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Task modulations of racial bias in neural responses to others' suffering

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ABSTRACT

Recent event related brain potential research observed a greater frontal activity to pain expressions of racial in-group than out-group members and such racial bias in neural responses to others' suffering was modulated by task demands that emphasize race identity or painful feeling. However, as pain expressions activate multiple brain regions in the pain matrix, it remains unclear which part of the neural circuit in response to others' suffering undergoes modulations by task demands. We scanned Chinese adults, using functional MRI, while they categorized Asian and Caucasian faces with pain or neutral expressions in terms of race or identified painful feelings of each individual face. We found that pain vs. neutral expressions of Asian but not Caucasian faces activated the anterior cingulate (ACC) and anterior insular (AI) activity during race judgments. However, pain compared to race judgments increased ACC and AI activity to pain expressions of Caucasian but not Asian faces. Moreover, race judgments induced increased activity in the dorsal medial prefrontal cortex whereas pain judgments increased activity in the bilateral temporoparietal junction. The results suggest that task demands emphasizing an individual's painful feeling increase ACC/AI activities to pain expressions of racial out-group members and reduce the racial bias in empathic neural responses.

Introduction

Empathy, especially that for other's suffering, has been suggested to serve as a proximate mechanism of altruistic behavior (De Waal, 2008; Decety and Jackson, 2004). The neural correlates of empathy for pain have been investigated extensively in recent functional magnetic resonance imaging (fMRI) studies. It has been shown that a neural circuit consisting of the anterior cingulate cortex (ACC), bilateral anterior insula (AI), and sensorimotor cortex is activated when perceiving painful stimulation applied to others (Avenanti et al., 2005; Gu and Han, 2007a; Lamm et al., 2010; Singer et al., 2004) or perceiving others' painful facial expressions (Botvinick et al., 2005; Han et al., 2009; Lamm et al., 2007; Saarela et al., 2007; see Fan et al., 2011; Lamm et al., 2011; for review). Event related potential (ERP) studies revealed that empathic neural responses to perceived pain in others occur as early as 140 ms after stimulus presentation over the frontal/central regions (Decety et al., 2010; Fan and Han, 2008; Han et al., 2008; Li and Han, 2010; Mu et al., 2008; Sheng and Han, 2012; Sheng et al., 2013). The neural responses to others' suffering are associated with subjective feelings of others' pain (e.g., Jackson et al., 2005) and observers' traits of empathy (e.g., Sheng and Han, 2012; Singer et al., 2004). The magnitude of neural responses to others' suffering predicts altruistic behavior such as donation (Ma et al., 2011) and costly help (Hein et al., 2010), suggesting that neural responses to others' suffering may mediate altruistic behavior.

Interestingly, recent brain imaging studies have shown that, rather than showing equal neural responses to perceived suffering in others, human adults exhibit different empathic neural responses to others' suffering depending on the intergroup relationship between a perceiver and a target. Xu et al. (2009) reported the first fMRI evidence that both Chinese and Caucasian participants exhibited stronger ACC activity to painful stimulations applied to racial in-group compared to racial out-group individuals. Other researchers reported racial in-group bias in neural responses to others' suffering in Black and White participants. Using transcranial magnetic stimulation, Avenanti et al. (2010) showed that observing painful stimulation applied to racial in-group but not out-group models inhibited the onlookers' sensorimotor activity. Mathur et al. (2010) showed fMRI evidence for greater activity in the dorsal medial prefrontal cortex (MPFC) when African-American individuals observed the suffering of racial in-group relative to out-group individuals. Azevedo et al. (in press) also reported that the left AI activity was more strongly activated by perceived pain experienced by own-race models compared to that of other-race models and that greater racial bias in implicit attitudes predicted increased activity within the left AI in response to own-race pain relative to other-race pain. The racial bias in empathy exhibits cultural difference as, compared to Caucasian-American participants, Korean participants reported experiencing greater empathy and showed stronger activity

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in the left temporoparietal junction (TPJ) for racial in-group compared to out-group members (Cheon et al., 2011, 2013). A recent ERP research further showed that a neural peptide, i.e., oxytocin that serves as both hormone and neurotransmitter, may be engaged in racial in-group bias in empathic neural responses because oxytocin vs. placebo treatments increased the racial in-group bias in neural responses to others' suffering (Sheng et al., 2013). These findings uncover neural, sociocultural and molecular basis of racial in-group bias in empathy.

Although humans exhibit racial bias in empathic neural responses and the racial bias in empathy may affect prosical behavior (Drwecki et al., 2011; Johnson et al., 2002), our recent research has shown evidence that the racial bias in neural responses to others' suffering is not inevitable. Zuo and Han (2013) found that Chinese individuals with long-term experiences of living in American and European countries showed comparable neural responses to perceived painful stimulations applied to Asian and Caucasian individuals. By recording ERPs from Chinese adults during perceiving pain and neutral facial expressions of Asian and Caucasian models, Sheng and Han (2012) found that, relative to neutral expressions, pain expressions increased neural responses at 128–188 ms after stimulus onset over the frontal/central brain regions when participants categorized faces in terms of race (race judgments). However, this effect was evident for racial in-group (i.e., Asian) faces but not for racial out-group (i.e., Caucasian) faces. More interestingly, they showed that the racial bias in neural responses to others' suffering can be reduced by enhancing attention to painful feelings of racial out-group individuals. Sheng and Han compared neural responses to pain vs. neutral expressions when participants performed race judgments or pain judgments (i.e., identifying each observed individual's feelings of pain) on face stimuli. They found that paying attention to each individual's painful feeling significantly eliminated the racial bias in empathic neural responses by increasing the neural activity to pain expressions of other-race faces. These findings indicate that the racial bias in empathic neural responses can be reduced when participants adopt a specific cognitive strategy.

The ERP findings of variable racial bias in empathic neural responses leave two open questions. First, due to the low spatial resolution of ERP signals, the exact brain regions in which neural responses to the suffering of racial out-group members were enhanced by task demands remain unknown. It is likely that empathic neural responses in the ACC and AI that are less activated to racial out-group compared to in-group individuals (Azevedo et al., in press; Xu et al., 2009) may be specifically enhanced by task instructions that promote attention to each individual's painful feeling. Second, although the ERP research has shown that pain judgments compared to race judgments increased empathic neural responses to racial out-group members (Sheng and Han, 2012), it is still unclear which brain regions are specifically engaged during pain vs. race judgments. As individuated processing of racial in-group and out-group faces, which encourage perceiving another person as a unique social entity rather than merely a member of a social group, engaged brain regions implicated in mentalizing and theory of mind (e.g., TPJ, Freeman et al., 2010), it is possible that performing pain judgments on facial expressions may induce greater TPJ activity relative to race judgments.

To test these hypotheses, we scanned Chinese adults using fMRI while they were presented with pain and neutral expressions of Asian and Caucasian faces that were used in our previous ERP study (Sheng and Han, 2012). Previous fMRI (de Greck et al., 2012; Gu and Han, 2007a; Lamm et al., 2010; Xu et al., 2009) and ERP (Fan and Han, 2008; Li and Han, 2010; Sheng and Han, 2012; Sheng et al., 2013) studies asked participants to either evaluate/empathize/perceive the pain of others on an individual level or categorize faces into different social groups (e.g., race). Similarly, the present study asked participants to perform race judgments or pain judgments on face stimuli in separate blocks of trials, respectively. We predicted that empathic neural responses in brain regions such as the ACC and AI would be stronger to racial in-group than out-group individuals during race judgments. However, such racial bias in empathic neural responses would be reduced during pain judgments that emphasize attention to each individual's painful feelings. Finally, we predicted that, relative to race judgments, pain judgments may engage theory-of-mind related brain regions such as the TPJ.

Materials and methods

Participants

Twenty one Chinese college students (11 females; 19–26 years, mean ± SD = 22.0 ± 1.8 years) participated in the study as pain volunteers. All participants were right-handed, reported no history of neurological or psychiatric diagnoses, and had normal or corrected-to-normal vision. Informed consent approved by a local ethics committee was obtained prior to the study.

Stimuli and procedure

The stimuli consisted of 64 color photos of 16 Asian (8 females) and 16 Caucasian faces (8 females) with pain or neutral expressions, which were adopted from our previous study (Sheng and Han, 2012). Emotional intensity, attractiveness and luminance of Asian and Caucasian faces were matched (see Sheng and Han, 2012).

Stimuli were presented through an LCD projector onto a rear projection screen, which were viewed with an angled mirror positioned on the head-coil. Each photo was presented at the center of a gray background, subtending a visual angle of 4.0° × 5.0° at a viewing distance of 100 cm. A mixed design was used. Each participant completed eight functional scans. Each scan consisted of 4 blocks of trials and participants conducted race judgments (Asian or Caucasian) in 2 blocks of trials but pain judgments (pain or neutral expression) in another 2 blocks of trials. During race judgments participants were asked to identify race of each face (Asian vs. Caucasian) while ignoring facial expressions. During pain judgments participants were asked to identify facial expression of each face (pain vs. neutral) while ignoring its race. Instructions emphasized both speed and accuracy. Each block started with a 4 s prompt screen with an instruction to define a judgment task, followed by 8 trials. On each trial an Asian or Caucasian face with pain or neutral expressions was presented with a duration of 2 s, which was followed by a cross fixation with a duration of 2, 4, 6 or 8 s. Participants responded to each stimulus by a button press using the left and right index fingers. The stimuli in each block and 4 blocks in each scan were presented in a random order. The association between response buttons and stimulus categories (Asian vs. Caucasian or pain vs. neutral expression) was counterbalanced across participants.

After scanning, participants were asked to rate pain intensity of each face and subjective feeling of self-unpleasantness induced by each face on an 11 point Likert scale (0 = not at all painful or unpleasant, 10 = extremely painful or unpleasant). Participants completed the Interpersonal Reactivity Index (IRI) that includes two cognitive subscales (Perspective Taking and Fantasy) and two affective subscales (Empathic Concern and Personal Distress) (Davis, 1996) to assess their trait empathy. Participants were also asked to rate the likability of each face (0 = not at all, 10 = very strong) in order to assess their explicit attitude toward racial in-group/out-group faces. In addition, participants were required to perform a race version of the Implicit Association Test (IAT; Greenwald et al., 1998) using another set of Asian and Caucasian faces with neutral expressions. The participants categorized Asian faces/positive words with one key and Caucasian faces/negative words with another key in two blocks and Asian faces/negative words with one key and Caucasian faces/positive words with another key in another two blocks. The difference of response latencies between the two types of blocks were calculated as an index of racial bias in attitude, namely D score (Greenwald et al., 2003). A D score