Asian Journal of Social Psychology

Asian Journal of Social Psychology (2010), **13**, 83–91 DOI: 10.1111/j.1467-839X.2010.01303.x

D namic bic lt ral brains: fMRI st d of their exible ne ral representation of self and signi cant others in response to c lt re primes

Sik Hung Ng,[1] Shihui Han,[2] Lihua Mao[2] and Julian C. L. Lai[1]

[1] [illegible] A[illegible], C[illegible] [2] [illegible] B[illegible], C

Where in the brain are the self and significant others (e.g. mother) represented? Neuroscientists have traced self-representation to the ventral medial prefrontal cortex for both Westerners and East Asians. However, significant others were represented alongside the self in the same brain area for East Asians but not for Westerners. In this experiment, Westernized bicultural Chinese were scanned using functional magnetic resonance imaging while performing trait judgments that referenced the self, mother, or a non-identified person (NIP) after Western or Chinese culture priming. Consistent with Western independent self-construals and Chinese interdependent self-construals, Western priming increased, whereas Chinese priming decreased the neural differentiation of mother and NIP from self.

[illegible] ([illegible]),

Introd ction

'Who am I?' is a question that interests not only social scientists (Ashmore & Jussim, 1997) but also neuroscientists (Damasio, 2003). One aspect of this broad question concerns the social contents of the cognitive structure of the self-concept, or, more specifically, who are included in or differentiated from the self-concept, and why. Three mechanisms of 'self-inclusiveness' and 'self-other differentiation' can be discerned from the social and cultural psychology literature, one affective (based on intimacy in interpersonal contexts), another cognitive (based on self-categorization in intergroup contexts), and the third cultural (based on independent and interdependent self-construals). In the present paper, we review the mechanisms and propose a bicultural frame switching model for understanding the flexible neural representation of the self and others in bicultural brains.

Self-inclusiveness and self-other differentiation: Evidence from social and cultural psychology

Interpersonally close or intimate others are referred to as 'we,' 'us' and 'our' in self-other descriptions, suggesting that they are perceived as part of the self (Agnew, Van Lange, Rushbult, & Langston, 1998). They are also more easily confused than less intimate others with self in 'source confusion' tasks that are designed to assess the overlap of different categories of people with the cognitive structure of the self (Mashek, Aron, & Boncimino, 2003). These and related findings point to affective processes in self-inclusiveness, as summarized in the self-expansion reference model: 'participants in a close relationship include each other in their selves in the sense that other's perspectives, resources, and identities are to some extent one's own' (Aron, Aron, & Norman, 2004, p. 111). Others not in a close relationship with the person are differentiated from the person's self.

Although intimacy enhances self-inclusiveness and the lack of it enhances self-other differentiation, it is not a necessary condition. Shared group membership resulting from cognitive self-categorization processes independently of interpersonal intimacy has been found to be sufficient for including ingroup members in and differentiating outgroup members from the self-concept (Turner, 1978; Turner, Hogg, Oakes, Reicher, & Wetherell, 1987). Corresponding to the interpersonal affective and the intergroup cognitive mechanisms are relational and collective self-definitions, respectively, which 'represent two different forms of social identification; that is, processes by which the individual self is extended to include others as integral to the self-concept' (Brewer & Chen, 2007, p. 137).

While the two mechanisms of self-inclusiveness and self-other differentiation are assumed to be universally applicable to all cultures, the cultural context that has shaped the self-concept also has a role to play. In cultural

[illegible]: Sik Hung Ng, Department of Applied Social Studies, City University of Hong Kong, Tat Chee Avenue, Kowloon, Hong Kong SAR, China. Email: sikhung.ng@cityu.edu.hk or Shihui Han, Department of Psychology, Peking University, 5 Yiheyuan Road, Beijing, 100871, Beijing, China. Email: shan@pku.edu.cn

Received 28 April 2009; accepted 15 December 2009.

psychology, two popular constructs for East-West comparisons are interdependent versus independent self-construal (Markus & Kitayama, 1991) and collectivism versus individualism (Hofstede, 1980; Triandis, 1995). Similar East-West contrasts are used in conjoint and disjoint models of agency (Markus & Kitayama, 2003), as well as relatedness and autonomy (Kagitçibasi, 2005). This family of concepts converges in proposing that whereas interdependent self-construal and collectivism are more typical of Eastern cultures (e.g. Chinese and Japanese), independent self-construal and individualism are more typical of Western cultures (e.g. Euro-American). Although the concepts have been criticized on conceptual and methodological grounds (e.g. Brewer & Chen, 2007; Levine ., 2006; Oyserman, Coon, & Kemmelmeier, 2002), they remain useful for generating propositions with respect to cultural variations in self-inclusiveness and self-other differentiation. More specifically, others are more likely to be mentally represented as part of the self when the culture that has shaped it values social connectedness (interdependent self-construal, collectivism, and so forth) whereas others are more likely to be differentiated from the self in cultures that value individuating uniqueness (independent self-construal, individualism, and so forth).

Self-inclusiveness and self-other differentiation: Evidence from cultural neuroscience

Several cultural neuroscience studies provide neural evidence for the expectation that self-inclusiveness is stronger in Easterners whereas self-other differentiation is stronger in Westerners. Functional magnetic resonance imaging (fMRI) studies scanning Europeans found that only the self was represented in the ventral medial prefrontal cortex (VMPFC) (D'Argembeau, A., Collette, F., Van der Linden, M. ., 2005; Fossati ., 2003; Han . 2008; Heatherton ., 2006; Macrae, Moran, Heatherton, Banfield, & Kelley, 2004; Northoff & Bermpohl, 2004; Northoff, DeGreck, Bermpohl, & Panksepp, 2006). For Chinese, however, both the self and mother were represented in the same brain area (Zhu, Zhang, Fan, & Han, 2007). Zhu . (2007) interpreted their neuroimaging results as supportive of Markus and Kitayama's (1991) theory of interdependent versus independent self-construal: the neural structure of the Chinese self is more closely connected with others (interdependent self-construal) whereas that of Westerners is more highly differentiated from others (independent self-construal). Chinese may use VMPFC to reference both

Bicultural participants

For nearly two centuries, Hong Kong has been at the confluence of Chinese and Western cultures, a period long enough to bring about biculturalism in languages, lifestyles, cinematic industries, values, education, commerce and businesses, as well as religious and child-rearing practices (Bond, 1993; Ng, 2007). It is a suitable milieu for biculturalism research, certainly among its population of bilingual university students (Hong ., 2000; Ng & Lai, 2009; Ng & Lai, in press). As a precautionary measure, in the present study, only those students who were brought up in Hong Kong and scored above the mean on a bicultural self questionnaire were selected. The four-item questionnaire, developed by Ng and his associates (Ng & Lai, in press; Ng, Yam, & Lai, 2007), had been shown to be able to distinguish individuals who were high in both Chinese self and Western self from those who were high in only one or none, on such bicultural criteria as language use, preference for bicultural entertainments and festivals, and bicultural integration (Benet-Martínez & Haritatos, 2005; LaFromboise, Coleman, & Gerton, 1993).

Eighteen graduate or undergraduate students from the City University of Hong Kong (six men and 12 women between the ages of 20 and 27 years) participated in this study as paid volunteers. (Three of them were excluded from data analysis because of excessive head movement during scanning.) They were right-handed and had normal or corrected-to-normal vision. None had any neurological or psychiatric history. Their Chinese self and Western self scores were, respectively, above 4.74 and 4.68 on a seven-point scale where seven represented the strongest self. Informed consent was obtained before testing. This study was approved by a local ethics committee.

Western and Chinese culture primes

As Hong Kong is a receptacle of not only British but also American and continental European cultures, pictures for the Western culture priming condition were carefully chosen to represent these varieties of Western culture. Similarly, pictures for the Chinese culture priming condition were chosen to represent not only Mainland Chinese but also Hong Kong Chinese culture. Each set of culture primes consisted of 13 pictures covering five cultural domains (foods and drinks, music and arts, popular movie stars, religion and legend, as well as folklores and famous constructions), and were matched between Chinese and Western cultures as closely as possible; for example, Bruce Lee (Kung Fu) was matched with Roger Moore (James Bond). The pictures were therefore more relevant to the Hong Kong context than those used by Hong . (2000), and were found to be effective in inducing prime-consistent changes (Ng & Lai, 2009).

Scanning procedure

Half of the participants were Western culture primed on the first day of the study and Chinese culture primed a day later. The order was reversed for the other half of participants. The pictures were presented one after another, each lasting 10 s. After the first round of presentation, nine of the pictures were presented again one at a time, each time followed by the question 'Which culture does it represent, Chinese or Western?' All participants answered correctly. The remaining four pictures were then presented, each followed by the instruction 'Use three adjectives to describe the culture depicted in this picture.' Afterwards, the participant was asked to write a short paragraph in response to 'In what ways has the culture shown in the pictures helped you develop yourself?' The questions and instructions were written in Chinese and English, and the whole exercise was designed to deepen participants' attention to the primed culture.

There were two functional scans after either Chinese or Western culture priming, each consisting of four blocks (judgment tasks, Fig. 1). The participant was scanned while performing personality trait judgment tasks. The stimuli were presented through an liquid crystal display (LCD) projector onto a rear-projection screen mounted above the participant's head. The screen was viewed with an angled mirror positioned on the head coil. In each scan, the

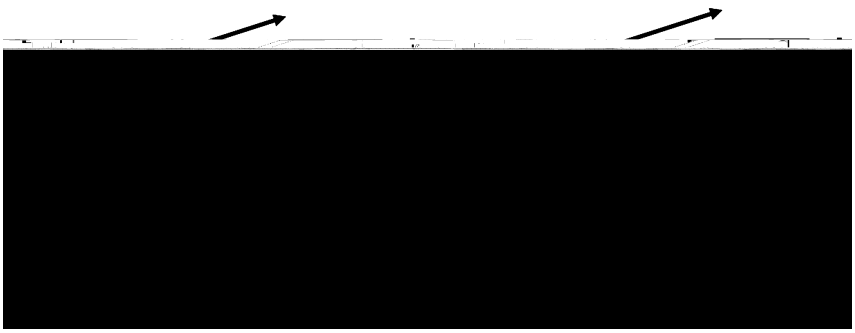

Figure 1 Illustration of the stimuli and procedure.

participant conducted the following judgment tasks in random order. (i) Self judgment: Does this adjective describe you? (ii) Mother judgment: Does this adjective describe your mother? (iii) NIP: Does this adjective describe a person whom you would not identify with, excluding your parents? (iv) Font judgment: Is the word presented in bold or normal style?

judgments, and between self- and NIP-judgments were defined for each participant. These individual contrast images were then submitted to a second-level random-effect analysis (threshold at $p < 0.05$, corrected for multiple comparisons). The statistical parametric mapping (SPM) coordinates for standard brain from the MNI template were converted to Talairach coordinates (Talairach & Tournoux, 1998) using a non-linear transform method (http://www.mrc-cbu.cam.ac.uk/Imaging/mnispace.html).

Results

Brain imaging

A whole-brain SPM analysis was first conducted to identify the brain areas involved in the semantic encoding process during the scanning procedure by contrasting fMRI signals in the self, mother and NIP conditions with those in the (non-semantic) font condition. These include the left inferior frontal cortex and the superior frontal cortex after both Chinese and Western culture priming (Table 1). These results suggest that semantic processing was comparable

mother versus NIP judgments. The overlap between self and others shown by the results of self-other contrast under Chinese culture priming supported the expectation of greater self-inclusiveness.

A region-of-interest (ROI) analysis was conducted to further assess the effect of culture priming on VMPFC activity associated with the processing of the self and others. We calculated parameter estimates of signal intensity in association with self and NIP judgments in the VMPFC centred at −8, 44, −7 in both Western and Chinese culture priming conditions. A two-way ANOVA with cultural priming (Western , Chinese) and judgment (self , NIP) as within-subject variables was carried out to examine the differential activation in the VMPFC with respect to self versus NIP judgment between the two culture priming conditions. There was a significant interaction between culture priming and judgment ((1,14) = 5.669, < 0.05, = 0.289). Consistent with the hypothesis, the significant interaction showed a stronger activation in the VMPFC linked to the dissociation between self and NIP judgments after Western than after Chinese culture priming (Fig. 2b). However, another two-way ANOVA with respect to self versus mother (1,14)

culture priming condition showed clear evidence that VMPFC activation did not differentiate between self and mother or even between self and NIP. By contrast, fMRI results in the Western culture priming condition showed that VMPFC activity differentiated between self and NIP judgments and even between self and mother judgments. The locus of VMPFC activity under Western culture priming is consistent with that observed in previous neuroimaging studies of Western participants (Kelley ., 2002; Macrae ., 2004; Moran, Macrae, Heatherton, Wyland, & Kelley, 2006; Zhu ., 2007).

The statistical significance of the effect of culture priming was confirmed by the ROI analysis for the self versus NIP comparison that showed a reliable interaction between priming and self-NIP contrast. A similar pattern of weakened self-mother differentiation after Chinese culture priming was found, although the ROI analysis for the interaction effect between self versus mother comparison and culture priming did not reach a significant level. It appears that, whereas Western culture priming also dissociates mother from self, the dissociation is less clear-cut than the dissociation of NIP from self. The overall fMRI results indicate that self-representation in the VMPFC in bicultural brains is exclusive of NIP and even of mother when they are exposed

Future research in this area would substantiate the importance of the self in cultural neuroscience that has been identified by Ames and Fiske (2010).

Ackno ledgements

Funding support for the present research was provided by the City University of Hong Kong (Project 9380024) and the National Natural Science Foundation of China (Project 30630025).

References

Agnew, C. R., Van Lange, P. A. M., Rushbult, C. E. & Langston, C. A. (1998). Cognitive interdependence: Commitment and the mental representation of close relationships. , *74,* 939–954.

Ames, D. L. & Fiske, S. T. (2010). Cultural neuroscience. *A* , *13,* 72–82.

Aron, A., Aron, E. N. & Norman, C. (2004). Self-expansion model of motivation and cognition in close relationships and beyond. In: M. B. Brewer & M. Hewstone, eds. , pp. 99–123. Malden, MA: Blackwell.

Ashmore, R. D. & Jussim, L. J., eds. (1997). : . New York: Oxford University Press.

Benet-Martínez, V. & Haritatos, J. (2005). Bicultural identity integration (BII): Components and psychosocial antecedents. , *73,* 1015–1050.

Bond, M. H. (1993). Between the yin and the yang: The identity of the Hong Kong Chinese. Hong Kong Chinese University, Professorial Inaugural Lecture Series 19). *B* , (Suppl. 31).

Brewer, M. B. & Chen, Y. R. (2007). Where (who) are collectives in collectivism? Toward conceptual clarification of individualism and collectivism. , *114,* 133–151.

Chao, M. M., Chen, J., Roisman, G. I. & Hong, Y-I. (2007). Essentializing race: Implications for bicultural individuals' cognition and physiological reactivity. , *18,* 341–348.

Damasio, A. (2003). Mental self: The person within. , *423,* 227.

D'Argembeau, A., Collette, F., Van der Linden, M., Laurys, S., Del Fiore, G., Degueldre, C., . (2005). Self-referential reflective activity and its relationship with rest: A PET study. , *25,* 616–624.

Fossati, P., Hevenor, S. J., Graham, S. J., Grady, C., Keightley, M., Craik, F. & Mayberg, H. (2003). In search of the emotional self: An fMRI study using positive and negative emotional words. *A* , *160,*

Oyserman, D., Coon, H. & Kemmelmeier, M. (2002). Rethinking individualism and collectivism: Evaluation of theoretical assumptions and meta-analysis. *B , 128,* 3–72.

Oyserman, D. & Lee, S. W. (2008). Does culture influence what and how we think? Effects of priming individualism and collectivism. *B , 134,* 311–342.

Rogers, T. B., Kuiper, N. A. & Kirker, W. S. (1977). Self-reference and the encoding of personal information. *, 35,* 677–688.

Sui, J. & Han, S. (2007). Self-construal priming modulates neural substrates of self-awareness. *, 18,* 861–866.

Talairach, J. & Tournoux, P. (1998). *A B* . New York: Thieme.

Triandis, H. C. (1995). . Boulder, CO: Westview.

Turner, J. C. (1978). Social categorization and social discrimination in the minimal group paradigm. In: H. Tajfel, ed. , pp. 101–140. London: Academic Press.

Turner, J. C., Hogg, M. A., Oakes, P. J., Reicher, S. D. & Wetherell, M. S. (1987). *: A* . Oxford, UK: Basil Blackwell.

Yang, K. S. & Li, B. H. (1971). *557* . Research Report 13 pp. 36–57. Department of Psychology, Faculty of Science, Taiwan National University, Taipei, Taiwan (in Chinese).

Zhou, H. & Cacioppo, J. (2010). Culture and the brain: Opportunities and obstacles. *A , 13,* 59–71.

Zhu, Y., Zhang, L., Fan, J. & Han, S. (2007). Neural basis of cultural influence on self representation. *, 34,* 1310–1317.