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Cultural influences on neural basis of intergroup empathy

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ABSTRACT

Cultures vary in the extent to which people prefer social hierarchical or egalitarian relations between individuals and groups. Here we examined the effect of cultural variation in preference for social hierarchy on the neural basis of intergroup empathy. Using cross-cultural neuroimaging, we measured neural responses while Korean and American participants observed scenes of racial ingroup and outgroup members in emotional pain. Compared to Caucasian-American participants, Korean participants reported experiencing greater empathy and elicited stronger activity in the left temporo-parietal junction (L-TPJ), a region previously associated with mental state inference, for ingroup compared to outgroup members. Furthermore, preferential reactivity within this region to the pain of ingroup relative to outgroup members was associated with greater preference for social hierarchy and ingroup biases in empathy. Together, these results suggest that cultural variation in preference for social hierarchy leads to cultural variation in ingroup-preferences in empathy, due to increased engagement of brain regions associated with representing and inferring the mental states of others.

Introduction

As an obligately interdependent species, dependent on adapting to and coordinating with one's group for survival (Brewer, 2004; Caporael, 1997), culture provides us mechanisms for solving problems associated with group living and coordination (Schaller et al., 2007; Caporael, 2007; Boyd and Richerson, 1985). Variations in social processes and behaviors across cultures (i.e. individualism and collectivism) may be conceptualized as culturally-variant solutions to universally-present dilemmas associated with group living, such as managing relationships with others or limiting infections from pathogens (Hofstede, 1980; Fincher et al., 2008; Chiao and Blizinsky, 2010). Hence, cultural processes have critical consequences for how one perceives and navigates interactions with ingroup and outgroup members (Wong and Hong, 2005; Triandis and Trafimow, 2001).

One such dilemma of group living encompasses the question of how societies should address the ever-present inequalities in ability, power, and status between individuals. Cultures vary in the extent to which they expect and endorse hierarchical versus egalitarian social relations, a phenomenon known as power distance (Hofstede, 1983). Members of higher power distance cultures, such as Korea, perceive power and status as an integral part of society, while members of lower power distance cultures, such as the United States, are less likely to view society as dependent on social hierarchies (Hofstede, 1983). Cultural differences in preference for hierarchical versus egalitarian social norms may serve adaptive functions due to geographic variation in environmental pressures, such as presence of infectious diseases. Geographic regions higher in historical and contemporary pathogen prevalence, such as East Asia, tend to endorse cultural norms that reify social hierarchy and parochialism compared to regions lower in pathogen prevalence, such as the United States (Fincher et al., 2008). Cultural emphasis on conformity to hierarchical social norms and strict coalitional ingroup–outgroup divisions may have ultimately served as an ‘anti-pathogen’ defense, protecting against the potential transmission of infectious disease from outsiders.

Across individuals, the degree to an individual prefers social hierarchy over egalitarianism as a guiding principle of social structure is known as social dominance orientation (SDO) (Pratto et al., 1994; Sidanius and Pratto, 2001). Individuals high on SDO tend to endorse attitudes and support practices that reinforce social hierarchies, whereas individuals low on SDO tend to endorse attitudes and support practices promoting equality. Higher levels of SDO have been associated with lower levels of empathic concern and altruism (Pratto et al., 1994) and reduced empathic neural response when observing the emotional pain of others (Chiao et al., 2009). In contexts when group membership is relevant, preference for social hierarchy may also lead to discrepant empathic and altruistic responses towards ingroup and outgroup members. For instance, people high on SDO tend to exhibit higher levels

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of cooperation and altruism towards ingroup relative to outgroup members, and when aid is provided to outgroup members, it may be provided in a fashion that reifies distinctions in status and competence between one's ingroup and the outgroup (Halabi et al., 2008; Sidanius et al., 1994). Thus, while SDO may generally attenuate empathic processes in interpersonal contexts, SDO may modulate intergroup empathy by preferentially biasing the recruitment of empathic processes for one's ingroup relative to an outgroup.

Recent studies on the neural basis of intergroup empathy reveal that neural response within regions associated with the component processes of empathy is heightened for the pain of ingroup relative to outgroup members (Chiao and Mathur, 2010). As an integrative social process, empathy involves underlying processes that include affective mechanisms that allow the perceiver to subjectively simulate and experience the pain of another, as well as social-cognitive mechanisms that allow the perceiver to understand and infer the internal mental and emotional states of another (Davis, 1994; Decety and Jackson, 2006; Hein and Singer, 2008). These component processes underlying empathy are supported by distinct neural networks. Specifically, affective pain matrix, including the anterior cingulate cortex (ACC) and anterior insula (AI), is typically associated with the affective components of empathy, while the social-cognitive network, consisting of the medial prefrontal cortex (MPFC) and the temporoparietal junction (TPJ), has been previously associated with the cognitive components of empathy, such as perspective-taking and mentalizing (Hein and Singer, 2008; Decety and Jackson, 2006; Saxe et al., 2006; Mitchell et al., 2005).

Prior work on the neuroscience of intergroup empathy has demonstrated that perceivers show preferential neural responses in regions that support the various processes that underlie empathy when perceiving the pain of an ingroup member compared to an outgroup member (Avenanti et al., 2010; Gutsell and Inzlicht, 2010; Hein et al., 2010; Xu et al., 2009). For instance, viewing physical pain inflicted on an ingroup member has been shown to lead to greater reactivity in the affective pain matrix, particularly within the ACC and AI (Hein et al., 2010; Xu et al., 2009), and greater sensorimotor simulation (Avenanti et al., 2010) compared to viewing similar pain inflicted on outgroup members. Such ingroup biases in empathic neural reactivity has also been observed for emotional pain, but may be reflected by biases in reactivity in regions associated with the social-cognitive processes that underlie empathy. When observing the emotional suffering of others regardless of the target's race, both Black and White participants recruited the ACC and bilateral AI, yet Black participants additionally recruited MPFC, a region involved in the social-cognitive empathic processes, when observing the suffering of members of their own racial group (Mathur et al., 2010). Moreover, neural activity within MPFC in response to pain expressed by ingroup relative to outgroup members predicts greater empathy and altruistic motivation for one's ingroup, suggesting that neurocognitive processes associated with social cognition and mental state representation may underlie extraordinary empathy and altruistic motivation for the emotional pain of members of one's own racial group. Despite emerging evidence that ingroup biases in empathy may be reflected at a neurobiological level, it remains unknown whether culture affects the neural basis of intergroup empathy.

Here we examined whether cultural variation in hierarchy preference, as indexed by SDO, affects intergroup empathy at behavioral and neural levels. We hypothesized that Korean participants would show stronger preference for social hierarchy and ingroup empathy biases compared to Caucasian-American participants. We also predicted that Koreans would show stronger neural response in brain regions associated with social-cognitive processes to interpret and understand emotional and mental states for ingroup relative to outgroup members, such as the MPFC and TPJ, compared to Caucasian-Americans. Finally, we predicted that cultural variation in preference for social hierarchy would predict ingroup empathy biases due to cultural variation in neural response within brain regions underlying social cognition for ingroup members. To test these hypotheses, we used cross-cultural neuroimaging to measure neural activity in Native Koreans (K) living in South Korea and Caucasian-Americans (CA) living in the United States while they viewed ingroup and outgroup members either in painful or neutral situations.

Methods

Participants

Twenty-seven right-handed participants, 13 Native Koreans living in South Korea (5 female; $M = 23.08$ years, $SD = 4.35$), and 14 Caucasian-Americans living in the United States (7 female; $M = 25.14$ years, $SD = 4.82$), with normal or corrected-to-normal vision completed this study and were compensated \$25 or 20,000 for their participation. None of the Korean nor American participants were of mixed ethnicity. All participants provided informed consent prior to participation.

Stimuli

Stimuli consisted of naturalistic visual scenes (640 pixels × 480 pixels) depicting either Korean or Caucasian-Americans in an emotionally painful (e.g., in the midst of a natural disaster) or neutral (e.g., attending an outdoor picnic) situation (Fig. 1). A total of 96 scenes (24 for each of the four conditions) were selected. All photos were standardized for size, luminosity and background color. To ensure there were no differences in perceptions of pain across the scenes based on ethnicity of the target, all scenes were rated by 25 (14 CA and 11 K) raters for the amount of pain the person/people in the scene appeared to be in on a 7-point Likert scale. There were no significant differences in ratings for scenes that comprised each of the four conditions between the Caucasian-American and Korean raters (all $ps > 0.05$).

Procedure

All instructions, stimulus materials, and questionnaires were translated and then back-translated from English to Korean by a bilingual speaker (Brislin, 1970).

Prior to entering the scanner participants were provided instructions and example stimuli. The task involved a block design consisting of sixteen counterbalanced blocks within the functional run. Each block consisted of six unique trials of that block type. There were four block types depicting either Native Koreans or Caucasian Americans in emotional pain or neutral scenes (Fig. 1). Each of these four block types was presented four times during the functional run. During each trial, a complex visual scene was displayed for 2500 ms, which also served as a response window, followed by a centered fixation cross for 500 ms.

Participants were instructed to pay attention to each scene and provide a rating of their empathy toward the person(s) in the scene. Participants made their responses by pressing a button one to four times with their right index finger to indicate their empathy toward the target(s) (1 = "not at all", 4 = "very much"). Trials were displayed in a pseudo-random order, in which all participants saw the stimuli in the same order. Control blocks interleaved between task blocks, in which participants pressed a button with their right index finger when a simple gray square appeared, served as a baseline condition to subtract common primary processes (e.g. primary visual and motor responses).

Following scanning, participants completed the Social Dominance Orientation (SDO) scale to assess their preference for social hierarchy over egalitarianism (Pratto et al., 1994).

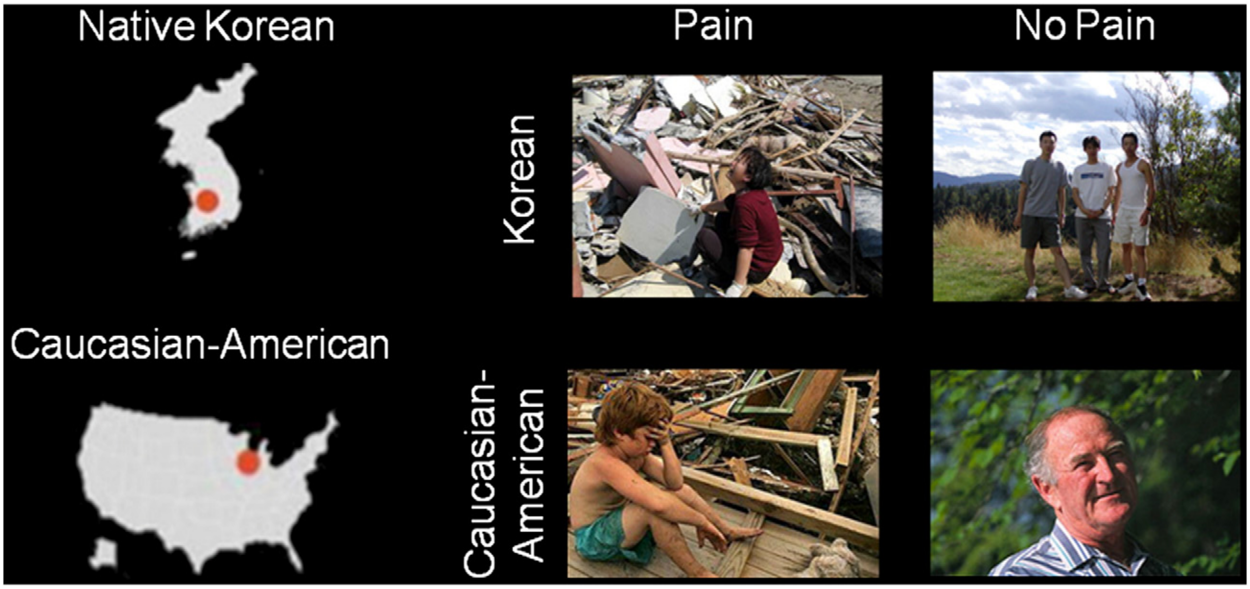

Fig. 1. Schema of sample stimuli.

fMRI parameters

Scanning at the U.S. site occurred at the Northwestern Center for Advanced Magnetic Resonance Imaging (CAMRI; Chicago, IL, USA) on a 3.0 Tesla Siemens TIM Trio MRI scanner, while scanning at the Korean Advanced Institute of Science and Technology (KAIST; Daejon, South Korea) was conducted on a comparable 3.0 Tesla ISOL-FORTE MRI scanner, using similar scanner parameters.

At CAMRI, functional images were acquired using T2*-weighted, gradient echo, echo planar imaging sequences [repetition time (TR) = 2000 ms; echo time (TE) = 25 ms; flip angle = 70°; FOV = 20 cm, 64 × 64 matrix; 34 slices; 3 mm slice thickness (no gap); in-plane resolution = 3.0 × 3.0 mm]. A high-resolution anatomical T1-weighted image was also acquired [TR = 2300 ms; TE = 2.91 ms; flip angle = 9°; FOV = 256 mm; 256 × 256 matrix; 160 slices; voxel size = 1.0 × 1.0 × 1.0 mm] for each participant. At KAIST, functional images were acquired using T2*-weighted, gradient echo, echo planar imaging sequences [repetition time (TR) = 2000 ms; echo time(TE) = 35 ms; flip angle = 70° ; FOV = 22 cm, 64 × 64 matrix; 24 slices; 4 mm slice thickness (no gap); in-plane resolution = 3.4 × 3.4 mm]. A high-resolution anatomical T1-weighted image was also acquired [TR = 10 ms; TE = 5.7 ms; flip angle = 10°; FOV = 220 mm; 256 × 256 matrix; 128 slices; voxel size = 0.86 × 0.86 × 0.86 mm] for each participant. All stimuli were presented using Presentation software (Neurobehavioral Systems, Albany, CA) and projected onto a half-transparent viewing screen located behind the head coil in the U.S. and displayed onto a small LCD display mounted on the head coil in Korea.

Prior cross-site and cross-culural neuroimaging studies have demonstrated the viability of analyzing fMRI data collected from multiple scanner sites (Chiao et al., 2010; Friedman and Glover, 2006). Given that the present study compares contrasts based upon differences in activity across blocks, differences in stimulus displays between sites would controlled through subtraction. To confirm that fMRI signal quality was comparable across the two scanner sites in the present study, we compared susceptibility related signal drop out due to B_0 inhomogeneity across the CA and Korean participant groups within our primary region of interest, the temporoparietal junction (TPJ), by drawing a sphere with a radius of 6 mm around peak voxels within the bilateral TPJ (L TPJ: $X = -42$, $Y = -47$, $Z = 41$) and (R TPJ: $X = 56$, $Y = -39$, $Z = 43$) (Chiao et al., 2008; Ojemann et al., 1997).

Functional images were analyzed using SPM2 software (Wellcome Department of Imaging Neuroscience, London, UK) implemented in Matlab (Mathworks, Cherborn, MA, USA). The first 6 volumes were discarded due to unsteady magnetization, and all of the remaining volumes were realigned spatially to the first volume and a mean image was created. After a high-resolution image was coregistered onto the mean image, all volumes were normalized to the MNI (Montreal Neurological Institute) space using a transformation matrix obtained from the normalization process of the high-resolution image of each individual participant to the MNI template. The normalized images were then spatially smoothed with an 8 mm Gaussian kernel.

After preprocessing, statistical analysis for each individual participant was conducted using the general linear model (Friston, et al., 1995). At the first level, each block was modeled by convolving with a hemodynamic response function. For each participant, a linear regressor was applied to filter noise from linear drift. In the subtraction analysis, the 4 task conditions ($\text{Ingroup}_{\text{Pain}}$, $\text{Ingroup}_{\text{Neutral}}$, $\text{Outgroup}_{\text{Pain}}$ and $\text{Outgroup}_{\text{Neutral}}$) were modeled separately, including fixation. Random effects analyses were conducted by taking the individual contrast images to the second level for statistical analysis and visualized at a statistical threshold of $p < 0.005$ uncorrected, extant threshold = 10 voxels.

To identify the common neural correlates of ingroup biases in empathy across both cultures, a whole-brain voxel-wise one sample analysis was performed on the whole sample using contrast [$(\text{Ingroup}_{\text{Pain}} - \text{Ingroup}_{\text{Neutral}}) > (\text{Outgroup}_{\text{Pain}} - \text{Outgroup}_{\text{Neutral}})$] with a statistical threshold of $p < 0.05$ (FDR) corrected, extant threshold = 10 voxels. To compare cultural variation in neural responses underlying ingroup biases in empathy between participant groups, we conducted whole-brain interaction analyses using two-sample t-tests [(Korean > CA) and (CA > Korean)] with ingroup empathy bias contrasts [$(\text{Ingroup}_{\text{Pain}} - \text{Ingroup}_{\text{Neutral}}) > (\text{Outgroup}_{\text{Pain}} - \text{Outgroup}_{\text{Neutral}})$], using a statistical threshold of $p < 0.05$ (FDR) corrected, extant threshold = 10 voxels.

Based on findings from random effects analyses, region of interest analyses (ROI) were conducted on the bilateral TPJ to examine whether cultural variation in the activity within this region may be related to reported ingroup biases in empathy and SDO. A functional ROI was defined by creating 6 mm-radius spheres around the peak voxels in the L-TPJ and R-TPJ clusters produced by the Korean > CA ingroup bias

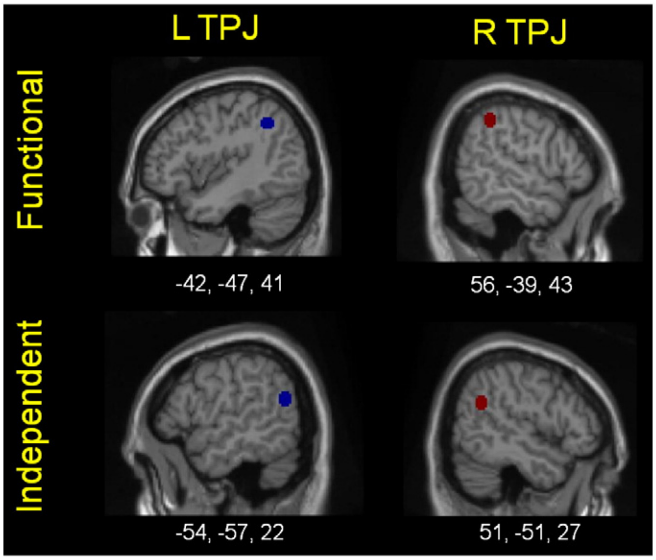

Fig. 2. Functional and independent ROIs in the bilateral TPJ. Functional and independent spherical ROIs in the left (blue) and right (red) TPJ. Independent ROIs were derived from peak activity in the left and right TPJ from Saxe and Kanwisher (2003).

whole-brain contrast. We also defined an independent ROI in the bilateral TPJ to examine whether this activity may be reflecting processs to infer mental and emotional states by drawing 6 mm-radius spheres around the peak voxels of activity identified in the L-TPJ (TAL: $X=-54$, $Y=-57$, $Z=22$) and R-TPJ (TAL: $X=51$, $Y=-51$, $Z=27$) in a study by Saxe and Kanwisher (2003) that revealed bilateral TPJ was selectively recruited when engaging in mental and emotional state inferences, but not inferences on people's physical characteristics or in non-social domains (Fig. 2). Percent signal change was extracted from both the functional and independent ROIs using Marsbar software (http://marsbar.sourceforge.net/). MNI coordinates were converted to Talairach using a non-linear transformation (http://imaging.mrc-cbu.cam.ac.uk/imaging/MniTalairach). Brodmann areas and brain regions were identified based on the Talairach Atlas (Talairach and Tournoux, 1988).

Results

Behavioral results

A 2 (*Culture of participant*: CA or K) × 2 (*Culture of target*: Ingroup or Outgroup) × 2 (*Pain of target*: Pain or Neutral) ANOVA was tested on empathy ratings. There was a significant main effect of pain, $F(1, 25)=195.86$, $p<0.001$, interaction of participant culture and pain, $F(1, 25)=33.66$, $p<0.001$, and interaction of target culture and pain, $F(1, 25)=11.78$, $p<0.005$, but these effects were qualified by a significant 3-way interaction, $F(1, 25)=21.33$, $p<0.001$. Korean participants reported significantly greater empathy for ingroup pain ($M=2.52$, $SD=0.54$) relative to outgroup pain ($M=2.19$, $SD=0.62$), $t(12)=2.72$, $p<0.05$, but CA participants did not differ in ratings between ingroup ($M=2.67$, $SD=0.51$) and outgroup ($M=2.76$, $SD=0.49$) pain, $p>0.05$. There were no significant differences in Korean participants' ratings of ingroup ($M=1.59$, $SD=0.38$) or outgroup ($M=1.75$, $SD=0.52$) neutral scenes, and CA participants' ratings of ingroup ($M=1.05$, $SD=0.09$) or outgroup ($M=1.07$, $SD=0.07$) neutral scenes, $ps>0.05$.

To further quantify cultural variation in ingroup empathy biases, an ingroup empathy bias index was computed: $[(\text{Ingroup}_{\text{Pain}}-\text{Ingroup}_{\text{Neutral}})-(\text{Outgroup}_{\text{Pain}}-\text{Outgroup}_{\text{Neutral}})]$. Korean participants ($M=0.50$, $SD=0.45$) showed greater ingroup empathy bias compared to CA participants ($M=-0.07$, $SD=0.05$), $t(25)=-4.45$, $p<0.001$ (Fig. 3a).

Korean participants (SDO: $M=3.13$, $SD=0.73$) also endorsed significantly higher levels of preference for social hierarchy compared to the CA participants (SDO: $M=2.16$, $SD=0.14$), $t(25)=-3.98$, $p=0.001$ (Fig. 3b). As predicted, across cultures, ingroup biases in empathy ratings were found to be significantly positively correlated with SDO, $r(25)=0.33$, $p<0.05$ (Fig. 3c).

fMRI results

Results from the scanner site comparison revealed no significant difference between CA and Korean participants in percentage of voxels activated in the bilateral TPJ for the main effect of pain contrast (Pain [CA & K targets]>Neutral [CA & K targets]) that survived at $p<0.01$, uncorrected threshold, extant threshold>0 voxels [L-TPJ: CA, $M=8.23\%$, $SD=21.04\%$, K, $M=25.64\%$, $SD=31.58\%$, $t(25)=-1.70$, $p>0.05$; R-TPJ: CA, $M=14.72\%$, $SD=27.28\%$, K, $M=8.62\%$, $SD=13.14\%$, $t(25)=0.73$, $p>0.05$]. Given there was no significant difference in signal drop-out within the bilateral TPJ, we conclude that there was comparable fMRI signal quality across the two scanner sites.

Across participants, greater neural activity within the MPFC, bilateral TPJ, posterior cingulate cortex (PCC), and precuneus was observed in response to ingroup compared to outgroup pain (Table 1a). Greater neural activity within left inferior frontal gyrus and right middle frontal gyrus was observed in response to outgroup compared to ingroup pain across participants (Table 1b).

When examining cultural variations in the neural correlates of ingroup empathy bias, Korean participants, exhibited greater reactivity in the bilateral TPJ and mid cingulate cortex when viewing the pain of ingroup members relative to outgroup members. Conversely, CA participants exhibited relatively greater reactivity in the right lingual gyrus when exposed to the emotional pain of ingroup relative to outgroup members (Fig. 4, Table 2).

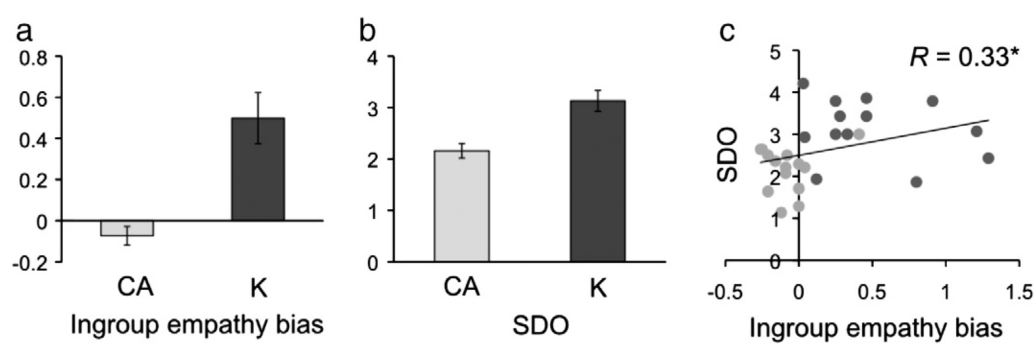

Fig. 3. Behavioral results. (a) Korean participants show significantly stronger ingroup empathy bias compared to Caucasian-American participants, $p<0.001$. (b) Korean participants show stronger preference for social hierarchy (SDO) relative to Caucasian-American participants, $p=0.001$. (c) Across cultures, ingroup empathy bias is significantly and positively correlated with SDO, $R=0.33$, $p<0.05$.

Table 1a
fMRI results for the whole sample for Ingroup Bias in empathy [$(\text{Ingroup}_{\text{Pain}}–\text{Ingroup}_{\text{Neutral}})>(\text{Outgroup}_{\text{Pain}}–\text{Outgroup}_{\text{Neutral}})$], $p<0.005$, extant threshold = 10 voxels.

MNI			TAL						
X	Y	Z	X	Y	Z	Z score	Voxels	BA	Brain area
−6	−66	18	−6	−63	20	3.65	46	31	L PCC
30	−51	−6	30	−50	−3	3.46	16	19	R parahippocampal gyrus
12	−54	9	12	−52	11	3.43	52	30	R PCC
−24	−51	−6	−24	−50	−3	3.41	11	19	L parahippocampal gyrus
−21	−81	18	−21	−78	21	3.81	10	18	L cuneus
33	−75	18	33	−72	20	3.79	24	31	R precuneus
−9	60	30	−9	60	25	3.77	13	10	L MPFC
42	−42	48	42	−39	46	3.56	26	40	**R TPJ**
−36	−45	45	−36	−42	44	3.15	14	40	**L TPJ**
27	−81	30	27	−77	32	3.45	11	7	R cuneus

Bold data are primary regions of interest among the regions listed on the table.

Functional ROI analyses within bilateral TPJ revealed a significant culture x target interaction in both the L-TPJ, $F(1, 25)=37.22$, $p<0.001$, and R-TPJ, $F(1, 25)=28.87$, $p<0.001$ as well as a significant main effect of target was observed in both the L-TPJ, $F(1, 25)=7.73$, $p=0.01$, and R-TPJ, $F(1, 25)=17.00$, $p<0.001$ (Figs. 5 and 6). Koreans exhibited significantly greater activity in the bilateral TPJ when viewing the pain of ingroup members compared to outgroup members (L-TPJ: $\text{ingroup}_{\text{pain–neutral}}M=0.29$, $SD=0.28$, $\text{outgroup}_{\text{pain–neutral}}M=-0.02$, $SD=0.14$), $t(12)=6.24$, $p<0.001$; R-TPJ: $\text{ingroup}_{\text{pain–neutral}}M=0.29$, $SD=0.33$, $\text{outgroup}_{\text{pain–neutral}}M=-0.18$, $SD=0.20$, $t(12)=5.56$, $p<0.001$). Conversely, CA participants exhibited significantly lower L-TPJ activity when viewing the pain of ingroup members compared to outgroup members ($\text{ingroup}_{\text{pain–neutral}}M=-0.04$, $SD=0.15$, $\text{outgroup}_{\text{pain–neutral}}M=0.08$, $SD=0.12$), $t(13)=-2.37$, $p<0.05$), and no difference in R-TPJ activity between conditions. Moreover, Korean participants displayed greater reactivity in the bilateral TPJ than CA participants when viewing ingroup members in pain relative to neutral situations, L-TPJ: $t(25)=-3.89$, $p=0.001$; R-TPJ: $t(25)=-2.55$, $p<0.05$.

Independent ROI analyses revealed an identical pattern of activity in the independent L-TPJ ROI. Koreans exhibited significantly greater activity in the independent L-TPJ ROI when viewing the pain of ingroup members compared to outgroup members ($\text{ingroup}_{\text{pain–neutral}}$: $M=0.27$, $SD=0.37$, $\text{outgroup}_{\text{pain–neutral}}$: $M=0.03$, $SD=0.21$), $t(12)=3.06$, $p<0.005$. Conversely, CA participants exhibited significantly lower L-TPJ activity when viewing the pain of ingroup members compared to outgroup members ($\text{ingroup}_{\text{pain–neutral}}$: $M=-0.10$, $SD=0.14$, $\text{outgroup}_{\text{pain–neutral}}$: $M=0.02$, $SD=0.16$), $t(13)=-2.41$, $p<0.05$). Moreover, Korean participants displayed greater reactivity in the L-TPJ than CA participants when viewing ingroup members in pain relative to neutral situations, $t(25)=-3.44$, $p<0.005$. There were no significant effects in the independent R-TPJ ROI, $ps>0.05$.

Across cultures, neural response within L-TPJ during ingroup bias in empathy [$(\text{Ingroup}_{\text{Pain}}–\text{Ingroup}_{\text{Neutral}})-(\text{Outgroup}_{\text{Pain}}–\text{Outgroup}_{\text{Neutral}})$] was positively correlated with ingroup biases in empathy ratings in functional ROI: $r(25)=0.46$, $p<0.05$, and independent ROI: $r(25)=0.57$, $p<0.005$ (Fig. 4b). Similarly, a positive correlation was also observed between L-TPJ activity during ingroup bias in empathy and SDO for both the functional, $r(25)=0.53$, $p=0.005$, and independent, $r(25)=0.42$, $p<0.05$, ROIs (Fig. 4c). Activity in the functional R-TPJ ROI during ingroup bias was also positively correlated with ingroup bias empathy ratings, $r(25)=0.62$, $p<0.001$, but not SDO, $p>0.05$.

A mediation model was tested to examine whether the relationship observed between SDO and ingroup biases in empathy ratings may be mediated by preferential activity in the L-TPJ for the emotional pain of ingroup members. A marginally significant mediation of SDO and ingroup empathy bias by activity L-TPJ activity was observed for both the functional (Sobel $Z=1.64$, $p=0.10$) and independent ROIs (Sobel $Z=1.85$, $p=0.06$). Importantly, this mediation was moderated by the culture of the participant, such that neither the direct nor indirect effects in the model were significant when participant culture was controlled for. In other words, this relationship between SDO, neural reactivity, and ingroup biases in empathy is contingent on cultural variation within these psychological and neural processes. The mediation was not supported for activity in the R-TPJ.

Discussion

Here we demonstrate that cultural variation in neural responses underlying intergroup empathy varies as a function of preference for social hierarchy. Koreans showed stronger preference for social hierarchy and ingroup biases in empathy relative to Caucasian-Americans. Additionally, Koreans showed stronger neural response within bilateral TPJ compared to Caucasian-Americans and neural response within these regions was associated with both preference for social hierarchy and ingroup empathy biases. Finally, mediation analyses revealed a trend such that cultural variation in hierarchy preferences predicted cultural variation in ingroup empathy biases due to the modulation of TPJ response to ingroup compared to outgroup emotional pain by culture. Taken together, these findings suggest that TPJ may play an important role in mediating the pathway by which cultural values influence intergroup processing in brain and behavior.

The network of regions recruited during ingroup bias in empathy represents a network supporting cognitive processes involved in empathy to understanding the internal states of another (Ruby and Decety, 2003; Vollm et al., 2006; Young et al., 2010). It has been suggested that within this network, only the TPJ may be selectively involved in representing and inferring the mental states of others (Saxe et al., 2006; Saxe and Wexler, 2005; Mitchell et al., 2005).

Accordingly, activity in the bilateral TPJ observed in the present study likely reflects engagement of these processes to infer and understand the mental and emotional experiences of another. First, preferential activity in this region when observing ingroup pain corresponds to greater levels of reported ingroup biases in empathy, suggesting that activity in this region is tracking a critical aspect of empathic processing. Consistent with this notion, social-cognitive processes associated with TPJ activity, such as theory of mind and mental state inference, have been noted to be major components of empathy (Hein and Singer, 2008; Decety and Jackson, 2006). Second, analysis of an independently defined L-TPJ ROI from a study that found

Table 1b
fMRI results for the whole sample for Outgroup Bias in Empathy [$(\text{Outgroup}_{\text{Pain}}–\text{Outgroup}_{\text{Neutral}})>(\text{Ingroup}_{\text{Pain}}–\text{Ingroup}_{\text{Neutral}})$], $p<0.005$, extant threshold = 10 voxels.

MNI			TAL						
X	Y	Z	X	Y	Z	Z score	Voxels	BA	Brain area
−48	36	9	−48	35	7	3.06	15	45	L IFG
27	27	42	27	28	37	2.91	16	8	R middle frontal gyrus

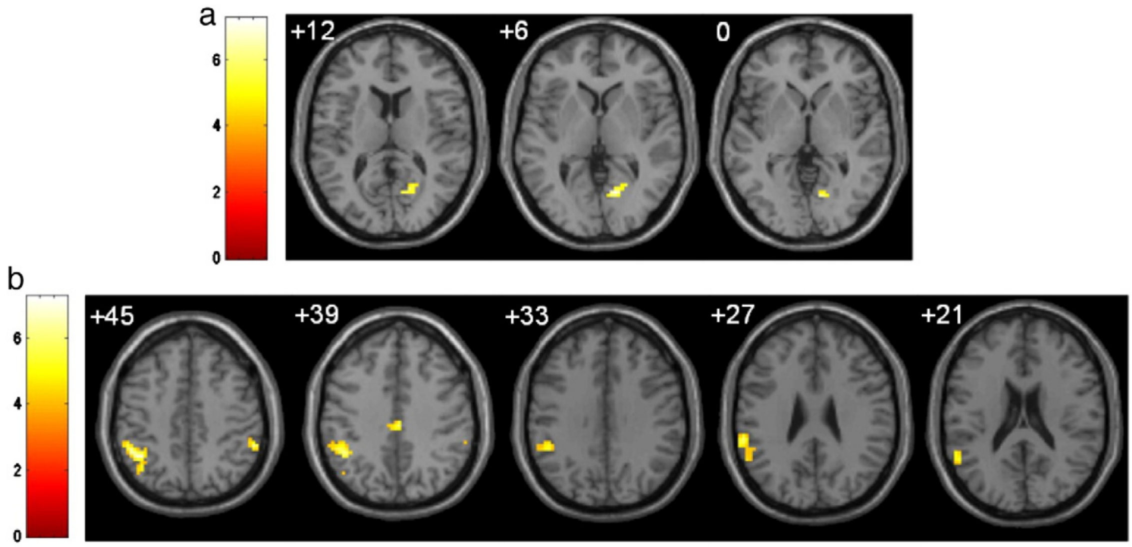

Fig. 4. Results of whole-brain interaction contrast for culture and ingroup empathy [$(\text{Ingroup}_{\text{Pain}}–\text{Ingroup}_{\text{Neutral}}) - (\text{Outgroup}_{\text{Pain}} - \text{Outgroup}_{\text{Neutral}})$], $p<0.05$ (FDR corrected), $k=10$. A) CA participants, relative to Korean participants, exhibited greater activity in the R lingual gyrus. B) Korean participants, relative to CA participants exhibited greater activity in the bilateral TPJ, mid cingulate cortex, and L temporal gyrus.

selective reactivity of the TPJ to inferences of thoughts and desires produced nearly identical results as our analysis of the functional ROI observed in the L-TPJ. Though right-lateralized TPJ activity has been primarily implicated in mental state inference, studies of mental state inference typically observe bilateral TPJ activity (Spreng et al., 2008), and left-lateralized TPJ lesions have been shown to critically impair mental state inference (Samson et al., 2004).

Activity within the R-TPJ has also been implicated in exogenous attention and deployment towards unexpected stimuli rather than mental state inference per se (Decety and Lamm, 2007). Yet it is unlikely that the TPJ activity in the present investigation is merely reflecting greater attentional deployment. First, TPJ activity is not localized only to the right hemisphere, but is observed bilaterally, suggesting a profile of activity that is consistent with the bilateral TPJ activity observed in mental state inference tasks (Saxe and Kanwisher, 2003; Saxe and Powell, 2006). Second, recent evidence suggests that bilateral TPJ activity is elicited when inferring mental state content independent of the level of attentional demand (Young et al., 2010). Finally, exogenous attention and cueing is expected to be strongest for low-frequency and unexpected stimuli (Bledowski et al., 2004; Vossel et al., 2009). If the TPJ activity observed in the present study indeed reflected exogenous attention, such activity would be strongest for outgroup targets, rather than ingroup targets, given the lower familiarity and frequency of exposure to outgroup images that could be expected from our sample.

Regions involved in theory of mind processing and mental state inference, such as the TPJ, have also previously been shown to reflect processes associated with autobiographical memory (Rabin et al., 2009; Spreng et al., 2008). Given that people in contemporary society often have cultural exposure to natural disasters from the media, it is possible that the TPJ activity observed in the current study reflects retrieval of autobiographical memory for natural disasters that occurred within the participant's country or region. However, we suggest that autobiographical memory retrieval is an unlikely explanation for the current finding for the following reasons. First, while the hippocampus is typically recruited during processing of personal experiences in episodic and autobiographical memory (Rabin et al., 2009; Rosenbaum et al., 2008), we observed no cultural variation in hippocampus response in the current study, suggesting that personal memories are not a likely explanation of cultural variation in empathic neural response. Furthermore, though the two processes may recruit a similar network of regions, recent neuroimaging studies comparing and contrasting the two processes have revealed distinct patterns of activity between them within this network, particularly with autobiographical memory engaging medial regions to a greater extent compared to theory of mind, which engages lateral regions to a greater extent, such as the TPJ (Spreng and Grady, 2010; Rabin et al., 2009). Finally, theory of mind and autobiographical memory are not necessarily competing processes, and in fact, may be dependent on shared underlying processes, such as projection of the self beyond the present context or into another's perspective (Buckner and Carroll, 2007). Hence, we conclude that autobiographical memory is not a likely interpretation of our current finding of cultural variation in TPJ response during ingroup empathy.

Though the Korean participants endorsed greater ingroup biases in empathy, their empathy for outgroup members in pain was still

Table 2
fMRI results between groups for Ingroup Bias in Empathy [$(\text{Ingroup}_{\text{Pain}}–\text{Ingroup}_{\text{Neutral}})>(\text{Outgroup}_{\text{Pain}}–\text{Outgroup}_{\text{Neutral}})$], $p<0.05$ (FDR corrected), extant threshold = 10 voxels.

MNI			TAL						
X	Y	Z	X	Y	Z	Z score	Voxels	BA	Brain area
CA>Korean									
15	−66	3	15	−64	6	5.32	50	19	R lingual gyrus
Korean>CA									
−42	−51	42	−42	−47	41	5.27	204	40	**L TPJ**
57	−42	45	56	−39	43	4.77	17	40	**R TPJ**
3	−24	39	3	−21	37	4.56	17	24	Mid cingulate cortex
−54	−63	15	−54	−60	17	4.06	15	19	L middle temporal gyrus
−54	−54	−3	−54	−52	0	4.04	12	37	L inferior temporal gyrus

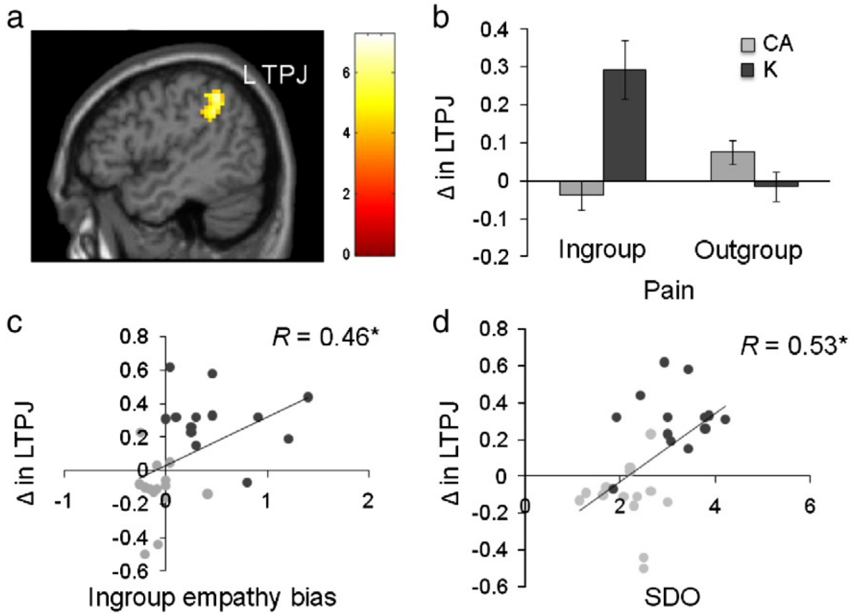

Fig. 5. Neural response in L TPJ and its relation to ingroup empathy bias and SDO. (a) Left TPJ cluster recruited to a greater extent among Korean relative to Caucasian-American participants when viewing ingroup versus outgroup members in pain, $p<0.05$ (FDR corrected), $k=10$. (b) Koreans, but not Caucasian-Americans, show greater L TPJ response for ingroup compared to outgroup pain, $F(1, 25)=37.22$, $p<0.001$. (c) Behavioral ingroup empathy bias is positively correlated with LTPJ response to ingroup>outgroup pain, $R=0.46$, $p<0.001$. (d) SDO is positively correlated with LTPJ response to ingroup>outgroup pain, $R=0.53$, $p=0.005$.

significantly higher than empathy ratings for outgroup members in neutral situations. These findings suggests that Korean participants may be engaging in "extraordinary empathy", or stronger empathy for the ingroup rather than indifference of hostility towards the outgroup (Mathur et al., 2010; Brewer, 1999). Moreover, viewing outgroup relative to ingroup members in pain did not elicit activity in any regions involved in reward processing, such as the nucleus accumbens, further suggesting that observed ingroup biases in empathy were driven by especially strong empathic reactivity to the pain of one's ingroup, rather than an absence of empathy, or even schadenfreude, towards the outgroup (Hein et al., 2010; Cikara et al., 2011).

Here we theorize that the observed cultural variability in the recruitment of the L-TPJ, rather than regions associated with the visceral and affective components of empathy (ACC, AI), reflects distinct social-cognitive processes may be recruited during intergroup empathy within a hierarchical versus egalitarian culture. Successfully navigating a hierarchical culture may require greater ability to infer

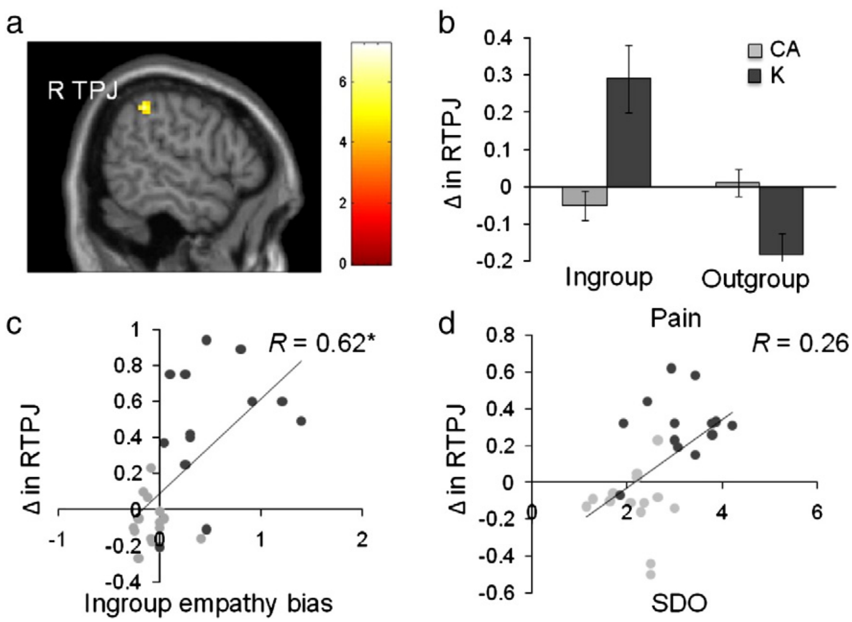

Fig. 6. Neural response in R TPJ and its relation ingroup empathy bias and SDO. (a) Right TPJ cluster recruited to a greater extent among Korean relative to Caucasian-American participants when viewing ingroup versus outgroup members in pain, $p<0.05$ (FDR corrected), $k=10$. (b) Koreans, but not Caucasian-Americans, show greater R TPJ response for ingroup compared to outgroup pain, $F(1, 25)=28.87$, $p<0.001$. (c) Behavioral ingroup empathy bias is positively correlated with R TPJ response to ingroup>outgroup pain, $R=0.62$, $p<0.001$. (d) SDO is not significantly correlated with R TPJ activity.

the mental states and needs of ingroup members in a manner consistent with hierarchical rule-based social norms. For instance, Confucian principles that have influenced East-Asian societies, stress that social order and harmony can be achieved through acting within the boundaries of one's place in the social hierarchy (Nisbett et al., 2001). However, studies of the interpersonal consequences of power suggest that power differences attenuate the ability to engage social cognitive processes typically associated with simulation brain regions (e.g., MPFC), such as perspective-taking (Decety and Jackson, 2006; Galinsky et al., 2006). Inferring and responding to the needs of ingroup members via conceptual rather than simulation processes may facilitate fulfilling obligations and reinforcing social harmony within hierarchical cultures in a manner consistent with formal social roles and norms. Though the process of understanding others through simulation may also recruit regions besides the MPFC, such as the inferior frontal gyrus and parietal lobe (Mitchell et al., 2005), which were also identified to be recruited during ingroup bias in the present study, the robust cultural variation in activity in the TPJ appears to suggest a central role of inferential social processes. Future cultural neuroscience research is needed to further understand cultural variation in recruitment of simulative versus inferential mechanisms during empathy, and social cognition more broadly.

In conclusion, cultural variation in preference for social hierarchy modulates neural response underlying intergroup empathy. The current investigation provides a foundation for future cultural neuroscience research (Chiao and Ambady, 2007; Chiao, 2009; Han and Northoff, 2008) examining how cultural values related to hierarchy preference modulate social brain mechanisms underlying intergroup processes.

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