Regarding gender, 62.5% of the participants were males. Age distribution was as

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follows: *18 to 21 years*, 66.0%; *22 to 34 years*, 34.0%. Most participants were undergraduate (99.3%) students from Business-related backgrounds. Most were originally from the United States (69.7%). The incentive to participate followed standard practice in experimental economics (Hertwig & Ortmann, 2001): First, participants were given school credit for their participation; second, with respect to their goal in the task, participants were instructed to earn as many points as possible, as the total amount of points would increase their chances of winning a lottery for $50.

Results

To test the hypothesis, we ran multiple mediation analyses following the bootstrapping approach suggested by Preacher and Hayes (2008). We ran a separate analysis for each combination of display (i.e., joy or regret) and outcome (i.e., mutual cooperation or counterpart exploits). The independent variable was the expressed emotion, which was binary coded: 0, for the neutral display; 1, for the display of joy or regret. Questions 1–4, pertaining to goal conduciveness, were collapsed because they were highly correlated ($\alpha = .926$). Thus, the proposed mediators were the perception of appraisals measures: goal conduciveness (averaged), self-blame (Question 5), and participant blame (Question 6). The dependent variable was the decision to cooperate (in the following round), which was also binary coded: 0, defected; 1, cooperated. We used Preacher's multiple mediation tools[1] to run the analyses. These results are shown in Table 4. For instance, following mutual cooperation, the point estimate for the total indirect effect of joy on people's decision to cooperate was .240, and this was significantly different than zero (because the corresponding bias-corrected 95% confidence interval did not contain zero); moreover, the specific indirect effect through goal conduciveness was significant and equal to .256. The remaining indirect effects for self- and participant blame were not significant. This means that goal conduciveness mediated the effect of joy, following mutual cooperation, on people's decision to cooperate. Overall, the results showed that the effects of joy and regret, following mutual cooperation, were mediated by perceptions of goal conduciveness; and, the effect of regret, after the counterpart exploits, was mediated by perceptions of self-blame.

Discussion

The results showed support for Hypothesis 3 that perceptions of appraisals mediate the effects of emotion displays on people's decision to cooperate in the prisoner's dilemma. In line with the results of Experiment 2, the only case in which mediation did not occur was when joy was expressed after the counterpart exploits.

Experiment 4

Experiment 4 further tested the mediating effect of perceptions of appraisals on the social effects of emotion expressions and expanded the previous experiments by including two other emotions, sadness and anger, that have received focused attention in the negotiation literature (e.g., Van Kleef et al., 2010). Specifically, the experiment systematically studied whether perceptions of appraisals mediated the effects of displays of joy, sadness, anger, and regret on expectations of cooperation when they occurred in the context of each of the possible outcomes of the prisoner's dilemma. Because we wanted to be able to control the outcome participants experienced, the experiment consisted of scenarios in which participants were told a certain outcome of the prisoner's dilemma occurred, followed by a video of the counterpart reacting by showing emotion in the face. After watching the video, participants indicated how they perceived the counterpart appraised the interaction and their expectations of the counterpart's likelihood of cooperation in the future. Regarding perception of appraisals, we focused on goal conduciveness and blameworthiness, two appraisal variables theorists agree are relevant for eliciting joy, sadness, anger, and regret (Ellsworth & Scherer, 2003; Frijda, 1989; Ortony et al., 1988; Roseman, 2001; Scherer, 2001; Smith & Ellsworth, 1985): Joy is elicited if the outcome is appraised to be goal conducive, sadness if the outcome is goal obstructive, anger if the outcome is goal obstructive and someone else is to blame, and regret if the outcome is goal obstructive and the self is to blame. Our hypothesis was as follows:

> *Hypothesis 4:* Perceptions of appraisals mediate the effects of emotion expressions on expectations of cooperation.

Method

Scenarios. We used similar scenarios to Experiment 2. Participants were told to imagine engaging in the iterated prisoner's dilemma with a counterpart named Ethan. A particular outcome of the task was said to have occurred in the first round, and then participants were shown a video of Ethan reacting emotionally. We then asked participants several questions and, upon completion of the questions, explained that the study was over.

Conditions. The experiment followed a 4 × 5 between-participants factorial design with two factors: Outcome (Mutual Cooperation vs. Mutual Defection vs. Counterpart Exploits vs. Participant Exploits) × Emotion Display (Neutral vs. Joy vs. Anger vs. Sadness vs. Regret). The emotion displays used in this experiment are shown in Figure 2.

Measures. After watching the video of the counterpart's emotional reaction, we asked participants the same questions about perceptions of appraisals as in Experiment 3. Finally, we asked the participant one question about expectations of cooperation (on a scale ranging from 1 [*not at all*] to 7 [*very much*]): How likely is Ethan to cooperate in the next round?

Participants. We recruited 1,256 participants online using Amazon Mechanical Turk. This resulted in approximately 60 participants for each condition. Regarding gender, 56.0% of the participants were males. Age distribution was as follows: *18 to 21 years*, 12.7%; *22 to 34 years*, 59.3%; *35 to 44 years*, 15.7%; *45 to 54 years*, 7.6%; *55 to 64 years*, 3.7%; *65 years and over*, 1.0%. Most participants were from the United States (45.4%) and India (36.6%). The education-level distribution was as follows (current or expected degrees): *basic*, 0.5%; *high school*, 14.1%; *college*, 61.5%; *master's*, 21.3%; *Ph.D. or above*, 2.6%. Education majors and profession were quite diverse. Participants were paid U.S. $1.02, and average participation time was 15 min.

[1] Available at: http://quantpsy.org/medn.htm (last accessed on April 9, 2013).

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Table 4
Multiple Mediation Analysis of Perception of Appraisals on the Effect of Emotion Displays on the Decision to Cooperate (Experiment 3)

Variable	Mutual cooperation		Counterpart exploits	
	Joy	Regret	Joy	Regret
Total				
Point estimate (*SE*)	.240[P] (.066)	−.542[P] (.125)	.024 (.062)	.185[P] (.098)
95% CI Lower	.124	−.799	−.094	.023
95% CI Upper	.381	−.314	.153	.413
Goal conduciveness				
Point estimate (*SE*)	.256[P] (.065)	−.458[P] (.095)	−.004 (.043)	−.009 (.028)
95% CI Lower	.142	−.663	−.095	−.108
95% CI Upper	.394	−.289	.086	.024
Self-blame				
Point estimate (*SE*)	.025 (.037)	.014 (.093)	.016 (.035)	.170[P] (.087)
95% CI Lower	−.016	−.173	−.027	.041
95% CI Upper	.151	.202	.132	.395
Participant blame				
Point estimate (*SE*)	−.041 (.046)	−.098 (.08)	.012 (.029)	.023 (.062)
95% CI Lower	−.178	−.277	−.017	−.089
95% CI Upper	.016	.044	.12	.169

Note. Five thousand iterations were used for the bootstrapping procedure. Confidence intervals (CIs) were bias corrected.
[P] Bias-corrected 95% confidence interval does not contain zero.

Results

The questions pertaining to goal conduciveness (Questions 1–4) were highly correlated ($\alpha = .811$) and thus were collapsed (averaged) into a single measure called goal conduciveness. The means, standard deviations, and standard errors for goal conduciveness, self-blame (Question 5), and participant blame (Question 6) are displayed in Figure 4 (see Table I in the supplemental materials for further details). For our main analysis, we subjected the perception of appraisal measures to an Outcome × Emotion Display factorial ANOVA. For each appraisal measure, we looked at the main effect of Emotion Display to understand how perception of appraisals varied with expressed emotion, and we looked at the main effect of Outcome to study how perception of appraisals varied with outcome (i.e., context). The results showed main effects of Emotion Display for all appraisals: goal conduciveness, $F(4, 1236) = 192.78$, $p < .01$, partial $\eta^2 = .384$; self-blame, $F(4, 1236) = 39.42$; $p < .01$, partial $\eta^2 = .113$; and, participant blame, $F(4, 1236) = 36.70$, $p < .01$, partial $\eta^2 = .106$. The results also showed main effects of Outcome for all appraisal variables: goal conduciveness, $F(3, 1236) = 71.79$, $p < .01$, partial $\eta^2 = .148$; self-blame, $F(3, 1236) = 5.52$, $p < .01$, partial $\eta^2 = .013$; and, participant blame, $F(3, 1236) = 20.64$, $p < .01$, partial $\eta^2 = .048$.

Regarding expectations of cooperation, the means, standard deviations, and standard errors for expectations of cooperation are displayed in Figure 5 (see Table II in the supplemental materials for further details). For the main analysis, we subjected this measure to an Outcome × Emotion Display factorial ANOVA. The results showed no main effect of Emotion Display, $F(4, 1236) = 1.93$, *ns*. There was, however, a main effect of Outcome, $F(3, 1236) = 12.00$, $p < .01$, partial $\eta^2 = .028$, and a significant Outcome × Emotion Display interaction, $F(12, 1236) = 5.77$, $p < .01$, partial $\eta^2 = .053$. To get further insight into this interaction, Table II in the supplemental materials reports one-way ANOVAs across Outcome in the rightmost column and one-way ANOVAs across Emotion Displays in the bottommost rows.

Finally, we ran bootstrapping multiple mediation analyses (Preacher & Hayes, 2008) of perceptions of appraisal on the effect of emotion displays on expectations of cooperation. We ran a separate analysis for each combination of display and outcome. The independent variable was the expressed emotion, which was binary coded: 0, for the neutral display; 1, for the display of joy, sadness, anger, or regret. The proposed mediators were the perception of appraisal variables: goal conduciveness, self-blame, and participant blame. The dependent variable was expectations of cooperation. Table 5 shows the results. For instance, following the case in which the participant exploits, the point estimate for the total indirect effect of anger on people's expectations of cooperation was −.839, and this was significantly different than zero (because the corresponding bias-corrected 95% confidence interval did not contain zero); moreover, the specific indirect effect through goal conduciveness tended to be significant (because the corresponding bias-corrected 90% confidence interval did not contain zero) and equal to −.278, and the specific indirect effect through participant blame was significant and equal to −.564. The remaining indirect effect for self-blame was not significant. This means that goal conduciveness and participant blame mediated the effect of anger, after the participant exploits, on people's expectations of cooperation. In sum, the results showed that in mutual cooperation, perceptions of goal conduciveness mediated the effects of joy, sadness, anger, and regret; in mutual defection, perceptions of self-blame mediated the effects of anger and regret; when the counterpart exploits, goal conduciveness mediated the effect of joy, all appraisals mediated the effect of sadness, goal conduciveness and participant blame mediated the effect of anger, and goal conduciveness and self-blame mediated the effect of regret. Finally, when the partici-

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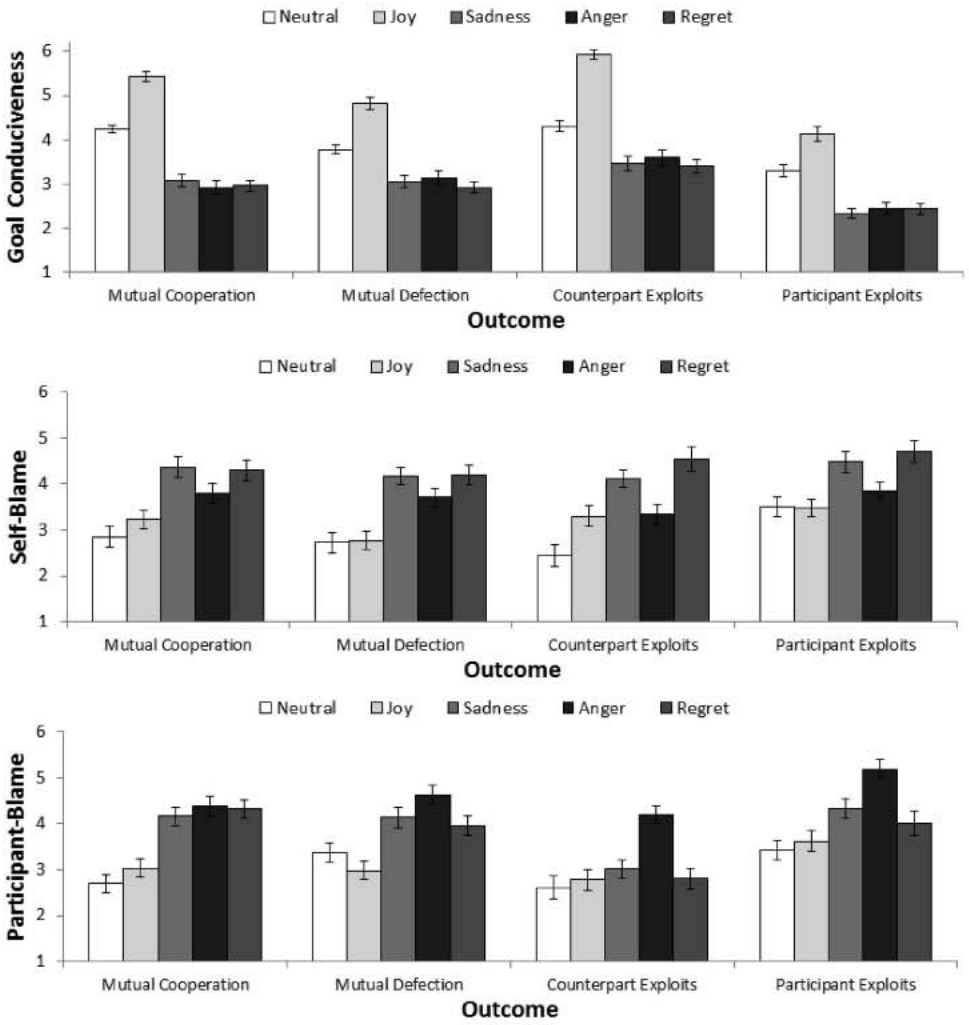

Figure 4. Perception of appraisals in Experiment 4. Error bars show standard errors.

pant exploits, participant blame mediated the effect of sadness, goal conduciveness and participant blame mediated the effect of anger, and self- and participant blame mediated the effect of regret.

Discussion

In line with Scherer and Grandjean's (2008) findings, the results showed that people were able to retrieve others' appraisals from emotion displays: a smile meant the counterpart found the outcome goal conducive; sadness meant the counterpart found the outcome goal obstructive; anger meant the counterpart found the outcome goal obstructive and blamed the participant for it; finally, regret meant the counterpart found the outcome goal obstructive and blamed itself for it. Overall, these patterns matched expectations from appraisal theories (Ellsworth & Scherer, 2003). The results also showed that facial displays of joy, sadness, anger, and regret impacted people's expectations of cooperation. The effects for joy and regret replicated the findings in the previous experiments. For instance, joy after mutual cooperation increased expectations of cooperation, whereas joy after the counterpart exploited the participant did not significantly differ from the neutral display. The results for sadness and anger were also mostly compatible with the existing literature (e.g., Van Kleef et al., 2010). For instance, anger in mutual cooperation reduced expectations of cooperation, whereas sadness after the counterpart exploited increased expectations of cooperation. Finally, the results showed that perceptions of appraisals (partially and, at times, fully) mediated the effects of emotion displays on expectations of cooperation, thus showing partial support for Hypothesis 4. The next experiment builds on this and presents complementary evidence for the mediating role of perception of appraisals.

Experiment 5

Spencer et al. (2005; see also Carnevale & De Dreu, 2005) argue that showing mediation statistically (Baron & Kenny, 1986; Preacher & Hayes, 2008) is no substitute to showing mediation experimentally. As an alternative to the statistical approach, they propose the experimental-causal-chain design, in which each link of the proposed causal model is shown experimentally. Applying this technique here means showing, experimentally, each of the

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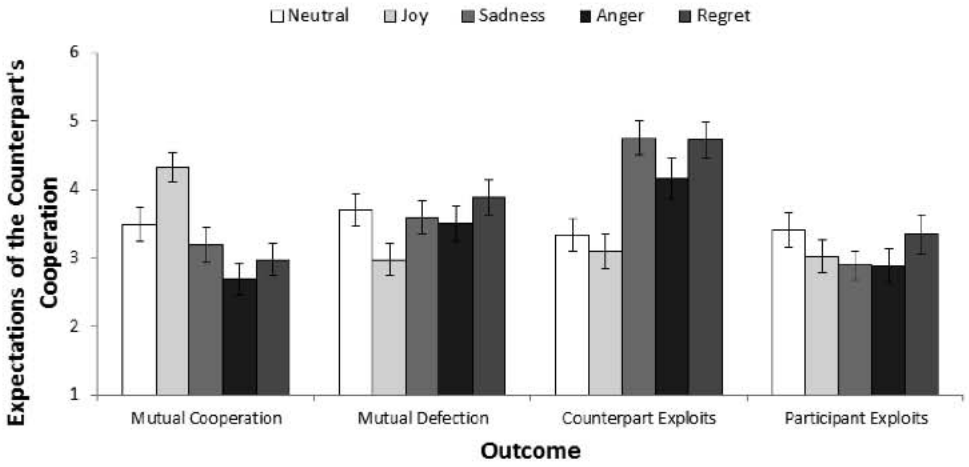

Figure 5. Expectations of cooperation in Experiment 4. Error bars show standard errors.

causal links in the proposed causal model in which emotion expressions cause perceptions of appraisals (Link i), which then cause inferences about expectations of cooperation (Link ii). The effect of emotion displays on perception of appraisals (Link i) was shown in Experiment 4. In turn, Experiment 5 focused on Link ii and tested, experimentally, whether explicitly communicating appraisals can impact expectations of cooperation in the same way the corresponding facial expressions did in Experiment 4. To accomplish this, perceptions of appraisals were, as in Experiment 2, explicitly manipulated by having the counterpart, instead of displaying emotion through the face, express the appraisals directly through text. In line with reverse appraisal's prediction that perception of appraisals mediate the effects of emotion on expectations about others' mental states (i.e., Hypothesis 4), we expected textual appraisals to lead to similar effects on expectations of cooperation as found with facial displays in Experiment 4.

Method

We use the same scenarios and task as in Experiment 4. The experiment also followed a between-participants factorial design with two factors: Outcome (Mutual Cooperation vs. Mutual Defection vs. Counterpart Exploits vs. Participant Exploits) × Textual Appraisals (Neutral vs. Joy vs. Anger vs. Sadness vs. Regret).

Table 5
Multiple Mediation Analysis of Perception of Appraisals on the Effect of Emotion Displays on Expectations of Cooperation (Experiment 4)

	Total		Goal conduciveness		Self-blame		Participant blame	
Variable	Point	*SE*	Point	*SE*	Point	*SE*	Point	*SE*
Mutual cooperation								
Joy	.649^{P}	.246	.694^{P}	.236	.019	.067	−.063	.079
Sadness	−.597	.348	−.551^{P}	.268	−.165	.191	.119	.17
Anger	−.313	.363	−.432†	.285	−.071	.104	.19	.183
Regret	−.62	.374	−.637^{P}	.295	−.182	.171	.199	.197
Mutual defection								
Joy	.052	.231	.107	.217	.001	.042	−.056	.082
Sadness	−.11	.24	−.16	.145	.08	.184	−.031	.096
Anger	.039	.224	−.138	.127	.286^{P}	.156	−.108	.164
Regret	.318	.273	−.11	.18	.500^{P}	.226	−.073	.099
Counterpart exploits								
Joy	−.957^{P}	.252	−.991^{P}	.249	.082	.085	−.047	.086
Sadness	.618^{P}	.224	.348^{P}	.156	.349^{P}	.174	−.079†	.069
Anger	.204	.246	.418^{P}	.164	.067	.108	−.282†	.181
Regret	.991^{P}	.312	.373^{P}	.171	.683^{P}	.248	−.064	.108
Participant exploits								
Joy	.147	.193	.178	.138	.003	.071	−.034	.072
Sadness	−.546^{P}	.209	−.276	.196	−.097	.127	−.173^{P}	.117
Anger	−.839^{P}	.23	−.278†	.177	.002	.05	−.564^{P}	.229
Regret	−.558^{P}	.212	−.173	.18	−.266^{P}	.163	−.119†	.102

Note. Values correspond to bootstrapping point estimates and standard errors (5,000 iterations) for total indirect effect and the specific indirect effects for the proposed mediators: goal conduciveness, self-blame, and participant blame.
† Bias-corrected 90% confidence interval does not contain zero. ^{P} Bias-corrected 95% confidence interval does not contain zero.

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The manipulation consisted, instead, of emotion displays, of textual expression of the appraisals. Following appraisal theories (Ellsworth & Scherer, 2003), joy was mapped to "I like this outcome," sadness to "I do not like this outcome," anger to "I do not like this outcome and I blame you for it,"regret to "I do not like this outcome and I blame myself for it," and the neutral display to "I do not like, nor dislike this outcome." As before, participants were introduced to the counterpart they imagined interacting with; however, only a static image was shown of the (neutral) face. The textual expression of appraisals was simulated by typing at the bottom of the screen, as if simulating a chat interface. After watching the video of the counterpart's reaction, we asked participants questions about perception of appraisals and expectations of cooperation as in the previous experiment.

We recruited 426 participants online using Amazon Mechanical Turk. This resulted in approximately 20 participants for each condition. Regarding gender, 59.9% of the participants were males. Age distribution was as follows: *18 to 21 years*, 14.3%; *22 to 34 years*, 56.1%; *35 to 44 years*, 18.8%; *45 to 54 years*, 5.6%; *55 to 64 years*, 4.5%; *65 years and over*, 0.7%. Most participants were from the United States (50.0%) and India (33.1%). The education-level distribution was as follows (current or expected degrees): *basic*, 0.7%; *high school*, 12.7%; *college*, 65.0%; *master's*, 18.3%; *Ph.D. or above*, 3.3%. Education majors and profession were quite diverse. Participants were paid U.S. $1.02, and average participation time was 15 min.

Results

As in Experiment 4, the questions pertaining to goal conduciveness (Questions 1–4) were highly correlated ($\alpha = .706$) and thus were collapsed (averaged) into a single measure called goal conduciveness. The measures for goal conduciveness, self-blame (Question 5), and participant blame (Question 6) were used to check that the manipulation was successful. To accomplish this, a one-way ANOVA tested perception of appraisals across Textual Appraisals. As shown in Table 6, all measures for perception of appraisals differed significantly across Textual Appraisals. Bonferroni post hoc tests showed that (all tests, $p < .05$) goal conduciveness was higher for the appraisal expression corresponding to joy than the neutral appraisal expression; goal conduciveness was lower for the appraisal expressions for the negative emotions than the neutral appraisal expression; self-blame was highest for the appraisal expression corresponding to regret; and participant blame was highest for the appraisal expression corresponding to anger. The results, thus, supported that the manipulation was successful.

The means and standard errors for expectations of cooperation are displayed in Figure 6 (see Table III in the supplemental materials for further details). For the main analysis, we subjected this measure to an Outcome × Textual Appraisals factorial ANOVA. The results showed no main effect of Textual Appraisals, $F(4, 406) = 0.80$, *ns*. There was, however, a main effect of Outcome, $F(3, 406) = 6.46$, $p < .01$, partial $\eta^2 = .046$, and a significant Outcome × Textual Appraisals interaction, $F(12, 406) = 4.98$, $p < .01$, partial $\eta^2 = .128$. To get further insight into this interaction, Table III in the supplemental materials reports one-way ANOVAs across Outcome in the rightmost column and one-way ANOVAs across Emotion Displays in the bottommost rows.

Finally, to compare the cooperation patterns when facial displays of emotion were shown (Experiment 4) and appraisals were expressed textually (Experiment 5), we collapsed data from both experiments and looked at interactions involving the new Sample (Experiment 4 vs. Experiment 5) factor. We subjected the perception of cooperativeness measure to a Sample × Outcome × Emotion Display/Textual Appraisals ANOVA, and the results revealed no significant Sample × Outcome interaction, $F(3, 1642) = 0.40$, $p = .753$; no significant Sample × Emotion Display/Textual Appraisals interaction, $F(4, 1642) = 1.03$, $p = .389$; and only a trend for a Sample × Outcome × Emotion Display/Textual Appraisals interaction, $F(12, 1642) = 1.57$, $p = .093$.

Discussion

The results showed that textual expression of how others appraise the ongoing interaction leads to similar effects on inferences about mental states as facial displays of emotion. Effectively, the results showed similar patterns for expectations of the counterpart's likelihood of cooperation when the counterpart expressed appraisals textually to the patterns reported in Experiment 4 when the counterpart displayed emotion in the face. The trend for a three-way Sample × Outcome × Emotion Display/Textual Appraisals interaction might have occurred due to subtle differences in the effects of textual appraisals, relative to the emotion displays, in the participant exploits conditions. Understanding these subtleties in the correspondence of effects of emotion displays and

Table 6
Perceived Appraisals in Textual Expressions of Appraisals in Experiment 5 (Manipulation Check)

	Textual appraisals										
	I neither like nor dislike this outcome		I like this outcome		I do not like this outcome		I do not like this outcome, and I blame you for it		I do not like this outcome, and I blame myself for it		
Perceived appraisal	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*F*(4, 421)
Goal conduciveness	4.12	1.03	4.97	1.19	3.05	1.23	2.90	1.05	2.99	0.85	61.24[P]
Self-blame	3.01	1.65	2.67	1.71	3.79	1.66	1.79	1.17	6.38	1.19	116.04[P]
Participant blame	3.11	1.71	2.76	1.76	4.65	1.71	6.44	1.05	2.10	1.29	107.72[P]

[P] $p < .05$.

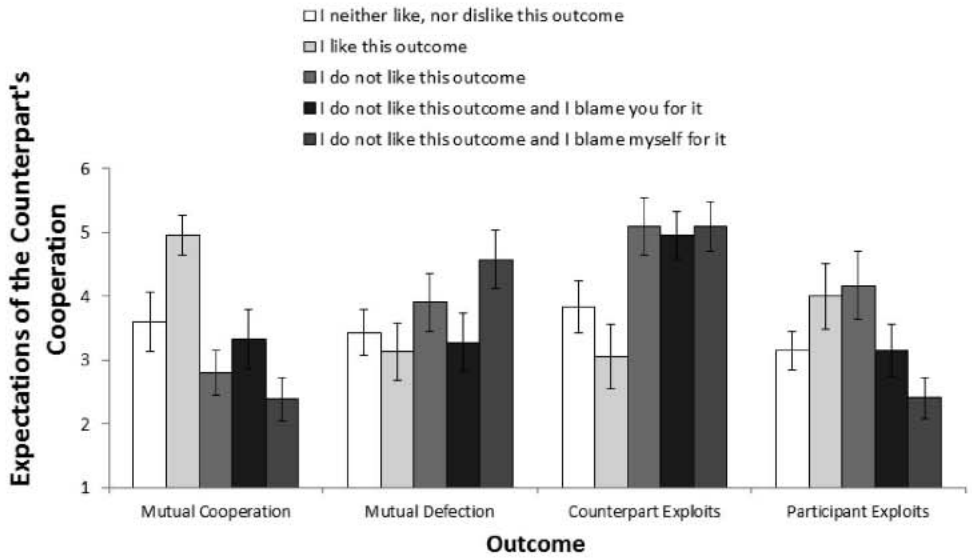

Figure 6. Expectations of cooperation in Experiment 5. Error bars show standard errors.

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textual appraisals may be an interesting line of future work. Overall, according to Spencer et al. (2005), because Experiment 4 showed that facial displays impacted perceptions of the counterpart's appraisals and Experiment 5 showed that perception of appraisals led to corresponding inferences about the counterpart's cooperation, there is, in further support of Hypothesis 4, experimental evidence that perception of appraisals mediate the effects of emotion expressions on expectations about others' mental states.

General Discussion

People are able to make inferences about others' mental states from emotion expressions in interdependent decision making. Experiment 1 showed that more than the displays per se, it is the underlying information that impacted people's decision making. Experiment 2, in turn, suggested that the information people retrieved from emotion expressions pertained to others' appraisals of the ongoing interaction. Furthermore, Experiments 3 and 4 showed, using multiple mediation analyses (Preacher & Hayes, 2008), that these perceptions of others' appraisals mediated the effects of emotion expressions on, respectively, people's decision making and on expectations about others' mental states. Finally, Experiment 5 presented complementary evidence, using a causal-chain design (Spencer et al., 2005), for the mediating role of appraisals.

Implications

Our findings are compatible with the view that emotion expressions serve the important social function of communicating information about one's beliefs, desires, and intentions (Frank, 2004; Frijda & Mesquita, 1994; Keltner & Haidt, 1999; Keltner & Kring, 1998; Morris & Keltner, 2000; Van Kleef et al., 2010), and, specifically, information about one's propensity for cooperation in interdependent decision making, in particular social dilemmas (Boone & Buck, 2003; Frank, 2004; Nesse, 1990; Trivers, 1971). Our results, furthermore, propose reverse appraisal as the mechanism by which such inferences regarding others' mental states are achieved. Accordingly, people retrieve, from emotion expressions, information about how others are appraising the ongoing interaction, and, in turn, this information leads to inferences about others' intentions.

The experiments reported here support the view that perceptions of appraisals mediate the effects of emotion displays on people's expectations about others' intentions (Experiments 4 and 5) and people's actual decisions (Experiment 3). These results are compatible with prior research that suggests expectations of others' behavior correlate positively with actual cooperation in social dilemmas (e.g., Balliet & Van Lange, 2012) and, further, support causality. Because, for many pairings of emotion with outcome, appraisals fully mediated the effects of emotion expressions, we can exclude alternative explanations such as affective processes—which imply own emotion mediates the effect of emotion expressions on decision making (Parkinson & Simons, 2009; Van Kleef et al., 2010)—and social appraisal—which imply own appraisals mediate the social effects of emotion (Manstead & Fischer, 2001; Parkinson & Simons, 2009).

More generally, our results speak to the role expressions play in shaping cooperation and competition. For example, our results contrast with research that suggests that genuine smiles are an unequivocal signal of cooperation (Brown, Palameta, & Moore, 2003; Mehu, Grammer, & Dunbar, 2007; Scharlemann, Eckel, Kacelnik, & Wilson, 2001) and are in line with research that argues a smile can have different interpretations according to context (Aviezer et al., 2008; Hareli & Hess, 2010; Lanzetta & Englis, 1989; Van Kleef et al., 2010). Effectively, our results showed that in a cooperative context, such as following mutual cooperation, a smile led to expectations of cooperation; in a noncooperative context, such as following mutual defection (Experiment 4), a smile decreased expectations of cooperation; yet in another context, such as following the case in which the counterpart exploits the participant, a smile seemed to have signaled

redundant information to that communicated by the counterpart's behavior and, thus, did not affect expectations of cooperation (which were low, similarly to the case for the neutral display).

The results on the expression of joy are striking: In the context of mutual cooperation, joy either from the face or from text reinforced expectations of cooperation (see Figure 3a) but joy had no impact on expectations of cooperation under conditions of exploitation. One might expect that joy expressed by the other when the other exploited (possibly a form of Schadenfreude) might decrease expectations of cooperation, but it did not (see Figure 3c). There are several possibilities that could explain this: it could be that there is a floor effect and that a better measurement procedure might show an effect (a level of 3 on the scale was about as low as participants went). Or, it could be simply that this behavior (exploitation in the prisoner's dilemma) is so salient that evidence of the other's Schadenfreude was simply ignored. Or, it could be that the other was simply assumed to be joyful at having exploited and done so well at one's own expense, and seeing evidence of their reaction did not add to the low view of it. Regardless, it is a potentially interesting avenue for further work.

The results also show that negative emotions can be important to identify cooperators (Chapman, Kim, Susskind, & Anderson, 2009) and support the general contention that people use both positive and negative emotion displays to identify and punish noncooperators (Boone & Buck, 2003; Schug, Matsumoto, Horita, Yamagishi, & Bonnet, 2010). Finally, despite not presenting specific predictions for the prisoner's dilemma, Van Kleef et al. (2010) advance general predictions for cooperative behavior according to whether a given situation is perceived as cooperative or competitive. Our results suggest that the combination of outcome with emotion display in the prisoner's dilemma can, indeed, impact the perception of how cooperative the situation is. For instance, in line with their predictions for cooperative situations, expression of joy in mutual cooperation or regret when the counterpart exploits the participant led to expectations of cooperation; in line with their predictions for competitive situations, the expression of anger in mutual cooperation tended to lead to noncooperation.

Our findings also have implications for the rationality of human social behavior. Findings such as in Experiment 1, where people depart from game-theoretic predictions of noncooperation, are often interpreted as either failures of human decision making or failures of rational models (e.g., Frank, 2004). However, from a certain perspective, our participants are acting rationally: they observed information about the other party's intentions, they judged the consistency of this information with past behavior, and decided how best to act. Traditional rational analysis of situations like the prisoner's dilemma make strong assumptions about the information available to each party, including the inability of parties to communicate. More recent decision-theoretic frameworks, however, relax this strict assumption and highlight the rationality of basing decisions on evidence concerning the beliefs and intentions of the other party (e.g., Battiggalli & Dufwenberg, 2009), including "cheap" talk. In this sense, our results are consistent with the view that people are acting as rational decision makers and that any analysis of rationality must encompass the informational role of emotional signals.

We also explored in the present article only a subset of the appraisal variables suggested by appraisal theorists; aside from goal conduciveness and blameworthiness, other appraisals have been proposed, such as certainty, urgency, coping potential, and social norm compatibility (Ellsworth & Scherer, 2003). Not considering some of these appraisal variables might explain why in Experiment 4, for some combinations of emotion and outcome, there was only partial mediation of perception of appraisals on the effects of emotion displays; the missing appraisals could represent some of the information people retrieve from emotion displays that the experiments failed to measure. Moving forward, these appraisals should be relevant for studying the social effects of other emotions (e.g., certainty, expectations, or probability of occurrence are pertinent for displays of fear or hope) and for distinguishing variations of the emotions studied here (e.g., social appraisals allow us to consider guilt as a form of regret related to the transgression of a social norm; Baumeister, Stillwell, & Heatherton, 1994).

We argue in the present article reverse appraisal is an inferential mechanism for the interpersonal effects of emotion expressions in decision making. Indeed, our mediation results suggest that inferences (about appraisals and other's intentions) play a central role explaining the social effects of emotions, at least in the context of the prisoner's dilemma. However, other researchers have argued affective processes. and social appraisal can also play a role in explaining interpersonal effects of emotions (e.g., Carnevale, 2008; Carnevale & Isen, 1986; Parkinson & Simons, 2009; Van Kleef et al., 2010). Our results do not exclude the possibility that these alternative processes might co-occur with reverse appraisal, first, for pairings of emotion and outcome in the prisoner's dilemma in which appraisals did not fully mediate the effects of emotion expressions and, second and most importantly, in different decision-making tasks. In fact, we expect situational context to influence how significant the role of each process is, as has been suggested before (Parkinson & Simons, 2009; Van Kleef et al., 2010). In the present research, participants presumably had a clear understanding of the prisoner's dilemma and of the implications of a given outcome for their goal of maximizing their own points. One could argue that under these conditions, the primary usefulness of the other player's emotional expressions would be to draw inferences about the player's likely move in the next round of the prisoner's dilemma, and that reverse appraisal provides an efficient way to make those inferences. Under other conditions (e.g., shared social identity with a player who is part of one's team rather than an opponent), one could imagine that affective processes might shape responses to his or her facial expressions and that under still other conditions (e.g., a more ambiguous setting in which the two players are jointly confronted with challenges), one could imagine that social appraisal processes might shape the way in which participants react to others' facial expressions. In other words, the setup used in the present research might have particularly lent itself to the reverse appraisal process. Thus, when studying other decision settings, it is important in the future to measure, aside from others' appraisals, own appraisals and own emotions so that it may be possible to identify the mediators (and the causal order) for the social effects of emotions on people's decision making. These mediation analyses could then be used to tease apart the contributions of reverse appraisal, affective processes, and social appraisal.

Regarding external validity, we have shown that reverse appraisal is useful in understanding the social effects of emotions in

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a Western student population (Experiments 1 and 3) as well as in a broader, more diversified online sample (Experiments 2, 4, and 5). However, it is also important to study reverse appraisal in the context of other decision-making tasks. Even though we used the prisoner's dilemma in the present work, there is no reason not to expect reverse appraisal to be relevant in other social decision-making contexts such as other two- or N-person dilemma tasks or negotiation. Carnevale and Pruitt (1992) called for this sort of generalization inquiry across mixed-motive tasks, and this represents a promising line of future inquiry.

Coda

The studies reported here serve as an important bridge between psychological findings on emotion and research in the fields of artificial intelligence and human–computer interaction. Increasingly, the computational sciences are seeking to develop algorithms that collaborate and sometimes compete with people in social tasks. For example, an active body of research seeks to develop algorithms that negotiate with or on behalf of human users (e.g., Lin & Kraus, 2010). Other research aims to improve the ability of computers to interact in such social tasks by both recognizing human emotional displays (e.g., Calvo & D'Mello, 2010; Zeng, Pantic, Roisman, & Huang, 2009) and even endowing computers and robots with anthropomorphic characteristics such as the ability to signal emotion (e.g., DeSteno et al., 2012).

It is beyond the scope of this article to motivate the value of this enterprise (but see Marsella, Gratch, & Petta, 2010); however, our results make important contributions for how to design such systems. For example, Experiments 1 and 4 illustrate that a computer can shape cooperation rates through judicious display of emotion and, more generally, illustrate that appraisal theory serves as a concrete mathematical framework for translating the beliefs, desires, and intentions of machines into intuitive human-readable signals. The results also suggest possible approaches for allowing machines to interpret human emotional displays. Although we only looked at how people decode emotional signals and not how they produce them, it is worth exploring whether machines should incorporate some mechanism akin to reverse appraisal. For example, if a person smiles as a result of one of the machine's actions, the machine would do well not simply to view the smile as a reward, but to reconstruct, using context, the underlying mental state that the smile presumably signifies. More generally, these findings highlight that emotions play a function role in social interactions (i.e., communicating mental state) and that computational systems can draw on this function to enhance their own efficacy.

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