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ORIGINAL ARTICLE

Neural correlates of the rejection of unfair offers in the impunity game

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Abstract

OBJECTIVES: This study examined the roles of the insula and the anterior cingulate activations in the rejection of unfair offers in the impunity game.
METHODS: Fifteen participants played the impunity game in ten trials as responders during neuroimaging.
RESULTS: About 45% of the unfair offers were rejected by the responders even when responders could not restore a fair outcome, which cannot be accounted for by social preference of inequity aversion. Imaging data showed that the right anterior insula was activated when participants faced and rejected unfair offers.
CONCLUSIONS: The insula activation during a rejection of the unfair offers is the reflection of an emotional response, rather than social preference of inequity aversion. The role of emotion in the neuroeconomics of fairness was demonstrated.

INTRODUCTION

While a large number of studies have investigated human behavioral responses to unfairness using some forms of economic games (e.g., the ultimatum game, and the dictator game) (Güth *et al.* 1982; Roth *et al.* 1991; Camerer, 2003; Henrich *et al.* 2005), a simple two-person game called the impunity game (Bolton & Zwick, 1995) has received very little attention despite its potentially significant characteristics. The impunity game is played by two players: a proposer and a responder. As in the ultimatum game, the proposer makes an offer concerning how to divide a fixed amount of money between him- or herself and a responder. The responder decides whether to accept or reject the offer. If the responder accepts the offer, both the responder and the proposer receive money from the experimenter according to the proposer's offer. If the responder rejects the offer, he or she loses what has been offered to him or her. Thus far, the impunity game is identical to the ultimatum game, but what follows is different. The money the proposer earns is immune to the rejection of the offer by the responder; the proposer still keeps the money he or she has designated to offer to him or herself when the responder rejects it. In contrast to the ultimatum game, in which the responder can punish the proposer and reduce unfairness by rejecting the proposer's offer at a cost to him or herself, the responder in the impunity game cannot punish an unfair proposer or restore fairness. The standard explanation of rejection behavior in the ultimatum game, that is, social preferences of inequity aversion and reciprocity (Fehr & Schmidt, 1999; Bolton & Ockenfels, 2001; Rabin, 1993; Falk

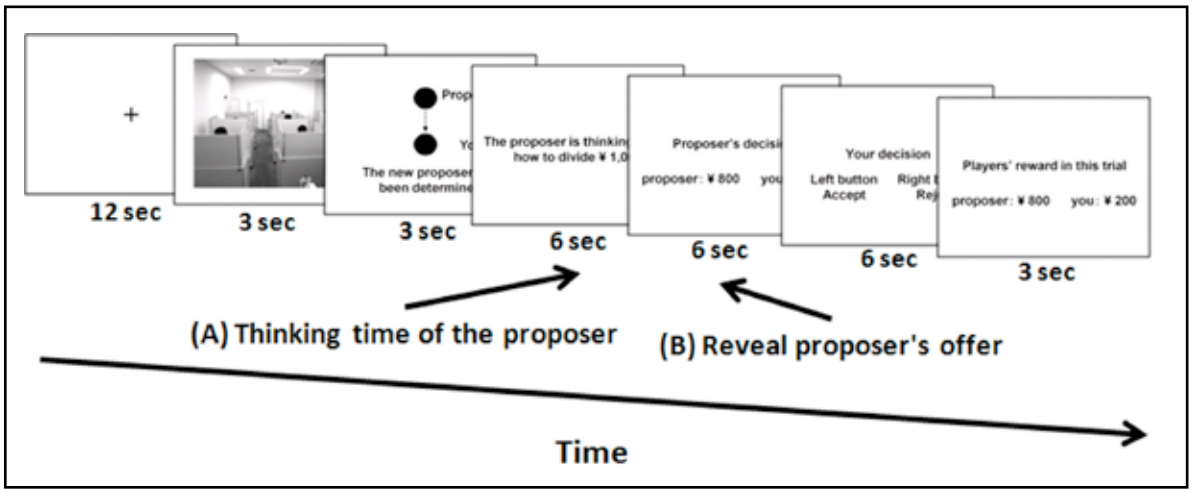

Figure 1. Timeline for a single trial in the impunity game.

& Fischbacher, 2006), cannot explain rejection of unfair offers in the impunity game. Nevertheless, rejection of unfair offers is often observed in experimental studies of the impunity game (Güth & Huck, 1997; Fukuno & Ohbuchi, 2001; Yamagishi *et al.* 2009). Güth and his colleagues, for example, showed that people do not always accept unfair offers in the impunity game (Güth & Huck, 1997) and Yamagishi and colleagues demonstrated in a series of three behavioral studies, each employing a different methodology, that about 40% of participants rejected unfair offers in the impunity game (Yamagishi *et al.* 2009).

The neuroscientific studies of social decision-making (known as neuroeconomics) were conducted in recent years (Glimcher *et al.* 2008) to explore cognitive and emotional processes of decision-making in the brain. In a pioneering neuroeconomic study, for example, Sanfey and his colleagues showed that the activation of the anterior insula correlated with the rejection rate of unfair offers in the ultimatum game (Sanfey *et al.* 2003). However, their study cannot specify whether the activation of the anterior insula associated with rejection of unfair offers in the ultimatum game reflected the player's pursuit of their goal of achieving fairness (social preferences of inequity aversion and reciprocity) or their emotional responses to unfair treatment which is assumed to be a challenge of their status by the responder (Burnham, 2007). We decided to use the impunity game to clarify the role of the activation of the anterior insula associated with rejection of unfair offers, by comparing the neural activities observed in the ultimatum game with those associated with rejection behavior in the impunity game in which social preferences for fairness should play no role. If the activation of the anterior insula is a reflection of social preference, then it should not be observed in the impunity game. If the activation of the anterior insula is reflection of emotional responses to unfair treatment, then the activation of the anterior insula may be observed in the impunity game.

MATERIALS & METHODS

Participants

A total of 15 healthy, right-handed Japanese students (5 females; age range: 21-23; mean age: 22.07) from Hokkaido University participated in the study. Participants were recruited from the subject pool at the Center for Experimental Research in Social Sciences, Hokkaido University. All participants submitted a consent form prior to the experiment. This study was conducted under a protocol approved by the Ethical Committee of the Center.

The Impunity Game

Participants played an impunity game ten times as a responder, each time with a different proposer. The participant was first greeted by the experimenter in a waiting room and was given the overall instructions including the rules of the impunity game and the player's role in the impunity game. During the delivery of instructions, the participant was shown a computer display of other participants who are participating in the study in an experimental room located in another building on campus, with whom the participant was going to interact with. The participant was told that he or she would play a game with each of those ten people, but his or her actual earnings would be determined by the outcomes in two of the ten games he or she would play.

At the beginning of each trial, the participant was told that the proposer who had been matched with him or her for that trial was going to make an offer concerning how to divide 1,000 yen (about $10) between the two players. The participant was then shown the offer by the matched proposer, and was asked to decide whether to accept or reject the offer. The proposers' decisions were actually programmed by the experimenter in advance, such that five of the 10 matched proposers made a 500/500 (500 yen to the proposer and 500 yen to the responder), one of them made a 700/300 (700 yen to the proposer and 300 yen to the responder) offer, two made

Table 1. The activation area in the rejection of unfair offers

	MNI Coordinates				
Brain Regions (Brodmann's area)	**x**	**y**	**z**	**voxels**	***z* value**
Right Superior Parietal Lobule (BA 7)	28	-60	54	37	3.85
Right Superior Parietal Lobule (BA 7)	26	-50	62	30	3.85
Left Anterior Cingulate Cortex (BA 32)	0	10	44	15	3.78
Right Anterior Insula (BA 13)	34	16	16	10	3.66
Right Precuneus (BA 7)	16	-66	40	32	3.61
Right Medial Frontal Gyrus (BA 6)	6	-2	60	15	3.55

Uncorrected *p* value of .001, with a 10-voxel threshold

a 800 /200 offers, and two made a 900 /100 offer, in a randomized order. We decided to use the scheduled decisions instead of letting human proposers decide on their own to minimize the risk that participants not receiving unfair offers, in which case their voluntarily donated time would be completely wasted. The participant was paid according to the outcomes from two randomly chosen trials out of the ten trials.

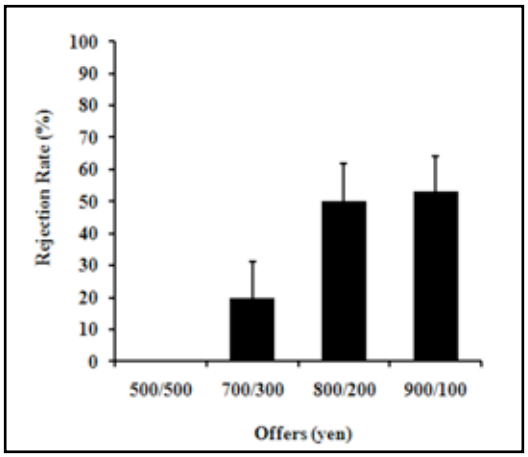

Figure 2 (right). Rejection rate for each offer. The horizontal axis indicates the offer by the proposer, while the vertical axis indicates the rate of rejection by the responder. Significant differences were observed between each offer (Friedman test, p=.0005). Error bar indicates SEM.

The timeline for a single trial in the impunity game is shown in Figure 1. First, a fixation point was shown for 12 seconds. Then a display of other participants who were supposed to be participating in the experiment in another experimental room was shown for 3 seconds (see Figure 1), followed by another display, lasted for 3 seconds, indicating that a new proposer randomly drawn from the participants shown before was being matched with the participant. During the following 6 seconds, the participant was told that the matched proposer was deciding his or her offer (display A in Figure 1). Then, the matched proposer's decision was shown for 6 seconds (display B), after which the responder was prompted to push an acceptance or decision button on the decision tool (a joystick for MRI, Resonance Technology Inc., USA) he or she was holding in his or her hand. This decision phase lasted for 6 seconds. Finally, the outcome of the trial was shown for 3 seconds.

Imaging Acquisition

1.5-Tesla Signa Echo-Speed scanner (General Electric) was used to acquire high-resolution T1-weighted anatomical images and gradient echo-planar T2*-weighted images (EPI) with blood oxygenation level-dependent (BOLD) contrast. The parameters of the sequence were

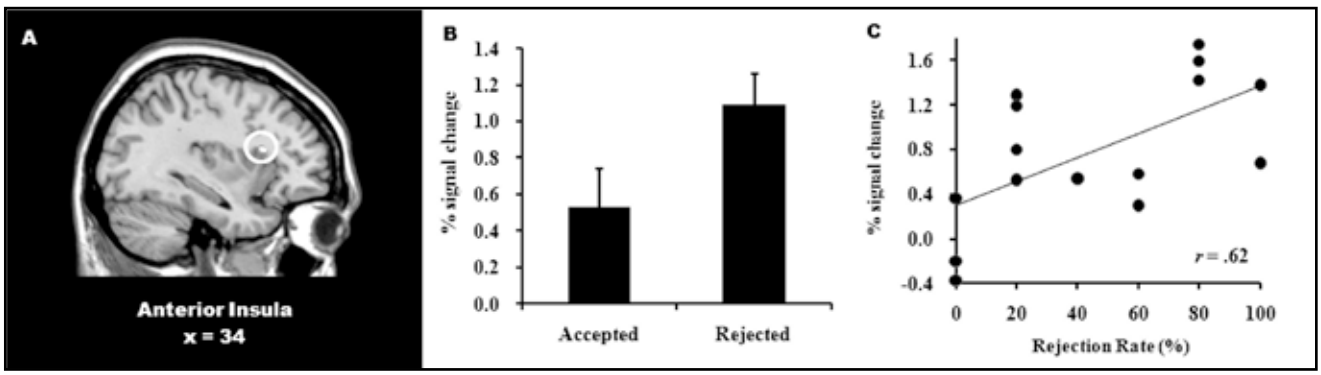

Figure 3 (below). Activation of the right anterior insula [34, 16, 16] in the rejection of unfair offers (p < .001, uncorrected) (A). Mean activation of the right anterior insula. There is significant difference between the two conditions (t(73) = 1.97, p < .05). Error bar indicates SEM (B). Scatter plot of the activation level of the right anterior insula and the rejection rate of unfair offers by the responder (r = .62, p = .01) (C).

set as follows: 64 x 64 matrix, field of view 240 x 240 mm, TR 3000 ms, TE 40 ms, flip angle 90°, twenty-two 4 mm axial slice with 0.8 mm gap.

Imaging Analysis

Data were analyzed using statistical parametric mapping 5 (SPM5, Wellcome Department of Cognitive Neurology, London, UK: http://www.fil.ion.ucl.ac.uk/spm) implemented in MATLAB 7.1 (Mathworks Inc., Sherborn, MA, USA). Images for each participant were slice-timed, realigned to the first image, coregistered with structural data, normalized to the Montreal Neurological Institute (MNI) space, and smoothed with an 8-mm (full-width at half-maximum) Gaussian kernel. For random effects analysis, a contrast image between the revealing of the proposers' offer (display B in Figure 1; duration = 6 sec) and thinking time for the proposer (display A; duration = 6 sec) was generated for each participant. Through this contrast, we can examine directly the neural activity when participants faced and rejected unfair offers. The statistical threshold was set using an uncorrected p-value of .001 (10-voxel threshold).

RESULTS

Behavioral Results

The rejection rates for each offer are shown in Figure 2. The mean rejection rate for unfair offers (700/300, 800/200, and 900/100 offers) was about 45%. There was a significant difference in the rejection rate between the offer levels (Friedman test, p =.0005). Unfair offers, especially those below 200 yen, were more likely to be rejected by participants than were fair offers.

Imaging Results

Because our interest is in the activation of areas associated with the responder's decision to reject unfair offers, we analyzed only the trials in which participants rejected unfair offers. This was done by subtracting activation levels during display A phase from those during display B phase as mentioned earlier. Several areas were activated when participants rejected unfair offers (Table 1). The activation of the right anterior insula (x = 34, y = 16, z = 16, z score = 3.66) (Figure 3A) and the dorsal anterior cingulate cortex (dACC) (x = 0, y = 10, z = 44, z score = 3.78) was observed. In contrast, when participants accepted unfair offers, there was no activation in the anterior insula or dorsal anterior cingulate cortex (p < .005, 10-voxel threshold, uncorrected). Figure 3B shows mean activation level of the right anterior insula when participants rejected or accepted the unfair offer. There was a significant difference between the two conditions ($t(73)$ = 2.03, p < .05).

Correlation Results

To examine the relationship between the activation of the right anterior insula in the five unfair trials (peak level of the activation during display B phase) and the rejection of unfair offers, we conducted a Pearson correlation analysis. There was a significant positive correlation between the activation level of the right anterior insula and the rejection rate of unfair offers (r = .62, p =.01) (Figure 3C).

DISCUSSION

This study is the first attempt to examine the neural basis of the rejection of unfair offer in the impunity game. The results showed that about 45% of unfair offers were rejected by the responders, even though the responders could not punish the proposer and restore fairness in the outcome through rejection. A large proportion of participants refused receiving the money allocated by the proposer when they faced unfair offers. The rejection rate of unfair offers observed in this study is comparable with that reported in the four experiments of a previous behavioral study (Fukuno & Ohbuchi, 2001; Yamagishi *et al.* 2009).

Imaging data showed that the right anterior insula was activated when participants faced and rejected unfair offers. Furthermore, a positive correlation between the activation of the right anterior insula and mean rejection rates for all unfair offers was observed. According to a recent neuroimaging study, the activation of the anterior insula is related to perceived physical pain (Craig, 2002; Henderson *et al.* 2007; Kong *et al.* 2006; Craig, 2009), experience of observing others' pain (Singer *et al.* 2004), and experiencing emotional feeling (e.g., indignation/anger, disgust) (Wicker *et al.* 2003; Zahn *et al.* 2008). Thus, our results suggest that participants who faced unfair offers experienced negative emotions such as disgust or anger in response to unfairly treated by the proposer, and this negative emotion may in turn have motivated participants to reject the unfair offers.

The activation of the dorsal ACC suggests that rejection behavior in the impunity game was a reflection of an emotional response. The function of the dorsal ACC is considered to be related to monitoring of cognitive conflicts (Kerns *et al.* 2004; Mansouri *et al.* 2009). The finding that the dorsal ACC was activated when participants faced and rejected unfair offers suggests that participants faced a conflict between two distinct cognitive and emotional goals, that is, between the goal of increasing one's own monetary rewards by accepting the unfair offer and the emotionally driven urge for refusing to accept the unfair treatment.

Our results are consistent with previous studies of social decision-making in the ultimatum game (Sanfey *et al.* 2003; Tabibnia *et al.* 2008). In previous studies, activation of the anterior insula was observed when participants rejected unfair offers in the ultimatum game. The fact that the anterior insula was also activated in the rejection of unfair offers in the impunity game is an indication that activation of the anterior insula was caused by a factor common to the two games, that is,

negative emotional responses to the unfair treatment, rather than the social preference of inequity aversion or reciprocity that is unique to the ultimatum game (Fehr & Schmidt, 1999; Bolton & Ockenfels, 2001; Rabin, 1993; Falk & Fischbacher, 2006). Further comparisons of rejection of unfair offers in the ultimatum game and the impunity game will provide us with opportunities to clarify neural basis of human responses to unfairness.

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