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RESEARCH ARTICLE

Perceived reputation of others modulates empathic neural responses

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Abstract Empathy enables us to understand and share the emotional and affective states of another person and plays a key role in social behaviors. The current study investigated whether and how empathic neural responses to pain were modulated by the perceived reputation of others. Action histories reflecting individuals' past cooperation or betrayal actions in the repeated prisoner's dilemma game were introduced as an index of reputation. We assessed brain activity with functional magnetic resonance imaging while the participants observed individuals with a good or bad reputation receiving or not receiving pain. The results indicated that the participants exhibited reduced empathic responses in AI and dACC to the individual who had a bad reputation relative to the one who had a good reputation, suggesting that their empathy for pain was modulated by the perceived reputation of others.

Keywords Empathy for pain · Reputation · Anterior insular cortex · dACC · fMRI

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Introduction

Empathy enables us to understand and share the emotional and affective states of another person and is thought to play a key role in motivating prosocial behavior, guiding our preferences and behavioral responses (Decety 2010, 2011; Preston and de-Waal 2002; Singer et al. 2006; Singer and Lamm 2009). In the case of pain, when individuals perceive or imagine others in painful or stressful situations, the pain matrix is activated to a great extent, and this activation includes the bilateral anterior insula (AI) and dorsal anterior cingulate cortex (dACC) (Akitsuki and Decety 2009; Decety et al. 2008; Decety 2010; Cheng et al. 2007; Danziger et al. 2009; Guo et al. 2012; Jackson et al. 2006; Morrison and Downing 2007; Morrison et al. 2004; Singer et al. 2004, 2006; Gu et al. 2010).

Recently, researchers in social neuroscience have begun investigating the modulating factors that interfere with empathic responses. Singer et al. (2006) engaged volunteers in an economic game in which two confederates played fairly or unfairly with the volunteers and found that empathic responses to pain in the AI and dACC were significantly reduced with regard to the unfair compared to the fair confederate, especially for male volunteers. Xu et al. (2009) found that individuals showed more empathic responses in the ACC when painful stimulations were applied to racial in-group faces relative to out-group faces. Guo et al. (2012) found increased brain empathic responses in the AI and dACC to others in pain when the pain targets received no reward rather than a large reward.

Few studies have explored the effect of reputation on human empathy. Reputation can be defined as a person's overall quality of character as judged by others (Merriam-Webster 2015; Izuma 2012). The evidence from indirect reciprocity has highlighted the important role of reputation during altruistic, cooperative interactions in human societies (Nowak and Sigmund 2005; Milinski et al. 2002a, b). The opportunities to acquire a good reputation could promote prosocial behaviors, such as helping and cooperation (Barclay; 2012; Sigmund 2012; Nowak and Sigmund 2005; Milinski et al. 2002a, b; Mohtashemi and Mui 2003; Meshi et al. 2013). More importantly, in social interaction, others' reputation status emerges as a key mediator in determining the way that we treat them (Suzuki and Akiyama 2005; Milinski et al. 2002a, b). For example, people would like to help and cooperate more often with those who have a good reputation (King-Casas et al. 2005; Sigmund 2012; Nowak and Sigmund 2005; Nowak 2006; Milinski et al. 2002a, b). In this study, we aimed to examine whether human empathy would be affected by the reputation of empathy targets. We predicted that participants would exhibit greater empathic responses to targets with a good reputation relative to targets with a bad reputation when the targets experienced pain.

To introduce empathy targets with different reputations in the present study, a modified version of the prisoner's dilemma game (PDG) (Axelrod and Hamilton 1981; Fudenberg and Maskin 1986; Suzuki et al. 2011) was used. Specifically, before scanning, the participants were asked to observe a stranger playing the PDG with two unknown players. Action histories reflecting the players' past cooperation or betrayal actions in the repeated PDG were introduced as the index of reputation. We then measured the participants' brain activities with functional magnetic resonance imaging (fMRI) while they observed the players in painful and non-painful situations. We focused on the modulation of empathic neural responses to players' pain by their reputation status and expected the engagement of pain-related responses in the AI and dACC in this modulation process.

Materials and methods

Participants

Twenty right-handed healthy volunteers (ten females, mean age 25.0 years, SD 1.6, range 22–28 years) with normal or corrected-to-normal vision were recruited from the university community. None of the participants reported a history of neurological or psychological disorders. All participants gave written informed consent before scanning. The study was approved by the local ethics committee.

Materials

A total of ninety-six pictures showing the left index finger in painful and non-painful situations were used as stimuli. Painful situations depicted two types of nociceptive stimulation (cutting the finger with a pair of scissors and pricking the finger with a needle or an awl). A non-painful situation was paired with each of the painful situations, in which the nociceptive tool did not touch the finger, but was placed next to the body part (see our previous study, Guo et al. 2012). The participants were informed that 48 pictures (24 painful and 24 non-painful) were from a person with a good reputation, whereas the remaining 48 pictures (24 painful and 24 non-painful) were from a person with a bad reputation. All of the pictures were 300 × 400 pixels in size.

Procedure

Before scanning, the participants were asked to observe a real person who was unknown to them (confederate of the experimenter, female or male, same sex as the participant) playing the prisoner's dilemma game (PDG) with two same-sex unknown players (Suzuki et al. 2011). The participants did not know any of three individuals playing the game. In fact, the two players were not real people but were computer-programmed players. The PDG consisted of ten rounds. The computer-programmed player with a good reputation cooperated nine times and defected once. The other computer-programmed player, who had a bad reputation, defected nine times and cooperated once. The participants were then required to view pictures depicting these players (empathy targets) in painful and non-painful situations while they were scanned. After the experiment, we confirmed that none of the participants doubted the cover story.

A mixed design was used during scanning. There were 12 blocks in the whole experiment, with six blocks for the target with a good reputation and six blocks for the target with a bad reputation. Different reputation blocks were alternated with one another. The presentation orders of the different reputation blocks were counterbalanced across the participants (ABABABABABAB for half of the participants and BABABABABABA for the rest). Each block lasted for 48.5 s, with a 5-s rest between every two blocks. Before each block, a 6-s cue picture depicting the person with a good or bad reputation was displayed to inform the participants which reputation condition the following block belonged to. Each block contained four painful pictures and four non-painful pictures that were displayed on a gray background and were randomly interspersed with null events. For the null events, the fixation cross remained on screen. Each trial was presented for 3.5 s with jittered interstimulus intervals (ISI) from 0.5 to 1.5 s, during which a black fixation cross was presented against the gray background. The participants were asked to watch the pictures attentively and to try to experience the feelings of the owner of the body part in the picture. The total scanning time was approximately 18 min (6 min for the high-resolution structural image and 12 min for functional images).

After scanning, the participants were asked to rate how agreeable, likeable, and attractive the two targets were (measured on a scale from −2, "not at all," to 2, "very much"). They were then presented with the 96 pictures again and asked to rate how much pain they thought the individuals in the pictures experienced (1- to 9-point Likert scale, where 1 indicated no pain and 9 indicated extreme pain).

MRI data acquisition

Imaging was carried out on a 3 T Siemens scanner at the Functional MRI Lab (East China Normal University, Shanghai). Functional images were acquired using a gradient echo-planar imaging (EPI) sequence (TR = 2200 ms, TE = 30 ms, FOV = 220 mm, matrix size = 64 × 64, voxel size 3.4 × 3.4 × 3.0 mm^3). Thirty-five slices parallel to the AC–PC line (slice thickness = 3 mm, gap = 0.3 mm) were acquired, covering the entire brain. The first five TRs acquired were discarded to allow for T_1 equilibration. Before functional neuroimaging, a high-resolution structural image was acquired using a T_1-weighted 3D magnetization-prepared, rapid acquisition gradient echo (MP-RAGE) pulse sequence (TR = 1900 ms, TE = 3.42 ms, 192 slices, slice thickness = 1 mm, FOV = 256 mm, matrix size = 256 × 256).

fMRI data analysis

The data preprocessing and statistical analyses were performed with Statistical Parametric Mapping (SPM5, Wellcome Department of Cognitive Neurology, London). During the data preprocessing, the first five functional images were discarded to allow for scanner equilibrium effects. All of the functional images were slice-time corrected. The data were then realigned spatially, normalized to the Montreal Neurological Institute template (re-sampled to 2 × 2 × 2 mm^3 voxel size), and smoothed using an 8-mm full-width half maximum isotropic Gaussian kernel. Statistical analyses were performed using the general linear model implemented in SPM5. Trials with responses were classified into four conditions: (1) GP: person with a good reputation in pain; (2) GNP: person with a good reputation not in pain; (3) BP: person with a bad reputation in pain; and (4) BNP: person with a bad reputation not in pain. Each trial was time-locked to the onset of the picture with a duration of 3.5 s and modeled using a canonical hemodynamic response function. Additional covariates of no interest including all of the cues, six regressors modeling movement-related variance and one regressor modeling the overall mean, were also employed in the design matrix. High-pass temporal filtering with a cutoff of 128 s was also applied in the models. For each participant at the first-level analysis, each of the four conditions was computed by applying the "1 0" contrasts. The four first-level individual contrast images were then analyzed at the second group level employing a random-effect model (flexible factorial design in SPM5). In this ANOVA, we tested for (1) the main effect of pain, (2) the main effect of reputation, and (3) the interaction and simple main effect of pain in the bad and good reputation conditions. Parameter estimates across regions identified in the interaction were extracted using the MarsBaR toolbox (Brett et al. 2002) to test the impact of reputation on empathy for pain. A cluster-level threshold of $p < .05$ (FWE correction) for multiple comparisons, with a voxel-level threshold corresponding to $p < .001$ (uncorrected), was consistently used to define activations. All of the brain regions reported were cluster maxima.

Results

Behavioral data

The post-scan behavioral ratings confirmed that participants rated the target with a good reputation as being significantly more agreeable, more likeable, and more attractive than the one with a bad reputation (agreeable: $t = 3.036$, $p = 0.007$; likeable: $t = 7.955$, $p < 0.001$; attractive: $t = 8.134$, $p < 0.001$) (see Table 1). A 2 (pain: painful vs. non-painful) × 2 (target: good reputation vs.

Table 1 Results of the subjective rating (mean ± SD)

Players	Agreeable	Likeable	Attractive	Pain	Non-pain
Good reputation	0.85 (±0.59)	0.70 (±0.57)	−0.10 (±0.91)	6.85 (±1.91)	1.44 (±2.13)
Bad reputation	−1.00 (±0.73)	−1.45 (±0.83)	−0.80 (±0.62)	3.89 (±2.34)	0.69 (±1.20)

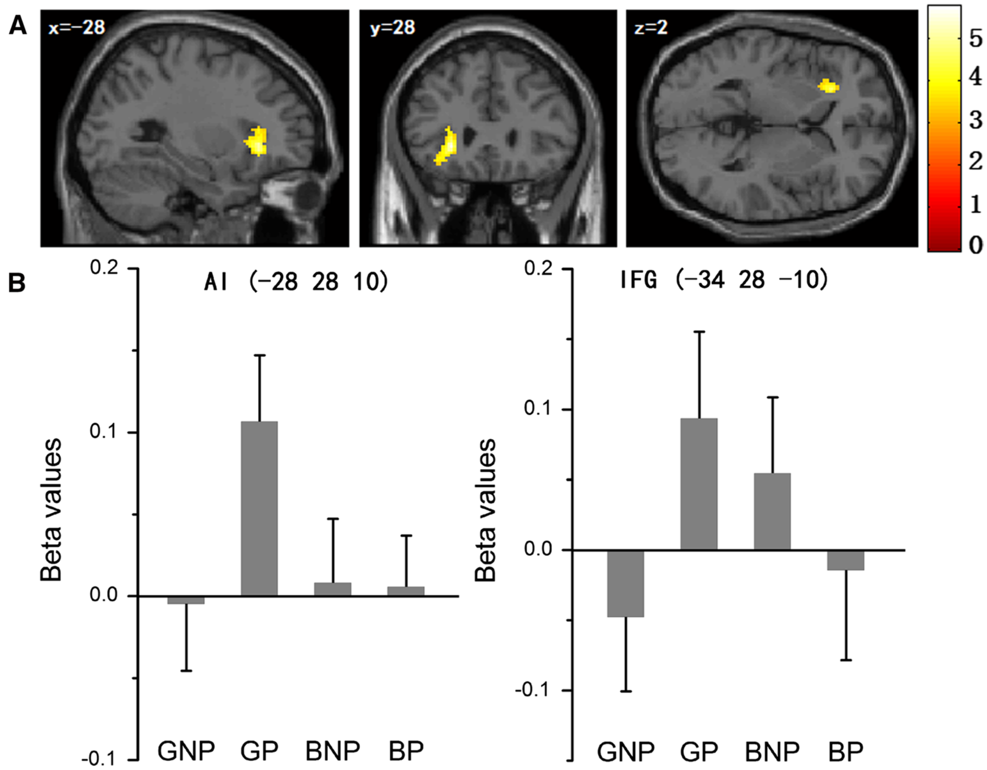

Fig. 1 **a** Left AI and left inferior frontal gyrus identified in contrast to (GP − GNP) − (BP − BNP) (interaction between reputation and pain). **b** Beta values for different conditions in the AI [(MNI −28 28 10)] and inferior frontal gyrus [(MNI −34 28 −10)]. *Error bars* indicate the standard error of the mean

bad reputation) ANOVA on the pain ratings revealed a significant main effect of pain and reputation [pain: F (1, 19) = 75.94, $p < .001$; reputation: F (1, 19) = 29.63, $p < .001$], indicating higher pain ratings for painful stimuli and for the target with a good reputation. A significant interaction effect between the pain and reputation was also observed [F (1, 19) = 20.83, $p < .001$], indicating a higher pain rating difference between painful and non-painful stimuli for the target with a good reputation relative to the one with a bad reputation.

fMRI results

Main effect of pain

The brain regions that showed more activation related to painful pictures versus non-painful pictures [(GP + BP) − (GNP + BNP)] were the supplementary motor area, left inferior frontal gyrus, left anterior insula, and right middle frontal gyrus (Fig. 1a; Table 2). The reverse contrast revealed significant activation in the right middle temporal gyrus, left middle occipital gyrus, right middle frontal gyrus, and right superior frontal gyrus (Table 2). Although the dACC did not show significant activation for the main effect of pain with the chosen threshold, we found greater activation in the dACC (MNI 14 16 34) during painful relative to non-painful trials when using a more lenient threshold (voxel-level threshold of $p < 0.005$, uncorrected) (Table 2).

Main effect of reputation

Data analyses revealed greater activation in regions including the bilateral thalamus and left caudate during the good reputation trials relative to the bad reputation trials by contrasting [(GP + GNP) − (BP + BNP)]. The reverse contrast revealed no significant activation clusters (Table 2).

Interaction

The interaction between pain and reputation defined by the [(GP − GNP) − (BP − BNP)] contrast revealed significant activity in the left AI and left inferior frontal gyrus. The reverse contrast showed no significant activated cluster (Table 3). We overlapped the activations in the contrasts of the main effect of pain and the pain × reputation interaction. It was found that the anterior insula overlapped well (see Fig. 2).

We extracted beta values of the four experimental conditions from the AI and inferior frontal gyrus (MNI −28 28 10; MNI −34 28 −10) based on the activation of the interaction between pain and reputation. A 2 (pain: pain vs. non-pain) × 2 (reputation: good vs. bad) repeated measure ANOVA was conducted for the beta values of the AI and inferior frontal gyrus. The results revealed that there was only a significant reputation × pain

Table 2 Regions showing the main effects of pain and reputation

Region	Lat.	*x*	*y*	*z*	*t* value	Voxels
Main effect of pain						
(GP + BP) − (GNP + BNP)						
Supplementary motor area	*L*	−10	2	70	5.63	1691
Dorsal anterior cingulate cortex*	*R*	14	16	38	3.54	
Inferior frontal gyrus	*L*	−48	8	4	5.18	1243
Anterior insula	*L*	−34	14	14	4.54	
Anterior insula	*L*	−30	22	6	4.01	
Middle frontal gyrus	*L*	−36	50	22	5.65	560
(GNP + BNP) − (GP + BP)						
Middle temporal gyrus	*R*	44	−66	20	6.49	5569
Middle occipital gyrus	*L*	−40	−80	14	5.44	1052
Middle frontal gyrus	*R*	28	30	48	4.86	800
Superior frontal gyrus	*R*	28	30	52	4.82	
Main effect of reputation						
(GP + GNP) − (BP + BNP)						
Thalamus	*L*	−8	−26	12	4.97	354
Thalamus	*R*	12	−24	−12	4.15	
Caudate	*L*	−16	−14	22	3.91	
(BP + BNP) − (GP + GNP)						
No regions						

Coordinates (mm) are in MNI space. All of the clusters survived FWE correction ($p < .05$) for multiple comparisons at the cluster level, with a voxel-level threshold corresponding to $p < .001$ (*$p < 0.005$), uncorrected

L left hemisphere, *R* right hemisphere

Table 3 Regions showing the interaction between pain and reputation

Region	Lat.	*x*	*y*	*z*	*t* value	Voxels
(GP − GNP) − (BP − BNP)						
Anterior insula	*L*	−28	28	10	3.94	207
Inferior frontal gyrus	*L*	−34	28	−10	3.80	
(BP − BNP) − (GP − GNP)						
No regions						

Coordinates (mm) are in MNI space. All of the clusters survived FWE correction ($p < .05$) for multiple comparisons at the cluster level, with a voxel-level threshold corresponding to $p < .001$, uncorrected

L left hemisphere, *R* right hemisphere

interaction [$F(1, 19) = 16.535$, $p = 0.001$; $F(1, 19) = 5.749$, $p = 0.027$] for both the AI and inferior frontal gyrus. Further paired *t* tests showed that greater AI and inferior frontal gyrus activations during the painful relative to the non-painful trials was only found for the target with a good reputation ($t = -2.631$, $p = 0.016$; $t = -2.342$, $p = 0.030$) but not the target with a bad reputation ($t = -0.612$, $p = 0.548$; $t = 1.515$, $p = 0.146$) (Fig. 1b).

In addition, a simple effect of pain under the good reputation conditions (GP − GNP) revealed greater activation in the left AI, left SMA, and right middle frontal gyrus. The reverse contrast revealed greater activation in the right middle occipital gyrus, right middle temporal gyrus, right superior frontal gyrus, and right precuneus. The contrast of (BP − BNP) showed no significant activated cluster. The reverse contrast activated the right middle temporal gyrus and left middle occipital gyrus (Table 4).

No significant dACC activation was found in the interaction or simple main effects of pain at the chosen threshold. When using a more lenient threshold (voxel-level threshold of $p < 0.005$, uncorrected), significant dACC activation was observed only in the contrast of (GP − GNP) (Table 4), indicating that relative to bad reputation targets, more empathic activity in the dACC (MNI 14 16 34) was elicited by the targets who had a good reputation when they were in pain.

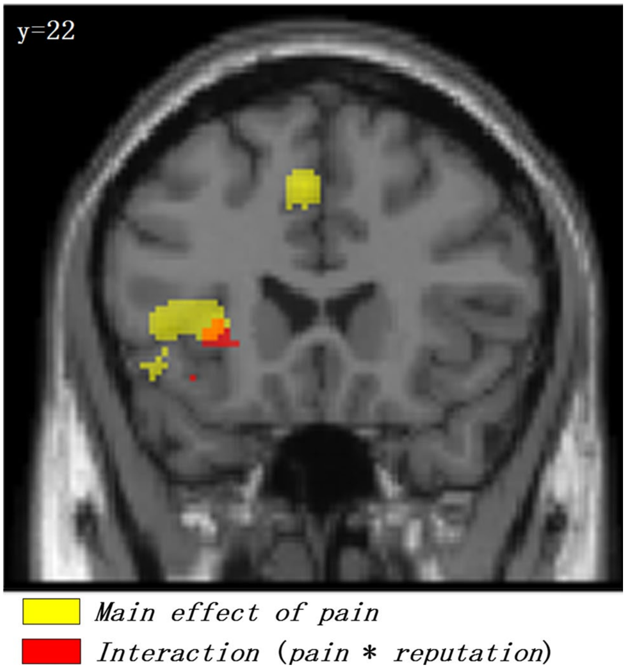

Fig. 2 Clusters in the anterior insula overlapped between the main effect of pain and the pain × reputation interaction

Correlation analyses

Correlation analyses were performed to determine the regions that had activities identified in the contrast (GP–BP) that correlated positively or negatively with participants' rating difference of agreeable, likeable, or attractive for the target with a good reputation relative to the target with a bad reputation. All of the analyses revealed no significant activation.

Discussion

Empathy is a complex form of psychological inference in which observation, memory, knowledge, and reasoning are combined to yield insight into the thoughts and feelings of others (Decety and Jackson 2004; Lee et al. 2010). Observing the emotional state of another person may result in the experience of similar emotions (Preis et al. 2013). Pain is a special psychological state with great evolutionary significance that individuals can experience themselves and perceive in others (Jackson et al. 2005). The ability to experience another person's pain is characteristic of empathy (Singer et al. 2004). The results of the present study showed the engagement of the AI in the perception of others in painful situations (relative to non-painful situations), which was in agreement with previous studies showing a crucial role of the AI in pain empathy (Decety et al. 2008, 2013; Singer et al. 2006; Gu et al. 2010; Decety 2010; Han et al. 2009; Guo et al. 2012).

More importantly, neuroimaging studies have demonstrated that human empathy for pain is not merely an automatic resonance of others' painful state but is more

Table 4 Regions showing simple main effects of pain in bad and good reputation conditions

Region	Lat.	*x*	*y*	*z*	*t* value	Voxels
GP − GNP						
Anterior insula	*L*	−34	16	14	5.00	1715
Anterior insula	*L*	−28	22	4	4.97	
Supplementary motor area	*L*	−8	10	56	4.80	1521
Dorsal anterior cingulate cortex*	*R*	14	16	38	3.58	
Middle frontal gyrus	*L*	−36	50	22	4.31	313
GNP − GP						
Middle occipital gyrus	*R*	36	−78	33	5.38	965
Middle temporal gyrus	*R*	44	−68	20	4.44	
Superior frontal gyrus	*R*	30	12	66	4.12	406
Precuneus	*R*	6	−48	38	3.93	404
BP − BNP						
No regions						
BNP − BP						
Middle temporal gyrus	*R*	42	−66	6	5.79	1495
Middle occipital gyrus	*L*	−44	−74	6	4.99	1141

Coordinates (mm) are in MNI space. All of the clusters survived FWE correction ($p < .05$) for multiple comparisons at the cluster level, with a voxel-level threshold corresponding to $p < .001$ (*$p < 0.005$), uncorrected

L left hemisphere; *R* right hemisphere context-dependent and modulated by many factors (Singer et al. 2006; Xu et al. 2009; Han et al. 2009; de Greck et al. 2012; Eres and Molenberghs 2013; Molenberghs 2013). The behavioral data of the present study revealed that participants disliked the individual with a bad reputation, but liked the individual with a good reputation, and reported lower pain ratings for the individual with a bad reputation relative to the individual with a good reputation. These findings were consistent with previous reports on indirect reciprocity (Milinski et al. 2002a). At the neural level, we found that the AI responded more strongly to painful relative to non-painful stimuli only when the target of empathy was an individual with a good reputation. Previous studies have demonstrated that personal reputation is important for social interactions such as gaining support and cooperation through indirect reciprocity (Sigmund 2012; Nowak and Sigmund 2005; Milinski et al. 2002a; Mohtashemi and Mui 2003). The current study further revealed that, relative to the individual with a bad reputation, the participants exhibited greater empathic responses to the individual with a good reputation at both behavioral and neural levels, suggesting that reputation also played an important role in modulating the empathic responses to others' pain.

The dACC has been regarded as another critical structure for empathetic pain processing (Singer et al. 2006; Xu et al. 2009; Han et al. 2009; de Greck et al. 2012; Eres and Molenberghs 2013; Decety et al. 2013). When using a more lenient threshold, significant dACC activity was observed when painful stimuli were observed compared with non-painful stimuli. This was in line with previous findings that the dACC was another important region engaged in empathy for others' pain (Singer et al. 2004, 2006; Xu et al. 2009; Decety et al. 2009). Conversely, the dACC also showed significant activity during the perception of pain in the targets with a good reputation but not in the targets with a bad reputation, suggesting that the empathic responses in the dACC, as in the AI, were also affected by others' reputation when perceiving pain in others.

Our findings were similar to those of a prior study by Singer et al. (2006), who engaged volunteers in an economic game, in which two confederates (empathy targets) played fairly or unfairly and then measured the brain activities of the volunteers when they observed the confederates receiving pain. However, unlike the study by Singer et al. (2006), the present study tried to manipulate the reputation of empathy targets in the absence of the personal involvement of the participant. The participants in our study did not know the empathy targets and did not engage in any economic interaction with them. In fact, they only observed the economic interaction actions between an unknown stranger and two empathy targets during a repeated prisoner's dilemma game (PDG). Thus, the present study sheds light on how the perceived reputation of empathy targets, especially when manipulated without personal involvement, modulates the neural correlates of empathy.

The present study has several limitations. No significant activation was associated with the behavioral rating data, which might be due to the relatively low sample size for regression analyses. This provides constraints for us to further explore the possible mediation effects induced by agreeable, likeable, and/or attractive ratings on the impact of reputation on empathic responses. Future research could focus on this mediation effect. In addition, the current study did not assess the perceived reputation of the targets, which is another limitation. Future research should increase the sample size and include the assessment of the perceived reputation of the targets.

In summary, the present study used fMRI to determine the impact of one's reputation on others' empathic responses to him/her. The results revealed that individuals showed greater empathic responses to targets with a good reputation compared with targets with a bad reputation. These findings extended prior findings on indirect reciprocity that showed that individuals with a good reputation tended to gain more support and cooperation from others.

References

Akitsuki Y, Decety J (2009) Social context and perceived agency affects empathy for pain: an event-related fMRI investigation. Neuroimage 47:722–734. doi:10.1016/j.neuroimage.2009.04.091

Axelrod R, Hamilton WD (1981) The evolution of cooperation. Science 211:1390–1396. doi:10.1126/science.7466396

Barclay P (2012) Harnessing the power of reputation: strengths and limits for promoting cooperative behaviors. Evol Psychol 10:868–883. http://www.epjournal.net/wp-content/uploads/EP10868883.pdf

Brett M, Anton JL, Valabregue R, Poline JB (2002) Region of interest analysis using an SPM toolbox. Neuroimage 16:1140–1141. http://matthew.dynevor.org/_downloads/marsbar_abstract.pdf

Cheng YW, Lin CP, Liu HL, Hsu YY, Lims KE, Hung D, Decety J (2007) Expertise modulates the perception of pain in others. Curr Biol 17:1708–1713. doi:10.1016/j.cub.2007.09.020

Danziger N, Faillenot I, Peyron R (2009) Can we share a pain we never felt? Neural correlates of empathy in patients with congenital insensitivity to pain. Neuron 61:203–212. doi:10.1016/j.neuron.2008.11.023

de Greck M, Shi ZH, Wang G, Zuo XY, Yang XD, Wang XY, Northoff G, Han SH (2012) Culture modulates brain activity during empathy with anger. Neuroimage 59:2871–2882. doi:10.1016/j.neuroimage.2011.09.052

Decety J (2010) To what extent is the experience of empathy mediated by shared neural circuits? Emot Rev 2:204–207. doi:10.1177/1754073910361981

Decety J (2011) Dissecting the neural mechanisms mediating empathy. Emot Rev 3:92–108. doi:10.1177/1754073910374662

Decety J, Jackson PL (2004) The functional architecture of human empathy. Behav Cogn Neurosci Rev 3:71–100. doi:10.1177/1534582304267187

Decety J, Michalska KJ, Akitsuki Y (2008) Who caused the pain? An fMRI investigation of empathy and intentionality in

children. Neuropsychologia 46:2607–2614. doi:10.1016/j.neuropsychologia.2008.05.026
Decety J, Echols S, Correll J (2009) The blame game: the effect of responsibility and social stigma on empathy for pain. J Cogn Neurosci 22:985–997. doi:10.1162/jocn.2009.21266
Decety J, Chen C, Harenski C, Kiehl KA (2013) An fMRI study of affective perspective taking in individuals with psychopathy: imagining another in pain does not evoke empathy. Front Hum Neurosci 24:489. doi:10.3389/fnhum.2013.00489
Eres R, Molenberghs P (2013) The influence of group membership on the neural correlates involved in empathy. Front Hum Neurosci 7:176–181. doi:10.3389/fnhum.2013.00176
Fudenberg D, Maskin E (1986) The folk theorem in repeated games with discounting or with incomplete information. Econometrica 54:533–554. doi:10.2307/1911307
Gu X, Liu X, Guise KG, Naidich TP, Hof PR, Fan J (2010) Functional dissociation of the frontoinsular and anterior cingulate cortices in empathy for pain. J Neurosci 30:3739–3744. doi:10.1523/JNEUROSCI.4844-09.2010
Guo X, Zheng L, Zhang W, Zhu L, Li J, Wang QF, Dienes Z, Yang ZL (2012) Empathic neural responses to others' pain depend on monetary reward. Soc Cogn Affect Neurosci 7:535–541. doi:10.1093/scan/nsr034
Han S, Fan Y, Xu X, Qin J, Wu B, Wang X, Aqlioti SM, Mao L (2009) Empathic neural responses to others' pain are modulated by emotional contexts. Hum Brain Mapp 30:3227–3237. doi:10.1002/hbm.20742
Izuma K (2012) The social neuroscience of reputation. Neurosci Res 72:283–288. doi:10.1016/j.neures.2012.01.003
Jackson PL, Meltzoff AN, Decety J (2005) How do we perceive the pain of others? A window into the neural processes involved in empathy. Neuroimage 24:771–779. doi:10.1016/j.neuroimage.2004.09.006
Jackson PL, Brunet E, Meltzoff AN, Decety J (2006) Empathy examined through the neural mechanisms involved in imagining how I feel versus how you feel pain. Neuropsychologia 44:752–761. doi:10.1016/j.neuropsychologia.2005.07.015
King-Casas B, Tomlin D, Anen C, Camerer CF, Quartz SR, Montague PR (2005) Getting to know you: reputation and trust in a two-person economic exchange. Science 308:78–83. doi:10.1126/science.1108062
Lee SJ, Kang DH, Kim CW, Gu B, Park JY, Choi CH, Shin NY, Lee JM, Kwon JS (2010) Multi-level comparison of empathy in schizophrenia: an fMRI study of a cartoon task. Psychiatry Res 181:121–129. doi:10.1016/j.pscychresns.2009.08.003
Merriam-Webster (2015) http://www.merriam-webster.com/dictionary/reputation. Accessed 30 May 2015
Meshi D, Morawetz C, Heekeren HR (2013) Nucleus accumbens response to gains in reputation for the self relative to gains for others predicts social media use. Front Hum Neurosci 7:1–11. doi:10.3389/fnhum.2013.00439
Milinski M, Semmann D, Krambeck HJ (2002a) Reputation helps solve the 'tragedy of the commons'. Nature 415:424–426. doi:10.1038/415424a
Milinski M, Semmann D, Krambeck HJ (2002b) Donors to charity gain in both indirect reciprocity and political reputation. Proc R Soc Lond 269:881–883. doi:10.1098/rspb.2002.1964
Mohtashemi M, Mui L (2003) Evolution of indirect reciprocity by social information: the role of trust and reputation in evolution of altruism. J Theor Biol 223:523–531. doi:10.1016/S0022-5193(03)00143-7
Molenberghs P (2013) The neuroscience of in-group bias. Neurosci Biobehav Rev 37:1530–1536. doi:10.1016/j.neubiorev.2013.06.002
Morrison I, Downing PE (2007) Organization of felt and seen pain responses in anterior cingulate cortex. Neuroimage 37:642–651. doi:10.1016/j.neuroimage.2007.03.079
Morrison I, Lloyd D, di Pellegrino G, Roberts N (2004) Vicarious responses to pain in anterior cingulate cortex: is empathy a multisensory issue? Cogn Affect Behav Neurosci 4:270–278. doi:10.3758/CABN.4.2.270
Nowak MA (2006) Five rules for the evolution of cooperation. Science 314:1560–1563. doi:10.1126/science.1133755
Nowak MA, Sigmund S (2005) Evolution of indirect reciprocity. Nature 437:1291–1298. doi:10.1038/nature04131
Preis MA, Schmidt-Samoa G, Dechent P, Kroener-Herwig B (2013) The effects of prior pain experience on neural correlates of empathy for pain: an fMRI study. Pain 154:411–418. doi:10.1016/j.pain.2012.11.014
Preston SD, de-Waal FB (2002) Empathy: its ultimate and proximate bases. Behav Brain Sci 25:1–72. http://www.psychology.emory.edu/cognition/rochat/lab/VariousKindsofempathyasrevealedb-monkeysbrain.pdf
Sigmund K (2012) Moral assessment in indirect reciprocity. J Theor Biol 299:25–30. doi:10.1016/j.jtbi.2011.03.024
Singer T, Lamm C (2009) The social neuroscience of empathy. Ann N Y Acad Sci 1156:81–96. doi:10.1111/j.1749-6632.2009.04418.x
Singer T, Seymour B, O'Doherty J, Kaube H, Dolan RJ, Frith CD (2004) Empathy for pain involves the affective but not sensory components of pain. Science 303:1157–1162. doi:10.1126/science.1093535
Singer T, Seymour B, O'Doherty JP, Stephan KE, Dolan RJ, Frith CD (2006) Empathic neural responses are modulated by the perceived fairness of others. Nature 439:466–469. doi:10.1038/nature04271
Suzuki S, Akiyama E (2005) Reputation and the evolution of cooperation in sizable groups. Proc R Soc B 272:1373–1377. doi:10.1098/rspb.2005.3072
Suzuki S, Niki K, Fujisaki S, Akiyama E (2011) Neural basis of conditional cooperation. SCAN 6:338–347. doi:10.1093/scan/nsq042
Xu X, Zuo X, Wang X, Han S (2009) Do you feel my pain? Racial group membership modulates empathic neural responses. J Neurosci 29:8525–8529. doi:10.1523/JNEUROSCI.2418-09.2009