Reverse Appraisal: Inferring from Emotion Displays who is the Cooperator and the Competitor in a Social Dilemma

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Abstract

This paper explores whether and how facial displays of emotion can impact emergence of cooperation in a social dilemma. Three experiments are described where participants play the iterated prisoner's dilemma with (computer) players that display emotion. Experiment 1 compares a cooperative player, whose displays reflect a goal of mutual cooperation, with a control player that shows no emotion. Experiment 2 compares a competitive player, whose displays reflect a goal of getting more points than the participant, and the control player. Experiment 3 compares the cooperative and competitive players. Results show that people: cooperate more with the cooperative than the control player (Experiment 1); do not cooperate differently with the competitive and control players (Experiment 2); and, cooperate more with the cooperative than the competitive player, when they play the latter first (Experiment 3). In line with a social functions view of emotion, we argue people infer, from emotion displays, the other player's propensity to cooperate by reversing the emotion appraisal process. Post-game surveys show that people interpret the emotion displays according to appraisal variables (desirability, responsibility and controllability) in ways that are consistent with predictions from appraisal theories of emotion.

Keywords: Emotion, Cooperation, Competition, Social Dilemma, Reverse Appraisal

Introduction

People frequently face social dilemmas where they must choose between pursuing their own self interest and collect a short-term reward or rely on another person for mutual cooperation and maximize joint long-term reward (Kollock, 1998). In these cases, it is valuable, from an adaptive point of view, to be able to detect how likely the other is to cooperate (Frank, 1988). Nonverbal displays have been argued to be an important cue in this detection process (Boone & Buck, 2003). In particular, there has been a lot of empirical research on the impact of facial displays of emotion on emergence of cooperation: studies show that cooperative individuals display higher levels of positive emotion than non-cooperators (Scharlemann et al., 2001); and Schug et al. (2010) argue that cooperators can be identified by high emotional expressivity of both positive and negative emotion. In this paper, we go further and try to understand how people make inferences in social dilemmas from information conveyed through the other party's facial displays of emotion.

The view that facial displays of emotion can be used to detect cooperators is in line with the idea that emotions serve important social functions and convey information about one's feelings and intentions (Frijda & Mesquita, 1994). One theory, compatible with this social view of emotions, is based on appraisal theories of emotion. In appraisal theories (Ellsworth & Scherer, 2003), displays of emotion 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. Now, since displays reflect the agent's intentions through the appraisal process, it is also plausible to ask whether people can infer from emotion displays the agent's goals by reversing the appraisal mechanism. Hareli and Hess (2009) provide preliminary evidence for this theory. In their study they show that people can, from expressed emotion, make inferences about the character of the person displaying emotion (e.g., a person who reacted with anger to blame was perceived as more self-confident than one that reacted with sadness). We refer to this theory as *reverse appraisal*.

In previous work, we suggested that reverse appraisal is useful in understanding how people make inferences, from facial displays of emotion, about the other party's propensity to cooperate (de Melo, Carnevale & Gratch, 2010). In that study, we ask people to play the iterated prisoner's dilemma with two computer players, or *agents*, that, even though following the same strategy to choose their actions, display different emotions according to the outcome of each round. Computer agents that show emotion had already been argued to be a useful research tool for basic human-human interaction research (Blascovich et al., 2001). One agent – the *cooperative* agent – had displays that were consistent with the goal of maximizing joint reward (e.g., expression of joy when both players cooperated). The other agent – the *individualistic* agent – had displays that reflected how good the outcome was for the self, independently of the value for the participant (e.g., expression of joy when agent defected and participant cooperated). The results show that people cooperate more with the cooperative agent. Moreover, the results show that the effect is particularly salient when participants play first with the individualistic agent (de Melo, Carnevale & Gratch, submitted). This contrast effect is in line with the well-known *black-hat/white-hat* (or *bad-cop/good-cop*) effect (Hilty & Carnevale, 1993) that argues people cooperate more with a cooperative opponent if they're first matched with a tough opponent. This effect suggests that initial firmness may lessen the temptation to exploit and that cooperative initiatives that are extended in the context of firmness are likely to evoke reciprocity.

In this paper, we further explore the role of reverse appraisal and the black-hat/white-hat contrast effect on emergence of cooperation in a social dilemma when playing with agents that display emotions. The paper presents three new experiments: in Experiment 1, people play the iterated prisoner's dilemma with a *cooperative* agent (which displays reflect a goal of maximizing joint reward) and a *control* agent (which displays no emotion); in Experiment 2, people play with a *competitive* agent (which displays reflect a goal of earning more points in relation to the participant) and the control agent; in Experiment 3, people play with the cooperative and competitive agents. This set of experiments extends our previous work in the following ways: (a) it explores the competitive orientation, which is the third and last of the common social value orientation we see in people (McClintock & Liebrand, 1988); (b) it introduces comparisons with a control agent that displays no emotion; (c) in a post-game questionnaire, we explicitly probe the mediating role of appraisal variables on the effect of emotion displays on emergence of cooperation.

Experiment 1: Cooperative vs. Control

Design

The experiment follows a repeated-measures design where participants play 25 rounds of the iterated prisoner's dilemma with two different computational agents for a chance to win real money: the cooperative agent; and the control agent. The cooperative agent displays emotions through the face, whereas the control agent displays no emotion. The strategy for choosing which action to take in each round is the same for both agents.

Game. Participants play the iterated prisoner's dilemma but, following the approach by Kiesler, Waters and Sproull (1996), the game is recast as an investment game. Essentially, participants can invest in one of two projects – *Project Green* (or cooperation) and *Project Blue* (or defection) – and the outcome is contingent on what the other party invests in. Table 1 summarizes the payoffs. The participant is told that there is no communication between the players before choosing an action. Moreover, the participant is told that the other party makes its decision without knowledge of what the participant's choice in that round is. *After* the round is over, the action each chose is made available to both players and the outcome of the round, i.e., the number of points each player got, is also shown. The experiment is fully implemented in software and a snapshot is shown in Fig.1: During game play, the real-time animation of the agent is shown on the left.

Action Policy. Agents in both conditions follow the same strategy to choose their actions. The policy is a variant of *tit-for-tat*. Tit-for-tat is a strategy where a player begins by cooperating and then proceeds to repeat the action the other player did in the previous round. Tit-for-tat has been argued to strike the right balance of punishment and reward with respect to the opponent's previous actions (Kollock, 1998). So, the action policy used in our experiment is as follows: (a) in rounds 1 to 5, the agent plays the following fixed sequence: cooperation, cooperation, defection, cooperation, cooperation; (b) in rounds 6 to 25, the agent plays pure tit-for-tat. The rationale for the sequence in the first five rounds is to make it harder for participants to learn the agents' strategy and to allow participants to experience a variety of facial displays from the start.

Table 1: Payoff matrix for the investment game.

		Agent Project Green	***Agent*** Project Blue
User	Project Green	Agent: 5 pts User: 5 pts	Agent: 7 pts User: 2 pts
User	Project Blue	Agent: 2 pts User: 7 pts	Agent: 4 pts User: 4 pts

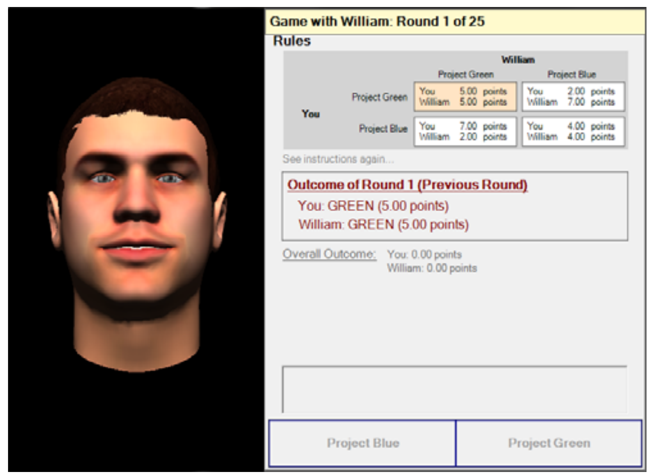

Figure 1: Software used in the experiment.

Conditions. There are two conditions in this experiment: the *cooperative* agent; and the *control* agent. Both agents follow the same action policy but differ in their facial display policies. The facial display policy defines the emotion which is conveyed for each possible outcome of a round. Table 2 shows the facial displays for the cooperative agent. The control agent shows no emotion. The facial displays are chosen to reflect the agents' goals in a way that is consistent with appraisal models of emotion (Ellsworth & Scherer, 2003). Thus, the cooperative agent's displays reflect the goal of mutual cooperation: when both players cooperate, it expresses gratitude (with a display of joy), as the outcome is appraised to be positive for the self and the participant is appraised to have contributed for it; when the agent cooperates but the participant defects, it expresses anger, as the event is appraised as negative and the participant is blamed for it; otherwise, the agent shows no emotion. Condition order is randomized across participants.

Table 2: Facial displays for the cooperative agent.

Cooperative		*Agent* Project Green	*Agent* Project Blue
User	Project Green	Joy	Neutral
User	Project Blue	Anger	Neutral

Facial displays are animated using a real-time pseudo-muscular model for the face that also simulates wrinkles (de Melo, & Gratch, 2009). Facial displays were all previously validated (de Melo, Carnevale & Gratch, 2010). The displays are shown at the end of the round, after both players have chosen their actions and the outcome is shown. Moreover, there is a 4.5 seconds waiting period before the participant is allowed to choose the action for the next round. This period allows the participant to appreciate the display before moving to the next round. To enhance naturalness, blinking is simulated as well as subtle random motion of the neck and back. Two different bodies are used: *Ethan* and *William*. These bodies are shown in Fig.2 as well as their respective facial displays. Bodies are assigned to each condition randomly and agents are referred to by these names throughout the experiment.

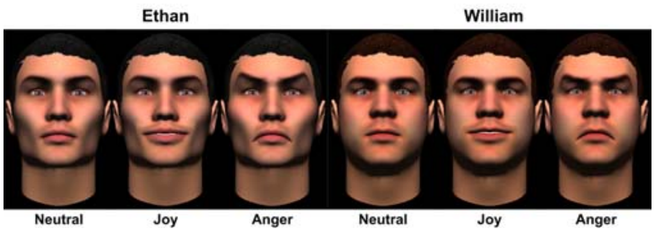

Figure 2: The agent bodies and their facial displays.

Measures. During game-play, we save information regarding whether the participant cooperated in each round. This is our main behavioral measure. After playing with both agents, we present a questionnaire that probes how participants are appraising the situations where emotion displays are shown. In this regard, three appraisal variables are relevant (Ellsworth & Scherer, 2003; Ortony, Clore & Collins, 1988): *desirability*, which reflects how congruent with the agent's goals the event is; *blameworthiness*, which reflects who is responsible for the event (the self or the other party); and, *control*, which reflects how capable is the agent of coping with the consequences of the event. Appraisal theories usually predict that: joy occurs when the event is desirable and the agent has control over it; anger occurs when the event is not desirable and another agent is responsible for it. So, in the post-game questionnaire, for each agent, we ask a set of questions regarding the cases where the cooperative agent expresses emotion (i.e., when mutual cooperation occurs or the participant exploits the agent). Therefore, the same questions are asked four times (2 agents x 2 cases). For each case, we show a picture of the emotion the agent displayed and ask the following questions (scale goes from 1 – 'not at all' to 7 – 'very much'), where the agent is actually referred to by its body's name:

- How desirable was the outcome of the round to *the agent*?
- How much do you think *the agent* feels you were responsible?
- How much do you think *the agent* feels he can control the outcome of future rounds?
- How likely was *the agent* to play GREEN in the next round?

Participants. Forty-eight participants were recruited at the University of Southern California Marshall School of Business. Average age was 21.6 years and 62.5% were males. Most participants were undergraduate (41.7%) or graduate (56.3%) students majoring in diverse fields. Most were also originally from Asia (66.7%) and North America (33.3%). The incentive to participate follows standard practice in experimental economics (Hertwig & Ortmann, 2001): first, participants were given $15 for their participation in this experiment; second, with respect to their goal in the game, participants were instructed to earn as many points as possible, as the total amount of points would increase their chance of winning a lottery for $100.

Results

Participants that did not experience joy with the cooperative agent[1] where excluded from analysis (though keeping them would lead to the same pattern of results). So, 10 (out of 48) participants were excluded.

To understand how people cooperated with the agents, we look at cooperation rate over all rounds. Figure 3 and Table 2 show the results for this variable. Significance levels are calculated using the *repeated-measures t test*.

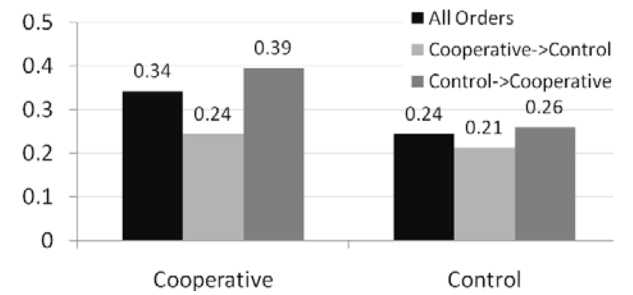

Figure 3: Cooperation rates in Experiment 1.

Table 3: Cooperation rates in Experiment 1.

Order	*N*	*Cooperative*		*Control*		*Sig. 2-sd*	*r*
		Mean	*SD*	*Mean*	*SD*		
All	*38*	.342	.173	.243	.142	.006*	.043
Coop→Ctrl	*13*	.243	.089	.212	.119	.409	ns
Ctrl→Coop	*25*	.394	.185	.259	.152	.008*	.506

* Significant difference, $p < .05$

Regarding the post-game questionnaire, since the results were similar for all condition orders, we show in Table 4 only the results when collapsing across all orders. Significance levels are calculated using the *repeated-measures ANOVA*. The table also shows *Bonferroni* post-hoc comparisons between the patterns for each agent.

Table 4: Appraisal variables in Experiment 1. Means are shown for each variable and SDs in parentheses.

Variables	*Cooperative*			*Control*			*Sig. 2-sd*
	CC (Joy)	*DC (Anger)*	*Sig.*	*CC*	*DC*	*Sig.*	
Desirable	4.89 (1.64)	2.50 (1.78)	.008*	4.58 (1.39)	3.53 (2.10)	.277	.000*
Responsible	4.92 (1.72)	5.16 (1.79)	1.000	4.53 (1.67)	4.74 (1.59)	1.000	.328
Control	4.61 (1.70)	3.47 (1.57)	.008*	3.84 (1.60)	3.74 (1.50)	1.000	.002*
Will agent cooperate?	4.76 (1.94)	2.37 (1.65)	.000*	4.29 (2.27)	2.58 (1.94)	.002*	.000*

* Significant difference, $p < .05$

[1] Notice our paradigm does not guarantee participants will experience all outcomes in the Prisoner's Dilemma game.

Discussion

The results show that people cooperate significantly more with the cooperative agent than the control agent (Table 3). This is in line with the view that, in social dilemmas, people look for cues in their trading partners that they might be willing to cooperate before engaging in cooperation themselves (Frank, 1988; Boone & Buck, 2003). The results also show that this effect is being driven by the condition order in which participants play with the control agent first, and the cooperative agent second. In a previous study (de Melo, Carnevale & Gratch, submitted) we got a similar contrast effect when people played with an individualistic agent first, followed by a cooperative agent. We advanced an explanation based on the black-hat/white-hat effect (Hilty & Carnevale, 1993) that argues people cooperate more with a cooperative opponent if they're first matched with a tough opponent. Applying the black-hat/white-hat effect to this case means that the cooperative agent is perceived as the white-hat (or cooperator) and the control agent as the black-hat (or non-cooperator). Whereas the former was expected, the latter requires further explanation. The control agent is perceived as a black-hat likely as a consequence of its lack of reactivity to the game. Absence of emotion displays can also emphasize the perception that the opponent is tough. Finally, human-computer interaction studies show that people prefer to interact with agents that display emotions than agents that do not (Beale & Creed, 2009).

But how do people identify who is the black-hat and the white-hat? We argue people infer from emotion displays what the agents' goals are by a process of reverse appraisal. The results from the post-game questionnaire provide insight (Table 5): in line with appraisal theories (Ellsworth & Scherer, 2003), people perceive the cooperative agent to desire more and have more control when it expresses joy (i.e., when mutual cooperation occurs) than when it expresses anger (i.e., when the participant exploits the agent). It is no surprise, then, that people perceive the agent to be more likely to cooperate again after joy, than after anger (last row in Table 5). Overall, this suggests people can infer from emotion displays, through appraisal variables, what the agents' goals are. However, it is interesting to note that people also tend to perceive the control agent to desire more the mutual cooperation case than the case where the participant exploits the agent. This suggests people make appropriate inferences regarding desirability even in the absence of emotion. Nevertheless, whereas the pairwise comparisons for the cooperative agent are significant for desirability and control, they are not for the control agent, which emphasizes the importance of the emotion displays.

Experiment 2: Competitive vs. Control

Design

Experiment 2 has a similar design to Experiment 1, except that participants play with a *competitive* agent and the control agent. The competitive agent has displays that reflect whether the agent got more points than the participant (Table 5), which is the usual definition of a competitive orientation (McClintock & Liebrand, 1988): when the agent exploits the participant, it expresses joy; when the agent is exploited by the participant, it expresses anger; otherwise, it shows no emotion. The post-game questionnaire asks the same questions as before only with respect to the two cases where the competitive agent expresses emotion. For this Experiment, 38 participants were recruited from the USC Marshall School of Business. Average age was 22.3 years and 63.3% were males. Most participants were undergraduate (46.7%) or graduate (53.3%) students majoring in diverse fields. Most were also originally from Asia (66.7%) and North America (33.3%).

Table 5: Facial displays for the competitive agent.

Competitive		*Agent*	
		Project Green	Project Blue
User	Project Green	Neutral	Joy
	Project Blue	Anger	Neutral

Results

Participants that did not experience joy with the competitive agent were excluded from analysis (though keeping them would lead to the same pattern of results). So, 8 (out of 38) participants were excluded. Figure 4 and Table 6 show the cooperation rates. Table 7 shows the results for the post-game questionnaire when collapsing across condition orders (since results were similar for each order).

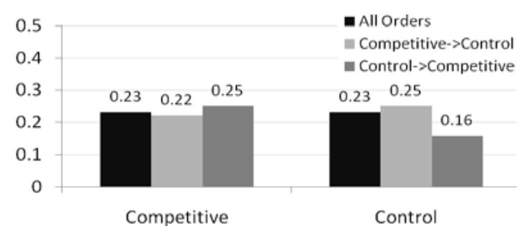

Figure 4: Cooperation rates in Experiment 2.

Table 6: Cooperation rates in Experiment 2.

Order	*N*	*Competitive*		*Control*		*Sig. 2-sd*	*r*
		Mean	*SD*	*Mean*	*SD*		
All	*30*	.232	.109	.232	.170	1.000	ns
Comp→Ctrl	*19*	.221	.096	.251	.178	.357	ns
Ctrl→Comp	*11*	.251	.133	.200	.158	.299	ns

Discussion

The results show that people are *not* cooperating differently with the competitive or control agents. This likely means both agents are perceived to be equally unlikely to cooperate. The results are also in line with what would be expected when playing the black-hat/black-hat sequence (Hilty & Carnevale, 1993). However, agents are likely being perceived as black-hats for different reasons. Whereas for the competitive agent this perception follows from its competitive displays, for the control agent it follows from its lack of reactivity (see the 'Discussion' for Experiment 1). The results for the post-game questions (Table 7) are also in line with expectations from appraisal theories (Ellsworth & Scherer, 2003). People perceive the competitive agent to desire more and have more control in the outcome it expresses joy (agent exploits participant) than in the outcome it expresses anger (participant exploits agent). Moreover, people perceive the competitive agent to assign responsibility significantly more to the participant when it expresses anger, than when it expresses joy. Notice this difference is not significant for the control agent. Finally, notice again that magnitude differences for appraisal variables are higher for the emotional agent than the control agent, thus, emphasizing the relevance of emotion displays.

Table 7: Appraisal variables in Experiment 2. Means are shown for each variable and SDs in parentheses.

Variables	*Competitive*			*Control*			*Sig. 2-sd*
	CD (Joy)	*DC (Anger)*	*Sig.*	*CD*	*DC*	Sig.	
Desirable	5.83 (1.66)	1.70 (1.15)	.000*	5.13 (1.70)	2.77 (1.55)	.000*	.000*
Responsible	4.50 (1.61)	5.40 (1.61)	.165	4.07 (1.48)	4.47 (1.70)	1.000	.005*
Control	5.00 (1.55)	3.87 (1.74)	.002*	4.40 (1.57)	3.97 (1.47)	.180	.002*
Will agent cooperate?	3.37 (2.08)	2.27 (1.76)	.114	2.87 (1.87)	2.37 (1.67)	1.000	.032*

* Significant difference, $p < .05$

Experiment 3: Cooperative vs. Competitive

Design

Experiment 3 has a similar design to Experiment 1, except that participants play with the cooperative agent and the competitive agent. Fifty-one participants were recruited from the USC Marshall School of Business. Average age was 22.0 years and 62.7% were males. Most participants were undergraduate (54.9%) or graduate (43.2%) students majoring in diverse fields. Most were also originally from Asia (52.9%) and North America (47.1%).

Results

Participants that did not experience joy at least once with *each* agent were excluded from analysis. So, 13 (out of 51) participants were excluded. Figure 5 and Table 8 shows the cooperation rates. Table 9 shows the results for the post-game questions when collapsing across condition orders (since results were similar for each order).

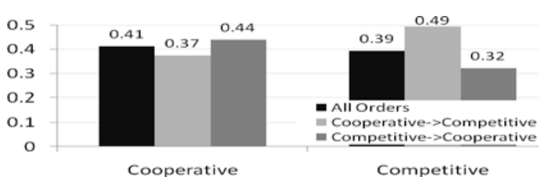

Figure 5: Cooperation rates in Experiment 3.

Table 8: Cooperation rates in Experiment 3.

Order	*N*	*Cooperative Mean*	*Cooperative SD*	*Competitive Mean*	*Competitive SD*	*Sig. 2-sd*	*r*
All	*34*	.413	.225	.393	.211	.678	ns
Coop→Comp	*14*	.374	.193	.494	.193	.120	.419
Comp→Coop	*20*	.440	.252	.322	.198	.044*	.443

* Significant difference, $p < .05$

Table 9: Appraisal variables in Experiment 3. Means are shown for each variable and SDs in parentheses.

Variables	*Cooperative*			*Competitive*			*Sig. 2-sd*
	CC (Joy)	*DC (Anger)*	*Sig.*	*CD (Joy)*	*DC (Anger)*	Sig.	
Desirable	5.47 (1.80)	2.56 (2.08)	.000*	5.76 (1.74)	2.65 (2.09)	.000*	.000*
Responsible	4.85 (1.67)	5.68 (1.47)	.040*	4.06 (2.23)	5.85 (1.54)	.001*	.000*
Control	4.97 (1.47)	3.82 (1.60)	.001*	5.09 (1.58)	3.29 (1.53)	.000*	.000*
Will agent cooperate?	5.09 (2.07)	2.50 (1.93)	.000*	4.53 (2.02)	3.24 (2.06)	.068	.000*

* Significant difference, $p < .05$

Discussion

Experiment 1 shows that the cooperative agent is perceived as a cooperator (white-hat). Experiment 2 shows that the competitive agent is perceived as a non-cooperator (black-hat). Thus, in Experiment 3, we expected people to cooperate more with the cooperative agent, especially in the black-hat/white-hat order. Effectively, Table 8 shows that, when playing with the competitive agent first (black-hat/white-hat order), people cooperate significantly more with the cooperative agent. However, when playing with the cooperative agent first (white-hat/black-hat order), there is an unexpected trend to cooperate more with the competitive agent. One possible explanation for this is based on adaptation level theory (Helson, 1964) which predicts high concessions in response to the white-hat/black-hat sequence because the black hat will appear toughest when preceded by a white hat; in a competitive context, this enhances the tendency to yield to a powerful opponent. A negative shift in cooperation can also evoke more concessions if it produces a desire to entice the black-hat adversary with cooperative gestures to return to former levels of cooperation. Finally, Hilty & Carnevale (1993) also report that, in bilateral negotiation, a negative shift in cooperation, elicits "unilateral concessions from participants in an effort to induce the bargainer to resume former levels of concession-making" (pg.458).

The results for the post-game questions (Table 9) show that: people perceive, for both agents, the outcomes that cause joy to be more desirable and controllable than outcomes that cause anger; and, people perceive the agent to assign more blame (to the participant) when it expresses anger than joy. As expected, this leads to a perception that the cooperative agent is more likely to cooperate in the next round after it expresses joy (mutual cooperation) than anger (agent is exploited), as shown in the last row of Table 9. However, unexpectedly, people tend to perceive the competitive agent to be relatively likely to cooperate in the next round after it expresses joy (i.e., after it defects when the participant cooperates). From the perspective of appraisal theory, if the competitive agent found that exploiting the participant is desirable and controllable, than one could expect people to predict the competitive agent to keep exploiting participants (i.e., defecting). Effectively, in Experiment 2, people did not perceive the competitive agent to be likely to cooperate after expressing joy. We hope to clarify this result in the future with further experiments.

General Discussion

The studies presented here confirm that people are influenced by facial displays of emotion when deciding whether to cooperate in a social dilemma. Experiment 1 reveals that people cooperate more with a player that shows cooperative displays than one that shows no emotion. Experiment 2 shows people do not cooperate differently with a player that shows competitive displays and one that shows no emotion. Experiment 3 shows that people cooperate more with a player that shows cooperative displays than one that shows competitive displays, when they play the latter first. Overall, the results emphasize the importance of *context* for interpreting what emotion displays means. Effectively, the cooperative and competitive players only differ in the context under which they express joy and, yet, people play differently with each. Hareli and Hess (2009) had also noticed the relevance of context for perception of smiling. The results, thus, question the view that the cooperator is simply the one that shows the most positive emotion (Scharlemann et al., 2001); or, seeing that the cooperative and competitive agents express just as much emotion, the view that cooperators are simply the ones that express more emotion, be it positive or negative (Schug et al., 2010). We argue that, in line with the social functions view of emotion (Frijda & Mesquita, 1994), people are making inferences from emotion displays regarding the other party's propensity to cooperate. Moreover, we propose reverse appraisal is the key to understanding how people make those inferences. Our findings from the post-game questionnaires suggest that people are, effectively, capable of interpreting the agents' emotion displays according to appraisal variables (desirability, responsibility and controllability) in ways that are congruent with the expectations from appraisal theories of emotion. In the future we plan on gathering further support for the reverse appraisal proposal, as well as understand its limitations, with new experiments that explore the mediating role of appraisal variables through statistical methods, as in Hareli and Hess (2009), or experimentally manipulate appraisal variables and measure the impact on cooperation rates.

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