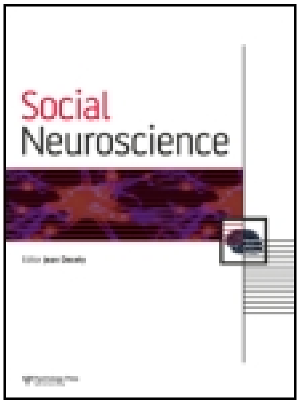

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Distinct effects of self-construal priming on empathic neural responses in Chinese and Westerners

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The present study investigated whether and how self-construal priming influences empathic neural responses to others' emotional states. We recorded event-related brain potentials to stimuli depicting the hands of unknown others experiencing painful or non-painful events from Chinese and Western participants after they had been primed in three conditions (independent self-construal priming, interdependent self-construal priming, and a control condition). Stimuli depicting painful events (as opposed to non-painful ones) elicited a positive shift of the fronto-central activity at 232–332 ms and of the central-parietal activity at 440–740 ms in the control condition. Moreover, neural responses to stimuli depicting painful (vs. non-painful) situations at 232–332 ms were decreased by interdependent self-construal priming among Chinese and by independent self-construal priming among Westerners. Our findings suggest that self-construal priming modulates sensitivity to perceived pain in unknown others and that this effect varies with culture.

Keywords: Culture; Empathy; ERP; Self-construal; Pain.

Self-construal refers to how individuals define and make meaning of the self and how one does so has a number of psychological and behavioral consequences (Cross, Hardin, & Gercek-Swing, 2011). It has been well documented that self-construals vary across cultures such that the self is viewed as bounded and autonomous (an independent self-construal) in Western cultures but is seen as interconnected and overlapping with close others (an interdependent self-construal) in East Asian cultures (Markus & Kitayama, 1991). Different self-construals tend to covary with a suite of cognitive and affective tendencies (Varnum, Grossmann, Kitayama, & Nisbett, 2010), and making different self-construals salient leads to changes in these psychological processes (Oyserman & Lee, 2008) and in neural responses (Han & Northoff, 2008; Han et al., 2013).

For example, neuroimaging studies have shown evidence that self-construal priming (a procedure that asks participants to read essays) with independent (e.g., "I", "mine") or interdependent pronouns (e.g., "we", "ours"), in order to shift their self-construals toward independence or interdependence (Gardner, Gabriel, & Lee, 1999; Oyserman & Lee, 2008), affects neural substrates underlying self-related processes. Wang et al. recorded event-related potentials (ERPs) to painful and non-painful electrical stimulations from adults after self-construal priming (Wang, Ma, & Han, in press). They found that independent (as opposed to interdependent) self-construal priming increased an early somatosensory activity over the frontal/central region in response to painful stimulation applied to participants' hands. Neural responses to images of one's own face are also modulated by

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self-construal priming such that independent (as opposed to interdependent) self-construal priming increases the right frontal activity during perception of one's own face (Sui & Han, 2007).

There is also evidence suggesting that self-construal priming affects neurocognitive processes related to others. For example, a recent transcranial magnetic stimulation (TMS) study found that interdependent self-construal primes superimposed throughout videos depicting others' hand movements (e.g., squeezing a rubber ball) increased motor-evoked potentials recorded from a participant's hand relative to a no-priming baseline condition (Obhi, Hogeveen, & Pascual-Leone, 2011), suggesting self-construal-induced changes in the motor system that may reflect self-construal effects on behavioral mimicry in social settings. In another study, Harada et al. found that the dorsal medial prefrontal cortex showed increased activity during implicit evaluation of information related to one's father (vs. a stranger) when bicultural (i.e., Asian-American) individuals were primed with independent (but not interdependent) self-construals (Harada, Li, & Chiao, 2010). Further, a recent study with Chinese young adults found that priming an interdependent self-construal increased activity in the bilateral ventral striatum in response to winning money for a friend (Varnum, Shi, Chen, Qiu, & Han, in press). Taken together, these findings suggest that self-construal priming modulates neural activity involved in cognitive and affective processing of information about the self and close others.

The present study examined whether self-construal priming modulates brain activity underlying the processing of strangers' emotional states. Specifically, we investigated the effect of self-construal priming on the neural activity elicited by perceived pain in others. We recorded ERPs from healthy adults when they perparticipants had normal or corrected-to-normal vision and were not color-blind. Informed consent was obtained prior to the study. This study was approved by a local ethic committee at the Department of Psychology, Peking University.

Self-construal priming

The materials for self-construal priming consisted of six short essays that described trips to the countryside and were used in our prior studies (Lin & Han, 2009; Sui & Han, 2007; Sui et al., 2013). Each essay consisted of 300–350 words and was presented in Chinese for Chinese participants and in English for Western participants. The priming materials contained independent pronouns (e.g., “I”, “mine”) during independent self-construal priming and interdependent pronouns (e.g., “we”, “ours”) during interdependent self-construal priming. The materials used for the control priming did not contain either type of pronoun. After reading each essay, participants had to indicate the number of occurrences of independent (or interdependent) pronouns or specific nouns (e.g., “lake,” “park”).

Visual stimuli

Visual stimuli consisted of 40 color pictures showing hands in painful situations and 40 color pictures of hands in non-painful situations (illustrated in Figure 1), similar to those used in our previous work (Fan & Han, 2008; Gu & Han, 2007). The pictures were shot from the first-person perspective and described accidents that may happen in everyday life. Painful stimuli included situations such as a hand trapped in a door or cut by scissors. The stimuli were presented in the center of a grey background on a 21-inch color monitor. Each stimulus subtended a visual angle of 2.58º × 3.43º (width × height) at a viewing distance of 100 cm. A pilot test of Chinese and Caucasian participants suggested that they were unable to tell whether hands in pictures were from Asian or Caucasians.

Procedure

Participants were presented with images of others' hands receiving painful and non-painful stimuli while an electroencephalogram (EEG) was recorded. There were 9 blocks of 80 trials for each participant. After reading one essay, EEG was recorded during three blocks of trials. The order of reading essays for independent, interdependent, and control priming was counterbalanced across participants. Each block started with the presentation of instructions for 3 s followed by 80 trails. On each trial, a painful or non-painful stimulus was presented for 200 ms at the center of the screen, which was followed by a fixation cross with a duration varying randomly between 800 and 1600 ms. Painful and non-painful stimuli were presented in a random order. Participants were asked to judge whether or not the target felt pain by a button press using the left or right index finger. The assignment of the left or right index finger to the painful and non-painful stimuli and the order of the priming procedure were counterbalanced across participants. Participants completed the Interpersonal Reactivity Index (IRI) to measure their trait-level empathy (Davis, 1983) after EEG recording. ERP recording and analysis were similar to those in our previous work (Fan & Han, 2008). Mean amplitudes of each ERP component were calculated at frontal (Fz, FCz, F3–F4, FC3–FC4), central (Cz, CPz, C3–C4, CP3–CP4), and parietal (Pz, P3–P4) electrodes.

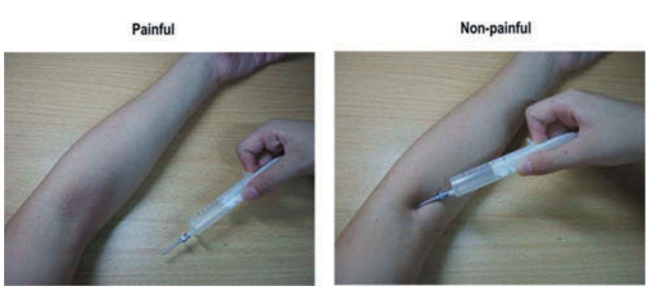

Figure 1. Illustration of a painful and a non-painful stimulus used in the current study.

RESULTS

Behavioral performance

Both behavioral and ERP data were subject to a 3 × 2 × 2 repeated-measures analyses of variance (ANOVA) with Priming (independent, interdependent, or control) × Pain (Painful vs. Non-painful) as within-subjects variables and Group (Westerners vs. Chinese) as a between-subjects variable. The ANOVA of reaction times (RTs) only showed a significant main effect of Pain, as participants responded faster to painful than to non-painful stimuli, $F(1, 34) = 10.343$, $p < .005$. Analysis of response accuracy data did not reveal any significant effects, *p*s > .1 (Table 1). There were no group differences on IRI subscales with the exception of personal distress. Chinese reported greater personal distress ratings compared to Westerners, $t(1,34) = -3.651$, $p < .001$ (Table 2).

ERP results

Grand-averaged ERPs to painful and non-painful stimuli are illustrated in Figure 2. ANOVAs of the mean ERP amplitudes at 232–332 ms, which covered both the N2 and N320 components, showed a significant main effect of Pain at fronto-central electrodes, (*F*s(1,34) = 7.28–24.36, *p*s < .01), such that painful stimuli induced a positive shift of ERP amplitude relative to non-painful stimuli. Importantly, there were significant three-way—Group × Priming × Pain—interactions observed at fronto-central electrodes (*F*s (2,68) = 3.13–5.55, *p*s < .05), indicating that priming independence decreased empathic responses for Westerners (relative to other conditions), whereas priming interdependence decreased empathic responses (relative to other conditions) for Chinese participants.

Next we analyzed the effects of priming separately for each cultural group. For Chinese participants, the ANOVAs of the ERP amplitude at 232–332 ms showed a significant main effect of Pain (*F*s (1,17) = 4.748–9.049, *p*s < .05) and a significant interaction of Pain × Priming at fronto-central electrodes (*F*s(2, 34) = 3.67–3.74, *p*s < .05). Post-hoc *t*-tests confirmed that, relative to non-painful stimuli, painful stimuli elicited a significant positive shift of the ERP amplitudes in this time window in the independent self-construal priming (*t*s(17) = 2.50–3.10, *p*s < .05) and control priming (*t*s(17) = 2.30–2.47, *p*s < .05) conditions but not in the interdependent self-construal priming condition (*p*s > .1).

For Westerners, ANOVAs of ERP amplitudes at 232–332 ms revealed a significant main effect of Pain (*F*s(1,17) = 14.765–16.184, *p*s < .01) and a significant interaction of Pain × Priming at frontal and parietal electrodes (*F*s(2, 34) = 3.46–4.16, *p*s < .05). Post-hoc *t*-tests confirmed that painful compared to non-painful stimuli significantly elicited positive shifts of the ERP amplitudes in this time window in the interdependent self-construal priming ($t(17) = 3.40$–4.04, *p*s < .005) and control priming ($t(17) = 3.21$–3.96, *p*s < .005) conditions but not in the independent self-construal priming condition (*p*s > .5).

TABLE 1
Mean RTs and response accuracy (standard deviation) in each condition

	RTs (ms)			*Accuracy (%)*		
	Control	*Independent*	*Interdependent*	*Control*	*Independent*	*Interdependent*
Westerners						
Painful	600(80)	588(91)	616(90)	79.6(10)	79.8(10.4)	79.0(8.3)
Non-painful	619(79)	616(97)	645(96)	86.4(14)	83.1(16.9)	83.6(11)
Chinese						
Painful	628(71)	649(98)	628(63)	83.7(8.9)	79.1(16.7)	82.1(8.2)
Non-painful	641(73)	671(87)	646(63)	86(11)	79.5(13.7)	85.4(8.0)

TABLE 2
Scores on IRI subscales of each group

	Westerners	*Chinese*
Perspective-taking scale	20.4(4.46)	21.0(2.93)
Fantasy scale	15.0(5.32)	17.4(2.96)
Empathic concern scale	18.6(5.56)	20.6(2.61)
Personal distress scale	11.4(6.03)	17.6(3.99)

Note: Personal distress ratings were significantly higher in Chinese than Westerners.

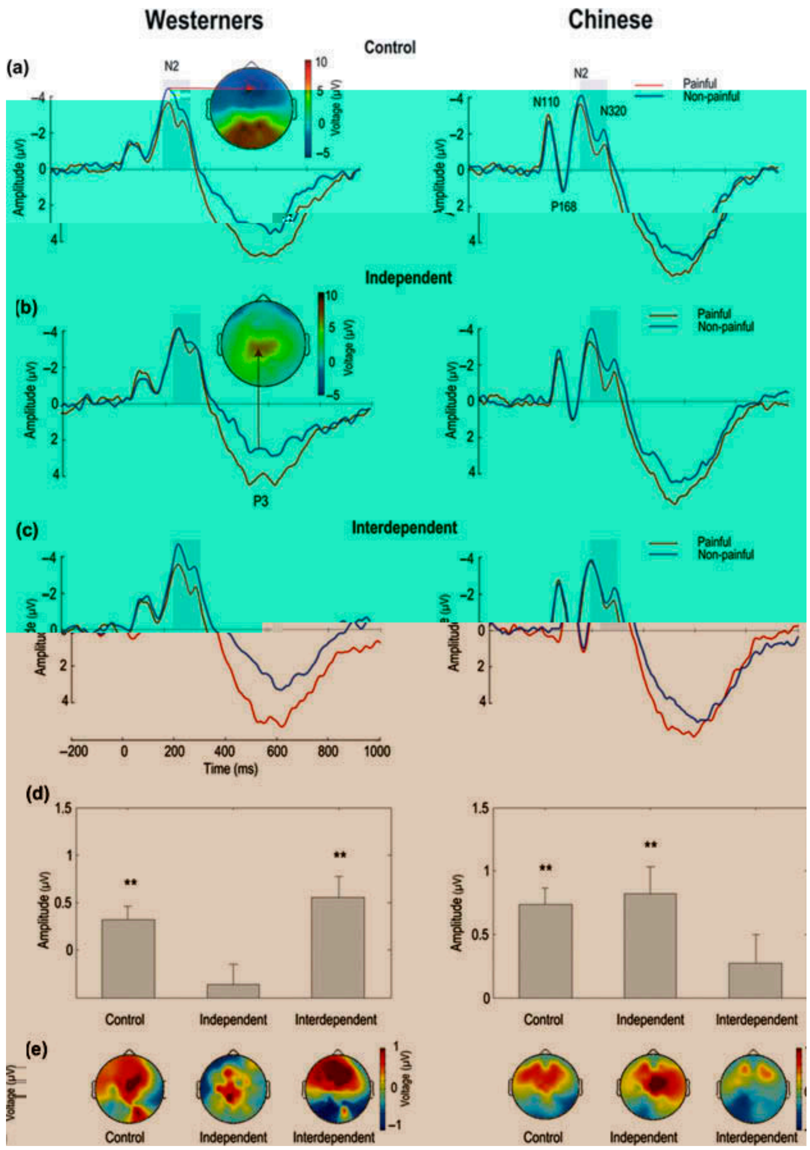

Figure 2. Illustration of ERP results in the current study. ERPs to painful and non-painful stimuli recorded at electrode F4 are illustrated in (a) the control priming condition, (b) independent self-construal priming condition, and (c) interdependent self-construal priming condition. The grey bars indicate the time window in which the ANOVA of mean ERP amplitudes showed significant 3-way interactions. (d) The mean amplitudes and standard deviations of difference waves to painful vs. non-painful stimuli at 232–332 ms post-stimulus at electrode F4 are illustrated in different priming conditions. (e) The voltage topographies illustrate the scalp distributions of the difference wave to painful vs. non-painful stimuli at 232–332 ms poststimulus in each priming condition. ** $p < .01$.

There was a main effect of Pain on mean P3 amplitudes at 440–740 ms (Fs(1,34) = 20.87–37.11, ps < .001). However, there was no significant interaction between Group, Priming, and Pain (ps > .1). Thus, self-construal priming did not significantly affect empathic neural responses in this time window.

Finally, to examine whether an individual's trait empathy can predict the effect of self-construal priming on empathic neural responses, we calculated the difference in neural responses at 232–332 ms to images of others' hands receiving painful versus non-painful stimuli between independent (or interdependent) self-construal priming and the control conditions across all participants. We then examined the correlation between IRI scores and the differential ERP amplitudes in this time window. However, correlations were not significant (ps > .5), suggesting that the effect of self-construal priming on empathic neural responses does not vary significantly as a function of individuals' trait empathy.

DISCUSSION

The current work examined the effect of self-construal priming on empathic neural responses to others' pain. Our ERP results in the control condition showed that painful stimuli elicited a positive shift in neural activity over the fronto-central regions in an early time window and over the parietal region in a later time window in both Chinese and Westerners. These results replicate previous findings (Decety et al., 2010; Fan & Han, 2008; Han et al., 2008; Li & Han, 2010) and suggest that, for both cultural groups, there are similar default neural responses to perceived pain in unknown individuals. Moreover, we found that temporarily highlighting different self-construals (e.g., interdependence or independence) significantly influenced neural responses to others' suffering. Social cognition consists of two components, i.e., processing information about the self and processing information about others (Iacoboni, 2006; Sedikides & Skowronski, 2009). Our ERP results showed that the manner in which one conceptualizes the self influences one's neural responses to others' pain. The effect of self-construal priming was limited to fronto-central activity at 232–332 ms, which is associated with the automatic component of empathy (Fan & Han, 2008). Thus, our ERP results suggest that self-construal priming modulates the early automatic component of empathy but produces little effect on the later controlled component of empathy in the P3 time window (Fan & Han, 2008).

Interestingly, we found that the effects of independent and interdependent self-construal priming on empathic neural responses significantly differed between Chinese and Westerners. Relative to the control condition, independent self-construal priming decreased empathic neural responses among Westerners, whereas interdependent self-construal priming decreased empathic neural responses among Chinese. Although chronic and temporary self-construals have been found to have parallel effects in terms of variables like cognitive style (Oyserman & Lee, 2008; Sui, Liu, & Han, 2009; Sui et al., 2013; Varnum et al., 2010), our findings hint that this may not be the case for empathic neural responses. Our findings also suggest that social contexts that promote chronic views of the self as independent or interdependent do not have a direct effect on empathic neural responses to strangers but may interact with temporarily activated self-views to modulate empathic neural responses.

One possible reason for the distinct effects of self-construal priming observed in Chinese and Westerners is the default ways in which the self is construed in Chinese and Western societies. One predominant theory holds that the independent self-construal dominates Western cultures and the interdependent self-construal dominates East Asian cultures (Markus & Kitayama, 1991). Moreover, interdependent self-construals induce a strong boundary between in-group (including the self and close others) and out-group (non-close others such as strangers), whereas independent self-construals define a strong boundary between the self and any others (including close and non-close others) (Markus & Kitayama, 2010). In cultures where the self is constituted of no one but the individual (such as the US or Western Europe), activating an independent mind-set may cause all others to be excluded from the self and thus reduce empathic responses to out-group members (i.e., unknown others). In cultures where the self is constituted of the individual and close others such as family members and friends (such as China), activating an interdependent mind-set may enhance the boundary between in-group (i.e., self and close others) and out-group (i.e., unknown others), which in turn may weaken empathic neural responses to perceived pain in unknown others. This account is in line with a recent finding that Asian-Americans (who tend to have a more interdependent view of the self) showed less empathic accuracy when determining strangers' emotions but greater accuracy when determining friends' emotions compared with European Americans (who tend to have a more independent view of the self; Ma-Kellams & Blascovich, 2012). This account is also consistent with recent findings that neural responses to out-group members' pain are significantly reduced compared to responses to in-group members' pain (Avenanti, Sirigu, & Aglioti, 2010; Hein, Silani, Preuschoff, Batson, & Singer, 2010; Sheng & Han, 2012; Sheng et al., 2013; Xu, Zuo, Wang, & Han, 2009; Sheng, Liu, Li, Fang, & Han, in press).

Previous studies have shown that empathic neural responses are modulated by a host of factors such as top–down attention to painful cues (Gu & Han, 2007), personal experiences (Cheng et al., 2007), affective connection (Singer et al., 2006), morality salience (Luo et al., in press), socioeconomic status (Ma, Wang, & Han, 2011), and intergroup experiences (Xu et al., 2009; Zuo & Han, 2013). The fact that the two cultural groups in our study did not show differences in empathic neural responses in the control condition suggests that chronic self-construals may not be one of these factors. However, as the present study did not measure the chronic self-construal of participants, the relationship between chronic self-construal and empathy remains a matter for further investigation.

One possible alternative interpretation of our results is that different routes to reduced empathy are more easily activated in different cultural contexts. Previous research suggests that while some degree of self–other overlap is necessary for empathy to occur, a strong sense of self–other overlap may actually decrease empathy (Preston & Hofelich, 2012), as may extreme self-focus (Biscardi & Schill, 1985; Konrath, Bushman, & Grove, 2009; Watson, Grisham, Trotter, & Biderman, 1984). Thus, it is possible that priming interdependence may activate an overly strong sense of self–other overlap in Chinese participants, whereas priming independence activated an overly strong sense of self-focus among Westerners. As we did not assess participants' subjective feeling of overlap with the targets, it is unclear whether the effects of interdependence priming on Chinese participants' empathic responses were due to either a greater sense of excluding the target individuals from the self or due to a greater sense of including them in the self. Although we suspect the former interpretation is more likely as interdependent self-construal involves a less rather than more permeable boundary between the self and non-close others (Falk, Heine, Yuki, & Takemura, 2009; Markus & Kitayama, 2010), future research should test these possible accounts by directly measuring participants' chronic self-construals.

Neither priming interdependent self-construals in Westerners nor priming independent self-construals in Chinese produced significant influences on empathic neural responses to others' suffering relative recorded ERPs in response to others' hands, it remains unknown whether self-construal priming modulates neural responses to others' facial expressions of pain in a way similar to what we observed here. These questions can be clarified in future research.

In sum, our findings shed new light on the relationship between self-construals and empathy for pain. Together with previous research (e.g., Sui et al., 2013), our findings suggest that self-construal priming may produce significant effects on neurocognitive processes of the self and others, and these effects may vary across cultures (e.g., Chinese and Westerners). Future research may investigate what effects such priming might have on empathy for close others, given that the previous study of Chinese showed differential neural activity in response to witnessing a friend or a stranger experiencing social pain (Meyer et al., 2013). It would also be interesting to examine the effect of self-construal priming on empathy for other emotions since de Greck et al. (2012) have found that culture influences neural correlates of empathy for anger.

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