

## Chapter 2

# Intergroup Relationship and Empathy for Others' Pain: A Social Neuroscience Approach

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**Abstract** Han reviews the neuroimaging evidence for the brain regions involved in empathy for pain. The implicated regions, the anterior cingulate and anterior insula, overlap with those involved in firsthand pain experiences. However, several factors, including sociocultural variables, can influence empathy toward others' pain states.

Han discusses the evidence of racial bias in feelings of empathy for pain states. Han shows that racial bias in empathy of pain can potentially produce real-world effects like differences in medical treatment between racial groups. Several brain regions are implicated including the anterior cingulate, the supplementary motor cortex, the anterior insula, and the medial prefrontal cortex.

Han concludes by discussing evidence that intercultural experiences can decrease racial bias of empathy of pain. Living in a country with an other-race majority can decrease the racial bias shown for empathy of pain and alter the neural responses to seeing pictures of pain expressions. Han suggests that future research should investigate how educational opportunities can be offered to eliminate racial bias in empathy toward others in pain.

### 2.1 Empathy for Pain and its Neural Correlates

Imagine that you are watching a friend who is cutting a cucumber into pieces to make a salad. She accidentally cuts one of her fingers and shows a pain expression. What would you feel and what would you do in such a situation? You quickly understand that she is feeling pain and may immediately try to find a Band-Aid to cover her finger and console her. Such life experiences illustrate well that we have an ability called *empathy* that engages complicated psychological processes and has

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been associated with prosocial behavior. Psychologists define empathy in many different ways. For example, according to Berger (1987), empathy refers to “the capacity to know emotionally what another is experiencing from within the frame of reference of that other person, the capacity to sample the feelings of another or to put one’s self in another’s shoes.” de Waal (2008) defined empathy as “the capacity to (a) be affected by and share the emotional state of another, (b) assess the reasons for the other’s state, and (c) identify with the other, adopting his or her perspective.” Regardless of subtle differences in the way psychologists define empathy, there are two common components among different definitions of empathy, that is, to understand and share emotional states of others.

How are the psychological processes involved in empathy mediated by the human brain? This issue is critical for understanding of the neurobiological mechanisms of empathy. It is also pivotal for understanding of the human prosocial nature and has important social implications. Empathy for pain provides a good model to study the neural correlates of empathy because most of us have vivid experiences of feeling others’ pain. Neural substrates of empathy for pain have been addressed extensively by recent brain imaging studies (see Fan, Duncan, de Greck, & Northoff, 2011; Lamm, Decety, & Singer, 2011 for review). A common paradigm used in the brain imaging research is to record neural responses to perceived painful or non-painful stimuli applied to others. An early functional magnetic resonance imaging (fMRI) study scanned female subjects while they received painful vs. non-painful stimuli or while they were informed by a visual symbol that their partners were receiving painful vs. non-painful stimuli (Singer et al., 2004). It was found that knowing others in pain activated brain regions such as the anterior cingulate (ACC) and anterior insula and these activations overlapped with those engaged in the firsthand pain experience. The following fMRI studies recorded brain activity in response to static images of body parts (hand or foot) receiving painful vs. non-painful stimulations (Gu & Han, 2007; Jackson, Meltzoff, & Decety, 2005) or painful vs. non-painful facial expressions (Han et al., 2009; Saarela et al., 2007). These studies also found increased activity in the ACC, insula, and somatosensory cortex (SII) in response to perceived pain in others. Moreover, the magnitude of neural activities in specific brain regions (e.g., ACC, Jackson et al., 2005) positively correlated with subjective feelings of the intensity of others’ pain. The findings indicate that the neural activity in the pain matrix that mediates the firsthand pain experience can differentiate between painful and non-painful stimuli applied to others and is associated with one’s own subjective feelings of others’ pain and thus provide evidence for shared neural representation of one’s own pain and others’ pain.

The neural activity underlying empathy for pain may occur quite early during perception of others in pain. Fan and Han (2008) conducted the first event-related potential (ERP) study that examined the time course of empathy for pain. They recorded ERPs from healthy adults while they perceived pictures of hands that were in painful (e.g., being cut by a scissor) or non-painful (holding a scissor) situations and had to judge whether or not models in the pictures were feeling painful. It was found that early neural activity underlying differentiation between painful and non-painful stimuli occurred over the frontal lobe at 140 ms after sensory stimulation.

Painful stimuli elicited a positive shift of the ERP amplitudes compared to non-painful stimuli. A long-latency positive activity over the central–parietal regions also showed increased amplitude to painful vs. non-painful stimuli after 380 ms. Moreover, the mean ERP amplitudes at 140–180 ms were correlated with subjective reports of the degree of perceived pain of others and of self-unpleasantness. Similar results were replicated in the following ERP research (Decety, Yang, & Cheng, 2010; Han, Fan, & Mao, 2008; Li & Han, 2010). Mu, Fan, Mao, and Han (2008) also reported evidence that non-phase-locked neural oscillations are also involved in empathic responses. They showed that, relative to perceiving non-painful stimuli, perceiving painful stimuli applied to others' body parts induced increased theta (3–8 Hz) event-related synchronization (ERS) at 200–500 ms but decreased alpha (9–14 Hz) event-related desynchronization (ERD) at 200–400 ms. In addition, subjective ratings of perceived pain and self-unpleasantness positively correlated with theta band ERS but negatively correlated with alpha band ERD related to painful stimuli, suggesting that theta and alpha oscillations are, respectively, involved in emotional sharing and regulation during empathy for pain.

Taken together, the previous brain imaging studies uncovered neural correlates of empathy for pain by showing that both blood oxygen level-dependent (BOLD) signals and scalp electrical activities can differentiate between perceived painful vs. non-painful stimuli applied to others and painful vs. neutral expressions. In addition, the neural activity elicited by perceived pain in others is associated with subjective feeling of others' pain intensity and of one's own unpleasant feelings. Therefore, from the neuroscience perspective, the brain imaging findings demonstrate that the human brain can understand and share others' painful feelings. Moreover, the insular activity in response to other's suffering predicted how frequently individuals helped the others by enduring physical pain themselves to reduce the other's pain (Hein, Silani, Preuschoff, Batson, & Singer, 2010). Empathy-related activity in the inferior frontal and secondary somatosensory cortices also predicted the amount of monetary donation given to a real charitable organization (Ma, Wang, & Han, 2011). Therefore, the neural correlates of empathy for others' pain may be linked to prosocial behaviors toward other individuals.

However, the neural activity underlying empathy for pain is not invariant. There has been evidence that the neural activity related to empathy for pain is influenced by task demand (Fan & Han, 2008; Gu & Han, 2007), prior knowledge about painful stimuli (Fan & Han, 2008; Gu & Han, 2007), personal experience (Cheng et al., 2007), attitude (Singer et al., 2006), etc. For instance, distracting attention from painful stimuli applied to others or decreasing the reality of perceived painful stimuli reduced empathic neural responses to others' pain (Fan & Han, 2008; Gu & Han, 2007). Personal experiences such as being exposed to painful stimuli frequently (Cheng et al., 2007) and negative attitude toward a target person (Singer et al., 2006) also weakened empathic neural responses. More recently, there has been increasing behavioral and brain imaging evidence that racial social group relationship strongly modulates empathy for others' pain. These findings have important social significance given that empathy provides a proximate mechanism of prosocial behavior (de Waal, 2008). Therefore, this chapter will focus on the variation of empathic

neural responses to others' pain as a function of racial group relationship. These brain imaging findings not only uncover the psychological and neurobiological mechanisms underlying racial bias in empathy for pain but also provide clues for how to reduce the racial bias in empathy. Related social significance of these brain imaging findings is also discussed.

## 2.2 Racial Bias in Empathy and Empathic Neural Responses

A human does not live alone. To be affiliated to a social group makes it possible for a person to accomplish tasks that he cannot do by himself and to get social support from others. Thus, a social group provides a basis for an individual to survive in a human society. Race is "a dynamic set of historically derived and institutionalized ideas and practices that sorts people into ethnic groups according to perceived physical and behavioral human characteristics" (Moya & Markus, 2011). It is common that people quickly categorize others, based on external attributes, such as skin tone and facial and body shapes, into "White," "Black" or "Asian," "Caucasian." Although it is debated whether there are racial differences in psychological tendencies and behavior and whether such differences are biologically determined, race as a sociocultural construction does produce social groups characterized by different values, power, and social status. In addition, racial group membership defines coalitions and alliances during evolution (Cosmides, Tooby, & Kurzban, 2003), and the concept of race "emerges when groups are perceived (a) to pose a threat (political, economic, or cultural) to each other's world view or way of life; and/or (b) to justify the denigration and exploitation (past, current, or future) of, and prejudice toward, other groups" (Moya & Markus, 2011). Thus, race gives a way to quickly categorize others as in-group or out-group members.

In human history, racially defined social groups often fought against each other to compete for natural resources. Imagine that two racial groups are fighting against each other. While a person watches an in-group member being hurt by out-group members during fighting and showing painful expression, he or she may empathize the in-group member's pain and help the victim, given that empathetic emotion evokes altruistic motivation to benefit the person for whom empathy is felt (Batson, 1987, 1991) and provides a proximate mechanism of prosocial behavior in response to another's pain (de Waal, 2008). However, if viewing an out-group member being hurt during fighting similarly induces empathy that provokes altruistic behavior, this would prevent one from further fighting against out-group members. Obviously, this is not the case we see in human history. A soldier usually keeps on fighting against out-group members even when he makes them feel painful and show painful expressions. Therefore, the human brain must evolve a mechanism to bias empathy for pain of in-group rather than out-group members so as to switch between different behaviors toward others' suffering during social group interactions such as fighting.

As race is often used to categorize people into racial in-group members (same-race individuals) and out-group members (other-race individuals), early behavioral

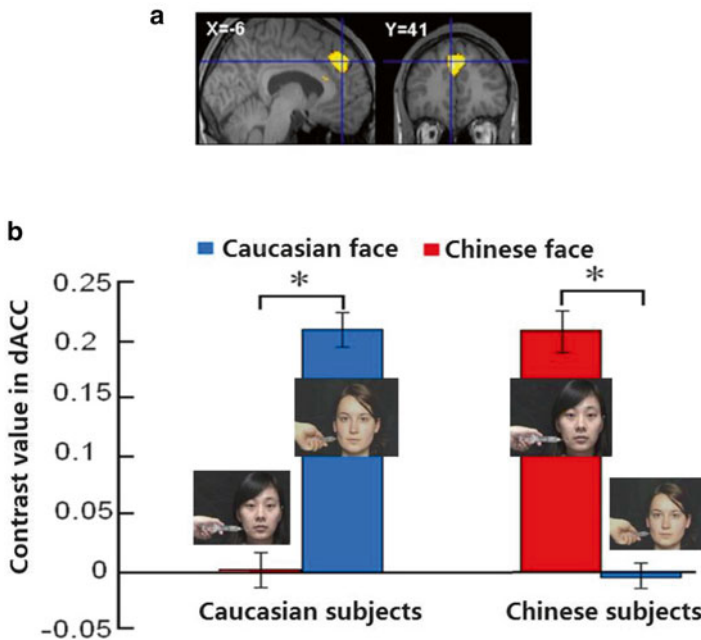
studies tested racial bias in empathy and related social consequences. Johnson and colleagues (2002) first asked Caucasian students to read a passage involving a Black or a White young man who was charged with a criminal act. The participants were induced to feel high empathy (by imagine how the defendant feels while reading the passage) or low empathy (by trying to be objective while reading the passage) for the defendant. Participants then had to answer five questions on a 7-point Likert-type scale that assessed their feelings of sympathy, compassion, warmth, soft-heartedness, and how moved they were. The responses to these five questions were averaged to yield a self-reported empathy score for each participant. Finally, participants were asked to answer two questions on a 7-point Likert scale that assessed their perceptions of the appropriate punishment for the defendant and the attributions regarding the defendant's actions. Johnson et al. reported two findings. First, Caucasian students reported greater feelings of empathy for the White defendant compared to the Black defendant. Second, Caucasian students assigned more lenient sentences to the White defendant relative to the Black defendant. These results suggest a tendency in Caucasian students for enhanced empathy for racial in-group compared to out-group members, and such racial bias in empathy may lead to different social behaviors such as judicial decision making toward racial in-group/out-group members.

Drwecki and colleagues (2011) further investigated racial bias in pain treatment decisions and empathy. They showed college students (all White) and nursing professionals (31 White out of 40) with videos of real Black and White patients' genuine facial expressions of pain. They then asked participants to make pain treatment recommendations using a 4-item treatment questionnaire (e.g., how much "pain medication" and "physical therapy" they would prescribe for each patient). They also measured their empathic reactions to each patient using the Empathic Concern Scale (Batson et al., 1977, 1988; Batson, Early, & Salvarani, 1977). Drwecki et al. found that participants exhibited significant pro-White pain treatment biases by assigning enhanced pain treatment to White than Black patients. Participants also reported higher mean levels of empathy for White patients than Black patients. Moreover, pro-White empathy biases were highly predictive of pro-White pain treatment biases. However, asking participants to imagine how patients' pain affected patients' lives significantly reduced pain treatment bias in comparison to controls.

While these behavioral observations suggest the existence of racial bias in empathy, the neural correlates of racial bias in empathy remain unclear. In particular, given that empathy for pain engages multiple brain regions associated with sensory, affective, and cognitive processes, it is critical to understand which part of the pain matrix involved in empathy for pain is modulated by racial intergroup relationship. We performed the first fMRI study to investigate the neural basis of racial bias in empathy for pain (Xu, Zuo, Wang, & Han, 2009). This study scanned both Chinese and Caucasian healthy college students in Beijing, China, who were matched in age. Caucasian students were from American and European countries. Participants watched video clips showing faces of six Chinese and six Caucasian models. Each clip lasted 3 s and depicted a face with neutral expressions that received either painful (needle penetration) or non-painful (Q-tip touch) stimulation applied to the left

or right cheeks. After each video clip, participants were asked to judge whether or not the model was feeling pain by pressing a button. BOLD signals were recorded to examine whether empathic neural responses were modulated by racial group membership between individuals. To examine whether participants showed explicit racial bias in empathy, after scanning, the participants were shown half of the video clips again and had to rate the pain intensity felt by the model and the unpleasantness felt by the onlooker.

Both Chinese and Caucasians reported greater rating scores of pain intensity and self-unpleasantness for painful than non-painful stimulations, but the differential rating scores (painful vs. non-painful stimuli) of pain intensity and self-unpleasantness did not differ between racial in-group and out-group members. Thus, neither Chinese nor Caucasian participants showed explicit racial bias in empathy for others' pain. fMRI results first showed that, relative to watching non-painful stimulation, watching painful stimulation applied to others significantly activated the ACC/supplementary motor cortex and the inferior frontal/insular cortex in both racial groups. Moreover, we found that the ACC/supplementary motor activation was significantly stronger for racial in-group members than for racial out-group members (Fig. 2.1). Post hoc analysis further confirmed that watching painful vs. non-painful stimulations activated the ACC/supplementary motor cortex when the stimulations were applied to racial in-group faces but not when applied to



**Fig. 2.1** Illustration of racial bias in empathic neural responses. (a) Viewing needle penetration vs. Q-tip touch to neutral faces significantly activated the ACC (from Fig. 2 in Han et al., 2009). (b) The activity in the ACC to painful vs. non-painful stimuli was stronger to racial in-group than out-group members (modified from Figure 1 in Xu et al., 2009)

racial out-group faces, providing fMRI evidence for racial bias in empathic neural responses. In addition, the racial bias in the ACC/supplementary motor activity to perceived pain did not differ between Chinese and Caucasian participants, indicating similar racial bias in empathy in both racial groups.

Recent meta-analysis studies have assigned distinct functions to different parts of the neural circuit involved in empathy for pain. The core network involved in empathy for pain consists of the ACC and anterior insula in which activations are independent of stimuli perceived (e.g., pictures of body parts in painful situations or abstract visual information about others' pain, Lamm et al., 2010). Fan et al. (2011) suggest that the ACC/supplementary motor cortex is recruited more frequently in the cognitive–evaluative form of empathy whereas the right anterior insula is engaged in the affective–perceptual form of empathy only and the left anterior insula is active in both forms of empathy. Thus, it may be speculated that the racial bias in empathic neural responses in the ACC implicates enhanced evaluation of racial in-group members' affective states. However, such neural empathic bias toward racial in-group members did not necessarily result in different conscious subjective ratings of others' pain intensity and induced self-unpleasantness related to racial in-group and out-group members.

Does perceived pain in racial in-group and out-group members affect neural activity in other brain regions? Using transcranial magnetic stimulation (TMS), a following research examined whether watching video clips depicting needle penetrating or Q-tip touching hands of stranger Black or White models modulates the excitability of sensorimotor regions in White-Caucasian and Black-African participants (Avenanti, Sirigu, & Aglioti, 2010). It was found that observing the pain of racial in-group models inhibited the onlookers' sensorimotor activity in both Black and White individuals. However, observing the pain of racial out-group models did not affect the onlookers' sensorimotor activity (Avenanti et al., 2010). Moreover, stronger sensorimotor response to in-group relative to out-group models' pain was observed in those subjects who showed greater negative attitude toward racial out-group members (i.e., who scored higher on the race implicit-association test). The same group also recorded BOLD signals from White and Black subjects during watching video clips depicting White and Black hands being either painfully penetrated by a syringe or being touched by a Q-tip (Azevedo et al., 2013). The activity in the bilateral anterior insula was greater for the pain experienced by same-race compared to that of other-race models. Greater implicit racial bias also predicted increased activity within the left anterior insula during the observation of own-race pain relative to other-race pain. These findings suggest stronger vicarious mapping of the pain of individuals culturally marked as in-group compared to out-group members, and the racial bias in empathic neural responses was linked to the difference of subjective attitudes toward racial in-group and out-group members.

Racial bias in empathic neural responses was also observed in the medial pre-frontal cortex. Mathur, Harada, Lipke, and Chiao (2010) scanned African-American and Caucasian-American individuals while they perceived naturalistic visual scenes depicting African-American or Caucasian-American individuals in painful (e.g., in the midst of a natural disaster) or neutral (e.g., attending an outdoor picnic) situations. They found that African-American individuals recruit the medial



prefrontal cortex specifically when observing racial in-group members who were suffering. Moreover, individuals who showed greater medial prefrontal activity to pain expressed by racial in-group relative to out-group members reported stronger altruistic motivation for racial in-group members. The same research group also reported that Korean participants showed greater activity in the left temporoparietal junction in response to perceived emotional pain from Koreans compared to Caucasian-Americans (Cheon et al., 2011).

Taken together, increasing brain imaging evidence indicates that racial inter-group relationship between an observer and a target person significantly influences the neural activity in multiple brain regions associated with perceived pain. The multiple levels of neural mechanisms involved in cognitive evaluation, affective sharing, and sensorimotor resonance are more sensitive to perceived pain in racial in-group than out-group members. The racial bias in empathic neural responses was confirmed in different ethnic groups, indicating a universal effect of racial inter-group relationship on empathy.

### **2.3 Psychological Manipulations Reduce Racial Bias in Empathic Neural Responses**

While the aforementioned brain imaging findings demonstrate the existence of racial bias in empathic neural responses, the psychological mechanisms underlying racial bias in empathy for pain remain undefined. In addition, it is unknown whether the racial in-group bias in empathic neural responses can be reduced by psychological manipulations. Discovering methods to reduce racial bias in empathic neural responses may further our understanding of the neurocognitive mechanisms underlying racial bias in empathy.

We explored psychological manipulations that may reduce racial bias in empathic neural responses by recording ERPs to Asian and Caucasian faces with pain or neutral expressions from Chinese healthy adults (Sheng & Han, 2012). We hypothesized 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 & Endo, 1992; Vizioli, Rousselet, & Caldara, 2010). Weakened individuation processing of other-race faces may lead an observer to perceive a racial out-group member without any reference to the individual's personal situation and result in decreased empathy. If this hypothesis is correct, one would predict that psychological manipulations that enhance individuation processing of other-race faces should increase empathy for other-race individual's pain. Thus, we tried two manipulations to test whether increasing attention to an individual's painful feelings and including other-race individuals in one's own social group (both lead to individuated processing of perceived faces) reduce racial bias in empathic neural responses to pain expression.

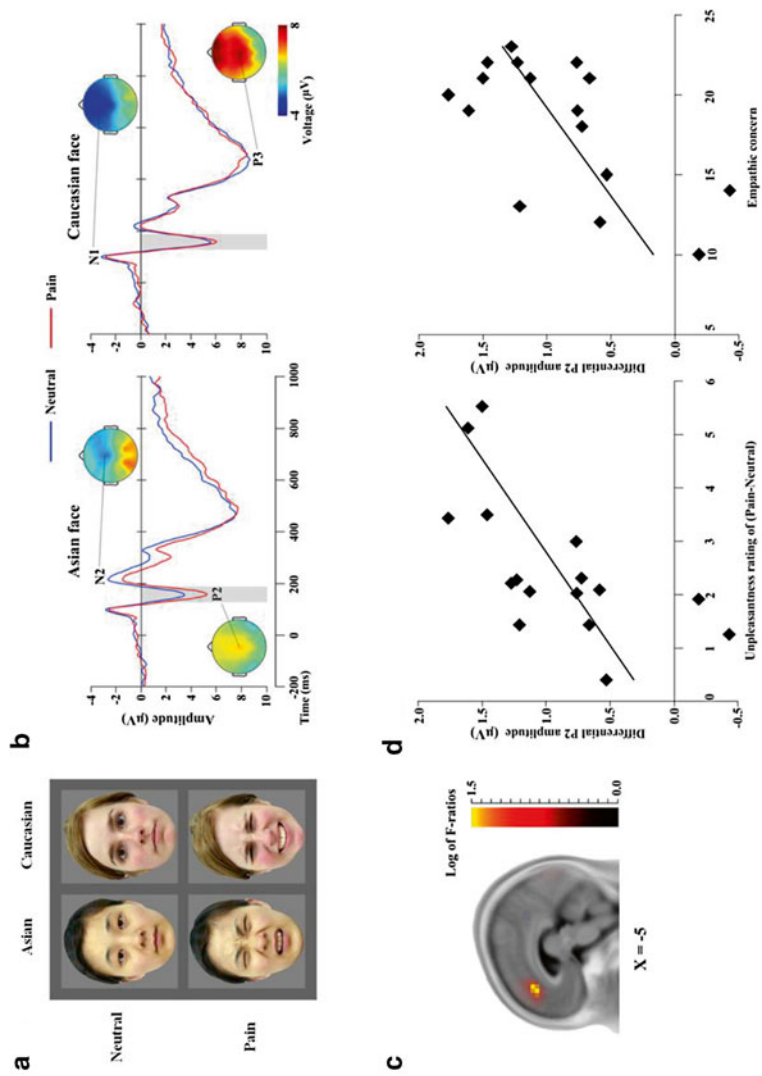
In Experiment 1, Chinese participants were asked to perform a race judgment task that required them to categorize perceived faces in terms of Asian vs. Caucasian but



ignore facial expressions. These faces were evaluated by two independent groups of Chinese and Caucasian participants to ensure that the emotional faces used in the study were indeed perceived as painful rather than as portraying any other emotions. In addition, subjective feelings of pain intensity, racial identity, and facial attractiveness were matched for Asian and Caucasian faces. ERP results showed that, relative to neutral expressions, pain expressions increased neural responses at 128–188 ms (P2) after stimulus onset over the frontal/central brain regions. Source estimation suggested that the frontal P2 component might have a source in the ACC. Moreover, the differential P2 amplitudes to pain vs. neutral expressions were positively correlated with subjective ratings of self-unpleasantness induced by perceived pain in others and with subjective ratings of the empathic concern subscale that measured empathic traits. These results indicate that the neural activity in the P2 window is associated with empathy for others' pain. Most important, the empathic neural response in the P2 time window was significantly stronger for same-race faces than for other-race faces. Post hoc analysis further confirmed that the P2 empathic response was evident for same-race faces but not for other-race faces (Fig. 2.2).

The key question addressed in Experiment 2 was whether increased attention to painful feeling of each individual face would reduce racial bias in the P2 empathic responses by increasing the P2 amplitude to Caucasian faces with painful expression. Thus, besides the race judgment task, Chinese participants were also asked to perform a pain judgment task that required them to identify whether each Asian or Caucasian face was feeling painful. It was found that, in the race judgment task, the P2 amplitude was greater to pain than neutral expressions and this effect was evident for Asian faces but not for Caucasian faces. During pain judgments, however, pain vs. neutral expressions elicited a larger P2 amplitude, and the enhanced P2 amplitudes to pain vs. neutral expressions were observed for both Asian and Caucasian faces and did not differ significantly between Asian and Caucasian faces. This suggests that top-down attention to each individual's emotional state significantly reduced racial bias in empathic neural responses by increasing empathy for other-race faces. Moreover, the increased neural responses to pain vs. neutral expressions of Caucasian faces during pain vs. race judgments were positively correlated with the participants' ability of perspective-taking. Thus, it seems that the increased empathy for other-race individuals' pain by top-down attention was stronger in those who were better in taking others' perspective.

Experiment 3 employed minimal group manipulations to examine whether embracing other-race individuals in one's own group can reduce racial bias. Participants were informed that they would be assigned to the blue or green team for a competitive game, and both the fellow team and opponent team consisted of half Asians and half Caucasians. Before EEG recording, participants had to perform learning tasks so as to remember fellow team and opponent team members. If in-group relationships increase empathy for other-race individuals of the fellow team, one would expect increased empathy-related neural activity to Caucasian faces of the fellow team, and thus, the racial bias in empathic neural responses would be reduced for Caucasian faces of the fellow team compared to Caucasian faces of the opponent team. Indeed, it was found that the P2 amplitudes were increased by



**Fig. 2.2** Illustration of the stimuli and results in Sheng and Han (2012). (a) Chinese participants were presented with Asian and Caucasian faces with pain or neutral expressions. (b) ERPs to Asian and Caucasian faces during race judgments. The P2 was of larger amplitude to pain compared to neutral expressions, but this effect was evident for Asian but not Caucasian faces. (c) Source estimation suggested that the P2 might arise from the dACC. (d) Ratings of subjective feelings and empathic concern ability predicted the magnitude of empathic neural responses (differential P2 amplitude to pain vs. neutral expressions)

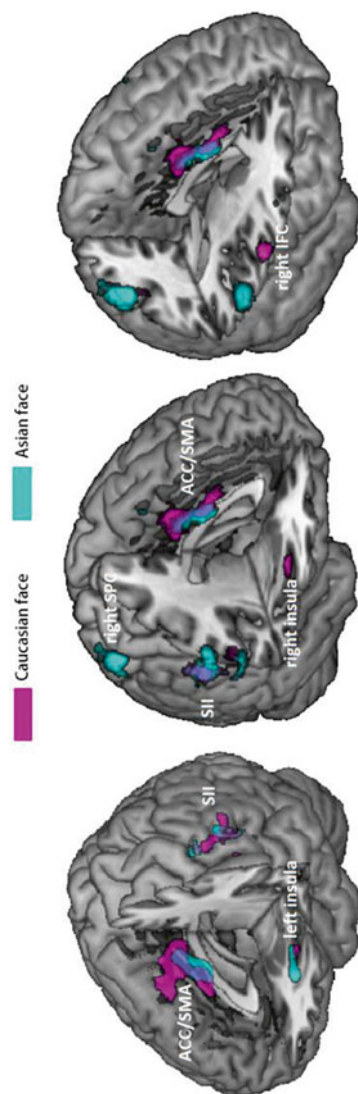
painful vs. neutral expressions of Asian faces but not of Caucasian faces from the opponent team. In contrast, the P2 amplitudes were significantly increased by painful vs. neutral expressions of both Asian and Caucasian faces from the fellow team. Thus, the manipulation of intergroup relationship mainly enhanced the empathic neural responses in the P2 time window to Caucasian faces from the fellow team, and consequently, the racial bias in empathic neural responses was reduced.

In all the three experiments, participants were asked to rate the intensity of pain expression and self-unpleasantness associated with the facial expressions of Asian and Caucasian faces. None of the rating scores was different between Asian and Caucasian faces though participants reported greater pain intensity and distressed feelings when watching painful compared to neutral expressions of both Asian and Caucasian faces. Therefore, while self-reports did not exhibit explicit racial bias in empathy, the neural activity shows clear evidence for implicit racial bias in empathy. However, the racial bias in empathic neural responses is not inevitable. Tasks that facilitate individuation processes of others can significantly enhance empathic neural responses to other-race individuals and result in reduction of the racial bias in empathic neural responses.

## **2.4 Cultural Experiences Reduce Racial Bias in Empathic Neural Responses**

Sheng and Han (2012) showed evidence that psychological manipulations that enhanced individuated processing of persons reduced racial bias in empathic neural responses by increasing empathic neural responses to other-race individuals. These findings leave an open question of whether real-life experiences such as living in a society where other-race individuals consist the majority may also reduce the racial bias in empathic neural responses. This is possible because daily experiences require dealing with each individual of other-race population and thus enhance the individuated processing of other-race people.

This hypothesis was tested in a recent fMRI study that scanned Chinese adults who were either born in or immigrated to the Western countries at an early age and thus had ample experiences with Caucasian individuals (Zuo & Han, 2013). Participants were presented with video clips of Asian or Caucasian models who received painful or non-painful stimulations, similar to those used in Xu et al. (2009). Life experiences of interacting with individual Caucasians may enhance individuated processing of Caucasians in general. If this is true, one would expect that Chinese participants have similar empathic neural responses to pain stimulation applied to Asian and Caucasian models. Indeed, Zuo and Han found that viewing painful vs. non-painful stimuli applied to both Asian and Caucasian models significantly activated the ACC, anterior insula, inferior frontal cortex, and somatosensory cortex in their Chinese participants. In addition, painful vs. non-painful stimuli applied to both Asian and Caucasian models induced overlapping activations in these brain regions (Fig. 2.3). Direct comparison between brain activations



**Fig. 2.3** Brain activations to painful vs. non-painful stimuli applied to Asian and Caucasian faces in Zuo and Han (2013). Note that these activations were partially overlapped in the ACC, supplementary motor cortex, somatosensory cortex, and insula

elicited by painful stimuli applied to Asian and Caucasian models did not differ significantly, suggesting comparable empathic neural responses to racial in-group and out-group members. Thus, it appears that cultural experiences with racial out-group members may increase the neural responses to the suffering of other-race individuals. Therefore, both manipulations of cognitive strategies and intergroup relationship in laboratory and real-life experiences can significantly reduce racial bias in empathic neural responses.

## **2.5 Molecular Mechanisms of Racial Bias in Empathic Neural Responses**

The racial bias in empathy for pain reflects the effect of social intergroup relationship on how we understand and share others' painful feelings. However, it remains unclear how social influences on empathic neural responses are mediated by neurobiological factors. Oxytocin is a neuropeptide of nine amino acids that is produced in the hypothalamus and functions as both a hormone and neurotransmitter. Oxytocin receptors are expressed by neurons in many parts of the brain and spinal cord. Recent behavioral studies have shown increasing evidence that oxytocin plays a key role in the maintenance of social groups and development of trust in in-group members (De Dreu, 2012 for a review). For example, intranasally administered oxytocin versus placebo promoted trust or cooperation with in-group members but not with out-group members (De Dreu et al., 2010; De Dreu, Greer, Van Kleef, Shalvi, & Handgraaf, 2011). Oxytocin also enhances the behavioral index of emotional empathy in response to both positive and negative stimuli (Hurlemann et al., 2010) and improves performance on inference of others' emotion (Domes, Heinrichs, Michel, Berger, & Herpertz, 2007). These behavioral findings suggest that oxytocin may improve empathic neural responses specifically to racial in-group members rather than function as a general facilitator of empathy.

Sheng, Liu, Zhou, Zhou, and Han (2013) tested this hypothesis by recording ERPs to Asian and Caucasian faces with pain or neutral expressions from healthy Chinese male adults. Using a randomized, double-blind, within-subject, placebo-controlled design, this study focused on oxytocin effect on the P2 empathic neural responses to pain expressions of racial in-group and out-group faces. If oxytocin plays a role in the racial bias in empathy, the in-group bias in the neural activity in the P2 time window observed in Sheng and Han (2012) should be increased by OT compared to placebo treatment. Sheng et al. (2013) first replicated their previous finding in the placebo condition that the fronto-central P2 amplitude was greater to pain vs. neutral expressions racial in-group members but not of racial out-group members. Oxytocin treatment did not influence the P2 amplitude to pain or neutral expressions of Caucasian faces but significantly increased the P2 amplitude to pain expression of Asian faces. This effect consequently induced greater racial bias in empathic neural responses after oxytocin compared to placebo treatments. Sheng et al. also measured the participants' implicit attitudes toward racial in-group and

out-group faces after oxytocin and placebo treatments using the implicit-association test (Greenwald, McGhee, & Schwartz, 1998) to assess whether OT affects the association between the racial bias in empathic neural responses and implicit racial attitudes. It was found that the racial bias in the empathic neural responses in the P2 time window was significantly associated with the racial bias in the implicit racial attitudes in the oxytocin condition but not in the placebo condition.

These findings suggest a molecular mechanism of racial bias in empathic neural responses. It appears that oxytocin does not function as a general facilitator of empathy. Instead, oxytocin improves empathic neural responses specifically to racial in-group members. In addition, it is likely that oxytocin modifies empathic neural responses to racial in-group members by enhancing the association between the implicit positive attitude toward racial in-group members and the racial bias in empathic neural responses. It seems that neither social relationship nor biological factors work alone to affect human empathy for the suffering of others. The final outcome of empathy for others' pain is determined by the interaction between social and biological factors.

## 2.6 Conclusion

Because bias in empathy is related to both within-group altruism and between-group conflict (Galinsky, Glin, & Maddux, 2011) and race is one of the factors that are most frequently used to categorize people into different social groups, it is highly important to uncover the social and neurobiological mechanisms underlying racial bias in empathic neural response and to discover methods to reduce neural activity related to racial bias in empathy for pain. The empirical brain imaging findings reviewed in this chapter provides solid evidence for racial bias in brain activity involved in empathy for pain. Empathy is an ability that facilitates social bonding not only in humans but in other primates as well (de Waal, 2008), and thus, there may be a long evolutionary history of this ability. Racial bias in empathy may also evolve with a long history during human evolution and function essentially to mediate racial in-group favoritism. On the other hand, racial bias in empathy may foster ignorance of painful feeling of racial out-group members and, in turn, aggravate tension between racial groups. Fortunately, current sociocultural world views do not encourage racial bias, and we have shown brain imaging evidence that racial bias in empathy is not inevitable. Future research should further explore how educational interventions may influence and weaken racial bias in empathy.

Future research should also address another important question raised by the previous brain imaging studies of racial bias in empathy, that is, are similar neural mechanisms engaged in the effects of racial intergroup relationship and other types of intergroup relationship on neural activity in response to others' pain? Sheng and Han (2012) found that minimal group manipulation in laboratory only influenced empathic neural response to perceived pain of racial out-group members but did not affect that to perceived pain of racial in-group members. Hein et al. (2010) found that

minimal group manipulation in the laboratory modulated the left insular activity, being stronger when participants saw high versus low pain in the in-group member as compared with high versus low pain in the out-group member. This is apparently different from the effect of racial intergroup relationship on empathic neural responses in the ACC (Sheng & Han, 2012; Xu et al., 2009). The racial intergroup relationship may be different from the minimal group relationship in that the former is powerful for creating stable social categorizations of a large population whereas the latter is useful for social categorizations of a small population and can vary easily. This possibly gives rise to distinct neural substrates underlying the effect of the racial intergroup relationship and the minimal group relationship on empathy for others' pain and may be clarified in future research.

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