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Physical coldness enhances racial in-group bias in empathy: Electrophysiological evidence

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ABSTRACT

Empathy for others' pain plays a key role in prosocial behavior and is influenced by intergroup relationships. Increasing evidence suggests greater empathy for racial in-group than out-group individuals' pain and the racial in-group bias undergoes sociocultural and biological influences. The present study further investigated whether and how physical environments influence racial in-group bias in empathy by testing the hypothesis that sensory experiences of physical coldness versus warmth enhance differential empathic neural responses to racial in-group vs. out-group individuals' suffering. We recorded event-related brain potentials to painful versus neutral expressions of same-race and other-race faces when participants held a cold or warm pack. We found that brain activity in the N2 (200–340 ms) and P3 (400–600 ms) time windows over the frontal/central region was positively shifted by painful (vs. neutral) expressions. Moreover, the N2/P3 empathic neural responses were significantly larger for same-race than other-race faces in the cold but not in the warm condition. Moreover, subjective ratings of different temperatures in the cold vs. warm conditions predicted larger changes of racial in-group bias in empathic neural responses in the N2 time window. Our findings suggest that sensory experiences of physical coldness can strengthen emotional resonance with same-race individuals.

1. Introduction

Racial in-group favoritism in behavioral tendency (e.g., intention to help members of one's own group more than members of other groups) can be observed in real life situations and has been identified in empirical psychological research. For instance, it was found that individuals reported greater altruistic motivation toward same-race compared to other-race individuals during judicial decisions and clinical pain treatments and the racial in-group favoritism in behavioral tendency was associated with better sharing of racial in-group members' emotional states (Drwecki et al., 2011; Johnson et al., 2002).

The behavioral findings led to increasing interests in brain imaging research to reveal whether and how the brain activity underlying emotional understanding and sharing (i.e., empathy) is modulated by racial intergroup relationships between observers and targets. An early functional magnetic resonance imaging (fMRI) study reported brain imaging evidence of racial in-group bias in empathic neural responses by showing that the anterior cingulate cortex responded more strongly to perceived painful stimulations applied to same-race than other-race individuals (Xu et al., 2009). Subsequent studies also revealed racial in-group bias in empathic neural responses in the sensorimotor cortex (Avenanti et al., 2010), dorsal medial prefrontal cortex (Mathur et al., 2010; Cheon et al., 2011), anterior insula (Azevedo et al., 2013; Sheng et al., 2014) and temporoparietal junction (Cheon et al., 2011). Event-related potentials (ERPs) research also revealed differential neural responses over the frontal/central regions to same-race and other-race individuals' pain as early as 120 ms after stimulus onset (Sheng and Han, 2012; Sheng et al., 2013, 2016; Han et al., 2016; Contreras-Huerta et al., 2014; Sessa et al., 2014). These brain imaging findings demonstrate that racial in-group bias in empathy occurs during the early stage of neural processes of others' suffering and in multiple brain regions involved in social cognition and emotion.

Because of the novel social significance of the brain imaging findings of racial in-group bias in empathy, recent research has focused on sociocultural and biological mechanisms involved in racial in-group bias in empathy. For example, an ERP study found that changing intergroup relationships by including other-race individuals into one's own team for competition reduced the racial in-group bias in empathy

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by enhancing neural responses to other-race individuals' pain (Sheng and Han, 2012). An fMRI study showed that priming a specific cultural trait (e.g., independence) can decrease racial in-group bias in empathic neural responses in the cingulate and insula (Wang et al., 2015). People with long-term life experiences with other-race individuals during development showed comparable empathic neural responses in the cingulate to perceived pain of same-race and other-race individuals (Zuo and Han, 2013). These findings indicate that social relationship and sociocultural experiences contribute to the differential empathic neural responses to same-race and other-race individuals' pain.

Other studies have revealed biological mechanisms underlying racial in-group bias in empathic neural responses. For instance, by examining repetition suppression of ERP amplitudes to painful expressions, Sheng et al. (2016) showed that neural responses to painful expression of a target face at 120–180 ms (P2) over the central/frontal region was decreased by a preceding face with pain expression when the two faces were of the same race but not different races, suggesting that distinct neuronal populations are engaged in coding painful expressions of same-race and other-race faces. Sheng et al. (2013) also found that intranasal administration of oxytocin selectively increased the P2 amplitudes to same-race but not other-race painful expressions, suggesting engagement of different neural transmitters in the processing of same-race and other-race individuals' pain. A recent fMRI study further revealed greater racial in-group bias in empathic neural responses in the anterior cingulate in G compared with A allele carriers of oxytocin receptor gene polymorphism rs53576 (Luo et al., 2015). Together these findings suggest that racial in-group bias in empathic neural responses is possibly mediated by multiple level biological mechanisms.

While the aforementioned brain imaging findings suggest sociocultural and biological underpinnings of racial in-group bias in empathic neural responses, it remains unclear whether and how physical environments influence the neural correlates of racial in-group bias in empathy. It has been proposed that an inclement environment with scarce resources threatens human survival and demands increased in-group favoritism (Brewer, 1979). In line with this proposal, a cross-culture study of 116 nations that examined inhabitants' cultural adaptations to climate-based demands and wealth-based resources found that inhabitants in lower-income countries reported greater indices of in-group favoritism such as compatriotism, nepotism, and familism when they had to cope with harsher climates (Van de Vliert, 2011). Laboratory studies also reported that physical coldness compared to warmth increased interpersonal distance (Bargh and Shalev, 2012), which was associated with psychological distance (e.g., Wang and Yao, 2016), and diminished prosocial behavior (Williams and Bargh, 2008). Because empathy has been supposed to be a proximate mechanism of prosocial behavior (Batson et al., 1987; De Waal, 2008; Batson, 2011; Decety et al., 2016) and empathic neural responses can predict altruistic behavior (Hein et al., 2010; Ma et al., 2011), one may hypothesize that an inclement environment that demands in-group favoritism for individuals' survival may increase racial in-group bias in empathic neural responses. In consistent with this hypothesis we recently found that reminding one's own death, which may occur in an inclement environment, increased racial in-group bias in empathic neural responses in multiple brain regions (Li et al., 2015). However, this study did not directly test how harsh physical environments influence racial in-group bias in empathic neural responses. It is likely that sensory experiences in a cold environment may enhance racial in-group bias in empathic neural responses relative to sensory experiences in a warm environment.

The present study tested this hypothesis by recording ERPs from Chinese healthy adults while they perceived Asian and Caucasian faces with painful or neutral expressions. Sheng and Han (2012) found that, during judgments of race identity of faces, the amplitude of a frontal positive activity at 128–188 ms (P2) was enlarged by painful compared to neutral expressions and this effect was stronger for same-race than other-race faces. A following negative activity at 200–300 ms (N2) showed similar racial in-group bias in neural responses to painful expression. However, the racial in-group bias in empathic neural responses in the P2/N2 time windows was eliminated (i.e., participants showed similar empathic neural responses to same-race and other-race faces) during judgments on emotional states of each individual's face. Therefore, the pattern of neural responses to painful versus neutral expressions during pain judgments provides a baseline for testing whether cold compared to warm experiences can increase the racial in-group bias in empathic neural responses. We asked participants to hold a cold or warm pack to generate cold and warm experiences while ERPs to painful or neutral expressions of same-race (i.e., Asian) and other-race (i.e., Caucasian) faces were recorded. Because racial bias in implicit attitudes predicted weakened empathic reactivity to racial out-group members' pain (Avenanti et al., 2010), we also measured participants' implicit attitudes toward racial in-group and out-group faces using the Implicit Association Test (Greenwald et al., 1998). This allowed us to assess whether the influences of cold versus warm experiences on racial in-group bias in empathy were constrained by individuals' social attitudes toward same-race and other-race people.

2. Methods

2.1. Participants

Forty Chinese male adults aged 18–28 years (M = 21.55, SD = 2.56) participated in this study as paid volunteers. The exclusion criteria included self-reported medical or psychiatric illness and use of medication. All participants were right-handed, and had normal or corrected-to-normal vision. Informed consent was obtained prior to participation. This study was approved by a local ethics committee. The sample size was determined based on our previous research (Sheng and Han, 2012) that showed robust evidence for racial in-group bias in ERPs results.

2.2. Stimuli and procedure

The stimuli consisted of photos of 32 face photos from 16 Asian models and 32 face photos from 16 Caucasian models and were adopted from our previous work (Sheng and Han, 2012). Each model contributed 2 face images with neural and painful expressions, respectively. Emotional intensity, facial attractiveness, and luminance levels were matched between Asian and Caucasian faces (Sheng and Han, 2012). During electroencephalograph (EEG) recording, each face was displayed for 200 ms in the center of a gray background with a visual angle of $3.8^{\circ} \times 4.7^{\circ}$ (width × height: 7.94 × 9.92 cm) at a viewing distance of 120 cm. The interstimulus intervals consisted of a fixation cross with a duration that randomly varied between 800 and 1400 ms. Participants held a cold pack of 6 °C using the left hand in the cold condition but a warm pack of 39 °C in the warm condition. In the control condition participants put their left hand on a handrail at room temperature (25 °C). There was a 3-min break between the warm, cold and control conditions and the order of the three conditions was counterbalanced across participants. Participants completed 12 EEG blocks during the experiment. There were 4 blocks of 128 trials in the cold, warm and control conditions, respectively. Each photo was presented twice in a random order in each block. Participants made judgments on expression of each face (painful versus neutral) with a button press using the right index and middle fingers.

After the EEG recording, participants rated the intensity of the pain portrayed by each face and their subjective ratings of unpleasantness induced by each face on a 9-point Likert scale. Participants were also asked to rate how warm/cold they felt in the warm/cold conditions on a 11-point Likert scale as manipulation check (with 0 = very cold , 10 = very warm). Differential sensory feelings in the cold and warm conditions were indexed by the difference in rating scores between the cold and warm conditions. After EEG recording, participants completed