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BRIEF REPORT

The Value of Genuine and Polite Smiles

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Humans show remarkable ability to adapt their social behavior to suit the changing requirements of their interactions. An interaction partner's social cues, particularly facial expressions, likely play an important role in motivating and reinforcing this behavioral adaptation. Over three studies, we test a key aspect of this idea. Specifically, we ask how the reinforcement value of facial expressions compares to that of nonsocial feedback and to what degree two frequently occurring expressions (genuine and polite smiles) differ in reinforcement value. Our findings show that social feedback is preferred over nonsocial feedback and that genuine smiles are preferred over polite smiles. Based on a logistic model of our data, we show that both monetary and social values of stimuli contribute significantly to participants' decisions. Indeed, participants were willing to sacrifice the chance of a monetary reward to receive a genuine smile and produced inflated estimates of the value of genuinely smiling faces. These findings suggest that genuine smiles, and potentially other social cues, may be useful social reinforcers and therefore important in the control of social behavior on a moment-to-moment basis during interaction.

Keywords: social interaction, emotion, reward, utility

Humans possess extraordinary ability to adapt their social behavior to an interaction's changing demands (Lynch, 2007), suggesting the presence of a highly flexible system for navigating social interactions. One candidate mechanism for understanding social ability is reinforcement learning. According to recent accounts (e.g., Behrens, Hunt, & Rushworth, 2009), people extract information about the social environment based on the outcome values of social actions, for example, deciding whether to trust a partner based on his or her history of providing sound advice (Behrens, Hunt, Woolrich, & Rushworth, 2008) or cooperating in a game (Tomlin et al., 2006). In nonsocial environments, reinforcement learning has received widespread attention as a model for human and animal behavior (Dayan & Balleine, 2002; Schultz, 2006). This work shows that reinforcement learning systems are highly flexible (Tremblay & Schultz, 1999), allowing finely tuned adaptation to environmental contingencies (Schultz, Dayan, & Montague, 1997). Here, we extend this research by testing the idea that social cues, specifically smiles, carry reward value and may therefore reinforce social behavior.

There are two ways in which facial expressions may be rewarding. First, they might possess innate emotional value (Ekman, 1992) or cause emotion in receivers (Geday, Gjedde, Boldsen, & Kupers, 2003). Second, they may predict social outcomes (Fridlund, 1991; Hooker, Germine, Knight, & D'Esposito, 2006). For example, interaction partners' smiles may lead receivers to anticipate positive social outcomes whereas frowns suggest otherwise (Kringelbach & Rolls, 2003). As with nonsocial cues, which acquire value depending on the outcomes they predict (O'Doherty, 2004; Schultz, 2004), facial expressions may acquire value via a history of cue-outcome pairings. Regardless of whether this value is innate or acquired, for clarity we call it "intrinsic."

The idea that facial expressions carry intrinsic value is important for understanding how they might shape behavior in real-world interactions. Much of the literature has focused on the emotional qualities of expressions. A question that remains unanswered is whether facial expressions can be understood in terms of their ability to shape receiver behavior. If facial expressions carry intrinsic value, they may have a more important role in guiding social behavior than previously reported (Gesn & Ickes, 1999). Moreover, the ability to understand facial expressions in terms of intrinsic values would help explain diverse findings showing, for example, that emotional faces modulate cognitive performance (Banich et al., 2009; Tsukiura & Cabeza, 2008). In three experiments, we test whether facial expressions carry intrinsic value, whether different expressions have different values, and how participants value social relative to monetary rewards.

Experiment 1

In a contingency learning game, we compared the relative ability of social and nonsocial feedback, both associated with the same monetary reward, to shape choice behavior. We predicted that if both types of feedback had equal intrinsic value, then participants' behavior would simply reflect relative differences in the likelihood of receiving monetary reward. However, if one

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feedback type is intrinsically more rewarding than the other, behavior should reflect both the relative likelihood of receiving monetary rewards and the added value of the intrinsically rewarding feedback.

Method

Participants. Forty-two undergraduate psychology students (7 male; mean age = 19.88, *SD* = 1.15) completed the study for course credits and bonus money. Participants gave written informed consent before participating. The local ethics committee approved the study (likewise for Experiments 2 and 3).

Procedure. Participants completed a "matching pennies" game with four computerized opponents, who provided rewards with different frequencies. A unique image identified each opponent (two photos of people, two of computers). The task had a learning phase followed by a test phase. In learning-phase trials, participants viewed a photo of one opponent in a neutral pose and selected "heads" or "tails" of a coin with a key press. Participants attempted "to choose the same side of the coin" as the opponent. After each choice, the opponent provided feedback (Figure 1A). Human opponents smiled to indicate matches and frowned to indicate nonmatches. Computer opponents displayed either green ticks (matches) or red crosses (nonmatches). Match feedback was worth 2 pence and nonmatch feedback was worth 0 pence. Participants played each opponent 40 times, divided randomly among 4 blocks of 40 trials (160 learning trials).

Unbeknownst to participants, feedback occurred independently of their behavior. Instead, opponents provided rewards at different rates (85, 70, 55, and 40%). For example, the 85% opponent provided reward feedback on 85% of trials and nonreward feedback on 15% of trials, regardless of behavior. To compare the value of social and nonsocial feedback one of the higher-frequency reward contingencies (either 85 or 70%) was randomly assigned to a computer opponent, as was one of the lower-frequency contingencies (55 or 40%). The other two reward contingencies were assigned to human opponents. This ensured that, across all participants, human and computer opponents provided reinforcement with approximately equal probability. Contingencies remained the same across both learning and test phases.

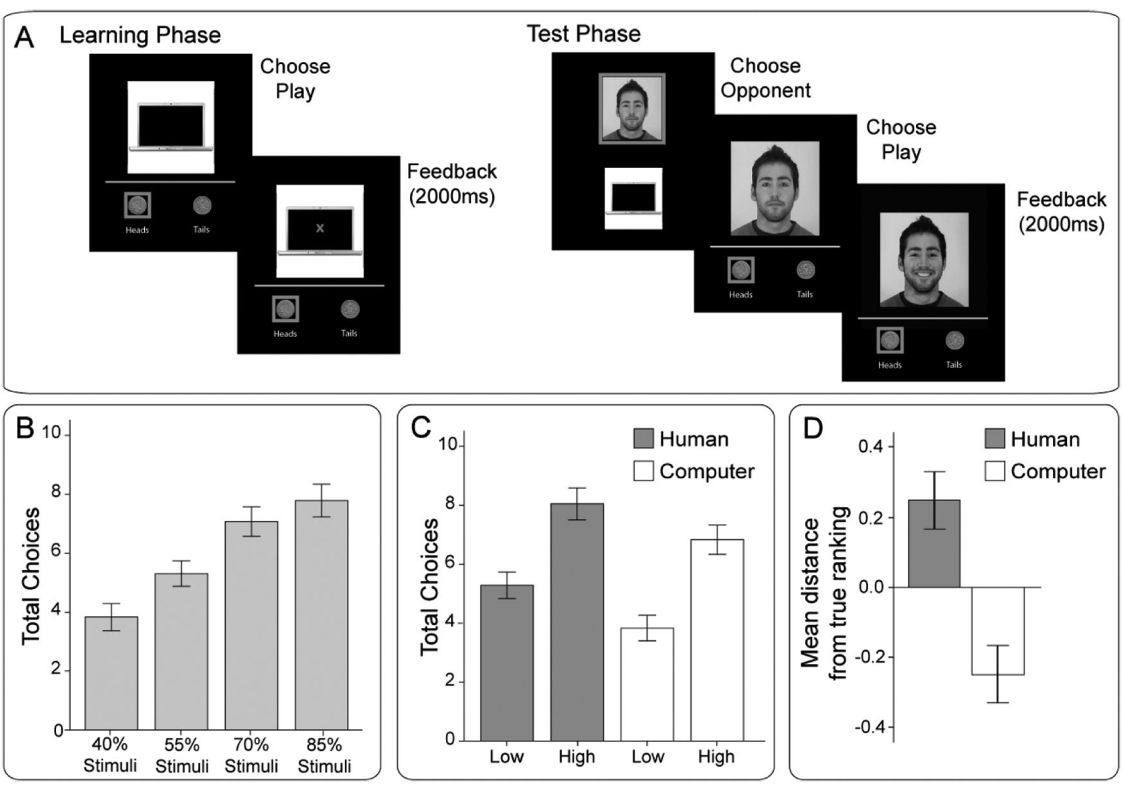

Figure 1. Experiment 1 game and results. (A) Example trials from both learning and test phases of a matching pennies game. In the learning trials, participants saw one of four opponents, indicated whether they wished to choose "heads" or "tails" of a coin via a key press, and received feedback from the opponent. In test phase trials, participants first chose which opponent they wished to play from given pair of opponents, thereafter trials continued as in the learning phase. (B) Average number of times participants chose opponents of each reward probability (40, 55, 70, and 85%). (C) Average number of times participants chose human and computer opponents with high or low reward probabilities. (D) Average rankings of computer and human opponents' reward frequency compared to opponents' true rankings (calculated by computing the difference between participants' ranking and opponents' "true" ranks based on reward likelihood). Positive scores indicate that human opponents were ranked as better than their true ranks.

In test-phase trials, participants chose which opponent they wished to play from a given pair (Figure 1A). Thereafter, trials proceeded as in the learning phase. There were six possible two-opponent pairs (opponents 1, 2; opponents 1, 3; etc.). Participants saw each pair 4 times in random order (24 test trials). Finally, participants ranked each opponent from 1 (most frequently rewarded) to 4 (least frequently rewarded), as an explicit measure of reward-contingency knowledge. At the end of the task, participants received the bonus money they had earned (average = £2.50). The task was programmed using the Psychophysics Toolbox (Brainard, 1997) in Matlab (The MathWorks).

Results

Figure 1B shows the average number of times participants chose opponents during test-phase trials, according to reward probability. A repeated-measures ANOVA examining the effects of reward probability (85, 70, 55, 40%) on choice behavior showed that participants learned the contingencies, $F(3, 41) = 9.92$, $p < .001$; $\eta_p^2 = 0.20$.[1]

A paired-samples t test confirmed there was no difference in the frequency of rewards from human versus computer opponents $t(41) = 1.10$, $p = .28$, Cohen's $d = 0.34$. However, a 2-factor (value: higher or lower reward likelihood; identity: human or computer) repeated-measures ANOVA on the choice data showed main effects of both value, $F(1, 41) = 22.39$, $p < .001$; $\eta_p^2 = 0.35$, and identity, $F(1, 41) = 5.42$, $p = .03$; $\eta_p^2 = 0.12$, suggesting that participants preferred social feedback, even though humans and computers provided monetary rewards equally frequently (Figure 1C).[2]

Finally, Figure 1D shows the average rank participants assigned to computer and human opponents, relative to opponents' actual ranks. A t test showed that participants ranked human opponents as better and computers as worse than they actually were, $t(41) = 3.04$, $p = .004$, Cohen's $d = 0.95$.

Discussion

These results show that although participants learned contingencies regardless of opponent type, they treated human opponents as if they were more valuable than computer opponents, despite a lack of objective value differences. Importantly, participants knew that all opponents were computer controlled, suggesting that this result cannot be explained by a simple preference to play human opponents (Aharoni & Fridlund, 2007; Moretti, Dragone, & di Pellegrino, 2009). This suggests that although social and nonsocial feedback carried the same monetary reward, social feedback was intrinsically more valuable.

Experiment 2

In Experiment 1, human opponents always displayed genuine smiles, meaning that participants' preference for social feedback might be specific to genuine smiles. Genuine smiles are distinguishable from nongenuine smiles based on the action of orbicularis oculi (Frank, Ekman, & Friesen, 1993). Genuine smiles have social (Fridlund, 1991) and emotional meanings (Ekman, 1992) and may have evoked positive feelings in our participants (Surakka & Hietanen, 1998), thereby inflating preferences for human opponents. To test whether genuine smiles are intrinsically rewarding, we compared genuine- with polite-smile feedback. We predicted that if genuine smiles were intrinsically more rewarding than polite, participants would prefer genuinely smiling opponents.

Method

Participants. Thirty-six undergraduate psychology students (18 male; mean age = 19.56, $SD = 1.90$) completed the study for course credits and bonus money (average = £3).

Procedure. As before, participants completed a matching pennies game. However, in this version, each opponent was identified by a unique human image (2 male, 2 female). Learning trials ran as in Experiment 1. Two opponents (1 male, 1 female; randomly assigned) always provided genuine smiles and the others always provided polite smiles. Each opponent provided rewards with a probability of 0.7, so that participants received reward feedback (genuine or polite smiles) on 70% of trials and nonreward feedback (frowns) on 30% of trials. Regardless of smile type, reward feedback was worth 2 pence. Participants played each opponent 20 times in random order (80 learning trials). On test-phase trials, as in Experiment 1, participants chose which opponent they wished to play from a pair of opponents. All six possible opponent-pairings were tested. Participants completed 60 test trials, 10 per pairing, in random order.

Smile Stimuli. The smile stimuli used in this and the other experiments consisted of still images of actors displaying genuine and polite smiles. We created the stimuli by asking eight actors (4 male) to pose a variety of facial expressions (including neutral poses and frowns). Expressions were recorded with a high-definition, digital camcorder. Actors posed each expression 8 times.

To obtain genuine smiles, we induced positive emotion by asking our actors to imagine/reexperience a situation in which they felt happy and display their happiness as if they were sharing the experience with a good friend. To obtain polite smiles, we asked actors to produce polite smiles after seeing them demonstrated.

From each of these short films, we chose the first frame at which the expression was at its peak and created a still image from that frame. We then selected, for each actor, the 5 photos for each expression that most closely resembled a prototypical expression of that type. To validate the smile stimuli, we conducted a separate study in which 60 participants (21 male; mean age = 20.53, $SD = 3.55$) viewed each smile photo for 1 s and classified it, as quickly

[1] We analyzed the learning data to determine whether participants engaged in nonstereotyped response strategies, as expected in mixed-strategy games. We used the analysis described in Vikery and Jiang (2009) to compute a "percent redundancy" score for each participant for each opponent (lower scores mean less redundancy). Across the three experiments, participants' response strategies were quite random, on average containing 1.99% (range: 1.00 to 2.92%) redundant information, suggesting that participants' response strategies were not particularly stereotyped.

[2] An alternate explanation for this finding is that participants prefer human opponents. A control experiment in which a human opponent provided nonsocial feedback (ticks and crosses) and a computer opponent provided social feedback (smiles and frowns) showed that participants prefer social feedback, even when this comes from computer opponents ($p = .02$).

as possible, as either a genuine or polite smile. There were no differences in mean reaction times to the two smile-types (genuine = 0.97 s, $SD = 0.10$; polite = 0.96 s, $SD = 0.09$); $t(59) = -1.55$, $p = .12$, Cohen's $d = -0.40$). We calculated d' for each participant as a measure of ability to distinguish between the smiles (Wickens, 2002). Overall, participants showed good ability to discriminate the smiles (mean $d' = 1.59$, $SD = 0.39$; which, for an unbiased observer, is about 75% correct).

We then calculated the proportion of participants who correctly identified each smile in the set. Based on these results, we chose the most frequently correctly identified genuine and polite smile for each actor to use in the present studies. All the smiles we used were correctly identified at rates significantly greater than chance (p values <0.01). The average proportion of correct identifications for the 8 genuine smiles was 0.86 ($SD = 0.02$); for polite, it was 0.84 ($SD = 0.03$). There were no smile-type differences in the rates at which participants identified these smiles, $t(14) = 1.01$, $p = .33$, Cohen's $d = 0.54$.

Results

Given that opponents provided rewards with equal frequency, we predicted that if genuine smiles had intrinsic value then participants would prefer genuinely to politely smiling opponents. A 2-factor (smile type; genuine or polite; opponent sex: male or female) repeated-measures ANOVA showed that participants chose genuinely smiling opponents more often than polite ($M_{Genuine} = 37.25$, $SD_{Genuine} = 9.39$, $M_{Polite} = 22.75$, $SD_{Polite} = 9.39$; $F(1, 35) = 21.44$, $p < .001$; $\eta^2_p = 0.38$). There was no main effect of sex and no interaction (p values $>.30$).

Discussion

As anticipated, participants preferred genuinely to politely smiling opponents, suggesting that genuine smiles have greater intrinsic value than polite smiles. However, in this study, all opponents provided monetary rewards with equal probability, meaning that their expected monetary value was identical (the expected value of a stimulus is calculated as the probability of receiving a reward, multiplied by the value of the reward, Sutton & Barto, 1998). To unequivocally demonstrate that genuine smiles possess intrinsic value, Experiment 3 decoupled monetary value from smiles, allowing direct comparison of the relative values of money and smiles.

Experiment 3

We predicted that if genuine smiles had intrinsic reward value, participants would sacrifice the chance to gain a monetary reward to obtain a genuine smile. Measuring the degree to which smiles influenced participants' choices, allowed us to estimate the value of a smile in monetary terms.

Method

Participants. Thirty-six undergraduate psychology students (14 male; mean age = 20.58, $SD = 2.76$) completed the study for course credits and bonus money (average = £3). We excluded one female participant for failing to follow task instructions ($N = 35$).

Procedure. Participants completed the same matching pennies task as in Experiment 2, with two opponents providing genuine and two providing polite smile feedback. To compare the value of smiles to money, we altered the rates at which the opponents provided rewards. In this experiment, two opponents (one genuinely, one politely smiling; randomly assigned) provided rewards on 70% of trials. The other two opponents rewarded participants on 80% of trials. As before, both smile-types were worth 2 pence. Because participants played only four opponents, we could not fully counterbalance reward probability, smile type and opponent sex. Therefore, participants saw opponents who were all of the same sex. Half the female participants played female opponents; likewise for male participants.

At the end of the task, participants ranked the opponents from 1 (most frequently rewarded) to 4 (least frequently rewarded), as an explicit measure of reward-contingency knowledge.

Results

We calculated the frequency with which participants chose each opponent in a given pair. When smile type was the same for both opponents in the test pair (e.g., the choice between the 80 and 70% politely smiling opponents), participants chose the opponent with the higher expected monetary value 58% of the time and significantly more often than chance, $t(34) = 2.30$, $p = .03$, Cohen's $d = 0.79$.

The degree to which genuine smiles carry intrinsic value should be evident in participants' preferences for genuinely over politely smiling opponents, when those opponents differ in expected monetary value. If genuine smiles have intrinsic value, then those smiles should increase an opponent's likelihood of being chosen. For example, an 80% genuinely smiling opponent should be chosen more often than an 80% politely smiling opponent. To test this, we calculated the proportion of times participants chose the 80% opponent when smile types were constant. We then subtracted this value from the proportion of times participants chose 80% opponents when smile types differed (Figure 2A). As anticipated, genuine smiles from the 80% opponent significantly increased choices of this opponent, relative to when smiles were matched, $t(34) = 3.59$, $p = .001$; Cohen's $d = 1.23$. Interestingly, when the 70% opponent displayed genuine smiles, participants showed a significant preference for that opponent, $t(34) = -2.51$, $p = .02$; Cohen's $d = -0.86$, suggesting that genuine smiles altered the desirability of the 70% opponent.

In Economics, the subjective desirability of a stimulus is called "utility." Here, the utility of both money and smiles can be modeled according to the degree to which they influence choice behavior. This framework allows us to determine the utility of genuine smiles in comparison to the utility of money (for a formal description of expected utility maximization, see Von Neumann & Morgenstern, 1947). To do this, we applied a logistic model to the choice data using the logistic response function:

$$\mathbf{P_{OpponentA} = exp(\theta)/(1 + exp(\theta))}$$

where $P_{OpponentA}$ is the probability of choosing opponent A (the upper opponent in the test-phase choice pair, see Figure 1A) over opponent B, and θ is the difference in the opponents' utilities. We modeled θ as a linear function of opponents' monetary and social values, and the social- by monetary-value interaction.

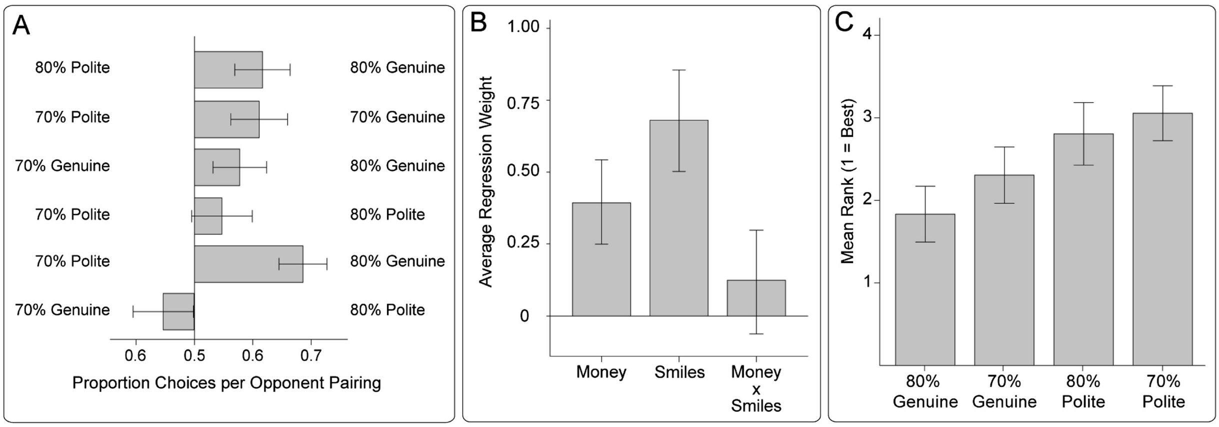

Figure 2. Experiment 3 results. (A) Average proportion of choices of each opponent in a given pair. (B) Average subjective contributions of opponents' monetary and social value to participants' choices. Subjective weightings are the estimated β weights from a logistic regression analysis. (C) Mean explicit ranking of opponents' reward frequency depending on reward probability and smile type (*1* = best, *4* = worst).

$$\boldsymbol{\theta = \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3}$$

X_1 indicates the difference between opponents' expected monetary values (value of Opponent_A minus value of Opponent_B; practically, this meant that if Opponent_A had the larger expected monetary value on a given choice trial, X_1 was coded 1; if Opponent_A was worse, $X_1 = -1$; and if both opponents were equal in expected monetary value, $X_1 = 0$). X_2 is the difference in the opponent's social values (genuine or polite smile, coded in the same way as the monetary values, thereby placing the βs for money and smiles on the same scale). X_3 is the interaction term. The βs are the unstandardized logistic regression weightings for each variable—the degree to which money (β_1), smiles (β_2), and the money × smiles interaction (β_3) contribute to choice behavior. The logistic regression was computed using an iteratively reweighted least squares algorithm (O'Leary, 1990) to obtain the maximum likelihood estimate for each β. We estimated the βs for each participant independently, based on choices during the task. *t* tests confirmed that both money, $t(34) = 2.32$, $p = .03$, Cohen's $d = 0.80$, and smiles significantly influenced participants' choices, $t(34) = 3.51$, $p = .001$, Cohen's $d = 1.20$. The interaction term was not significant, $t(34) = 0.61$, $p = .55$, Cohen's $d = 0.21$, suggesting that monetary and social rewards operated independently in this experimental design (Figure 2B). Surprisingly, the regression weight for smiles was 1.75 times higher than that for money, meaning that the difference between genuinely and politely smiling opponents was 1.75 times more important in determining choices than a 10% difference in the probability of wining 2 pence. Based on this difference, we estimate that our participants would have chosen a genuinely smiling opponent with a reward probability of 62.5% (80-17.5%) equally as often as a politely smiling opponent with an 80% reward probability. Put differently, a single genuine smile in this task had a utility equal to 0.35 pence.

Figure 2C shows the average rank participants assigned to each opponent. A repeated-measures ANOVA showed a main effect of smile type, $F(3, 102) = 8.24$, $p < .001$; $\eta_p^2 = 0.20$. Contrasts revealed that participants ranked genuinely smiling, 80% opponents highest, $F(1, 34) = 17.35$, $p < .001$; $\eta_p^2 = 0.34$, and politely smiling 70% opponents lowest, $F(1, 34) = 15.20$, $p < .001$; $\eta_p^2 = 0.31$. Consistent with the choice data, participants ranked 70% genuinely smiling opponents as better than 80% politely smiling opponents, although this difference was not statistically significant, $F(1, 34) = 2.03$, $p = .16$; $\eta_p^2 = 0.06$. Taken together, these findings suggest that participants were willing to choose an opponent with lower expected monetary value, if that opponent offered a desirable social reward.

General Discussion

Our findings demonstrate that social stimuli, such as genuine smiles, carry intrinsic reward value, even when they are irrelevant to the task and not predictive of monetary outcome. In Experiment 1, participants learned a reinforcement contingency from both social and nonsocial cues, and demonstrated preferences for social feedback. In Experiment 2, participants demonstrated a preference for opponents who provided genuine compared to polite smiles. Experiment 3 genuine smiles altered opponents' utility such that genuinely smiling opponents were more desirable than expected value calculations would predict. Accordingly, participants ranked genuinely smiling opponents as having greater reward likelihood than politely smiling opponents.

Together, these results show that genuine smiles enhance stimulus utility. One way in which this might happen, is that smiles enhance the degree to which monetary rewards are incorporated (Averbeck & Duchaine, 2009). Alternatively, their utility may be added to that of other stimuli. Unfortunately, the present methods do not allow us to disentangle these explanations, nor do they allow us to determine whether a genuine smile's intrinsic value is innate or acquired.

As with all computer tasks, this task is only a proxy for the real social world. To show that learning mechanisms drive true social behavior, these results must be replicated in the less constrained world of live social interaction. However, the fact that photographs of genuine smiles influenced behavior, even in this artificial setting, suggests that they are likely to be powerful reinforcers in face-to-face interaction.

Learning to predict social outcomes from an interaction partner's cues is a beneficial skill (Behrens et al., 2009; Hampton, Bossaerts, & O'Doherty, 2008). Our findings demonstrate that genuine smiles have intrinsic reinforcement value. As such, these cues may guide social behavior both on a moment-to-moment basis within an interaction and from one interaction to the next.

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