ORIGINAL ARTICLE

Cultural experiences reduce racial bias in neural responses to others' suffering

Xiangyu Zuo · Shihui Han

Abstract   Recent neuroimaging research has shown increased neural activity in adults in response to perceived pain in same-race versus other-race individuals. Moreover, manipulations of cognitive strategies and intergroup relationships in laboratory can significantly reduce the racial bias in empathic neural responses by increasing the neural activity to perceived pain in other-race individuals. The current study further investigated whether real-life cultural experiences with other-race individuals can reduce the racial bias in empathic neural responses to others' suffering. Using functional magnetic resonance imaging, we scanned 20 Chinese adults who were brought up in Western countries (United States, United Kingdom, and Canada) where Caucasians consist of the majority of population. Participants viewed video clips in which either Asian or Caucasian models received painful or non-painful stimulations. We found that the neural activity in the pain matrix including the anterior cingulate cortex, anterior insula, inferior frontal cortex and somatosensory cortex was significantly increased in response to painful versus non-painful stimuli applied to both Asian and Caucasian models. Moreover, these empathic neural responses to Asian and Caucasian models did not differ significantly and were positively correlated with each other. Our results indicate that cultural experiences with racial out-group members may increase the neural responses to the suffering of other-race individuals and thus reduce the racial bias in empathy.

Keywords   Empathy · fMRI · Racial bias · Cingulate · Insula

X. Zuo · S. Han (✉)
Department of Psychology, Peking University, 5 Yiheyuan Road,
Beijing 100871, People's Republic of China
e-mail: shan@pku.edu.cn

X. Zuo
e-mail: zuoxiangyu.pku@gmail.com

Introduction

Social interactions are profoundly different when occurring among members of one social group and between members of different social groups. From the evolution perspective, cooperation often takes place between in-group members in order to enhance individual and/or group benefits, whereas competition often occurs against out-group members to protect group territories and benefits (e.g., Knauft 1991). Different kinds of social interactions within in-group members and between members from different groups may give rise to specific psychological and neural processes of in-group and out-group members. This has been supported by recent studies of empathy.

Empathy refers to the ability to understand and share emotional states of conspecific others. Empathy for others' suffering plays an important role in prosocial behavior (Batson 1998; de Waal 2008). However, empathy for other's pain is strongly shaped by intergroup relationships between a perceiver and a target person. In a study that examined how defendant race and empathetic induction affect a subsequent juror decision-making task, Johnson et al. (2002) asked White university students to read a passage involving a Black or a White defendant in a criminal case. Participants were then induced to feel empathy for the defendant and to make punishment judgments. It was found that participants reported greater empathy for and assigned more lenient punishments to the White than Black defendant. A recent research also found that pro-white empathy biases to patients' pain expressions in white students and nursing professionals predicted their pro-white pain treatment biases (Drwecki et al. 2011). However, participants engaged in an empathy-inducing, perspective-taking intervention significantly reduced pain treatment bias.

Consistent with these behavioral findings, recent brain imaging studies have shown neuroscience evidence for the racial bias in empathy for others' suffering. Xu et al. (2009) scanned Chinese and Caucasian participants, using functional magnetic resonance imaging (fMRI), while they perceived video clips showing Asian or Caucasian models who received painful (needle penetration) versus non-painful (Q-tip touch) stimulation. It was found that, while painful stimulations applied to racial in-group faces induced increased activations in the anterior cingulate cortex (ACC) and inferior frontal/insula cortex in both Caucasian and Chinese participants, the empathic neural response in the ACC decreased significantly when participants viewed other-race models. This racial bias in empathic neural responses was also observed when participants perceived pain versus neutral expressions in recent event-related brain potential (ERP) studies (Sheng and Han 2012; Sheng et al. 2013). A frontal/central activity at 128–188 ms (P2) was of larger amplitude to pain versus neutral expressions and the P2 empathic responses were significantly reduced in response to racial out-group faces compared to racial in-group faces. Avenanti et al. (2010) also found that motor evoked potentials were reduced by viewing painful stimulation applied to racial in-group but not out-group individuals in both white and black participants. These findings indicate that the neural activity engaged in both affective sharing and sensorimotor resonance is shaped by race-based social group relationships. Mathur et al. (2010) showed that the increased

medial prefrontal activity to pain expressed by racial in-group versus out-group members predicted altruistic motivation for racial in-group members, suggesting an association between the racial bias in empathic neural responses and prosocial behavior.

However, the racial bias in empathic neural responses is not inevitable. Sheng and Han (2012) showed that manipulations of both cognitive strategies and intergroup relationships can reduce the racial bias in empathic neural responses. They found that either asking participants to pay attention to the observed individual's feelings of pain or including other-race individuals in one's own team for competitions significantly reduced the racial bias in empathy by increasing neural responses to pain expressions in other-race faces. Sheng and Han (2012) argued that the racial bias in empathy occurs due to that an other-race face is perceived as a symbol of a social group rather than an individual person. The manipulations of both cognitive strategies and intergroup relationships enhanced the individuated processing of persons and thus increased empathic neural responses to other-race individuals. If this proposal is correct, we would expect that real-life experiences such as living in a society where other-race individuals consist of the majority may also reduce the racial bias in empathic neural responses because daily experiences require dealing with each individual of other-race population and thus enhance the individuated processing of other-race people.

The current study tested this hypothesis by scanning Chinese adults who were either born in or immigrated to the Western countries at an early age. These participants were brought up and received education in the Western countries. Thus, relative to the participants in the previous research (Xu et al. 2009; Sheng and Han 2012) who were born and brought up in China, participants in the current work had much more experiences with Caucasian individuals, which then might lead to individuated processing of Caucasian individuals. Therefore, we would expect increased empathic neural responses to Caucasian models and similar empathic neural responses to pain stimulation applied to Asian and Caucasian models in these participants.

Methods

Participants

Twenty young Chinese (twelve females, aged between 18 and 32 years, Mean $\pm D = 23.3 \pm 3.39$) participated in this study as paid volunteers. Seven participants were born in China and emigrated to the United States or Canada at an early age between 1 and 9 years (Mean $\pm$ SD = 5.1 $\pm$ 2.6). Other participants were born and brought up in the United States or United Kingdom. All participants were right-handed, had normal or corrected-to-normal vision, and reported no neurological history. Informed consent was obtained prior to scanning. This study was approved by a local ethics committee.

Stimuli and procedure

These were the same as those in our previous study (Xu et al. 2009). We used 48 video clips showing faces of six Chinese (3 males) and six Caucasian models (3 males). Each clip, subtending a visual angle of $21° \times 17°$ (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 applied to the left or right cheeks. 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 followed by a fixation of 12 s. After each video clip, participants were instructed to judge whether or not the model was feeling pain by pressing a button using the right index or middle finger.

After fMRI scanning, participants were shown half of the video clips again and were asked to rate the pain intensity felt by the model ("How painful do you think the model feels?") and the unpleasantness felt by the onlooker ("How unpleasant do you feel when observing the video clip?") on an 11 point Likert-type scale (0 = not at all painful or unpleasant, 10 = extremely painful or unpleasant). Participants completed the Multigroup Ethnic Identity Measure (Phinney 1992) to assess their attitudes of ethnic identity. The degree of endorsement of individualistic and collectivistic values was estimated using a 7-point Likert-type scale (Triandis and Gelfand 1998). The independent and interdependent self-construal was measured using the Self-Construal Scale (Singelis 1994). Individual differences in empathy ability were measured using the Interpersonal Reactivity Index (Davis 1983). Participants' identification with Western culture was assessed using Suinn–Lew Asian Self-identity Acculturation Scale (Suinn et al. 1992).

fMRI acquisition and analysis

A GE 3-T scanner with a standard head coil was used for this study at the Peking University First Hospital. A standard head coil was used with thirty-two transverse slices of functional images covered the whole brain. The pulse sequence used for anatomical images was $256 \times 256 \times 128$ matrix with a spatial resolution of $0.93 \times 0.938 \times 1.4$ mm, repetition time (TR) = 7.4 ms, inversion time (TI) = 450 ms, echo time (TE) = 3.0 ms, flip angle = 20°. Functional images were acquired with a gradient-echo echo-planar pulse sequence [$64 \times 64 \times 32$ matrix with a spatial resolution of $3.75 \times 3.75 \times 4$ mm, TR = 3000 ms, TE = 30 ms, field of view (FOV) = 24×24 cm, flip angle = 90°].

SPM8 (the Wellcome Trust Centre for Neuroimaging, London, United Kingdom) was used for fMRI data analysis. The functional images were corrected for differences in acquisition time between slices for each whole-brain volume and realigned within and across runs to correct for head movement. The anatomical image was co-registered with the mean functional image produced during the process of realignment. All images were normalized to a $2 \times 2 \times 2$ mm^3 Montreal

Neurological Institute (MNI) template. Functional images were spatially smoothed using a Gaussian filter with the full-width/half-maximum parameter (FWHM) set to 8 mm and temporally filtered using a cut-off of 128 s. The event-related neural activity was modeled using a canonical hemodynamic response function.

We first conducted ROI analyses to test our hypothesis. The five ROIs defined here were drawn from a recent meta-analysis that identified brain regions associated with empathy for pain (Fan et al. 2011). These include the right insula/inferior frontal gyrus (38 24 −2), left insula/inferior frontal gyrus (−36 16 2), ACC (−2 24 38), left supplementary motor area (SMA) (−8 12 48) and right SMA (6 8 60). Parameter estimates of signal intensity were calculated from 5-mm radius spheres centered at these coordinates using MarsBaR 0.43. The signal intensity from each brain region was then subjected to a repeated-measures analysis of variance (ANOVA) with Pain (painful vs. non-painful stimuli) and Race (Asian vs. Caucasian models) as within-subjects variables.

Whole-brain statistical parametric mapping analyses were performed to further examine neural responses to perceived pain in others. 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. non-painful stimulation) was calculated to define empathy specific neural activations to Asian and Caucasian models, respectively. Random effect analyses were then conducted based on statistical parameter maps from each individual participant to allow population inference. Whole-brain statistical parametric mapping analyses were calculated to examine racial in-group bias in empathy by calculating the contrast 1 −1 −1 1 (needle penetration applied to Asian faces, Q-tip applied to Asian faces, needle penetration applied to Caucasian faces, Q-tip applied to Caucasian faces). We also conducted a conjunction analysis to examine overlapped neural responses to perceived pain in Asian and Caucasian models. Given the prior hypothesis of brain activation related to empathy, significant activations were defined using a voxel threshold of $P < 0.001$ and a spatial extent threshold of $k = 50$.

Result

Behavioral results

Reaction times to pain judgments on painful and non-painful stimuli were subjected to a 2 (Pain: painful vs. non-painful stimuli) × 2 (Race: Asian vs. Caucasian models) ANOVA but did not show any significant effect (Asian faces in painful condition: 1,324 ms; Asian faces in non-painful condition: 1,270 ms; Caucasian faces in painful condition: 1,269 ms; Caucasian faces in non-painful condition: 1,291 ms, ps > 0.05). The response accuracy to identify painful and non-painful stimuli was 78.2 % for Chinese models and 76.7 % for Caucasian models [$t(19) = 1.391, P = 0.172$].

Participants rated higher pain intensity and self-unpleasantness for painful than non-painful stimuli [$F(1,19) = 29.617$ and 36.282, ps < 0.001, see Table 1]. The

main effect of Race on these ratings was not significant [$F(1,19) = 0.193$ and 1.614, ps > 0.1]. However, there were significant interactions of Pain × Race [$F(1,19) = 13.035$ and 11.569, ps < 0.005]. Post hoc analysis revealed that the rating score of pain intensity of painful stimuli was significantly higher for Asian than Caucasian models [$t(19) = 2.887$, $P = 0.009$] whereas the rating scores of pain intensity of non-painful stimuli did not differ significantly between Asian and Caucasian models ($P > 0.1$). Similarly, the rating score of self-unpleasantness of painful stimuli was significantly higher for Asian than Caucasian models [$t(19) = 2.609$, $P = 0.017$] whereas the rating scores of self-unpleasantness of non-painful stimuli did not differ significantly between Asian and Caucasian models ($P > 0.1$).

Participants' rating scores of individualism and collectivism did not differ significantly [4.82 ± 0.83 vs. 4.78 ± 0.54, $t(19) = 0.239$, $P = 0.814$]. However, they reported greater independent self-construal compared to interdependent self-construal [5.27 ± 0.52 vs. 4.27 ± 0.49, $t(19) = 7.512$, $P < 0.001$]. Participants rated more than the median value on Multi-group Ethnic Identity Measure [3.08 ± 0.49 vs. 2.5, $t(19) = 5.344$, $P < 0.001$], suggesting their identification with Asian ethnicity. However, their rating scores of the Suinn–Lew Asian Self-identity Acculturation Scale were marginally larger than 3 [3.13 ± 0.32, $t(19) = 1,818$, $P = 0.085$], suggesting their identification with Western cultures. Rating scores of the subscales of empathy were 21.05 ± 3.72 (empathic concern), 16.35 ± 5.56 (perspective-taking), 16.40 ± 5.58 (fantasy) and 10.90 ± 3.97 (personal distress), respectively.

fMRI results

We first conducted 2 (Pain: painful vs. non-painful stimuli) × 2 (Race: Asian vs. Caucasian models) ANOVAs of signal intensity in the 5 ROIs. This revealed significant main effect of Pain in the right insula/inferior frontal gyrus [$F(1,19) = 12.044$, $P = 0.003$], left insula/inferior frontal gyrus [$F(1,19) = 16.367$, $P = 0.001$], ACC [$F(1,19) = 7.674$, $P = 0.012$], left SMA [$F(1,19) = 13.000$, $P = 0.002$], and right SMA [$F(1,19) = 23.435$, $P < 0.001$; Fig. 1]. Painful stimuli elicited significantly larger BOLD responses compared to non-painful stimuli in these brain regions. There was a significant main effect of Race in the ACC [$F(1,19) = 5.588$, $P = 0.029$], suggesting greater neural responses to Asian than Caucasian models. However, the interaction between Pain and Race was not significant in any of these brain regions (ps > 0.05), indicating comparable empathic neural responses to Asian and Caucasian faces.

**Table 1** Pain intensity and self-unpleasantness rating scores (SD) in post-scanning session

Stimuli	Asian face		Caucasian face	
	Needle	Q-tip	Needle	Q-tip
Pain intensity	3.39 (2.36)	0.16 (0.39)	3.03 (2.21)	0.40 (1.07)
Self-unpleasant	4.16 (2.73)	0.30 (0.77)	3.62 (2.44)	0.51 (1.12)
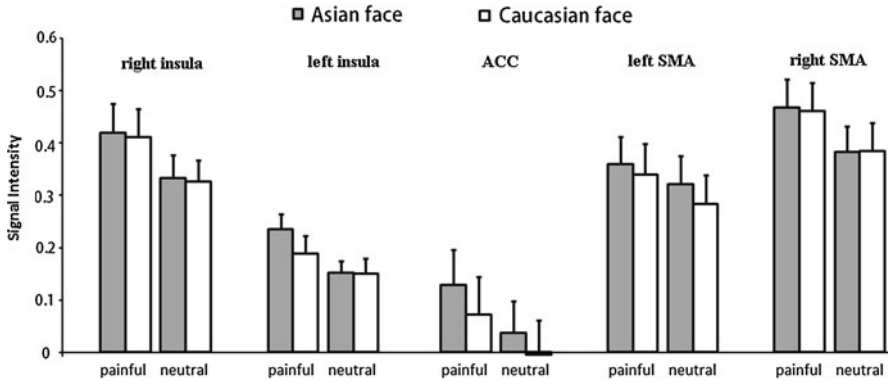
Fig. 1 Illustration of the results of ROI analyses. Viewing video clips of both Asian and Caucasian models receiving painful versus non-painful stimulation induced stronger activity in the ACC, bilateral insula and SMA

Figure 2 illustrates the results of the whole brain analysis. This further revealed that painful versus non-painful stimuli applied to Asian models significantly activated the mid ACC (2 10 26, $k = 332$, $Z = 4.15$), left insula (-30 20 -2, $k = 258$, $Z = 4.13$), right SII (60 -22 34, $k = 654$, $Z = 4.11$), left SII (-64 -24 34, $k = 339$, $Z = 4.09$), right superior parietal cortex (34 -58 66, $k = 228$, $Z = 4.06$) and cerebellum (6 -64 -34, $k = 119$, $Z = 4.10$). Similarly, painful versus non-painful stimuli applied to Caucasian models significantly activated the ACC and SMA (4 -2 38, $k = 917$, $Z = 4.49$), right insula (34 16 -6, $k = 78$, $Z = 3.52$), right inferior frontal cortex (56 6 18, $k = 385$, $Z = 4.47$), right SII (54 -28 32, $k = 385$, $Z = 4.05$), left SII (-64 -28 32, $k = 400$, $Z = 4.83$), and right inferior parietal cortex (34 -46 44, $k = 57$, $Z = 3.93$).

The conjunction analysis of painful versus non-painful stimuli applied to Asian and Caucasian models showed common activations in the left SII (-64 -26 32, $k = 298$, $Z = 4.68$), right SII (60 -24 36, $k = 404$, $Z = 4.36$), and ACC (2 12 26, $k = 314$, $Z = 4.27$). Activations were also observed in the right insula (36 16 -8, $k = 312$, $Z = 3.30$) and left insula (-32 22 -4, $k = 137$, $Z = 3.32$) at a lenient
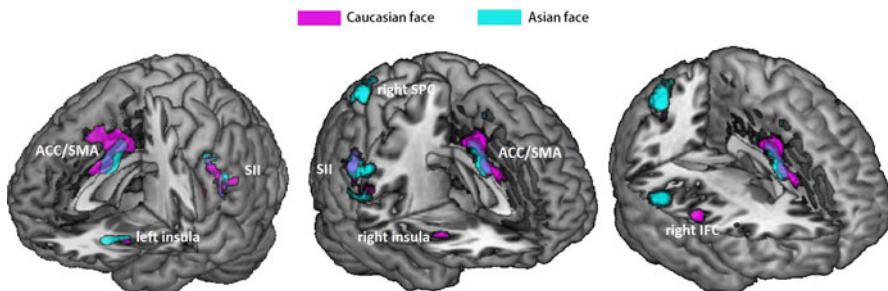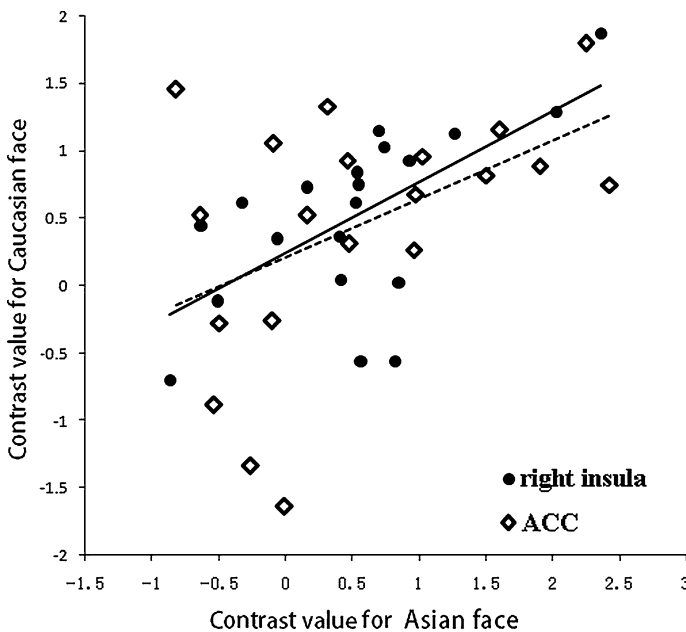

Fig. 2 Illustration of activations in the whole brain analysis. Brain activations to Asian and Caucasian models receiving painful versus non-painful stimulation are shown in *different colors*. (Color figure online)

threshold of $P < 0.005$ (uncorrected) and $k = 100$. However, the interaction analysis did not show any significant difference between Asian and Caucasian models, again suggesting comparable empathic neural responses to racial in-group and out-group members.

Finally, we examined the relationship between neural responses to perceived pain in Asian and Caucasian models. We found that neural responses to painful versus non-painful stimuli applied to Asian models in the right anterior insula ($r = 0.627$, $P = 0.003$) and middle cingulate cortex were significantly positively correlated with those associated with Caucasian models ($r = 0.627$ and 0.466, ps < 0.05; Fig. 3). Individuals with greater empathic neural responses in these brain regions to Asian models also showed greater empathic neural responses in these brain regions to Caucasian models.

Discussion

The present study examined the hypothesis that long-term experiences with Caucasian individuals may increase empathic neural responses to painful stimulations to Caucasian models in Chinese adults and thus reduce the racial bias in empathic neural responses. Previous fMRI studies of empathy for pain have shown that perceiving painful versus non-painful stimulation to others' body parts (Singer et al. 2004; Jackson et al. 2005; Gu and Han 2007a; Gu et al. 2010; Ma et al. 2011)

Fig. 3 Illustration of the correlation between brain activations in the right insula and ACC to Asian and Caucasian models receiving painful versus non-painful stimulation

or perceiving pain versus neutral expressions (Saarela et al. 2007; Han et al. 2009) activated the pain matrix involved in the first hand pain experience including the ACC, SMA, SII, insula and inferior frontal cortex. Rating pain intensity of painful actions depicted in words also induced activations in the SII and insula (Gu and Han 2007b). The results of the current study replicated the previous findings by showing that perceiving painful versus non-painful stimulation applied to others' faces increased activity in the pain matrix. The behavioral measurements are consistent with the fMRI results as participants reported greater perceived pain intensity and greater subjective feelings of unpleasantness when perceiving painful compared to non-painful stimuli.

Moreover, we found that our participants showed significant empathic neural responses to the suffering of both same-race and other-race individuals in the brain regions involved in empathy. The interaction analysis did not reveal significant difference in empathic neural responses to Asian and Caucasian models. In addition, the empathic neural responses to Asian models were positively correlated with those to Caucasian models. These results are different from the previous work that showed significantly reduced empathic neural responses in the ACC and sensorymotor cortex to other-race than same-race faces (Xu et al. 2009; Avenanti et al. 2010; Sheng and Han 2012). In particular, Chinese participants in Xu et al. (2009) and in Sheng and Han (2012) showed reduced empathic neural responses to Caucasian than Chinese faces in the ACC. Therefore, unlike the Chinese participants in the previous studies, Chinese participants in the current work showed comparable empathic neural responses to the suffering of both same-race and other-race individuals and thus failed to show racial bias in empathic neural responses to the suffering of others. Our results indicate that the racial bias in empathy for pain is not intrinsically determined by one's own race. Participants in the current study reported identification with Asian ethnicity. Thus in both biological and psychological senses, our participants were of the same race (Asian) as those in the previous research (e.g., Xu et al. 2009; Sheng and Han 2012). Nevertheless, this does not necessarily give rise to less empathic neural responses to Caucasian than Asian models. These findings together demonstrate that life experiences with same-race and other-race others are critical for producing and reducing the racial bias in empathy for pain.

The variation of racial bias in empathy as a function of personal experience fits well with the previous studies of racial face recognition. Kelly et al. (2005) found that, while 3-month-old infants showed a significant preference for faces from their own-ethnic group, newborn infants demonstrated no spontaneous preference for faces from either their own- or other-ethnic groups. Thus preferential selectivity based on ethnic differences is learned within the first 3 months of life rather than intrinsically determined by biology. Bar-Haim et al. (2006) examined three groups of 3-month-old infants (Caucasian infants living in a Caucasian environment, African infants living in an African environment, and African infants living in a predominantly Caucasian environment) in a visual preference task. They found that visual preference for African faces was evident in African infants living in an African environment but not in African infants living in a predominantly Caucasian environment. Consistent with the behavioral findings, a recent fMRI research of

childhood and adolescence ranging from 4 to 16 years found that differential amygdala responses to African and European American faces do not emerge until adolescence (Telzer et al. 2013), suggesting that the salience of race is not an innate process but increases across development.

The other-race effect (Meissner and Brigham 2001), a well-known bias in racial face recognition, refers to the fact that adults perform better to discriminate between own-race faces compared to other-race faces. However, the other-race effect is also strongly dependent on one's life experience and social contexts. Sangrigoli and de Schonen (2004) demonstrated that, while 3-month-old Caucasian infants are able to discriminate between own-race faces but not other-race faces, this discrimination bias does not occur to familiar faces, that is, Caucasian infants are able to recognize both own- and other-race familiar faces. The findings indicate that limited experiences with faces from another race can greatly improve the ability to discriminate within other-race face category. Personal life-experience can even reverse the other-race effect. Sangrigoli et al. (2005) found that, while native Korean participants who had been brought up in Korea recognized Asian faces better than Caucasian faces, adults of Korean origin who were adopted by European Caucasian families performed better during recognition of Caucasian faces than Asian faces. The other-race effect may essentially reflect the effect of intergroup relationship on individuated processing of faces. Shriver et al. (2008) found that middle-class White perceivers showed superior recognition for same-race faces when these faces were presented in wealthy but not in impoverished contexts and tended to categorize White faces in impoverished contexts as out-group members.

Together, these findings support the proposal that an other-race face may be perceived as a symbol of a group rather than of an individual because other-race faces are perceived as more psychologically similar to each other relative to same-race faces (Valentine and Endo 1992; Vizioli et al. 2010). Moreover, a 'symbolized' other-race face may lead to lack of reference to the individual's personal situation (Kinder and Sears 1981) and thus weaken empathy for other-race individuals. The findings of previous research and the current study indicate that, real-life experiences with other-race individuals may enhance individuating processes. The enhanced individuating process of other-race faces not only facilitate recognition of other-race faces but enhance emotional sharing with other-race individuals as well.

It should be noted that subjective reports of empathic feelings do not always match brain imaging results. In Xu et al. (2009) participants showed racial bias in empathic ACC activity but did not show racial bias in self-reported empathic feelings. In the current work, participants showed comparable empathic neural responses to same-race and other-race models but reported greater feelings of pain intensity and self-unpleasantness in association with painful stimulations applied to same-race models. One possible account is that self-report empathic feelings are influenced by social desire more strongly than empathic neural responses. Chinese adults who were born in and grew up in China do not like to show their racial bias toward other-race models whereas Chinese adults who were born in or grew up in Western countries may intend to show their preference for racial in-group members when being tested in China. One may also ask why White and Black participants may show racial bias in empathic neural responses even when living in Western

countries (Avenanti et al. 2010; Mathur et al. 2010). It is likely that, because race is used to sort people into not only ethnic groups according to perceived physical characteristics but also social classes based on their socioeconomic status (Moya and Markus 2011), the observed racial bias in empathic neural responses in White and Black participants in Western countries may arise from categorization of White and Black individuals based on their social status, which apparently cannot be easily eliminated by life experiences with other-race individuals.

Recent neuroimaging studies have shown increasing evidence that sociocultural experiences strongly modulate neural mechanisms to social cognition (Ambady and Bharucha 2009; Ames and Fiske 2010; Chiao and Bebko 2011; Han and Northoff 2008, 2009; Kitayama and Uskul 2011; Park and Gutchess 2006; Park and Huang 2010; Rule et al. 2013). The findings of the effect of real-life experiences on empathic neural responses to others' suffering give additional evidence for the biosocial nature of the human brain (Han et al. 2013). The brain is functionally organized so as to support efficient social behavior. Increased empathic neural responses to the suffering of Caucasians obviously help a Chinese to take appropriate action quickly in a society where Caucasians consist of the majority of the population. Our findings are of novel social significance by showing that real-life experiences can improve the understanding and sharing the emotional states of other-race individuals. The current work raised interesting questions regarding the relationship between life experience and the racial bias in empathy such as how long one's life experiences are necessary for enhancing empathy for other-race individuals. These can be addressed in future research.

References

Ambady, N., & Bharucha, J. (2009). Culture and the brain. *Current Directions in Psychological Science, 18*, 342–345.

Ames, D. L., & Fiske, S. T. (2010). Cultural neuroscience. *Asian Journal of Social Psychology, 13*, 72–82.

Avenanti, A., Sirigu, A., & Aglioti, S. M. (2010). Racial bias reduces empathic sensorimotor resonance with other-race pain. *Current Biology, 20*, 1018–1022.

Bar-Haim, Y., Ziv, T., Lamy, D., & Hodes, R. M. (2006). Nature and nurture in own-race face processing. *Psychological Science, 17*, 159–163.

Batson, C. D. (1998). Altruism and prosocial behavior. In D. T. Gilbert, S. Fisk, & L. Gardner (Eds.), *The handbook of social psychology* (pp. 282–316). Boston: McGraw Hill.

Chiao, J. Y., & Bebko, G. M. (2011). Cultural neuroscience of social cognition. In S. Han & E. Pöppel (Eds.), *Culture and neural frames of cognition and communication (on thinking)* (pp. 19–40). Berlin: Springer.

Davis, M. H. (1983). The effects of dispositional empathy on emotional reactions and helping: A multidimensional approach. *Journal of Personality, 51*, 167–184.

de Waal, F. B. (2008). Putting the altruism back into altruism: The evolution of empathy. *Annual Review of Psychology, 59*, 279–300.

Drwecki, B. B., Moore, C. F., Ward, S. E., & Prkachin, K. M. (2011). Reducing racial disparities in pain treatment: The role of empathy and perspective-taking. *Pain, 152*, 1001–1006.

Fan, Y., Duncan, N. W., de Greck, M., & Northoff, G. (2011). Is there a core neural network in empathy? An fMRI based quantitative meta-analysis. *Neuroscience Biobehavioral Review, 35*, 903–911.

Gu, X., & Han, S. (2007a). Attention and reality constraints on the neural processes of empathy for pain. *NeuroImage, 36*, 256–267.

Gu, X., & Han, S. (2007b). Neural substrates underlying evaluation of pain in actions depicted in words. *Behavioural Brain Research, 181*, 218–223.

Gu, X., Liu, X., Guise, K. G., Naidich, T. P., Hof, P. R., & Fan, J. (2010). Functional dissociation of the frontoinsular and anterior cingulate cortices in empathy for pain. *Journal of Neuroscience, 30*, 3739–3744.

Han, S., & Northoff, G. (2008). Culture-sensitive neural substrates of human cognition: A transcultural neuroimaging approach. *Nature Review Neuroscience, 9*, 646–654.

Han, S., & Northoff, G. (2009). Understanding the self: A cultural neuroscience approach. *Progress in Brain Research, 178*, 203–212.

Han, S., Fan, Y., Xu, X., Qin, J., Wu, B., Wang, X., et al. (2009). Empathic neural responses to others' pain are modulated by emotional contexts. *Human Brain Mapping, 30*, 3227–3237.

Han, S., Northoff, G., Vogeley, K., Wexler, B. E., Kitayama, S., & Varnum, M. E. W. (2013). A cultural neuroscience approach to the biosocial nature of the human brain. *Annual Review of Psychology, 64*, 335–359.

Jackson, P. L., Meltzoff, A. N., & Decety, J. (2005). How do we perceive the pain of others? A window into the neural processes involved in empathy. *NeuroImage, 24*, 771–779.

Johnson, J. D., Simmons, C. H., Jordan, A., MacLean, L., Taddei, J., & Thomas, D. (2002). Rodney King and O. J. revisited: The impact of race and defendant empathy induction on judicial decisions. *Journal of Applied Social Psychology, 32*, 208–1223.

Kelly, D. J., Quinn, P. C., Slater, A. M., Lee, K., Gibson, A., Smith, M., et al. (2005). Three-month-olds, but not newborns, prefer own-race faces. *Developmental Science, 8*, F31–F36.

Kinder, D. R., & Sears, D. O. (1981). Prejudice and politics: Symbolic racism versus racial threats to the good life. *Journal of Personality and Social Psychology, 39*, 303–320.

Kitayama, S., & Uskul, A. K. (2011). Culture, mind, and the brain: Current evidence and future directions. *Annual Review of Psychology, 62*, 419–449.

Knauft, B. (1991). Violence and sociality in human evolution. *Current Anthropology, 32*, 391–428.

Ma, Y., Wang, C., & Han, S. (2011). Neural responses to perceived pain in others predict real-life monetary donations in different socioeconomic contexts. *NeuroImage, 57*, 1273–1280.

Mathur, V. A., Harada, T., Lipke, T., & Chiao, J. Y. (2010). Neural basis of extraordinary empathy and altruistic motivation. *NeuroImage, 51*, 1468–1475.

Meissner, C. A., & Brigham, J. C. (2001). Thirty years of investigating the own-race bias in memory for faces: A meta-analytic review. *Psychology, Public Policy, and Law, 7*, 3–35.

Moya, P., & Markus, H. R. (2011). Doing race: A conceptual overview. In H. R. Markus & P. Moya (Eds.), *Doing race: 21 essays for the 21st century* (pp. 1–102). New York: Norton.

Park, D. C., & Gutchess, A. (2006). The cognitive neuroscience of aging and culture. *Current Directions of Psychological Science, 15*, 105–108.

Park, D. C., & Huang, C. M. (2010). Culture wires the brain: A cognitive neuroscience perspective. *Perspectives on Psychological Science, 5*, 391–400.

Phinney, J. (1992). The Multigroup Ethnic Identity Measure: A new scale for use with diverse groups. *Journal of Adolescent Research, 7*, 156–176.

Rule, N. O., Freeman, J. B., & Ambady, N. (2013). Culture in social neuroscience: A review. *Social Neuroscience, 8*, 3–10.

Saarela, M. V., Hlushchuk, Y., Williams, A. C., Schurmann, M., Kalso, E., & Hari, R. (2007). The compassionate brain: humans detect intensity of pain from another's face. *Cerebral Cortex, 17*, 230–237.

Sangrigoli, S., & de Schonen, S. (2004). Recognition of own-race and other-race faces by three-month old infants. *Journal of Child Psychology and Psychiatry, 45*, 1–9.

Sangrigoli, S., Pallier, C., Argenti, A. M., Ventureyra, V. A., & de Schonen, S. (2005). Reversibility of the other-race effect in face recognition during childhood. *Psychological Science, 16*, 440–444.

Sheng, F., & Han, S. (2012). Manipulations of cognitive strategies and intergroup relationships reduce the racial bias in empathic neural responses. *NeuroImage, 61*, 786–797.

Sheng, F., Liu, Y., Zhou, B., Zhou, W., & Han, S. (2013). Oxytocin modulates the racial bias in neural responses to others' suffering. *Biological Psychology, 92*, 380–386.

Shriver, E. R., Young, S. G., Hugenberg, K., Bernstein, M. J., & Lanter, J. R. (2008). Class, race, and the face: Social context modulates the cross-race effect in face recognition. *Personality and Social Psychology Bulletin, 34*, 260–274.

Singelis, T. M. (1994). The measurement of independent and interdependent self-construals. *Personality and Social Psychology Bulletin, 20*, 580–591.

Singer, T., Seymour, B., O'Doherty, J., Kaube, H., Dolan, R. J., & Frith, C. D. (2004). Empathy for pain involves the affective but not sensory components of pain. *Science, 303*, 1157–1162.

Suinn, R. M., Ahuna, C., & Khoo, G. (1992). The Suinn–Lew self-identity acculturation scale: Concurrent and factorial validation. *Educational and Psychological Measurement, 52*, 1041–1046.

Telzer, E. H., Humphreys, K. L., Shapiro, M., & Tottenham, N. (2013). Amygdala sensitivity to race is not present in childhood but emerges over adolescence. *Journal of Cognitive Neuroscience, 25*, 234–244.

Triandis, H. C., & Gelfand, M. (1998). Converging measurement of horizontal and vertical individualism and collectivism. *Journal of Personality and Social Psychology, 74*, 118–128.

Valentine, T., & Endo, M. (1992). Toward an exemplar model of face processing: The effects of race and distinctiveness. *Quart Journal of Experimental Psychology: Human Experimental Psychology, 44*((A)), 161–204.

Vizioli, L., Rousselet, G. A., & Caldara, R. (2010). Neural repetition suppression to identity is abolished by other-race faces. *Proceedings of National Academy of Sciences USA, 107*, 20081–20086.

Xu, X., Zuo, X., Wang, X., & Han, S. (2009). Do you feel my pain? Racial group membership modulates empathic neural responses. *Journal of Neuroscience, 29*, 8525–8529.