Brief Communications

Do You Feel My Pain? Racial Group Membership Modulates Empathic Neural Responses

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The pain matrix including the anterior cingulate cortex (ACC) mediates not only first person pain experience but also empathy for others' pain. It remains unknown, however, whether empathic neural responses of the pain matrix are modulated by racial in-group/out-group relationship. Using functional magnetic resonance imaging we demonstrate that, whereas painful stimulations applied to racial in-group faces induced increased activations in the ACC and inferior frontal/insula cortex in both Caucasians and Chinese, the empathic neural response in the ACC decreased significantly when participants viewed faces of other races. Our findings uncover neural mechanisms of an empathic bias toward racial in-group members.

Introduction

Empathy refers to the ability to understand and share others' emotion and plays a key role in social behaviors. Perception of others in pain or distress generates empathic concerns that provide a proximate mechanism selected by evolution that motivates altruistic behaviors (Batson, 1991; de Waal, 2008). Empathy may influence social behaviors by changing people's attitudes toward a target (Batson et al., 1997a), which sometimes produces serious consequences such as when making judicial decisions on a defendant (Johnson et al., 2002).

The perception–action model of empathy proposes that empathic responses do not require conscious and effortful processing and often occur automatically (Preston and de Waal, 2002). Consistent with this, neuroimaging studies have shown that perception of others in pain activates the neural circuit consisting of the anterior cingulate cortex (ACC) and insula that mediate first-person pain experience (Singer et al., 2004; Botvinick et al., 2005; Jackson et al., 2005; Saarela et al., 2007). However, the empathic neural responses are modulated by affective link between individuals (Singer et al., 2006) and top-down attention to painful cues in stimuli (Gu and Han, 2007; Fan and Han, 2008). In addition, empathy may be influenced by social relationship between individuals such that empathic concerns increase if a perceiver and a target share common membership in a social category (Hornstein, 1978). The evidence supporting this hypothesis comes from research that measured subjective reports of empathic concern. Johnson et al. (2002) asked White university students to read a passage involving a Black or a White man who was charged with a criminal act. Participants were induced to feel no empathy, low empathy, or high empathy for the defendant and then evaluate punishments applied to the defendant. Johnson et al. (2002) found that White participants reported greater feelings of empathy for and assigned more lenient punishments to the White than the Black defendant, suggesting an empathic bias toward racial in-group members.

The current work investigated the neural mechanism underlying modulations of empathic neural responses by racial group membership between individuals. We scanned Caucasian and Chinese participants using functional magnetic resonance imaging (fMRI) while they watched video clips of Caucasian or Chinese faces receiving painful stimulation (needle penetration) or non-painful stimulation (cotton Q-tip touch). Automatic categorization of others by race defines the intragroup or intergroup relations between a perceiver and the target. Our recent research (Han et al., 2009) found that, relative to Q-tip touch, needle penetration applied to faces of Chinese models with neutral expressions induced increased activations in the ACC and bilateral frontal cortices of Chinese participants. The present study further tested the hypothesis that the empathic neural responses are weakened by race-defined intergroup relationship and such effect is independent of perceivers' own race.

Materials and Methods

S b c . Seventeen Chinese (8 males, mean ▫ 23 years, SD ▫ 2.0 years, all right handed) and 16 Caucasian healthy college students (8 males, mean ▫ 23 years, SD ▫ 3.7 years, 10 Americans, 2 Dutch, 1 Italian, 1 German, 1 Russian, 1 Israeli, 12 right handed, 4 left handed) were paid for participation. All had normal or corrected-to-normal vision and reported no abnormal neurological history. Informed consent was obtained from all participants before scanning. This study was approved by a local ethics committee.

S a d c d . The stimuli consisted of 48 video clips showing faces of six Chinese (3 males) and six Caucasian models (3 males). Each clip, subtending a visual angle of 21° ▫ 17° (width ▫ height) at a viewing distance of 80 cm, lasted 3 s and depicted a face with neutral expressions receiving painful (needle penetration) or non-painful (Q-tip touch) stimulation (Fig. 1*a*,*b*) applied to the left or right cheeks. After each video clip, participants were instructed to judge whether or not the model was

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feeling pain by pressing a button using the right index or middle finger. Six functional scans of 204 s were obtained from each subject. Each scan consisted of 16 video clips (8 Chinese and 8 Caucasian faces, half with painful and half with non-painful stimulations in a random order). The interstimulus interval between two successive clips lasted 9 s during which participants fixated at a central cross. The last clip in each scan was

related neural activity was modeled using a canonical hemodynamic response function.

Region-of-interest (ROI) analyses were conducted to test our hypothesis. The ROIs were defined based on an entirely independent data set that also compared needle penetration with Q-tip touch applied to neutral faces (Han et al., 2009). The ROI of the ACC was defined as a sphere with a radius of 10 mm centered at / / □ 4/40/38 [MNI coordinates, Brodmann area (BA) 32/9]. ROIs of the left and right frontal cortices were defined as spheres with a radius of 10 mm centered at □ 52/16/16 (BA 44/45) and 52/22/20 (BA 45). The parameter estimates of signal intensity in association with the needle penetration and Q-tip touch applied to faces of the same or other races were calculated using Marsbar from both racial groups and subject to a repeated-measures ANOVA with Pain (painful vs nonpainful) and Group Membership (same vs other race) as within-subjects independent variables and Ethnicity (Caucasian vs Chinese participants) as a between-subjects variable.

Whole-brain statistical parametric mapping analyses were also performed to examine any other brain areas linked to the painful and nonpainful stimulation. Effects at each voxel were estimated and regionally specific effects were compared using linear contrasts in individual participants using a fixed effect analysis. One contrast (painful vs nonpainful stimulation) was calculated to define pain specific neural activations. Random effect analyses were then conducted across each participant group based on statistical parameter maps from each individual participant to allow population inference. Whole-brain statistical parametric mapping analyses were also calculated to confirm the interaction between Pain and Group Membership in each subject group by calculating the contrast 1 □ 1 □ 1 1 (needle penetration applied to same-race faces, Q-tip applied to same-race faces, needle penetration applied to other-race faces, Q-tip applied to other-race faces). Given the previous hypothesis of brain activation related to empathy, significant activations were defined using a voxel threshold of □ 0.001 and a spatial extent threshold of □ 50.

Results

Behavioral results

Relative to Chinese participants, Caucasian participants scored higher on the Triandis individualism subscale (4.86 □ 0.48 vs 4.38 □ 0.51, $_{(31)}$ □ 2.762, □ 0.01) but lower on the collectivism subscale (5.03 □ 0.43 vs 5.74 □ 0.69, $_{(31)}$ □ 3.521, □ 0.001). The mean ethnic identity scores were higher for Chinese than for Caucasians (3.10 □ 0.38 vs 2.69 □ 0.43, $_{(31)}$ □ □ 2.874, □ 0.01). Relative to Chinese participants, Caucasian participants showed higher rating scores of empathic concern (25.6 □ 3.26 vs 22.6 □ 3.42, $_{(31)}$ □ 2.553, □ 0.016), perspective-taking (27.0 □ 4.25 vs 20.2 □ 3.43, $_{(31)}$ □ 5.083, □ 0.001), and fantasy (26.8 □ 5.77 vs 19.6 □ 3.44, $_{(31)}$ □ 4.359, □ 0.001). No significant difference on the personal distress scale was observed between the two racial groups (16.4 □ 3.89 vs 18.5 □ 2.47, $_{(31)}$ □ □ 1.852, □ 0.074).

Response accuracy of the identification of painful and nonpainful stimuli during scanning was high and did not differ between the two racial groups (Caucasians: 94.0%; Chinese: 93.2%, □ 0.246; □ 0.5). Rating scores of pain intensity and self-unpleasantness were higher for painful than non-painful stimulations ($F_{(1,31)}$ □ 156.82 and 107.544, both □ 0.001 (see Table 1). Chinese scored higher in both pain intensity and self-unpleasantness than Caucasians ($F_{(1,31)}$ □ 35.645 and 20.187, □ 0.001). Differential rating scores (painful vs non-painful stimuli) of pain intensity and self-unpleasantness were higher for Chinese than for Caucasians ($F_{(1,31)}$ □ 15.421 and 3.915, □ 0.001 and 0.057) but did not differ between racial in-group and out-group members (both

□ 200, *Z* □ 3.65; 0/20/38, □ 105, *Z* □ 2.94) and left inferior frontal/insula cortex (□ 48/34/□ 2, □ 299, *Z* □ 3.48, Fig. 1) in Chinese. The contrast of painful versus non-painful stimulation applied to racial out-group faces did not show any significant activation in both groups of subjects. The interaction analysis that compared the two contrasts (needle penetration vs Q-tip applied to racial in-group and out-group faces) revealed increased activation in the ACC (Caucasians: 4/28/42, □ 243, *Z* □ 3.37; Chinese: □ 4/38/40, □ 488, *Z* □ 3.27). The reverse comparison did not show any significant activation.

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