Emotional expressivity as a signal of cooperation

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Abstract

Previous research has suggested that the spontaneous display of positive emotion may be a reliable signal of cooperative tendency in humans. Consistent with this proposition, several studies have found that self-reported cooperators indeed display higher levels of positive emotions than non-cooperators. In this study, we defined cooperators and non-cooperators in terms of their behavior as the proposer in an ultimatum game, and video-taped their facial expressions as they faced unfair offers as a responder. A detailed analysis of the facial expressions displayed by participants revealed that cooperators displayed greater amounts of emotional expressions, not limited to positive emotional expression, when responding to unfair offers in the ultimatum game. These results suggest that cooperators may be more emotionally expressive than non-cooperators. We speculate that emotional expressivity can be a more reliable signal of cooperativeness than the display of positive emotion alone.

Keywords:

Emotional expression, cooperation

It is contended that cooperation among non-kin can evolve in a population when cooperators can be identified by honest and unfalsifiable signals, allowing for mutual selection among cooperators (Dawkins 1976; Frank 1988; Hamilton 1964; Trivers 1971). Spurred by this theoretical explanation of the evolution of cooperation, many researchers looking for such signals in humans have focused on involuntary facial expressions of emotion (Boone & Buck 2003; Brown & Moore, 2002; Frank 1988; Krumhuber et al., 2007; Mehu, Little, & Dunbar, 2007; Oda et al., 2009; Trivers 1971; Scharlemann, Eckel, Kacelnik & Wilson, 2001). It has been proposed that the display of spontaneous positive emotion (Ekman & Friesen, 1982; Frank & Ekman, 1993; Frank, Ekman, & Friesen, 1993), also known as "Duchenne" smiles, can serve as a relatively honest signal of positive subjective experience. Duchenne smiles involve the innervation of the *orbicularis occuli*, a facial muscle surrounding the eyes that is difficult to intentionally control, and been empirically demonstrated to correlate with the experience of positive emotion (Frank, Ekman, & Friesen, 1993; Hess, Banse, & Kappas, 1995; Keltner & Bonanno, 1997). "Non-duchenne" smiles, in contrast, do not involve the contraction of the *orbicularis occuli* and are not associated with positive subjective experience (Bonanno, Keltner, Noll, Putnam, Trickett, LeJeune, & Anderson, 2002; Keltner, 1995). Many studies have found that cooperative and altruistic individuals display higher levels of positive emotion than non-cooperators (Brown, Palameta & Moore, 2003; Mehu, Grammer & Dunbar, 2007; Mehu, Little & Dunbar, 2007). This tendency has indeed been confirmed in various situations, such as when participants talk with an experimenter about their personal experiences (Shelley & Kuhlman, 2007), engage in natural conversation (Oda et al., 2009), read aloud a short story (Brown et al., 2003), or share with a friend (Mehu, Grammer & Dunbar, 2007).

Research findings also suggest that the nature of the situation may determine the degree to which displays of positive emotion predict an individual's cooperative tendency. In Mehu, Grammer, and Dunbar's (2007) study, for example, Duchenne smiles correlated with altruistic tendency only in situations requiring cooperation, such as when sharing a financial reward with a friend. Duchenne smiles displayed by participants as they waited for the experiment to begin, however, were unrelated to the participant's altruistic tendency. Another study examining the relationship between facial expressions of emotion and behavior in a prisoner's dilemma game in preschool

children found that while Duchenne smiles were predictive of conciliatory behavior, they were also observed in children who successfully defected on their partners (Matsumoto et al., 1986). Genuine smiles can also be displayed in competitive and coercive contexts where one benefits at the expense of others, such as when one overthrows an opponent in an athletic match (Matsumoto & Willingham, 2006). These findings suggest that the situation in which emotions are displayed may determine the degree to which they reflect cooperative disposition.

Further observations suggest that positive emotional expressions may not be unique in their ability to identify cooperators. Indeed, even the display of negative emotion can reflect pro-social preferences in certain situations. One recent study (Chapman et al., 2009) found higher levels of activation of the *leviator labii*, a facial muscle which elevates the upper lip in facial expression of disgust, in response to unfair offers in the Ultimatum Game. This result suggests that disgust can signal an aversion to unfairness. Furthermore, there is evidence suggesting that many facial expressions of negative emotion can be as, if not more, difficult to intentionally falsify than Duchenne smiles (Ekman, 2003; Ekman, Roper, & Hager, 1980; Porter & ten Brinke, 2008). Thus, the same logic used in previous studies asserting that Duchenne smiles can reliably signal cooperative tendency because they are difficult to fake can also apply to the expression of negative emotion in certain contexts, such as sadness, outrage, or disgust in the face of unfairness. If so, the conjecture that Duchenne smiles in particular can signal cooperation because they are difficult to intentionally produce may be one part of a larger picture.

In this paper we propose and test a hypothesis linking emotional expressivity, not limited to the display of positive emotion, to the cooperative tendency of individuals. While emotional expressivity as an honest signal of cooperativeness would certainly lead to greater amounts of positive emotion in neutral and cooperative situations in which mutually desirable consequences are expected, such as those examined in earlier studies, it should also cause cooperators to display greater levels of negative emotion when faced with a negative situation. This hypothesis is based on a recent theoretical contention (Boone & Buck, 2003) proposing that emotional expressivity in itself can serve as a marker for an individual's cooperative disposition. Emotional expressivity makes it easier for cooperative individuals to be identified as such, providing them with

opportunities to choose other cooperative individuals as interaction partners. While egoists may try to imitate cooperators by simulating their patterns of emotional expression, such an endeavor would prove difficult on two grounds. First, intentionally producing both negative and positive emotions would be more difficult than simply producing positive emotions alone (Ekman, 2003; Ekman, Roper, & Hager, 1980; Porter & ten Brinke, 2008). Secondly, displaying the right emotions, both positive and negative, in the right situations would require considerable mental effort, more so than simply displaying higher levels of positive emotion overall. This would make the open and uninhibited expression of emotion across situations exceptionally difficult for non-cooperators to falsify.

The emotional expressivity hypothesis is also consistent with Frank's (1988) commitment model of emotion, which suggests that the involuntary nature of emotional experience enables individuals who may otherwise be tempted to defect to commit to fair behaviors. Because emotionally expressive individuals are less able to conceal their emotions (DePaulo, 1992; DePaulo et al, 1992; Friedman & Miller-Herringer, 1991), expressivity can work to constrain egoistic behavior. That is, individuals who honestly reveal their motivational intentions to potential interaction partners through involuntary signals such as facial expressions of emotion, blushing, or perspiration must commit to having cooperative intentions and behaving in a cooperative manner. Otherwise, they would be avoided as interaction partners at best or be punished for harboring malignant intentions. From this perspective, individuals who are unable to effectively regulate or conceal their emotions may learn that, for them, deception is not a good strategy.

To date, no study has examined the facial expressions of behaviorally identified cooperators in the context of a situation which is likely to trigger negative emotion. We do so here, by investigating the relationship between emotional expressivity and cooperation as individuals face a negative event likely to elicit negative emotion, that is, unfair offers from proposers in an ultimatum game. To analyze the nature of their facial expressions, we use a version of a behavioral coding system known as Emotion Facial Action Coding System (EMFACS; Matsumoto, 1991). We predict that cooperators, defined as those who make fair (i.e., 50-50) resource distributions as the proposer in the ultimatum game, would display higher levels of both positive and negative emotion than non-cooperators when they face unfair offers as the responder.

Method

Participants

Twenty male participants were recruited from a subject pool at a major research university in Japan on the promise of earning money. Participants were informed that they would participate in several "transactions," and that they would be paid the total of the earnings from each of these transactions.

Measures of Cooperative Disposition

In this study, we used a combination of two independent methods to measure participants' cooperative tendency. First, we measured individual participants' cooperative tendency through their actual behavioral choices in an economic game known as the ultimatum game (Güth, Schmittberger & Schwarze, 1982). The ultimatum game is played by two players—a *proposer* and a *responder*. One player, the proposer, is provided with a certain amount of money by the experimenter and then given the opportunity to make a proposal concerning how to divide the money with another player, referred to as the *responder*. The responder is given two alternatives—to either accept or reject the proposal. If the proposal is accepted, each player receives the amount specified in the proposal. If the proposal is rejected, neither party receives any money.

We chose the ultimatum game as opposed to other games such as the prisoner's dilemma game because it is best suited to observe the emotional expressions of participants as they face a negative social situation in which they are treated unfairly by their game partners—that is, when as responders they face an unfair offer from the proposer. At the same time, this game allows us to behaviorally measure cooperativeness by observing whether the participant makes a fair or unfair proposal to the responder. In short, by letting each participant play ultimatum games both in the role of proposer and responder, we are able to not only measure their expressions of emotion displayed in a negative situation, but also their behavioral tendency to cooperate. Other games, such as the prisoner's dilemma game, do not provide us with opportunities to independently measure these two tendencies.

One potential problem with the use of participants' offers in the ultimatum game as a behavioral measure of cooperative tendency is that such offers may not purely

reflect the proposer's cooperative intent. Rather, a proposer may offer an equal division of money if he or she believes that a less than fair offer will incite negative emotional responses in the responder, leading to rejection of the offer. In the latter case, the fair offer indicates that the proposer is a "prudent egoist," rather than a cooperator who cares about his partners' welfare as well as his own. We thus supplemented the behavioral measure with an additional measure of participants' cooperative tendency, namely, a measure of social value orientation (Messick & McClintock, 1968; Liebrand, 1984). Social value orientation is expressed in terms of the valence and relative weights people assign to their own outcome and to a partner's outcome to form an overall utility of the consequence of their choices. In its earlier formulation (Liebrand, 1984), individuals were classified into *individualists* who assign a positive weight to their own outcome and zero weight to their partner's outcome, *cooperators* (positive weights to their own and their partner's outcomes), *competitors* (a positive weight to their own outcome and a negative weight to their partner's outcome), *altruists* (no weight to their own outcome and a positive weight to their partner's outcome), and so on. Later studies found that the overwhelming majority of the population are either individualists or cooperators, with only a small fraction of competitors, and very small number of altruists and other types. Thus, social value orientation researchers often use the simpler classification of pro-socials (who assign a positive weight to the partner's outcome) and pro-selfs (who do not assign a positive weight to the partner's outcome). Pro-socials are those who care about their partner's welfare, and pro-selfs are those who do not care about their partner's welfare.

We used the Ring Measure of Social Value Orientation (SVO) developed by Liebrand (1984), which is widely used in studies of social value orientation (Garling, 1999; Van Lange, 1999). Simply put, this particular measure of SVO consists of a set of choices between particular combinations of payoffs to the self and a partner, for example, between "¥1,000 yen to the self and ¥500 yen to the other" or "¥500 yen and ¥500 to the other. This measure was used to qualify the behavioral measure of cooperativeness (i.e., a fair offer as a proposer in the ultimatum game). By doing so, we can safely conclude that a cooperative proposer in the ultimatum game who is also classified as pro-social by the measure of social value orientation can truly be identified

as a cooperator, rather than as a prudent egoist who anticipates punishment in response to an unfair offer.

Procedure

Upon arrival at the laboratory, participants were greeted by a receptionist who assigned the participant an ID number to protect their anonymity. A separate experimenter, who knew neither the participant's name nor ID number, escorted the participants individually to a sound-proof experimental booth. Participants were informed that they would engage in economic transactions with other participants. In reality, however, the partners were pre-programmed responses by the computer. Instructions explaining the nature of the ultimatum game were presented via an automated computer program. Participants did not meet, see, or interact with other participants.

Each participant played a truncated ultimatum game (Falk, Fehr, & Fischbacher, 2003) three times, each time with a different proposer. The proposer was given an endowment of ¥1,000 (about $10) from the experimenter and was asked to make a proposal to the recipient concerning how to divide the ¥1,000 between them. A truncated ultimatum game differs from the standard ultimatum game in that proposers are asked to choose between two alternative divisions of ¥1,000 provided by the experimenter, rather than freely dividing the money. The recipient was given two alternatives—to accept or to reject the proposal. If the recipient accepted the proposal, each received the money specified in the proposal. If the recipient rejected the proposal, neither player received any money.

Our participants first played as recipients in two rounds of a truncated ultimatum game. Both rounds were comprised of a negative situation in which participants faced unfair offers from each proposer. In the first game used in this study, the two alternatives were A) 800 yen to the proposer and 200 yen to the recipient (unfair offer) and B) 500 yen to the proposer and 500 yen to the recipient (fair offer). The participants were informed of the fact that the proposer had been provided with this set of alternatives. The proposer in the first game was programmed to choose an unfair alternative as an offer to the participant who played the role of the recipient. We thus call the first game the *intentional* unfair proposal game.

In the second game, both of the alternatives presented to the proposer were unfair offers. That is, both Option A and Option B were 800/200. Participants were informed that the combinations of the two alternatives presented to the proposer would be randomly generated by the computer. Thus, while the proposer in the second game presented the participant with an unfair offer, because both of the offers available were unfair to begin with there was no way for participants to know if the proposer intentionally selected an unfair offer. We thus call the second game the *non-intentional* unfair proposal game.

In the third game, used to identify cooperators, the participant was assigned to role of the proposer and was presented with two options "randomly" generated by the computer: 800 yen to self and 200 yen to the responder (Option A), and 500 yen to self and 500 yen to the responder (Option B). It was made clear to participants that they would play with separate partners in all three games. No feedback regarding the recipient's choice was given to the proposer after each game, to avoid learning from taking place.

Each game consisted of three phases: a pre-game phase, a response phase, and a post game phase. In the pre-game phase, the computer displayed a screen stating that a new pair had been formed, and that the participant had been assigned to the role of the responder (or, the proposer in the third game). This phase lasted approximately 10-20 seconds. The response phase immediately followed the pre-game phase, beginning with the display of the proposer's (unfair) offer and ending when the participant input his decision to accept or reject the offer, and lasted approximately 15-25 seconds. This phase was the focus of our study, as we expected the presentation of unfair offers to elicit emotional reactions from participants. The response phase was followed by the post-game phase, which was a 30 second waiting period after the participants had made their decision. Since each phase varied in duration, we divided the raw frequency of each emotion in each phase by the duration of the phase in seconds, and use the resulting per-second frequency in the following analysis.

Video-taping and Coding of Facial Expressions of Emotion

Video-taping commenced as soon as participants gave consent to the recording of their faces. The computer display was configured in a way that the participant's face

was video-taped through the display (Prompter: Canon CWP-10H(21)), and was thus relatively obscured from view. Emotional expressions were analyzed using an adapted version of the Emotion Facial Action Coding System (EMFACS: Matsumoto, Ekman & Fridlund, 1991), an abbreviated version of the Facial Action Coding System (FACS: Ekman & Friesen, 1978). EMFACS can be used instead of FACS when an investigator is interested only in emotion signals in the face. FACS (Ekman and Friesen, 1978) is a more detailed coding system which includes the scoring of movements not related to emotional signaling, such as head and eye position, and is typically preferred when scoring expressions that are likely to be highly controlled (Ekman, 1972; Ekman and O'Sullivan, 2006). Because we were primarily concerned with emotion signals, and there was no reason for participants to modify their expression, we determined EMFACS to be the best scoring method for this study.

EMFACS coding identifies the facial behaviors associated with eight emotional categories: anger, disgust, fear, sadness, contempt, Duchenne smile, non-Duchenne smile, surprise. No eye movements were coded. Coding was conducted by three coders trained in the FACS system, who identified each occurrence of any combination of facial behaviors associated with the eight emotion categories above. The coding was based on facial emotion "events," defined as a facial muscle configuration (i.e., action units) consistent with EMFACS criteria. All coders were blind to the condition and behavioral outcomes of each participant, and all emotion codes were adjudicated by the second author. The inter-rater reliability (Cohen's kappa) was .70.

Emotion categories were grouped into positive, negative, and neutral emotional categories. In the analysis, Duchenne smiles were classified as positive expressions, anger, disgust, fear, sadness, and contempt were classified as negative expressions, and non-Duchenne smile and surprise were classified as neutral facial expressions.

Results

Behavioral Choices

Six of the 20 participants (30%) rejected the unfair offer in the intentional game, in which the proposer chose an unfair offer in spite of the presence of a fair alternative. In contrast, none of the participants rejected the unfair offer in the non-intentional game,

in which there was no fair alternative for the proposer to choose. These results are consistent with similar studies comparing recipients' responses to intentional and non-intentional offers (Falk et al., 2003; Ohmura & Yamagishi, 2005). In the third game where participants played the role of proposer and decided between a fair offer (500–500) and an unfair offer (800-200), 11 participants (55%) chose the fair offer. This choice was used as the behavioral measure of the participants' cooperativeness.

Expressions of Emotion by Fair and Unfair Proposers

We first classified the observed emotional expressions into three categories: positive (Duchenne smile), negative (anger, disgust, fear, sadness, and contempt), and neutral (non-Duchenne smile and surprise). As described above, the expressions were observed over intervals up to thirty seconds, and it was possible for participants to contribute more than one facial expression during each phase. Table 1 shows per-sec frequencies of all types of emotional categories during the three phases of the first two games for the eleven cooperators and the nine non-cooperators. First, we examined per-second frequencies of positive, neutral, and negative facial expressions of emotion expressed by fair and unfair proposers throughout the experiment. To do so, we conducted a proposer type (fair vs. unfair) x game type (intentional, unintentional) x game phase (pre-game, response, post-game) x emotion valence (positive, neutral, negative) ANOVA, with proposer type as a between subject factor and the remaining factors as between subjects factors. The results found a marginal effect of proposer type, $F_{1,18} = 3.48$, $p = .078$, $\eta_p^2 = .16$, and a significant effect of emotion valence, $F_{2,36} = 8.56$, $p = .0009$, $\eta_p^2 = .32$, while the main effects of phase, $F_{2,36} = 0.47$, $p = .63$, and game $F_{1,18} = 1.96$, $p = .179$, were not significant. These main effects were qualified by a significant interaction between proposer type and game phase, $F_{2,36} = 5.62$, $p = .008$, $\eta_p^2 = .23$. No other effects including the interaction between proposer type and emotion valence, $F_{2,36}=.14$, $p=.869$, were significant. The marginal effect of proposer type together with the proposer type x phase interaction indicates that fair proposers were more likely than unfair proposers to express all types of emotion (positive, negative, and neutral) particularly in the response phase. This finding, together with the lack of an interaction effect between proposer type and emotion valence, supports our hypothesis

that compared to non-cooperators, cooperators will show higher levels of emotional expressions, regardless of valence, when faced with an unfair situation.

The predicted effect of proposer type on emotional expressivity was observed most clearly in the response phase in which participants faced an unfair offer. We thus focused our analysis on the emotions expressed in the response phase, by examining the per-sec frequencies of positive, neutral, and negative emotions displayed by cooperators and non-cooperators in the response phase of the first two games. A proposer type x

Table 1. Mean level of facial expressions observed per second in the first two games, by game phase. Unparenhesized numbers show the means for behavioral cooperators (n=11) and non-cooperators (n=8), while parenthesized values show means for pure cooperators (n=8) and non-cooperators (n=8) whose cooperative tendency was identified consistently by both the behavioral and social value orientation measures.

		Intentional Game			Unintentional Game		
		Pre-game phase	Response phase	Post-game phase	Pre-game phase	Response phase	Post-game phase
Cooperators (Pure Cooperators)	Anger	.022 (.023)	.023 (.010)	.048 (.008)	.013 ####	.000 (.000)	.012 ####
	Contempt	.018 (.018)	.015 (.021)	.026 (.013)	.025 ####	.033 (.000)	.015 ####
	Disgust	.003 (.000)	.030 (.042)	.004 (.000)	.012 ####	.018 (.025)	.000 ####
	Fear	.004 (.006)	.018 (.025)	.011 (.004)	.002 ####	.000 (.000)	.003 ####
	Sadness	.009 (.013)	.030 (.041)	.007 (.029)	.019 ####	.045 (.063)	.021 ####
	Total Negative	.055 (.060)	.116 (.139)	.096 (.054)	.070 ####	.096 (.088)	.052 ####
	Surprise	.019 (.020)	.018 (.025)	.022 (.004)	.016 ####	.000 (.000)	.009 ####
	Non-Duchenne	.008 (.012)	.040 (.056)	.004 (.008)	.017 ####	.018 (.025)	.003 ####
	Total Neutral	.028 (.032)	.059 (.081)	.026 (.013)	.033 ####	.018 (.025)	.012 ####
	Duchenne	.010 (.010)	.041 (.056)	.007 (.017)	.034 ####	.023 (.031)	.000 ####
		Pre-game phase	Response phase	Post-game phase	Pre-game phase	Response phase	Post-game phase
Non-Cooperators (Pure Non-cooperators)	Anger	.017 (.020)	.025 (.023)	.024 (.046)	.034 ####	.014 (.016)	.011 ####
	Contempt	.009 (.010)	.000 (.018)	.012 (.029)	.023 ####	.000 (.000)	.019 ####
	Disgust	.003 (.003)	.000 (.000)	.000 (.004)	.016 ####	.000 (.000)	.004 ####
	Fear	.005 (.005)	.009 (.006)	.003 (.013)	.004 ####	.000 (.000)	.000 ####
	Sadness	.012 (.013)	.000 (.013)	.036 (.008)	.004 ####	.000 (.000)	.004 ####
	Total Negative	.045 (.051)	.034 (.060)	.076 (.100)	.080 ####	.014 (.016)	.037 ####
	Surprise	.015 (.017)	.009 (.020)	.003 (.021)	.010 ####	.000 (.000)	.004 ####
	Non-Duchenne	.002 (.003)	.000 (.012)	.006 (.004)	.009 ####	.000 (.000)	.000 ####
	Total Neutral	.017 (.019)	.009 (.032)	.009 (.025)	.019 ####	.000 (.000)	.004 ####
	Duchenne	.000 (.000)	.012 (.010)	.015 (.008)	.012 ####	.000 (.000)	.004 ####

game type x emotion valence ANOVA on emotions expressed in the response phase found a strong main effect of proposer type, $F_{1,18} = 10.02$, $p = .005$, $\eta_p^2 = .36$, and a main effect of emotional valence, $F_{2,36} = 3.32$, $p = .048$, $\eta_p^2 = .15$. As above, no other effects, including, the interaction between emotion valence and proposer type, $F_{2,36}=1.16$, $p=.324$, were significant. The main effect of proposer type and the lack of a proposer type x emotion valence interaction indicate that fair proposers were more likely to express all emotion, regardless of valence, than non-cooperators. The main effect of emotion valence indicates that participants generally expressed negative emotions more frequently than positive emotions in response to unfair offers. Separate analyses of each emotion valence indicated that while fair proposers tended to display positive emotion (Duchenne smiles) (M=.032, SD=.057) more frequently than unfair proposers (M=.006, SD=.019), this difference did not reach statistical significance $F_{1,18}=1.67$, $p=.21$, $\eta_p^2=.085$. Fair proposers expressed marginally higher levels of neutral (M=.038, SD=.049 vs. M=.005, SD=.014), $F_{1,18}=3.94$, $p=.063$, $\eta_p^2=.18$, and negative (M=.106, SD=.114 vs. M=.024, SD=.04), $F_{1,18}=4.21$, $p=.055$, $\eta_p^2=.19$, facial expressions of emotion.

Qualified behavioral measure of cooperativeness

As mentioned above, a fair offer in the ultimatum game is not necessarily a pure measure of a proposer's cooperative tendency. It is possible that even those who care solely for their own personal gain, rather than for joint gain to the self and other, may make a fair proposal if they fear their partner will reject an unfair offer. Thus, in order to identify true cooperators, we decided to qualify the behavioral measure (i.e., the fair offer in the Ultimatum Game) with the measure of social value orientation.

Based on the score from the Ring Measure of Social Value Orientation (Liebrand, 1984), nine of 20 participants were classified as cooperators ("pro-socials") and the remaining 11 as non-cooperators ("pro-selfs"). The relationship between the behavioral measure of cooperation and the measure of social value orientation was fairly strong (Fisher's Exact Test, $p < .01$). Eight of the 11 behavioral cooperators were classified as pro-socials by the Ring Measure of SVO, whereas eight of the nine behavioral non-cooperators were classified as pro-selves. The three participants who were

classified as pro-selves and yet made a fair offer in the ultimatum game are likely to be prudent egoists who made fair allocations for their own personal gain rather than for the joint gain of the self and other, while the one participant who was identified as a pro-social in the social value orientation measure but behaved unfairly in the ultimatum game may not be fully cooperative.

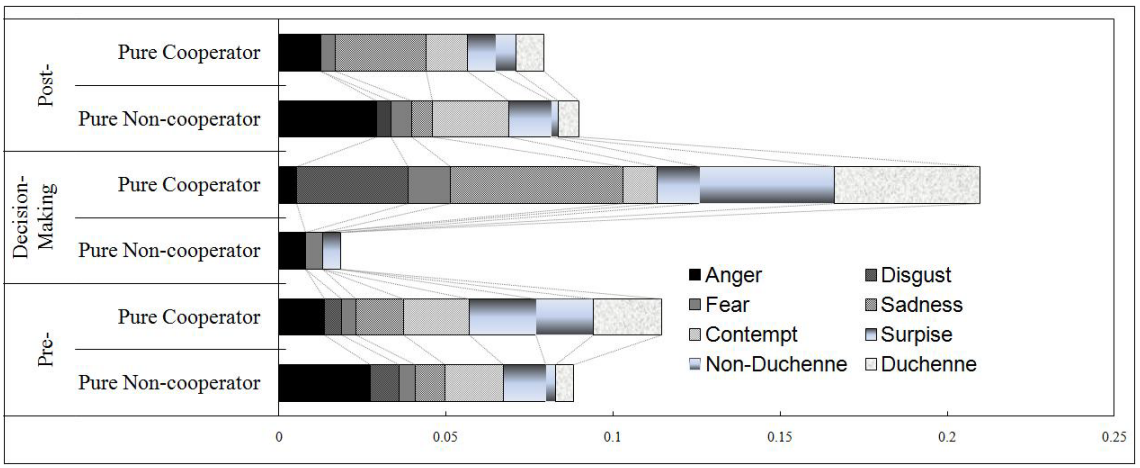

Figure 1. Individual emotions expressed by pure cooperators and pure non-cooperators in each phase. Means from the two games are combined.

To be safe, we conducted the above analyses including only pure cooperators and pure non-cooperators for whom the two measures coincided. Mean levels of emotional expressions observed in pure cooperators and non-cooperators are shown in Figure 1. The proposer type (fair vs. unfair) x game type (intentional, unintentional) x game phase (pre-game, response, post-game) x emotion valence (positive, neutral, negative) ANOVA found a marginal effect of proposer type, $F_{1,14} = 4.18$, $p = .06$, $\eta_p^2 = .23$, and a significant effect of emotion valence, $F_{2,28} = 5.23$, $p = .012$, $\eta_p^2 = .27$, and the proposer type x emotion valence interaction was not significant, $F_{2,28}=0.02$, $p=.985$. The marginally significant main effect of proposer type was qualified by a strong interaction between proposer type and game phase, $F_{2,28} = 11.21$, $p = .0003$, $\eta_p^2 = .43$. No other effects were significant.

As in the earlier analysis, because the effect of proposer type was most pronounced in the response phase where participants faced unfair offers, we examined differences in emotional expressions displayed by participants in the response phase. The proposer type (pure cooperator vs. pure non-cooperator) x game type (intention and non-intention) x emotion valence (positive, neutral, and negative) ANOVA on emotions expressed in the response phase found a strong main effect of proposer type, $F_{1,14}$=19.84, p=.0005, η_p^2=.59, and no interaction between proposer type and emotion valence $F_{2,28}$=0.90, p=.417. No other effects reached the significance level. As above, this result indicates that, compared with pure non-cooperators, pure cooperators were more likely to display all types of emotional expressions in the response phase. Pure cooperators not only displayed marginally more expressions of positive emotion (Duchenne smiles) (M=.044, SD=.063 vs. M=0, SD=0), $F_{1,14}$=3.81, p=.071, η_p^2=.21, they also expressed significantly higher levels of both neutral (M=.053, SD=.051 vs. M=.005, SD=.013), $F_{1,14}$=6.44, p=.024, η_p^2=.32, and negative (M=.113, SD=.123 vs. M=.013, SD=.025), $F_{1,14}$=5.10, p=.041, η_p^2=.27, facial expressions of emotion.

Discussion

In this study, we examined the facial expressions of cooperators and non-cooperators as they faced unfair offers in an ultimatum game, predicting that cooperators would show greater levels of overall emotional expressivity compared with non-cooperators. The results strongly supported our predictions. Cooperators expressed emotion, regardless of their valences, more frequently than did non-cooperators. The same pattern was more clearly observed when participants' game behavior was qualified with a measure of their social value orientation. These results strongly support the idea that cooperators are more emotionally expressive than non-cooperators (Boon & Buck, 2003).

We believe that the tendency for cooperators to display higher levels of positive emotion such as Duchenne smiles, observed in previous studies (Brown et al., 2003; Shelley & Kuhlman, 2007; Mehu, Grammer & Dunbar, 2007), may stem from the tendency for cooperators to openly express all of their emotions. Just as displays of positive emotion signal altruism in pro-social situations requiring cooperation and sharing (Mehu, Grammer, & Dunbar, 2007), negative emotion elicited by pro-social

preferences such as contempt or disgust in the face of unfairness can also signal cooperative tendency in specific situations. In this sense, the particular valence of an emotion itself may be less important than whether the emotion is pro-self or pro-social in nature. In the case of this study, negative emotion expressed by cooperators in response to unfair offers may reflect pro-social preferences for justice and equality (i.e., Fehr, Fischbacher, & Gächter, 2002; Gintis, 2000), or expectations for fair behavior in others.

Emotional expressivity can function as a reliable signal of cooperation in three respects. First, consistent with biological and economic models on signaling (Zahavi 1975; Spence, 1973; Maynard-Smith, 1995), emotional expressivity can serve as a signal of cooperation in the sense that both positive and negative facial expressions of emotion are physiologically difficult to fake (Ekman, 2003; Ekman, Roper, & Hager, 1980; Gazzaniga & Smylie, 1990; Porter & ten Brinke, 2008). Adding difficult-to-fake negative emotions to the list of difficult-to-fake positive emotions makes the task of faking one's emotions more difficult than faking positive emotion alone. Furthermore, the difficulty of selectively displaying emotions appropriate to particular situations makes the task of faking even more formidable. While egoists would need to determine both when to fake negative emotions (as is the case of facing unfair offers in the ultimatum game) and when to suppress negative emotions (such as when they fail to exploit their exchange partners), cooperators who truly care about their partner's welfare may freely express their true emotion. Finally, the costs associated with the honest display of emotion would be much greater for egoists, who would be excluded from profitable future exchanges due to inappropriate expressions of their true emotions.

These three rationales for emotional expressivity as a reliable signal of cooperation suggest that the cooperative tendency of an individual may determine the utility of openly expressing one's emotional state. Simultaneously, emotional expressivity in itself can facilitate cooperative behavior. That is, because the malignant intentions of emotionally expressive individuals would be easily detected by others, these individuals will likely be unable to successfully exploit others. Just as bluffing would not be a good strategy for poker players who are unable to conceal their emotional expressions, emotionally expressive individuals would be advised to avoid

any futile attempt to deceive others. In this sense, cooperation would the best strategy for those who cannot effectively conceal their emotional state. These two possible causal relationships may not be mutually exclusive, but instead may contribute concurrently toward the prosperity of emotionally expressive cooperators. Future investigations should examine the plausibility of different theories and underlying mechanisms responsible for these results.

Some cautions are called for regarding the current study. First, while the current study examined the facial expression of emotion in a small culturally homogenous sample of males, there are documented differences in both emotional expressivity between genders (Hall, 1984), as well as cultural differences in the display rules which dictate emotional expression (Matsumoto, 1990; Matsumoto, Yoo, & Fontaine). As such, future studies are needed to examine the relationship between emotional expressivity and cooperativeness using larger and more diverse samples. In addition, it may be beneficial to examine the effect of differing social settings on the relationship between emotional expressivity and cooperation. For example, the current study investigated facial expressions of emotion displayed in reaction to negative events occurring in privacy where there were no incentives to conceal or falsify one's intention to defect or cooperate. As such, future studies should investigate the facial expressions of those who have incentives to deceive their partners, such as in direct face to face interaction.

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