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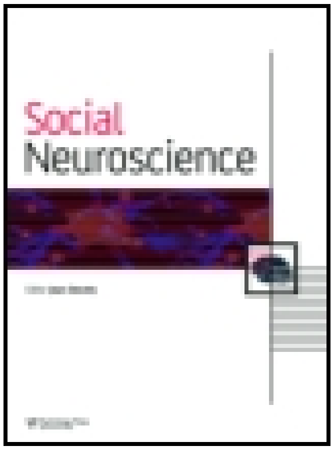

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Shared beliefs enhance shared feelings: Religious/ irreligious identifications modulate empathic neural responses

Siyuan Huang[a] & Shihui Han[a]
[a] Department of Psychology, PKU-IDG/McGovern Institute for Brain Research, Peking University, Beijing, China
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Shared beliefs enhance shared feelings: Religious/irreligious identifications modulate empathic neural responses

Siyuan Huang and Shihui Han

Department of Psychology, PKU-IDG/McGovern Institute for Brain Research, Peking University, Beijing, China

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Recent neuroimaging research has revealed stronger empathic neural responses to same-race compared to other-race individuals. Is the in-group favouritism in empathic neural responses specific to race identification or a more general effect of social identification—including those based on religious/irreligious beliefs? The present study investigated whether and how intergroup relationships based on religious/irreligious identifications modulate empathic neural responses to others' pain expressions. We recorded event-related brain potentials from Chinese Christian and atheist participants while they perceived pain or neutral expressions of Chinese faces that were marked as being Christians or atheists. We found that both Christian and atheist participants showed stronger neural activity to pain (versus neutral) expressions at 132–168 ms and 200–320 ms over the frontal region to those with the same (versus different) religious/irreligious beliefs. The in-group favouritism in empathic neural responses was also evident in a later time window (412–612 ms) over the central/parietal regions in Christian but not in atheist participants. Our results indicate that the intergroup relationship based on shared beliefs, either religious or irreligious, can lead to in-group favouritism in empathy for others' suffering.

Keywords: Empathy; Religious belief; ERP; Pain; In-group bias.

How does the human brain understand and share others' emotional states such as pain? Recent neuroimaging studies have investigated this issue extensively as empathy for others' emotions is closely related to human social behaviour (e.g., Batson, 2011). Functional magnetic resonance imaging (fMRI) research has shown that watching others in pain, indicated by symbols of painful electric shock applied to others (Singer et al., 2004), painful stimuli applied to others' body parts (Gu & Han, 2007; Gu et al., 2010; Jackson, Meltzoff, & Decety, 2005) or pain expression (Han et al., 2009; Saarela et al., 2006), significantly activates a neural network consisting of the anterior cingulate, anterior insula, somatosensory cortex, etc. (see Fan, Duncan, De Greck, & Northoff, 2011; Lamm, Decety, & Singer, 2011 for meta-analyses). In addition, the neural responses to perceived pain in others are associated with one's own empathy traits, distressed feelings and altruistic behaviour (e.g., Jackson et al., 2005; Ma, Wang, & Han, 2011; Singer et al., 2004).

The time course of empathic neural responses has been investigated by recording event-related potentials (ERPs) to perceived pain in others. Fan and Han (2008) first recorded ERPs to perceived painful and non-painful stimuli applied to others' body parts. They found that an early positive activity at 140–200 ms over the frontal lobe (P2) was of larger

Correspondence should be addressed to: Shihui Han, Department of Psychology, PKU-IDG/McGovern Institute for Brain Research, Peking University, 5 Yiheyuan Road, Beijing 100871, China. E-mail: shan@pku.edu.cn

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amplitude to painful compared to non-painful stimuli. A long-latency positive component also showed increased amplitude to perceived pain in others after 380 ms over the central–parietal regions (P3). Pain expression compared to neutral expression also increased the amplitude of an early positive component at 120–180 ms (P2) over the frontal–central region (Sheng & Han, 2012). The amplitude of a following negative component (N2) was also decreased (or positively shifted) at 200–300 ms over the central region by pain expression. The modulations of ERP amplitudes by perceived pain in others have been replicated in the following studies: Decety, Yang, and Cheng (2010), Han et al. (2008), Ibáñez et al. (2011), Li and Han (2010), Sheng, Liu, Zhou, Zhou, and Han (2013). Taken together, the neuroimaging findings suggest that the key nodes of the emotional network are engaged in understanding and sharing of others' suffering and such empathic neural responses occur early during perception.

However, behavioural studies have shown that people do not empathize with others' pain equally. Participants report greater shared feelings with same-race than other-race individuals and show racial in-group favouritism in altruistic behaviour (Drwecki, Moore, Ward, & Prkachin, 2011; Johnson et al., 2002). In line with the findings of behavioural studies, recent brain imaging studies have uncovered the neural basis of racial in-group favouritism in empathy. An early fMRI study showed that both Chinese and Caucasian adults exhibited greater activity in the anterior cingulate in response to painful (versus non-painful) stimulations applied to same-race than other-race individuals (Xu, Zuo, Wang, & Han, 2009). The following fMRI research also reported increased activity in response to racial in-group versus out-group members' pain in the dorsal medial prefrontal cortex (Mathur, Harada, Lipke, & Chiao, 2010) and in the anterior insula (Azevedo et al., 2013; Sheng, Liu, Li, Fang, & Han, 2014).

ERP studies also reported evidence for racial in-group bias in empathic neural responses. By recording ERPs from Chinese adults in response to pain and neutral expressions of Asian and Caucasian faces, Sheng and Han (2012) found that the frontal/central P2 was of larger amplitude to pain versus neutral expressions and the P2 empathic responses were greater to racial in-group than out-group faces. In addition, the racial in-group favouritism in the P2 empathic responses was enhanced by oxytocin (Sheng et al., 2013). Similarly, Sessa, Meconi, Castelli, and Dell'Acqua (2014) reported that, for White participants, perceived painful versus non-painful stimulation applied to White faces resulted in a positive shift of the ERP amplitudes in the N2–N3 time window (280–340 ms) whereas such empathic neural responses were significantly reduced when White participants perceived painful versus non-painful stimulation applied to Black faces. Thus, both fMRI and ERP findings indicate that empathic neural responses are significantly modulated by race-based intergroup relationships, being stronger to racial in-group compared out-group members.

Most of the previous studies of in-group favouritism in empathy for pain focused on the differential empathic neural responses to same-race and other-race individuals (but see Hein, Silani, Preuschoff, Batson, & Singer, 2010) and thus leave two open questions. First, does the racial in-group favouritism in empathic neural responses arise from perceptual processes of skin colour and facial features whereby people are more receptive to ethnic in-group members and their emotions? This is possible because there has been evidence that it is easier to recognize same-race faces and to interpret their facial expressions relative to other-race faces (Elfenbein & Ambady, 2002; Sporer, 2001). Second, is the in-group favouritism in empathy specific to race identification or a more general effect of social identification including that based on religious/irreligious beliefs? People of the same race may have different religious identifications that offer distinctive social group memberships (Burris & Jackson, 2000; Ysseldyk, Matheson, & Anisman, 2010) and separate one religious community from another (Tiliopoulos & Mcvittie, 2010). To date, there has been no research that examines whether and how intergroup relationships based on shared beliefs affect empathy for others' pain.

The current work addressed these issues by recruiting Christian and atheist participants who were all Han Chinese in China and thus were identical in terms of race. We recorded ERPs while participants viewed pain and neutral expressions of Chinese faces that were marked as Christians or atheists so that participants shared religious (or irreligious) beliefs with half of the faces but not with the others. Findings of religion-based in-group favouritism in empathic neural responses would support a general effect of intergroup relationships on empathic neural responses. In addition, findings of similar in-group favouritism in empathic neural responses in Christian and atheist participants would suggest that philosophical belief systems that are held in high regard, either religious or irreligious, may be equally important for generating intergroup relationships and thus affect empathy for others' pain.

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METHODS

Participants

Forty Chinese adults participated in this study as paid volunteers. Twenty participants were self-identified atheists (10 males, 22.6 ± 2.1 (mean age ± SD) years) and 20 self-identified Christians (10 males, 22.1 ± 2.3 years). Christians were members of local faith communities and had been attached to the Christian communities for 1 to 18 years (4.9 ± 4.6 years) when participating in this study. Sixty-five percent of Christian participants reported to attend to Church or fellowship at least once a week, and 95% reported to pray every day and 90% reported to read the Bible everyday. Christian and atheist participants were matched on education. 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

Stimuli were adopted from our previous work (Sheng & Han, 2012) and consisted of digital photographs of faces with neutral or pain expressions from 10 male and 10 female Chinese models. The stimuli were modified so that half models wear a necklace with a cross and half with a round pendant, as illustrated in Figure 1. Participants were informed that the models wearing a cross were Christians and the models wearing a round pendant were atheists. The assignment of each model to Christian or atheist category was counterbalanced across participants.

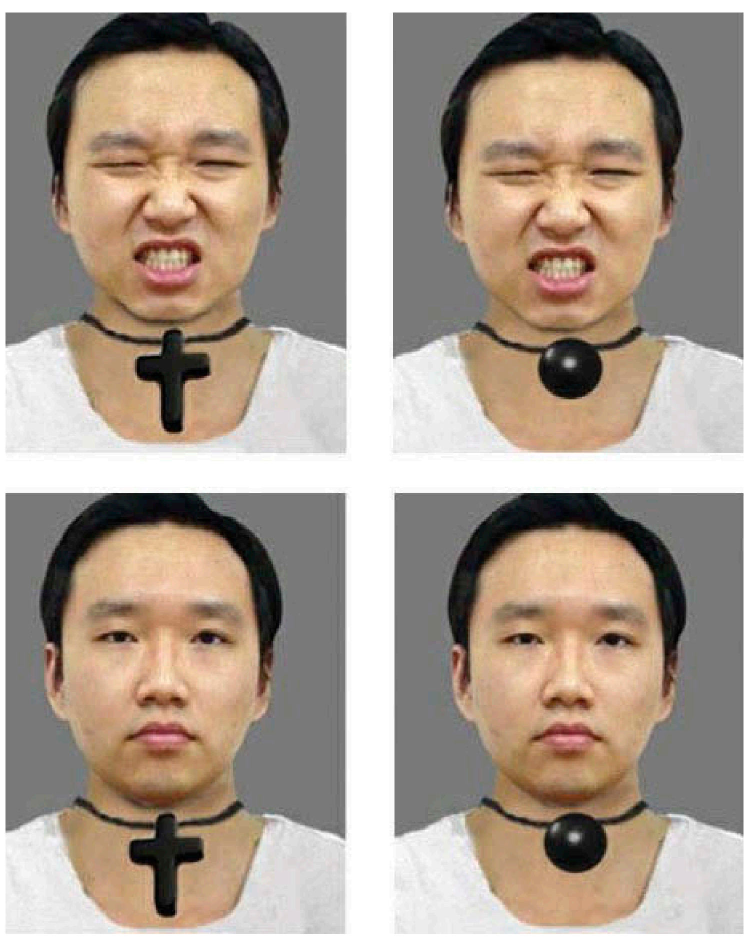

Figure 1. Illustration of the face stimuli used in the present study. Participants were informed that models wearing a cross were Christians and models wearing a round pendant were atheists. Each face was used as a Christian model for half participants but as an atheist model for other participants. This assignment was counterbalanced across participants.

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Before the electroencephalography (EEG) recording, participants completed two learning tasks in order to remember Christian and atheist models. In the first task, participants were presented with neutral faces of all models wearing a necklace with a cross or a round pendant. Participants were informed that the models with a cross were Christians and the models with a round pendant were atheists. Participants were asked to remember the social category of each model. Each face was presented on a screen until participants pressed a button. This encoding procedure lasted for about 5 minutes. In the second task, each face without a necklace (with pain or neutral expression) was presented on a screen until participants pressed a button to categorize the face as a Christian or an atheist. Each response was followed by a feedback on correctness. Each participant completed 6 blocks of 40 trials. After the learning task, participants were given a memory test (2 blocks of 40 trials) that used a procedure similar to that in the second learning task. The same memory test was conducted again after the EEG recording.

During the EEG recording, each photograph marked with a cross or a round pendant was presented in the centre of a 21-inch colour monitor, subtending a visual angle of 3.8° × 4.7° at a viewing distance of 120 cm. Each trial consisted of a face stimulus with a duration of 200 ms, which was followed by a fixation cross with a duration that varied randomly between 800 and 1400 ms. Participants performed judgements on pain versus neutral expressions of each face by a button press using the left or right index finger. In each block, 20 faces wearing a cross or a pendant were presented once in a random order. Ten faces showed pain expressions and 10 showed neutral expressions. There were 12 blocks of trials with faces wearing a cross and 12 blocks of trials with faces wearing a pendant.

After the EEG session, participants were asked to rate pain intensity portrayed by each face and their own subjective feelings of unpleasantness induced by each face on a 9-point Likert scale (1 = not at all painful or unpleasant, 9 = extremely painful or unpleasant). To assess explicit subjective attitudes towards each face, participants were asked to rate the likability of each face on a 9-point Likert scale (1 = not at all, 9 = extremely strong). Participants completed the Interpersonal Reactivity Index (IRI) as a measure of empathy ability (Davis, 1983). The IRI is a questionnaire measure that contains four subscales including the Perspective Taking subscale that assesses the “tendency to spontaneously adopt the psychological point of view of others in everyday life”, the Fantasy subscale that estimates the “tendency to imaginatively transpose oneself into fictional situations”, the Empathic Concern subscale that assesses the “tendency to experience feelings of sympathy and compassion for unfortunate other” and the Personal Distress subscale that assesses “tendency to experience distress and discomfort in response to extreme distress in others” (Davis, 1996, p. 57). Each subscale consists of seven items. Participants rated each item on a 5-point scale.

Participants were also asked to complete a religion version of the Implicit Association Test (IAT; Greenwald, McGhee, & Schwartz, 1998), where they categorized Christian faces/positive words with one key and atheist faces/negative words with another key in two blocks. A reverse arrangement was used in another two blocks. Latency differences between the blocks with different response association between faces and words reflected the relative ease to make associations between Christian versus atheist faces and concepts of good and bad. According to the established algorithm of the latencies (Greenwald, Nosek, & Banaji, 2003), a positive IAT D score indicates that compared to out-group faces, in-group faces are associated with positive rather than negative attitude.

ERP data recording and analysis

The EEG was continuously recorded from 62 scalp electrodes that were mounted on an elastic cap in accordance with the extended 10–20 system and were referenced to the average of the left and right mastoid electrodes. The electrode impedance was kept less than 5 kΩ. Eye blinks and vertical eye movements were monitored with electrodes located above and below the left eye. The horizontal electro-oculogram was recorded from electrodes placed 1.5 cm lateral to the left and right external canthi. The EEG was amplified (band pass 0.1–100 Hz) and digitized at a sampling rate of 250 Hz. The ERPs in each condition were averaged separately offline with an epoch beginning 200 ms before stimulus onset and continuing for 1200 ms. Trials contaminated by eye blinks, eye movements or muscle potentials exceeding ±50 μV at any electrode were excluded from the average. The baseline for ERP measurements was the mean voltage of a 200 ms pre-stimulus interval and the latency was measured relative to the stimulus onset. ERP components were identified by visual inspections and in reference to the previous ERP results (e.g., Sheng & Han, 2012). The mean amplitudes of each ERP component were calculated at electrodes selected from frontal (Fz, FCz, F3, F4,

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FC3, FC4), central (Cz, C3, C4) and parietal (Pz, P3, P4) regions. The time window for measuring the mean amplitude of an ERP component was centred at the peak of each component. Behavioural performances and ERPs were subjected to ANOVAs with expression (pain versus neutral) and intergroup relationship (in-group with shared beliefs versus out-group with different beliefs) as within-subjects variables and belief (Christian versus atheist participants) as a between-subjects variable.

RESULTS

Behavioural performances

The response accuracies of the memory tests before and after EEG recording are shown in Table 1. The mean response accuracy was high (88.6%). ANOVAs of the responses accuracies with intergroup relationship as a within-subjects variable and Belief as a between-subjects variable did not show any significant effect (*p*s > 0.1), indicating that participants remembered in-group and out-group faces similarly well before and after EEG recording.

The response accuracy of expression judgements during EEG recording was slightly higher for neutral than pain expressions ($F(1,38) = 11.10$, $p < 0.01$, Table 2). ANOVAs of reaction times during expression judgements did not show any significant effect (*p*s > 0.1, Table 2), suggesting comparable task difficulty during expression judgements on in-group and out-group members in Christians and atheists. Participants reported greater pain intensity, stronger self-unpleasantness and less likability associated with pain than neutral expressions ($F(1,38) = 6.56$, 44.68, 15.68, *p*s < 0.01, Table 3). However, these effects did not differ between Christian and atheistic models and between Christian and atheistic participants (*p*s > 0.05). Participants reported less self-unpleasantness and greater likability linked to models who shared beliefs with participants compared to those who did not ($F(1,38) = 12.56$ and 21.05, *p*s < 0.001). In addition, the in-group bias in likability was stronger in Christian than atheistic participants ($F(1,38) = 8.83$, $p < 0.01$), suggesting stronger in-group bias in explicit attitudes in Christian relative to atheistic participants. Christian and atheist participants did not differ in any subscale scores of IRI (see Table 4 for rating scores). The IAT D score did not differ significantly from zero for both Christian

TABLE 1
Response accuracy (%) during the memory tests (mean ± SD)

	In-group face	*Out-group face*
Before EEG recording		
Christian participants	90.75 ± 8.32	90.50 ± 7.59
Non-religious participants	88.75 ± 7.59	88.50 ± 7.80
After EEG recording		
Christian participants	86.65 ± 10.06	90.25 ± 8.35
Non-religious participants	84.75 ± 9.10	89.00 ± 8.83

TABLE 2
Behavioural performances during EEG recording (mean ± SD)

		In-group face		*Out-group face*	
		Neutral	*Pain*	*Neutral*	*Pain*
RTs (ms)	Christians	551 ± 54.9	548 ± 54.5	554 ± 62.3	554 ± 58.9
	Atheists	542 ± 62.5	534 ± 62.4	536 ± 65.4	533 ± 63.4
Accuracy (%)	Christians	92.8 ± 5.16	91.4 ± 7.59	92.4 ± 4.68	91.7 ± 4.44
	Atheists	94.4 ± 5.20	92.3 ± 4.17	94.4 ± 4.44	91.4 ± 4.09

TABLE 3
Pain intensity, self-unpleasantness and likability rating scores (mean ± SD)

		In-group face		*Out-group face*	
		Neutral	*Pain*	*Neutral*	*Pain*
Pain intensity	Christians	1.39 ± 0.59	6.33 ± 1.20	1.46 ± 0.57	6.34 ± 1.22
	Atheists	1.33 ± 0.44	6.38 ± 1.32	1.26 ± 0.38	6.48 ± 1.23
Self-unpleasantness	Christians	2.28 ± 1.21	3.50 ± 1.80	2.64 ± 1.38	4.06 ± 2.00
	Atheists	2.77 ± 1.29	4.73 ± 1.57	3.12 ± 1.19	5.06 ± 1.33
Likability	Christians	5.23 ± 1.18	4.81 ± 1.03	4.48 ± 9.95	3.99 ± 1.13
	Atheists	4.78 ± 1.01	4.38 ± 1.02	4.63 ± 9.54	4.19 ± 8.03

TABLE 4
Rating scores of IRI subscales (mean ± SD)

	Christians	*Atheists*	*t (38)*	*P*
Perspective-taking	2.56 ± 0.49	2.36 ± 0.58	1.18	>.10
Fantasy	2.53 ± 0.51	2.45 ± 0.81	.37	>.10
Empathic concern	2.96 ± 0.58	2.64 ± 0.55	1.76	.087
Personal distress	2.43 ± 0.48	2.34 ± 0.84	.40	>.10

(mean ± SD = 0.05 ± 0.94, $t(19) = 0.26$, $p = 0.80$) and atheist participants (0.12 ± 0.72, $t(19) = 0.72$, $p = 0.48$), suggesting comparable implicit attitudes towards the models who shared or did not share religious/irreligious beliefs with participants.

ERP results

The percentage of the accepted trials for ERP analyses in each condition is shown in Table 5. The mean percentage of accepted trials for ERP analyses was high (81.6%). ANOVAs of the percentage of accepted trials did not show any significant effect (ps > 0.1), indicating comparable numbers of trials used for ERP analysis in each condition. Figure 2 illustrates grand-averaged ERPs to pain and neutral expressions recorded from Christian and atheist participants. The ERPs elicited by faces were characterized by a negative wave at 80–120 ms (N1) and a positive deflection at 124–176 ms (P2) over the frontal–central area. These were followed by a negative wave at 200–320 ms (N2) over the frontal region and a long-latency positivity at 400–700 ms (P3) over the central/parietal area.

ANOVAs of the N1 amplitude did not show any significant effect. ANOVAs of the P2 amplitude at 132–168 ms over the frontal/central electrodes showed a significant main effect of expression ($F(1,38) = 49.28$ to 88.65, ps < 0.001). This replicates the previous findings of stronger neural responses to pain than neutral expressions (Sheng & Han, 2012; Sheng et al., 2013). Moreover, ANOVAs of the P2 amplitude showed a significant interaction of expression × intergroup relationship ($F(1,38) = 4.16$ to 5.68, ps < 0.05), indicating stronger P2 empathic neural responses to those with shared beliefs compared to those without shared beliefs. The three-way interaction of expression × intergroup relationship × belief was not significant (ps > 0.1), suggesting that the in-group bias in the P2 empathic neural responses did not differ significantly between Christian and atheist participants.

Similarly, there was a significant positive shift of the N2 amplitude at 200–320 ms over the frontal/central electrodes elicited by pain compared to neutral expressions ($F(1,38) = 6.22$ to 87.49, ps < 0.05). ANOVAs of the N2 amplitude also showed a significant interaction of expression × intergroup relationship ($F(1,38) = 4.67$ to 6.53, ps < 0.05), due to stronger empathic neural responses in the N2 time window to those with shared beliefs compared to those without shared beliefs. The in-group bias in the N2 empathic neural responses did not differ significantly between Christian and atheist participants because the triple interaction of expression × intergroup relationship × belief was not significant (ps > 0.05).

The P3 was of larger amplitudes at 412–612 ms over the central/parietal electrodes in response to pain than neutral expressions ($F(1,38) = 5.50$ to 12.13, ps < 0.05). Moreover, there was a significant three-way interaction of Expression × Intergroup Relationship × Belief ($F(1,38) = 4.20$ to 6.70, ps < 0.05). Separate analyses confirmed stronger empathic neural responses in the P3 time window to those with shared beliefs compared to those without shared beliefs in Christian participants ($F(1,38) = 3.79$ to 13.43, ps < 0.05) but not in atheist participants (ps > 0.1).

Finally, to explore whether the in-group bias in the P2, N2 and P3 amplitudes was associated with

TABLE 5
Percentage of the accepted trials (%) in each condition

	In-group face		*Out-group face*	
	Neutral	*Pain*	*Neutral*	*Pain*
Christian	82.67 ± 13.81	82.17 ± 14.76	82.52 ± 11.80	82.47 ± 13.41
Non-religious	81.22 ± 12.62	81.23 ± 13.45	79.82 ± 14.33	81.17 ± 13.64

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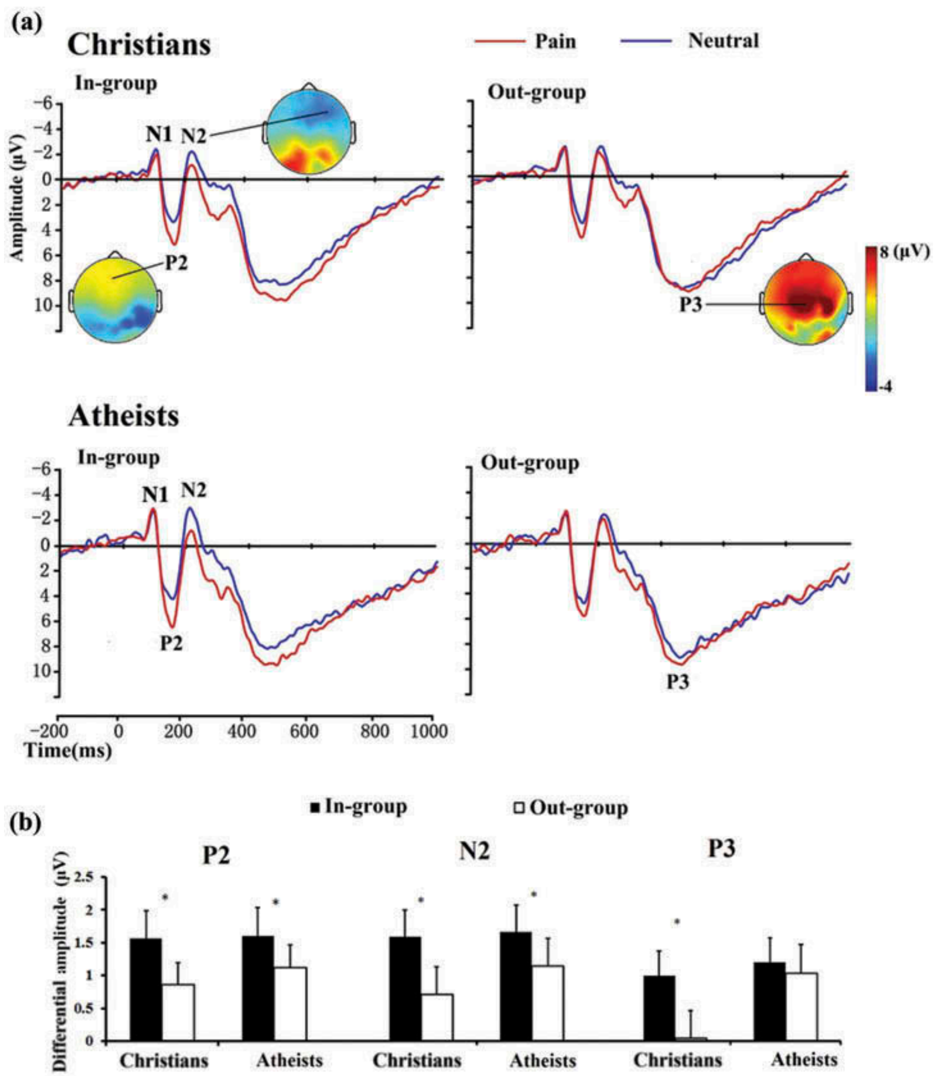

Figure 2. (**a**) Illustration of ERP results at the electrode FCz in the present study. ERPs recorded from Christians and atheists are shown in the upper and lower panel, respectively. (**b**) Illustration of the mean differential P2, N2 and P3 amplitudes to pain versus neutral expressions.

empathy traits, explicit and implicit attitudes, we calculated correlations between the ERP index of in-group bias (i.e., differential ERP amplitudes to pain versus neutral expressions of those with shared beliefs minus differential ERP amplitudes to pain versus neutral expressions of those without shared beliefs) and IRT scores, likability rating scores and IAT D score. However, these analyses did not show any significant effect ($ps > 0.05$).

DISCUSSION

The present study tested the hypothesis that the intergroup relationships based on religious/irreligious beliefs modulate empathic neural responses to other's suffering. Christian and atheist participants shared religious or irreligious beliefs with perceived models with pain or neutral expressions. As Chinese participants were presented with only Chinese faces in the current experiment, observers were equally familiar with facial features of the models with or without share religious/irreligious beliefs. In addition, as each model's face was marked as both a Christian and an atheist (counterbalanced across participants), face stimuli in the Christian and atheist categories were identical across all participants. Therefore, it was shared beliefs rather than perceptual features of faces that identified the intergroup relationships between an observer and a target in the current experiment.

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Interestingly, subjective reports revealed in-group favouritism in the current study. Both Christian and atheist participants explicitly reported greater self-unpleasantness and less likability linked to the models with different versus same (religious/irreligious) beliefs, even though IAT did not show significant differences in implicit attitudes towards the models with or without shared beliefs. Moreover, Christian participants reported greater in-group favouritism in likability compared to atheist participants. This is discrepant from the results of our previous studies of racial in-group bias in empathy where self-reports of self-unpleasantness and likability did not differ between racial in-group and out-group members (Sheng & Han, 2012; Sheng et al., 2013; Xu et al., 2009). It appears that the racial in-group bias is strongly intolerable in the current Chinese society and this may result in the absence of any racial in-group bias in self-report in the previous research, even though racial in-group favouritism in empathic neural responses was observed in these studies. In contrast, explicit attitudes towards those with same or different religious/irreligious beliefs may be tolerated to a certain degree and this allowed participants in the current study to uncover their less likability and stronger unpleasant feelings linked to those who did not share religious/irreligious beliefs.

Although behavioural performances during EEG recording did not show any significant difference between models with the same or different religious/irreligious beliefs, the differential ERP amplitudes elicited by pain versus neutral expressions indicate robust in-group bias in empathic neural responses in both Christian and atheist participants. We first showed that pain compared to neutral expressions elicited greater P2 amplitudes and a positive shift of the N2 amplitudes over the frontal/central regions. These results replicate the previous ERP findings (Decety et al., 2010; Fan & Han, 2008; Li & Han, 2010; Mu, Fan, Mao, & Han, 2008; Sheng & Han, 2012; Sheng et al., 2013), indicating that the amplitudes of neural activities in the P2 and N2 time windows are sensitive to perceived pain in others. Moreover, the current work showed that the religious/irreligious identifications significantly modulated the differential P2 and N2 amplitudes to pain versus neutral expressions, being stronger when an observer and a target shared religious (or irreligious) beliefs than when they did not. The modulations of the P2 and N2 amplitudes to pain versus neutral expressions by shared religious/irreligious beliefs are similar to our previous findings that shared race identifications enhance empathic neural responses in the P2 and N2 time windows (Sheng & Han, 2012; Sheng et al., 2013).

Because face stimuli in Christian and atheist categories were identical in the current study, the modulations of P2 and N2 empathic neural responses extend the previous research by showing that similarity in physical appearance (e.g., perceptual features of faces or skin colour) between an observer and a target is not necessary for the emergence of in-group bias in empathic neural responses. Our memory tests before and after EEG recording indicate that participants remembered in-group and out-group models equally well. Thus, the in-group bias in empathic neural responses observed in the current work cannot be explained by distinct familiarity with either in-group or out-group faces. Therefore, mere shared beliefs between an observer and a target can significantly enhance empathic neural responses to others' suffering. Ample behavioural evidence demonstrates that religious identification offers a distinctive "sacred" worldview and "eternal" group membership that play key roles in both individuals' well-being and intergroup conflict (Ysseldyk et al., 2010). Whereas our previous research found evidence for modulations of brain activity underlying self-related processing by religious beliefs (Han et al., 2010, 2008), it remains unclear whether and how religious identifications influence human brain activity involved in social/affective processes related to others. Empathy has been proposed to be a proximate mechanism underlying altruistic behaviour (Decety & Jackson, 2006; De Waal, 2008) and the neural responses to others' suffering in the medial prefrontal cortex and lateral inferior frontal cortices can predict prosocial motivations (Ma et al., 2011; Mathur et al., 2010). Our ERP results supplement previous research by showing that religious identifications significantly enhance empathic neural responses that have been shown to be associated with altruistic motivations and behaviours.

One may notice that Christian and atheist participants in the current study exhibited similar in-group bias in empathic neural responses in the P2 and N2 time windows. Previous research has shown that the empathic neural responses in an early time window from 140 to 300 ms after sensory stimulation are independent of task demands of attention to others' suffering (Fan & Han, 2008) and of self/other perspectives taken by observers (Li & Han, 2010). In contrast, task demands and perspective taking influence the empathic neural responses in the time window covering the P3 component. Thus, it has been assumed the early empathic neural responses are more or less automatic and engaged in encoding stimulus emotional contents of the stimuli whereas the later empathic neural responses are more or less top-down

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controlled and involved in enhanced evaluation and appraisal of others' pain (Fan & Han, 2008). Thus, the current ERP results indicate that religious and irreligious identifications similarly induced stronger neural activity associated with early, automatic empathic processing of the suffering of those with shared beliefs as opposed to those without shared beliefs. It is well known that religious beliefs produce significant effects on human social cognition and behaviour. For example, religious (Christian) identifications are associated with weakened self-face recognition (Ma, Han, & Botbol, 2012), enhanced tendency to avoid risk behaviours (Sinha, Cnaan, & Gelles, 2007) and reduced depressive symptomatology (Koteskey, Little, & Matthews, 1991). However, it remains unclear how irreligious beliefs influence human social cognition and behaviour (Johnson, 2012; Ysseldyk et al., 2010). Here, we showed neuroscience evidence that religious and irreligious beliefs lead to similar in-group favouritism in neural activity within a specific time course in response to others' suffering. Thus, irreligious beliefs may be as efficient as religious beliefs to generate social categories of others and to modulate human brain activity to the suffering of those with or without irreligious beliefs.

Unlike the empathic neural responses in the P2 and N2 time windows, the P3 amplitudes showed in-group bias in response to others' suffering in Christian but not in atheist participants. Thus, the late evaluation and appraisal of the suffering of those who do not believe Christianity were significantly reduced in Christian participants. In contrast, the late evaluation of others' suffering was not significantly affected by shared beliefs in atheist participants. Christians constitute a minority group of members of the current Chinese society.[1] There has been evidence that people from optimally distinct minority groups show greater in-group identification, greater satisfaction with their in-group members and higher self-esteem than members of nonoptimally distinct majority groups (Leonardelli & Brewer, 2001). Similarly, relative to atheists, our Christian participants who belong to a minority group in the current Chinese society might have greater in-group identification, which then resulted in stronger in-group favouritism in the late evaluation process of other' pain. Consistent with our findings, a previous fMRI study found that, relative to European-Americans, African-Americans as a minority group in the United States displayed greater empathic neural responses in the medial prefrontal cortex to the suffering of same-race versus other-race individuals (Mathur et al., 2010). As the P3 component with the largest amplitudes over the frontal–central area is associated with the evaluation of novel stimuli for subsequent behavioural action (Friedman, Cycowicz, & Gaeta, 2001), our results suggest that, relative to atheist participants, Christian participants engaged more extensive evaluation of the suffering of those with shared beliefs in order to take further altruistic actions.

Previous research using minimal group manipulations also revealed in-group bias in empathy for pain. Hein et al. (2010) asked soccer fans to witness a fan of their favourite team or of a rival team experience pain and to choose to help the other by enduring the physical pain themselves to reduce the other's pain. They found that helping in-group members was best predicted by the anterior insular activation when seeing an in-group member's pain and by associated self-reports of empathic concern. Montalan, Lelard, Godefroy, and Mouras (2012) reported that participants who were assigned to different groups based on their cognitive performances also showed in-group bias in imaging others' painful feelings. Sheng and Han (2012) found that participants who were assigned to the same team for a competition game showed increased empathic neural responses to in-group but other-race members. In all these studies, an observer and a target to be observed did not have any interpersonal relationships. Similarly, participants and models were strangers to each other in the current study. Therefore, it is the intergroup relationship rather than interpersonal relatedness that plays a key role in modulations of empathic neural responses in these studies. However, these findings do not exclude the possibility that interpersonal relatedness may influence empathic neural responses in a specific situation. For example, Singer et al. (2006) found that an emotional link between an observer and a target resulted in variation of empathic neural responses in the anterior insula. Therefore, it may be proposed that both intergroup and interpersonal relationships shape empathic neural responses to others' suffering.

In conclusion, our ERP results showed evidence that shared religious or irreligious beliefs similarly increased empathic neural responses to others' suffering. Our results complement the previous research of influences of cultural experiences on human brain activity (Han & Northoff, 2008; Han et al., 2013). Our findings suggest that similarity in physical appearance between an observer and a target is not necessary for producing in-group favouritism in empathy and mere shared beliefs can enhance shared feelings in human adults. Such in-group favouritism

[1] The Blue book of religions: Annual report of religions in China. Beijing: Social Sciences Academic Press. 2011.

in emotion understanding and sharing may play a fundamental role in human behaviour such as cooperation that strongly distinguishes between in-group and out-group members (Henrich & Henrich, 2007).

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REFERENCES

Azevedo, R. T., Macaluso, E., Avenanti, A., Santangelo, V., Cazzato, V., & Aglioti, S. M. (2013). Their pain is not our pain: Brain and autonomic correlates of empathic resonance with the pain of same and different race individuals. *Human Brain Mapping*, *34*, 3168–3181. doi:10.1002/hbm.22133

Batson, C. D. (2011). *Altruism in humans*. New York, NY: Oxford University Press.

Burris, C. T., & Jackson, L. M. (2000). Social identity and the true believer: Responses to threatened self-stereotypes among the intrinsically religious. *British Journal of Social Psychology*, *39*, 257–278. doi:10.1348/014466600164462

Davis, M. H. (1983). The effects of dispositional empathy on emotional reactions and helping: A multidimensional approach. *Journal of Personality*, *51*, 167–184. doi:10.1111/j.1467-6494.1983.tb00860.x

Davis, M. H. (1996). *Empathy: A social psychological approach*. Boulder, CO: Westview Press.

De Waal, F. B. M. (2008). Putting the altruism back into altruism: The evolution of empathy. *Annual Review of Psychology*, *59*, 279–300. doi:10.1146/annurev.psych.59.103006.093625

Decety, J., & Jackson, P. L. (2006). A social-neuroscience perspective on empathy. *Current Directions in Psychological Science*, *15*, 54–58. doi:10.1111/j.0963-7214.2006.00406.x

Decety, J., Yang, C., & Cheng, Y. (2010). Physicians down-regulate their pain empathy response: An event-related brain potential study. *Neuroimage*, *50*, 1676–1682. doi:10.1016/j.neuroimage.2010.01.025

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. doi:10.1016/j.pain.2010.12.005

Elfenbein, H. A., & Ambady, N. (2002). On the universality and cultural specificity of emotion recognition: A meta-analysis. *Psychological Bulletin*, *128*, 203–235. doi:10.1037/0033-2909.128.2.203

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 Reviews*, *35*, 903–911. doi:10.1016/j.neubiorev.2010.10.009

Fan, Y., & Han, S. (2008). Temporal dynamic of neural mechanisms involved in empathy for pain: An event-related brain potential study. *Neuropsychologia*, *46*, 160–173. doi:10.1016/j.neuropsychologia.2007.07.023

Friedman, D., Cycowicz, Y. M., & Gaeta, H. (2001). The novelty P3: An event-related brain potential (ERP) sign of the brain's evaluation of novelty. *Neuroscience & Biobehavioral Reviews*, *25*, 355–373. doi:10.1016/S0149-7634(01)00019-7

Greenwald, A. G., McGhee, D. E., & Schwartz, J. L. K. (1998). Measuring individual differences in implicit cognition: The implicit association test. *Journal of Personality and Social Psychology*, *74*, 1464–1480. doi:10.1037/0022-3514.74.6.1464

Greenwald, A. G., Nosek, B. A., & Banaji, M. R. (2003). Understanding and using the implicit association test: I. An improved scoring algorithm. *Journal of Personality and Social Psychology*, *85*, 197–216. doi:10.1037/0022-3514.85.2.197

Gu, X., & Han, S. (2007). Attention and reality constraints on the neural processes of empathy for pain. *Neuroimage*, *36*, 256–267. doi:10.1016/j.neuroimage.2007.02.025

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. doi:10.1523/JNEUROSCI.4844-09.2010

Han, S., Fan, Y., Xu, X., Qin, J., Wu, B., Wang, X., . . . Mao, L. (2009). Empathic neural responses to others' pain are modulated by emotional contexts. *Human Brain Mapping*, *30*, 3227–3237. doi:10.1002/hbm.20742

Han, S., Gu, X., Mao, L., Ge, J., Wang, G., & Ma, Y. (2010). Neural substrates of self-referential processing in Chinese Buddhists. *Social Cognitive and Affective Neuroscience*, *5*, 332–339. doi:10.1093/scan/nsp027

Han, S., Mao, L., Gu, X., Zhu, Y., Ge, J., & Ma, Y. (2008). Neural consequences of religious belief on self-referential processing. *Social Neuroscience*, *3*, 1–15. doi:10.1080/17470910701469681

Han, S., & Northoff, G. (2008). Culture-sensitive neural substrates of human cognition: A transcultural neuroimaging approach. *Nature Reviews Neuroscience*, *9*, 646–654. doi:10.1038/nrn2456

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. doi:10.1146/annurev-psych-071112-054629

Hein, G., Silani, G., Preuschoff, K., Batson, C. D., & Singer, T. (2010). Neural responses to in-group and out-group members' suffering predict individual differences in costly helping. *Neuron*, *68*, 149–160. doi:10.1016/j.neuron.2010.09.003

Henrich, N., & Henrich, J. (2007). *Why humans cooperate: A cultural and evolutionary explanation*. Oxford: Oxford University Press.

Ibáñez, A., Hurtado, E., Lobos, A., Escobar, J., Trujillo, N., Baez, S., . . . Decety, J. (2011). Subliminal presentation of other faces (but not own face) primes behavioral and evoked cortical processing of empathy for pain. *Brain Research*, *1398*, 72–85. doi:10.1016/j.brainres.2011.05.014

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. doi:10.1016/j.neuroimage.2004.09.006

Johnson, D. (2012). What are atheists for? Hypotheses on the functions of non-belief in the evolution of religion. *Religion, Brain & Behavior*, *2*, 48–70. doi:10.1080/2153599X.2012.667948

Johnson, J. D., Simmons, C. H., Jordav, A., Maclean, L., Taddei, J., Thomas, D., … Reed, W. (2002). Rodney King and O. J. revisited: The impact of race and defendant empathy induction on judicial decisions. *Journal of Applied Social Psychology*, *32*, 1208–1223. doi:10.1111/j.1559-1816.2002.tb01432.x

Koteskey, R. L., Little, M. D., & Matthews, M. V. (1991). Adolescent identity and depression. *Journal of Psychology and Christianity*, *10*, 48–53.

Lamm, C., Decety, J., & Singer, T. (2011). Meta-analytic evidence for common and distinct neural networks associated with directly experienced pain and empathy for pain. *Neuroimage*, *54*, 2492–2502. doi:10.1016/j.neuroimage.2010.10.014

Leonardelli, G. J., & Brewer, M. B. (2001). Minority and majority discrimination: When and why. *Journal of Experimental Social Psychology*, *37*, 468–485. doi:10.1006/jesp.2001.1475

Li, W., & Han, S. (2010). Perspective taking modulates event related potentials to perceived pain. *Neuroscience Letters*, *469*, 328–332. doi:10.1016/j.neulet.2009.12.021

Ma, Y., Han, S., & Botbol, M. (2012). Is the self always better than a friend? Self-face recognition in Christians and atheists. *PLoS ONE*, *7*(5), e37824. doi:10.1371/journal.pone.0037824

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. doi:10.1016/j.neuroimage.2011.05.003

Mathur, V. A., Harada, T., Lipke, T., & Chiao, J. Y. (2010). Neural basis of extraordinary empathy and altruistic motivation. *Neuroimage*, *51*, 1468–1475. doi:10.1016/j.neuroimage.2010.03.025

Montalan, B., Lelard, T., Godefroy, O., & Mouras, H. (2012). Behavioral investigation of the influence of social categorization on empathy for pain: A minimal group paradigm study. *Frontiers in Psychology*, *3*, 389. doi:10.3389/fpsyg.2012.00389

Mu, Y., Fan, Y., Mao, L., & Han, S. (2008). Event-related theta and alpha oscillations mediate empathy for pain. *Brain Research*, *1234*, 128–136. doi:10.1016/j.brainres.2008.07.113

Saarela, M. V., Hlushchuk, Y., Williams, A. C., Schurmann, M., Kalso, E., & Hari, R. (2006). The compassionate brain: Humans detect intensity of pain from another's face. *Cerebral Cortex*, *17*, 230–237. doi:10.1093/cercor/bhj141

Sessa, P., Meconi, F., Castelli, L., & Dell'Acqua, R. (2014). Taking one's time in feeling other-race pain: An event-related potential investigation on the time-course of cross-racial empathy. *Social Cognitive and Affective Neuroscience*, *9*, 454–463.

Sheng, F., & Han, S. (2012). Manipulations of cognitive strategies and intergroup relationships reduce the racial bias in empathic neural responses. *Neuroimage*, *61*, 786–797. doi:10.1016/j.neuroimage.2012.04.028

Sheng, F., Liu, Q., Li, H., Fang, F., & Han, S. (2014). Task modulations of racial bias in neural responses to others' suffering. *Neuroimage*, *88*, 263–270. doi:10.1016/j.neuroimage.2013.10.017

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. doi:10.1016/j.biopsycho.2012.11.018

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. doi:10.1126/science.1093535

Singer, T., Seymour, B., O'Doherty, J. P., Stephan, K. E., Dolan, R. J., & Frith, C. D. (2006). Empathic neural responses are modulated by the perceived fairness of others. *Nature*, *439*, 466–469. doi:10.1038/nature04271

Sinha, J. W., Cnaan, R. A., & Gelles, R. J. (2007). Adolescent risk behaviors and religion: Findings from a national study. *Journal of Adolescence*, *30*, 231–249. doi:10.1016/j.adolescence.2006.02.005

Sporer, S. L. (2001). Recognizing faces of other ethnic groups: An integration of theories. *Psychology, Public Policy, and Law*, *7*, 36–97. doi:10.1037/1076-8971.7.1.36

Tiliopoulos, N., & Mcvittie, C. (2010). Aspects of identity in a British Christian sample. *Mental Health, Religion & Culture*, *13*, 707–719. doi:10.1080/13674670902720380

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. doi:10.1523/JNEUROSCI.2418-09.2009

Ysseldyk, R., Matheson, K., & Anisman, H. (2010). Religiosity as identity: Toward an understanding of religion from a social identity perspective. *Personality and Social Psychology Review*, *14*, 60–71.

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