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RESEARCH NOTE

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Affective state and decision-making in the Ultimatum Game

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Abstract The emerging field of neuroeconomics has provided evidence that emotional as well as cognitive processes may contribute to economic decision-making. Indeed, activation of the anterior insula, a brain area involved in emotional processing, has been shown to predict decision-making in the Ultimatum Game. However, as the insula has also been implicated in other brain functions, converging evidence on the role of emotion in the Ultimatum Game is needed. In the present study, 30 healthy undergraduate students played the Ultimatum Game while their skin conductance responses were measured as an autonomic index of affective state. The results revealed that skin conductance activity was higher for unfair offers and was associated with the rejection of unfair offers in the Ultimatum Game. Interestingly, this pattern was only observed for offers proposed by human conspecifics, but not for offers generated by computers. This provides direct support for economic models that acknowledge the role of emotional brain systems in everyday decision-making.

Keywords Decision-making · Emotion · Arousal · Skin conductance · Ultimatum Game · Social utility

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Introduction

Although traditional economic models typically regard decision-making as a rational, cognitive process, recent approaches incorporate the idea that emotions and their physiological components, bioregulatory signals, may play an important role in decision-making (Bechara et al. 1997; Camerer 2003). Indeed, in a recent fMRI study, Sanfey et al. (2003) reported that activation of the anterior insula, a brain area implicated in aversive emotions such as disgust (Phillips et al. 1997), was related to performance in a task of decision-making known as the Ultimatum Game. Specifically, activation of the insula was correlated with rejecting unfair financial offers made by other people. The authors suggested that this neural activation reflected negative emotional responses to these unfair offers (Sanfey et al. 2003). However, there has not been a direct test of the hypothesis that a specific measure of emotional arousal is related to decisions in the Ultimatum Game. Therefore, converging evidence on the role of emotion in the Ultimatum Game is needed.

In the Ultimatum Game a sum of money is split between two people, a proposer and a responder. The proposer decides how this money should be split between the two. The responder decides if he or she will either accept or reject this offer. If the responder accepts the offer, the amount of money is split as agreed. However, if the responder rejects it, neither player receives anything. In either event, the game is over. The rational strategy suggested by classical game theory is for the proposer to offer the smallest possible positive share and for the responder to accept in turn. Instead however, proposers tend to offer around 50% of the total, and responders reject about half of offers below 20% of the total (Nowak et al. 2000). Notably, the rejection rates are substantially lower when the proposer is a computer instead of a fellow human being. This suggests that there is something special about an unfair offer from another person (Sanfey et al. 2003).

One possible explanation is that responders experience an unpleasant emotional state in response to these unfair offers and as a consequence 'punish' human proposers by rejecting the offer, thus depriving the proposer of their greater share of the money (Nowak et al. 2000). The present study was designed to test this hypothesis, namely that physiological emotional responses are associated with the receipt and particularly the rejection of unfair offers. To do this, we measured skin conductance activity prior to the decision to accept or reject an offer in the Ultimatum Game. Skin conductance reflects sympathetic tone, and a relationship between changes in phasic response in skin conductance and rejection rates in the Ultimatum Game may well reflect the involvement of the affect arousal system (Bouscein 1992). Specifically, we hypothesized that higher skin conductance responses would be associated with more rejections for the human offers in the Ultimatum Game, based on the positive relationship between anterior insula activation and such rejections demonstrated by Sanfey et al. (2003).

Methods

Participants and procedure

Thirty undergraduate students (12 males) participated in the experiment. Mean age was 21.25 years (SD 1.86). The study was conducted in compliance of the Declaration of Helsinki and local ethics committee approval. All participants provided written informed consent after the procedure had been fully explained.

Participants were instructed as to the nature and rules of the Ultimatum Game. Participants acted only in the role of responder in the Ultimatum Game. In the task instructions it was emphasized that the participant's partners in the game would play the game independently of each other, with no collusion. Participants were also told that they would be paid according to their choices in the game.

Participants played 20 rounds, 10 times with a person (a different person in each round) and 10 times with a computer partner, each time dividing 5 euro ($6.50). Of these 20 rounds, the money was fairly split 10 times (2.50 euro to each player) and in another 10 rounds the offer was unfair (in euros: four times 4.50 vs. 0.50; four times: 4.00 vs. 1.00 and twice 3.50 vs. 1.50). The ten offers from human partners were identical to the ten offers from the computer. The different offers (fair and unfair from each of human and computer partners) were assigned in a random order. All participants were paid an initial 5 euro for their participation. In addition, participants received 10% of the amount of money that was earned in the Ultimatum Game.

The Ultimatum Game format and description

Participants sat in front of a computer screen, approximately 90 cm away. Each trial started with the presentation of a fixation point. The duration of this fixation point was variable and could be 10, 15, 20 or 25 s and was followed by an image display with a picture of the proposer (human face or computer) for 10 s. After this, the offer (fair or unfair) was presented for 10 s. For example when a human proposed the offer participants saw: "Mary gets 4 euro, you get 1 euro" and in a typical computer trial participants saw: "Computer gets 4 euro, you get 1 euro". This was followed by a 10 s interval after which participants were able to make their response ("accept" or "reject") by button press, highlighted on the computer keyboard. After this response, the 10, 15, 20 or 25 s fixation point was presented again. This resulted in a variable intertrial interval of at least 10 s. This was chosen to allow skin conductance responses to return to baseline after gain (acceptance of offer) or no-gain (rejection of offer) and to reduce possible habituation.

Skin conductance recording

All testing was done in a quiet, dimly lit room at the University Medial Center Utrecht on a computer with a 15-in. monitor. While playing the Ultimatum Game, skin conductance level was continuously recorded. Skin conductance was recorded using SC5 24 bit digital skin conductance amplifier applying a constant voltage of 0.5 V (Contact Precision Instruments: psychophysiological equipment, London, UK). 8 mm prewired Ag/AgCl electrodes were attached to the medial phalanx surfaces of the middle and index finger of the non-dominant hand. A water-soluble jelly, i.e., KY Jelly (Johnson & Johnson) was used as an electrolyte for conductance. Before starting the Ultimatum Game 2 min of baseline were recorded, followed by two external stimuli, a sigh and handclap, in order to ensure a correct attachment and conductance of the electrodes. Values of skin conductance were transformed to microsiemens values using PSYLAB 7 software for windows (http://www.psylab.com). Presentation of the offer in the Ultimatum Game and pressing a response key ("reject" or "accept") was synchronized with the sampling computer. Skin conductance responses occurring 1–5 s after presentation of the offer were computed. A phasic increase in conductance of more than 0.02 μS was counted as a response. To normalize the data a log transformation was used.

Results

All fair offers were accepted, but this was not the case for unfair offers and acceptance rate decreased as the offers became less fair. Of the unfair offers proposed by humans 56.7% accepted the 3.50:1.50 offer, 41.7% accepted the 4:1 offer and 20.0% accepted the 4.50:0.50 offer. The acceptance rates of the unfair offers proposed by computers were 66.7% for the 3.50:1.50 offer, 53.3% for the 4:1 offer and 38.3% for the 4.50:0.50 offer. Unfair offers proposed by humans were more frequently rejected (60.56%) than unfair offers generated by computers (47.22%), Wilcoxon signed rank test: $t=-2.43$ df = 1 $P=0.02$ (two-tailed).

Regarding skin conductance measurements, a repeated measures analysis of skin conductance activity showed an effect of fair versus unfair offers, $F(1,29)=5.08$, $P=0.03$ (two-tailed). This demonstrates that skin conductance responses to unfair offers were significantly higher than responses to fair offers.

To investigate whether emotional arousal would be predictive of decisions made in the Ultimatum Game, we conducted a further analysis. Specifically, we hypothesized that higher skin conductance responses would be associated with more rejections for the human offers, based on the previously observed positive relationship between anterior insula activation and such rejections (Sanfey et al. 2003). Therefore, following Sanfey et al. (2003), we employed a one-tailed test and focused on the two most unfair offers (4:1 euro; 4.50:0.50 euro). Results showed that skin conductance activity correlated with rejection of unfair offers for human proposers, $r=0.35$, $P=0.03$ (see Fig. 1), where higher skin conductance activity was associated with higher rejection rates. This shows that skin conductance activity as a response to the presented offer and prior to the decision is related to the rejection of unfair offers in human proposers. On the contrary, this was not the case for computer proposers, $r=-0.18$, $P=0.17$, i.e., rejections of unfair offers proposed by computers were not related to skin conductance activity (see Fig. 1). Figure 2 shows mean skin conductance levels for accepted and rejected offers, across trials.

Discussion

In the present study we investigated whether emotional state, as measured by autonomic reactivity as reflected by skin conductance responses, would be associated with unfair offers and the subsequent rejection of these unfair offers in the Ultimatum Game. Our finding of a significantly higher skin conductance response for unfair offers compared to responses for fair offers, suggests that participants experienced more emotional arousal when confronted with an unfair offer as compared to a fair offer. Moreover, emotional arousal was specifically related to rejections of unfair offers proposed by humans. That is, participants with higher skin conductance activity in response to unfair offers rejected a higher proportion of these offers when they came from human proposers, but not when computer proposers made the offers. This extends earlier findings of a comparable relationship between anterior insula activation and rejection of unfair offers from humans (Sanfey et al. 2003) and research demonstrating a relationship between emotional arousal and advantageous gambling (Bechara et al. 1997).

We replicated the well-documented behavioral pattern of accepting all fair offers and a declining acceptance rate as the offers became progressively less fair (Guth et al. 1982; Bolton and Zwick 1995; Roth 1995; Guth et al. 2001; Sanfey et al. 2003). The idea that unfair offers proposed by humans convey more than just inequality is strengthened by the behavioral observation of overall lower acceptance rates of unfair offers from humans as compared to from computers.

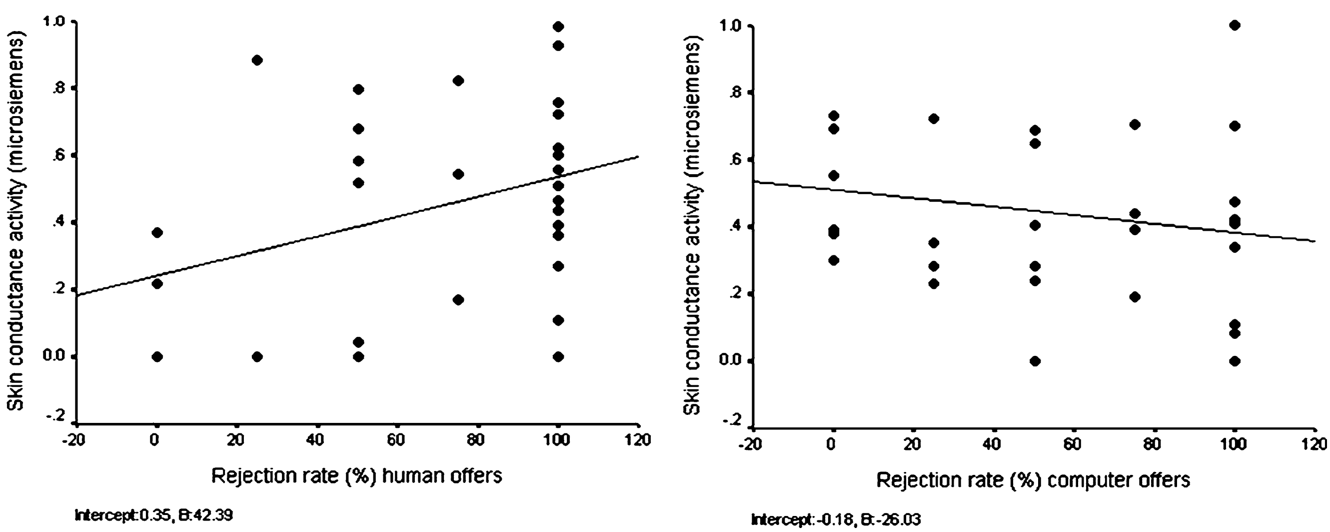

Fig. 1 Rejection rates (%) of unfair offers proposed humans (Beta = 0.35, $B=42.39$) and computers (Beta = −0.18, $B=-26.03$), respectively, plotted against skin conductance activity for each participant

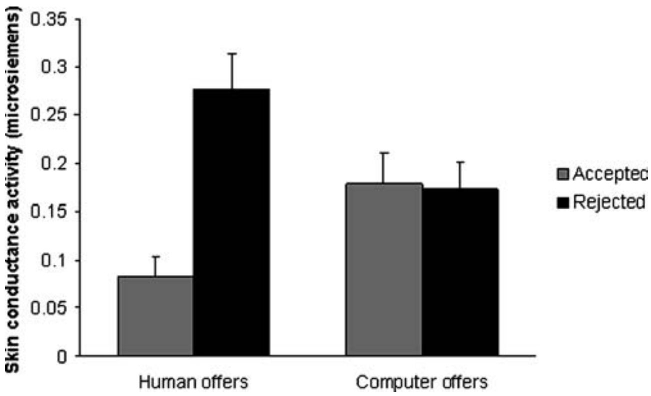

Fig. 2 Mean and SE skin conductance activity (in microsiemens) for subsequently accepted and rejected unfair offers

The rejection of unfair offers, and the finding that the most frequent outcome is a fair share, can be explained by social utility theories, that focus on guilt from getting more than others, and envy from getting less, which predicts rejections of low ultimatum offers to reduce envy, and repayment of trust to reduce guilt (Camerer 2003). Alternative explanations have focused on the human instinct to reciprocate, and the idea that adaptive human behavior emerged from playing repeated "games" in close-knit groups. Hence, "punishing" others for unfair offers in order to keep up social status and reputation will persist even in one-shot games (Nowak et al. 2000). Both of these factors should play a far greater role in unfair offers proposed by humans than proposed by computers.

The results of the present study corroborate and extend earlier research that demonstrated that feelings of anger were a better predictor of rejecting unfair offers than the unfairness of the offer itself (Pillutla and Murnighan 1996). The importance of emotions in decision-making, which includes aspects of uncertainty, has been recognized previously. For instance, patients with damage to important brain regions involved in emotion, the ventromedial prefrontal cortex damage and amygdala, showed impairments in decision-making (Bechara et al. 1999). Furthermore, skin conductance responses have been shown to be predictive of deciding advantageously on a gambling task (Bechara et al. 1997). This was taken to support the view that nonconscious somatic markers can guide advantageous behavior, consistent with the somatic marker hypothesis (Damasio 1994), although it has been recently argued that subjects performing the gambling task might have more conscious knowledge than was previously presumed, potentially accounting for the advantageous decisions (Maia and McClelland 2004). And it is important to note that the results from the Ultimatum Game in the present study do not concern nonconscious somatic markers in the absence of consciously accessible knowledge. In contrast, the Ultimatum Game has no uncertainty, and outcomes of the decision are perfectly predictable even before the decision has been made. Then again, Bechara et al. (2005) have made clear that the somatic marker hypothesis does not address the question of conscious knowledge of the situation, but rather that emotion-related signals guide decision-making. Taking this into account, somatic markers are based on the affective and emotional system and are able to guide actions such as decision-making, independently of conscious knowledge of the decision situation (Bechara et al. 2005), suggesting that the observed relationship between increased skin conductance responses to human offers specifically could be interpreted as a somatic marker. Thus, our findings suggest that emotional state plays a crucial role in such strategic decision-making.

By employing an autonomic measure of emotional arousal we were able to test the hypothesis that affective state influences decision-making in the Ultimatum Game. Our finding of higher skin conductance responses to unfair human offers, which were correlated with subsequent rejections, provides direct empirical support for economic models that acknowledge the role of emotional factors in decision-making behavior (Camerer 2003; Sanfey et al. 2003). Indeed, the role of emotions in decision-making has been previously acknowledged from studies that demonstrated that patients with ventromedial prefrontal cortex damage not only show deficient decision-making behavior but also deficits in the ability to express and experience emotions, resulting in the somatic marker hypothesis (see Bechara and Damasio 2005). In addition, the relationship between elevated skin conductance activity and rejections of unfair offers mirrors and extends the relationship between anterior insula activation and rejections of unfair offers reported by Sanfey et al. (2003), using brain imaging. This is consistent with findings reporting that insula activity is related to awareness of bodily processes and affective feeling states (Critchley et al. 2004). On the other hand, the amygdala and ventromedial prefrontal cortex have also been implied to be important structures for emotion (including the physiological component) as well as decision-making (Bechara et al. 1999). We conclude that taking emotions and its neural basis into account will ultimately yield more powerful economic models of strategic decision-making.

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