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In search of the Chinese self: An fMRI study

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Abstract Cultural influences on the concept of self is a very important topic for social cognitive neuroscientific exploration, as yet, little if anything is known about this topic at the neural level. The present study investigates this problem by looking at the Chinese culture's influence on the concept of self, in which the self includes mother. In Western cultures, self-referential processing leads to a memory performance advantage over other forms of semantic processing including mother-referential, other-referential and general semantic processing, and an advantage that is potentially localizable to the medial prefrontal cortex (MPFC). In Chinese culture, however, the behavioral study showed that mother-referential processing was comparable with self-referential processing in both memory performance and autonoetic awareness. The present study attempts to address whether similar neural correlates (e.g. MPFC) are acting to facilitate both types of referencing. Participants judged trait adjectives under three reference conditions of self, other and semantic processing in Experiment I, and a mother-reference condition replaced the other-reference condition in Experiment II. The results showed that when compared to other, self-referential processing yielded activations of MPFC and cingulate areas. However, when compared to mother, the activation of MPFC disappeared in self-referential processing, which suggests that mother and self may have a common brain region in the MPFC and that the Chinese idea of self includes mother.

Key words: self-reference, mother-reference, interdependent self, medial prefrontal cortex.

There has been increasing interest in neuroimaging studies of the self since Craik *et al.*'s initial work[1−6]. A common theme of these studies was to localize the self in the brain. All these studies adopted the self-referential processing paradigm introduced by Rogers *et al.*[7]. In their paradigm, a self-reference condition is added to a standard level-of-processing condition. Self-reference effect is observed when the degree of self-reference of the to-be-remembered materials is varied. A typical result using Western participants showed that self-referential processing (e.g. "Does the trait adjective describe you?") was better in recognition performance than any other type of processing including mother-referential processing (e.g. "Does the trait adjective describe your mother?"), other-referential processing (e.g. "Does the trait adjective describe Jimmy Carter?") and semantic processing[8−10].

However, our recent behavioral study on the self-reference effect using Chinese participants presented a different picture[11]: mother-referential processing is comparable with self-referential processing in both memory performance and autonoetic awareness. These results are contrary to much Western literature, which has shown that memory performance that uses mother-referential processing is not as strong as the performance with self-referential processing[8−10]. One possible reason for the similarity between *mother* condition and *self* condition for the Chinese is that in the East Asia culture (including Chinese culture), *mother* is a component of the self schema[12]. Therefore mother may share the rich cognitive structure of the self, which serves to facilitate the encoding and retrieval of information. However, we do not know whether a self schema that includes mother has a neural basis.

Previous neuroimaging studies of the self using a self-referential processing paradigm have uniformly shown that self-referential processing yields activations of the medial prefrontal cortex (MPFC) when compared with other-referential processing or semantic processing[1,2,6,13]. We notice that in previous studies, when compared to semantic processing, self-referential processing conformably activated MPFC, which was similar to the situation of *other* as contrast[4,5,14]. The purpose of the present fMRI study was to examine whether similar neural correlates (e.g. MPFC) were acting to facilitate both self-referential and mother-referential processing in Chinese participants. If the self minus other comparison yields MPFC activity that cannot be observed when self and mother are contrasted, it would provide strong evidence that in Chinese culture the idea of self includes mother. The alternative result would be equally interesting: if the self minus mother comparison also yields MPFC activity, it would provide strong evidence for a unique role for MPFC in self-referential processing. In order to argue either conclusion we need to first demonstrate that the self minus other or self minus semantic comparison yields MPFC activity, so we set three conditions in Experiment I: self, other and semantic processing. In Experiment II we intended to examine the role that mother-referential processing may play by replacing other-referential processing with mother-referential processing. If the self minus other or self minus semantic comparison yields a difference in MPFC activity, then we hypothesize there will be less difference in MPFC activation in the self minus mother comparison.

1 Method

1.1 Participants

Fourteen participants (7 men and 7 women) between the age of 18 and 22 years (Mean=20.4) were recruited from the Capital Normal University in Beijing, China. All participants were strongly right-handed as measured by the Edinburgh handedness inventory (http://airto.bmap.ucla.edu/BMCweb/ consent/edinburgh.html). They reported no significant abnormal neurological history and had normal or corrected-to-normal visual acuity. Informed consent was obtained from all participants before their participation. Participants were compensated for their participation. All the participants were divided randomly into two groups (7 subjects each group). The first group (4 men and 3 women) was assigned to Experiment I, and the second group (3 men and 4 women) to Experiment II.

1.2 Stimulus materials

Three similar 28-word lists were constructed using the personality trait adjectives[11]. These lists were used in four encoding tasks (self, other, mother and semantic). Within each list, half of the words were positive and half were negative. Additionally, each list contained equal number of words with two-, three-, or four-Chinese characters. Block design was used in the present study. Each list was presented in random order in 12 blocks. The first two words in each block served as buffer items. Each participant group contained 12 blocks and each block contained nine words (since the first two were buffers, the images acquired for them were excluded). Six additional personality trait-adjectives were used in practice trials, two words per task.

For the test phase, we added 84 new adjectives to serve as distracters during the recognition test. In total, there were 168 adjectives presented in completely random order.

1.3 Experimental design of Experiment I

Before the experiment, participants were given 6 practice trials to ensure that they understood the experiment. In the experiment, each trial consisted of a 1000-ms fixation point followed by an adjective with a duration of 2000-ms. This was followed by a mask, which appeared for 2000-ms. The screen then went blank for 1000-ms before the next fixation point appeared (see Fig. 1).

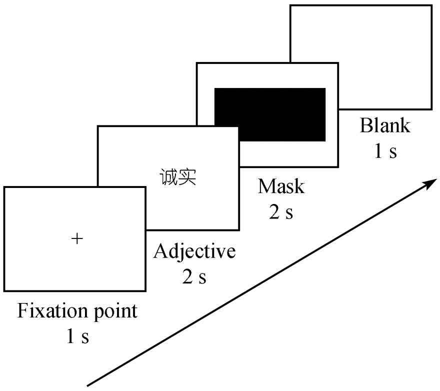

Fig. 1. An example of the fixation adjectives and masking trial types. Trials were randomly intermixed, and one trial was presented every 6 s.

For the encoding phase of the task, we adopted a within-subject design with three conditions: self-referential encoding, other-referential encoding, and common semantic encoding. In the self-processing condition (condition A), participants were asked to judge "Does this adjective describe you?"; in the other-processing condition (condition B), participants were asked to judge "Does this adjective describe LuXun (a famous Chinese writer)?"; and in semantic processing condition (condition C), participants were asked to judge "Is the trait positive or negative?". If participants judged a word as "yes" (or "positive"), he/she was asked to press a button once; If participants judged a word as "no" (or "negative"), he/she was asked to press a button twice. If participants judged a word as "not sure" (or "neutral"), he/she was asked not to respond. The experiment was conducted with block design. In order to counterbalance the order, 12 blocks were designed as ABC CBA CBA ABC. The encoding phase lasted for approximately 30 min. The retrieval phase began one hour after the completion of the encoding phase[15]. We adopted the R/K judgment paradigm popularized by Tulving[16] to test their recognition. In this paradigm, for each item judged to be "old", subjects are asked to indicate whether they "remember" (R) the item or simply "know" (K) the item. A "remembering" item is defined as one for which subjects can consciously recollect specific details of the item which appeared in the earlier list, and a "knowing" item is defined as one that is not accompanied by recollective experience but has a feeling of knowing or familiarity to the subjects[15−17]. Participants were asked to identify old or new items by pressing the "N" key (for new items) or the "Y" key (for old items). If the participants pressed the "N" key, the word disappeared from the screen; if the participants pressed the "Y" key, they were asked to carry out an additional task requiring them to indicate whether their memory for the item was based on the subjective experience of remembering or of knowing. This was indicated by pressing the "R" key, for remembering, or the "K" key, for knowing. During this phase, participants were ordered to answer every item one by one without a time limit. They were not scanned, but their responses were recorded.

1.4 Experimental design of Experiment II

The task design of Experiment II was the same as Experiment I, except that the other-referential processing condition was replaced by a mother-referential processing condition. Participants were asked to judge "Does the adjective describe your mother?".

1.5 Image acquisition

Adjectives were delivered via computer to a shielded LCD projector. Participants were in a supine position and viewed the screen through an adjustable mirror mounted on the head coil. The image was back-projected onto a screen positioned at the foot end of the participant.

Brain imaging was performed by the use of a 1.5 Tesla GE Signa MR scanner. A special 5GP head coil was used to provide a high signal to noise ration (SNR). An EPI sequence (TR=2000 ms, TE=40 ms, and flip angle=90°, thickness=6 mm, skip=0.5 mm, FOV=240 mm, matrix=64×64) was used to acquire a set of 11 oblique/axial slices (from superior to inferior, with the AC-PC line located at the center of the 10th slice). Every task includes 44 volumes, which was arranged in 4 blocks with 11 volumes each. The first two images of each scan were discarded. The MR scan for each session started after the stimulus had been presented for 10 s for saturation of cerebral blood oxygenation. High resolution anatomic images (T1-weighted, 63－69 slices-to get a large enough volume to cover the whole brain, thickness=2.0 mm, skip=0.5 mm, FOV=240 mm, matrix=256×256) were used to identify landmarks associated with the neural activity found in the functional images.

1.6 Image analysis

Statistical Parametric Mapping software (SPM99, Wellcome Department of Cognitive Neurology, London, UK; http://www.fil.ion.ucl.ac.uk) implemented in MATLAB (Math Works, Natick, MA) was used for imaging data processing and analysis. First, all functional scan data were preprocessed to remove sources of noise and artifacts. Then the differences in acquisition time between slices for each volume were corrected. Functional images were realigned to correct for head movement between scans, and coregistered with each participant's anatomical scan. Functional images were then transformed into a standard anatomical space (2×2×2 mm^3 isotropic voxels) based on the Montreal Neurological Institute (MNI) template which approximates Talairach & Tournoux's (1988) atlas space. Normalized data were then spatially smoothed using a Gaussian filter with a full-width at half-maximum parameter of 8 mm.

Contrasts were used to compare stimulus conditions to test our hypotheses. In our study, we defined areas that were more activated by self-referential processing than other-referential processing or semantic processing as regions preferentially engaged by self-referential processing. For each participant, a general linear model was used to compute parameter estimates for each comparison at each voxel. These individual contrast images were then submitted to a second-level analysis. Due to a relatively small number of subjects in these experiments, we used conjunction analysis, which adequately serviced some qualitative aspect of neural function anatomy in the studies of normal subjects[18]. For each conjunction analysis, areas of significant activation were identified at the cluster level as values exceeding an uncorrected p value of 0.0001.

2 Results

2.1 Behavioral results

Table 1 shows response probability as a function of encoding phase in both Experiment I and Experiment II. In Experiment I, MANOVA showed that there was no significant difference among the three oriented conditions but significant interaction between R and K among conditions ($F(2,36)=8.05$, $p<0.01$). Further simple effect analysis showed that self-referential processing was not better than semantic processing on total recognition ratio. The analysis of R and K showed that self-referential processing produced significantly higher R ($F(1,12)=6.11$, $p<0.05$), but lower K ($F(1,12)=7.13$, $p<0.05$) than semantic-processing. A one-way F test revealed a near significant effect on total recognition ratio between self encoding and other

Table 1 Mean values of total recognition ratio, R and K as function of tasks[a)]

	Self	Other/mother [b)]	Semantic	New words
Exp. I				
Total	0.81(0.15)	0.67(0.09)	0.73(0.10)	0.12(0.05)
Remember	0.72(0.13)	0.44(0.19)	0.50(0.19)	0.03(0.02)
Know	0.08(0.04)	0.23(0.14)	0.23(0.12)	0.09(0.04)
Exp. II				
Total	0.85(0.11)	0.74(0.16)	0.78(0.07)	0.10(0.10)
Remember	0.64(0.17)	0.57(0.21)	0.50(0.15)	0.05(0.06)
Know	0.21(0.19)	0.18(0.12)	0.28(0.16)	0.05(0.04)

a) Standard errors are given in parentheses; b) others is in Exp. I and mother is in Ewp. II.

encoding. However, analysis of R and K showed that self-referential processing produced significantly higher R ($F(1,12)=9.50$, $p<0.05$), but lower K ($F(1,12)=5.85$, $p<0.05$) than other-referential processing, demonstrating a self-reference effect, . In Experiment II, both the main effect and the interaction between R and K among tasks were not significant.

2.2 fMRI results

Table 2 summarizes the Talairach coordinates and the *Z* scores of peak activation during the self-referential condition compared with semantic and other-referential conditions in Experiment I ($p<0.0001$, uncorrected). Significant activation for the self minus other comparison was found in the medial prefrontal gyrus (BA9 and BA10) and anterior cingulate gyrus (BA42 and BA32). Similarly, significant activation for the self minus semantic comparison was found in the medial prefrontal gyrus (BA10 and BA9) and superior frontal gyrus (BA8).

Table 3 summarizes the Talairach coordinates and the *Z* scores of peak activation during self-referential condition compared with semantic and mother-referential conditions in Experiment II ($p<0.0001$, uncorrected). The results of the self minus semantic comparison in Experiment II were very similar to those of the self minus semantic comparison in Experiment I: The medial prefrontal gyrus (BA10 and BA9) and superior frontal gyrus (BA8 and BA9) and posterior cingulate (BA30) were significantly activated. In the self minus mother comparison, the anterior cingulate gyrus was the only activated area (BA32 and BA10); medial prefrontal gyrus activations disappeared, which was different from the result of the self minus semantic comparison (see Fig. 2).

3 Discussion

The behavioral results showed that adjectives in the *self* condition were better recognized than those in the semantic conditions on R in both Experiment I and Experiment II (Table 1), indicating the existence of

Table 2 Significant differences in brain activation associated with self-semantic and self-other information in Exp. I ($p<0.0001$, uncorrected)

Task comparison and region	BA[a)]	*x*	*y*	*z*	*K*[b)]	*Z*[c)]
Self minus Semantic						
Medial frontal gyrus	BA10	2	56	12	287	5.25
Medial frontal gyrus	BA10	8	48	14		5.04
Superior frontal gyrus	BA8	–2	42	44	19	4.72
Medial frontal gyrus	BA9	0	48	26	12	4.21
Self minus Other						
Medial frontal gyrus	BA10	–6	52	12	64	5.10
Medial frontal gyrus	BA9	–2	46	18	—	4.46
Anterior cingulate gyrus	BA42	–12	44	6	15	4.76
Cingulate gyrus	BA32	2	44	12	15	4.46

a) BA = Brodmann's area, as identified in Talairach and Tournoux (1988); b) *K*=voxels; c) *Z*=significant value.

Table 3 Significant differences in brain activation associated with self-semantic and self-mother information in Exp. II ($p < 0.0001$, uncorrected)

Task comparison and region	BA[a)]	*x*	*y*	*z*	*K*[b)]	*Z*[c)]
Self minus Semantic						
Right superior frontal gyrus	BA8	22	30	46	29	5.21
Posterior cingulate	BA30	–18	–56	10	16	5.09
Medial frontal gyrus	BA9	0	52	14	219	5.09
Medial frontal gyrus	BA10	8	46	14	—	4.86
Superior frontal gyrus	BA9	6	52	30	—	4.74
Self minus Mother						
Anterior cingulate gyrus	BA32	–14	40	4	41	4.44
Anterior cingulate gyrus	BA10	–10	48	–2	—	4.25

a) BA = Brodmann's area, as identified in Talairach and Tournoux (1988); b) *K*=voxels; c) *Z*=significant value.

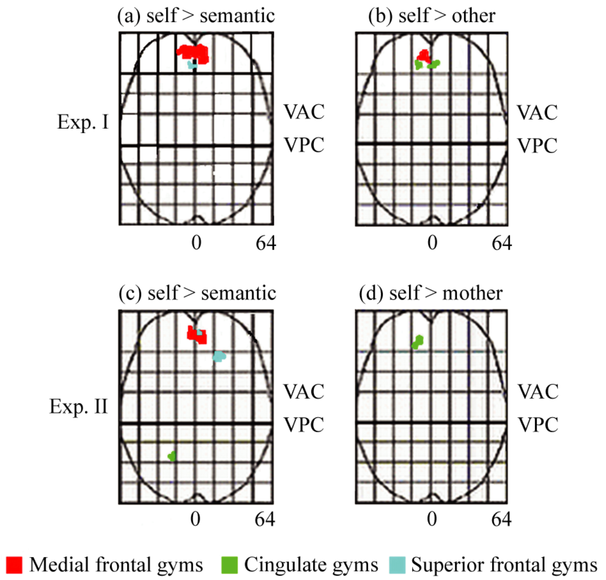

Fig. 2. A transverse view of the statistical parametric map (as seen from above, "R" signified right side, VAC is a vertical line through the anterior commissure, VPC is a vertical line through the posterior commissure, p<0.0001, uncorrected). (a) Self minus semantic: medial prefrontal gyrus (BA10, (x, y, z)=(2, 56, 12); BA10, (x, y, z)=(8, 48, 14); BA9, (x, y, z)=(0, 48, 26)); superior frontal gyrus (BA8, (x, y, z)=(−2, 42, 44)). (b) Self minus other: medial prefrontal gyrus (BA10, (x, y, z)=(−6, 52, 12); BA9, (x, y, z)=(−2, 46, 18)); anterior cingulated gyrus (BA42, (x, y, z)=(−12, 44, 6)); cingulated gyrus (BA32, (x, y, z)=(2, 44, 12)). (c) Self minus semantic: medial prefrontal gyrus (BA10, (x, y, z)=(8, 46, 14); BA9, (x, y, z)=(0, 52, 14)); superior frontal gyrus (BA8, (x, y, z)=(22, 30, 46); BA9, (x, y, z)=(6, 52, 30)); posterior cingulated gyrus (BA30, (x, y, z)=(−18, −56, 10)). (d) Self minus mother: anterior cingulated gyrus (BA32, (x, y, z)=(−14, 40, 4); BA10, (x, y, z)=(−10, 48, −2)).

self-reference effect, which was in line with previous studies[15,19]. Although there was no significant effect on R between *self* condition and semantic condition in Experiment II, we attribute this lack of effect to our small sample size. As we expected, there was similar recognition memory performance on the *mother* condition and the *self* condition, especially on R response in Experiment II (Table 1). Our recent experiments showed that when the number of participants was increased to 14 in each condition, the *mother* condition and *self* condition still had similar memory performance, but *self* condition had significant higher R than semantic condition[11].

3.1 Area activated by self-referential processing

We found that a region of the medial prefrontal lobe (BA10, (x, y, z)=(−6, 52, 12); BA9, (x, y, z)=(−2, 46, 18)) is engaged during self-referential processing, as shown by the *self* minus *other* contrast for Experiment I, shown in Table 2. This result is very similar to previous results. For instance, Craik *et al.*[1], using positron emission tomography (PET) and blocked-design paradigm, found that the medial prefrontal cortex was activated during self-referential processing (BA9, (x, y, z)=(6, 40, 28); BA10, (x, y, z)=(−6, 56, 8)). Kelley *et al.*[2], using an event-related fMRI paradigm, also found that the medial prefrontal cortex was activated during self-referential processing (BA10, (x, y, z)=(10, 52, 2)). These studies consistently showed that self-referential processing yielded the medial prefrontal activations regardless of using different imaging techniques and different design paradigms.

Self is a complex concept, which has not been well scientifically defined. Klein *et al.*[20] have proposed that a seemingly unitary self may actually be composed of several different functionally separate, though normally interacting, systems. Based on results of neuropsychological studies, they suggest that the self consists of six components: episodic memories of one's own life, representations of one's own personality traits, knowledge of facts about one's own life, and so on. We propose that the concept of self is three-sided: the self as perception, recognition of one's own face, the self as memory, autobiographical memory and episodic memory retrieval, and the self as thought, self-reference or self-reflection. Each side has its corresponding brain mechanism[6]. We propose that the activations of the medial prefrontal cortex may only modulate the representations of one's own personality traits, self-referential processing. There is evidence supporting our proposition. First, recognition of one's own face does not yield activation of the medial prefrontal cortex[3,21]; second, autobiographical memory retrieval does not yield medial prefrontal cortex activations[22−24]; finally, episodic memory retrieval, which necessarily involves the concept of the self, also does not yield activations of the medial prefrontal cortex. In an analysis of PET data pooled over several different studies in which subjects had been given episodic recognition tests, Lepage *et al.*[25] succeeded in identifying six different "retrieval mode sites" in the brain: three stronger sites were in the right prefrontal cortex and two weaker ones in the left prefrontal cortex, and one in the medial anterior cingulate. Tulving[26] emphasized that: "No similar sites were seen in any other part of the brain". On the scope of self studies, the mere connection of medial prefrontal gyrus and self-reference has its important theoretical meaning, because different aspects of the self correlate with different brain regions. Actually, recognition of one's own face activates the right brain, autobiographical memory mainly relates to the hippocampus and the episode memory retrieval mainly relates to right prefrontal cortex. The long-term mission of self studies is to combine self as perception, self as memory and self as thought to achieve the consistent understanding of the multiple self[27].

Besides the medial prefrontal gyrus, when compared to *other*, self-referential processing also activated the anterior cingulate gyrus. It is interesting that this pattern of results is in complete accordance with the theory of mind. In answering the question "Do we activate the same brain regions to read our own and other minds?" Ross[28] pointed out that "neuroimaging study shows that the theory of mind activity occurs in the medial frontal cortex and paracingulate cortex for both kinds of mind reading".

When compared to the semantic condition, self-referential processing also yielded activations of the medial prefrontal lobe (BA10, (x, y, z)=(2, 56, 12) or (x, y, z)=(8, 48, 14) and BA9, (x, y, z)=(0, 48, 26) in Experiment I; BA10, (x, y, z)=(8, 46, 14) and BA9, (x, y, z)=(0, 52, 14) in Experiment II), as shown in Tables 2 and 3. These results are similar to those when the *self* condition compared to the *other* condition in Experiment I (see Table 2). They are also similar to the results of Gusnard *et al.*[4], who found that when compared with semantic processing, self-referential processing activated the medial prefrontal gyrus (BA8/9, (x, y, z)=(−9, 39, 42); BA10, (x, y, z)=(−3, 53, 24)). In another experiment conducted by Johnson *et al.*[5], participants answered some "Who am I" type questions, which reflected their own abilities, personality traits and attitudes. Their results showed that the anterior medial prefrontal cortex (BA10, (x, y, z)=(0, 54, 8)) was activated when self-reflection was compared with semantic processing. In Zysset *et al.*'s study[14], they also found a similar result (BA9/10, (x, y, z)=(−6, 55, 13)).

3.2 *Mother and self both activate medial prefrontal gyrus*

In Experiment II, the *self* minus semantic contrast, self-referential processing, mainly yielded activations of the medial prefrontal gyrus (BA9 and BA10) and the posterior cingulated gyrus (BA30). However, the *self* minus *mother* contrast only yielded activations of the anterior cingulate gyrus (BA32/10); the medial prefrontal activation disappeared. This result provides strong evidence that the Chinese self includes mother.

We compared mother-reference and semantic processing. No activations were found in MPFC. This lack of effect may be due to the small sample in our study. Additionally, *mother* is only a part of self; the MPFC area activated by mother-reference could not be totally the same as that activated by self-reference. Using the semantic condition, instead of the other condition, as the baseline for the *self* condition in Experiment II is a weakness in our study since difference of self minus semantic could have other "person" representations contained in it. However, both the self minus semantic contrast in Experiment II and the self minus other contrast in Experiment I activated the medial prefrontal cortex, suggesting that it is reasonable to use the semantic condition as a baseline.

It should be noted that since the Western independent self does not include mother[12], we expect that mother would not share medial prefrontal gyrus with the self for the Westerner. Future research is needed to examine this point of view[29].

4 Conclusion

The present study examines the neural correlates of the Chinese self including mother using verbal materials. The fMRI data showed that mother-referential encoding and self-referential encoding both activated the MPFC. This finding explains why memory performance of mother encoding is similar to self encoding for the Chinese.

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References

1. Craik, F. I. M., Moroz, T. M., Moscovitch, M. *et al.*, In search of the self: A positron emission tomography study, Psychological Science, 1999, 10: 26—34.
2. Kelley, W. M., Macrae, C. L., Wyland, C. L. *et al.*, Finding the self? An event-related fMRI study, Journal of Cognitive Neuroscience, 2002, 14: 785—794.
3. Kircher, T. T. J., Senior, C., Philips, M. L. *et al.*, Towards a functional neuroanatomy of self processing: Effects of faces and words, Cognitive Brain Research, 2000, 10: 133—144.
4. Gusnard, D. A., Akbudak, E., Shulman, G. L. *et al.*, Medial prefrontal cortex and self-referential mental activitiy: relation to a default mode of brain function, Proceedings of the National Academy of Sciences, USA, 2001, 98: 4259—4264.
5. Johnson, S. C., Baxter, L. C., Wilder, L. S. *et al.*, Neural correlates of self-reflection, Brain, 2002, 125: 1808—1814.
6. Ying, Z., Neuroimaging studies of self-reflection, Progress in Natural Science, 2004, 14 (4): 296—302.
7. Rogers, T. B., Kuiper, N. A., Kirker, W. S., Self-reference and the encoding of personal information, Journal of Personality and Social Psychology, 1977, 35: 677—688.
8. Keenan, J. M., Baillet, S. D., Memory for personally and significant events, in Attention and performance (ed. Nickerson, R. S.), New Jersey: Lawrence erlbaum associates, 1980, 651—669.
9. Lord, G. G., Schemas and images as memory aids: Two modes of processing social information, Journal of Personality and Social Psychology, 1980, 38: 257—269.
10. Klein, S. B., Loftus, J., Burton, H, A., Two self-reference effects: The importance of distinguishing between self-descriptiveness judgments and autobiographical retrieval in self-reference encoding, Journal of Personality and Social Psychology, 1989, 56: 853—865.
11. Ying, Z., Li, Z., An experimental study on the self-reference effect, Science in China, Ser. C, 2002, 45: 120—128.
12. Markus, H. R., Kitayama, S., Culture and the self: Implication for cognition, emotion and motivation, Psychological Review, 1991, 98: 224—253.
13. Northoff, G., Bermpohl, F., Cortical middline structures and the self, Trends in Cognitive Science, 2004, 8(3): 102—107.
14. Zysset, S., Huber, O., Ferstl, E. *et al.*, The antierior frontomedian cortex and evaluative judgment: An fMRI study, Neuroimage, 2002, 15: 983—991.
15. Conway, M. A., Dewhurst, S. A., The self and recollective experience, Applied Cognitive Psychology, 1995, 9: 1—19.
16. Tulving. E., Memory and consciousness, Canadian Psychology, 1985, 26: 1—12.
17. Tulving, E., On the uniqueness of episodic memory. in Cognitive Neuroscience of Memory(eds. Nilsson, L. G., Markowitsch, H. J.), Toronto: Hogrefe & Huber Publishers, 1999, 11—42.
18. Friston, K. J., Holmes, A. P., Worsley, K. J., How many subjects constitute a study? Neuroimage, 1999, 10: 1—5.
19. Symons, C. S., Johnson, B. T., The self-reference effect in memory: A meta-analysis, Psychological Bulletin, 1997, 121: 371—394.
20. Klein, S. B., Rozendal, K., Cosmides, L., A social-cognitive neuroscience analysis of the self, Social Cognition, 2002, 20: 105—135.
21. Kircher, T. T. J., Senior, C., Philips, M. L. *et al.*, Recognizing one's own face, Cognition, 2001, 78: 1—15.
22. Conway, M. A., David, J. T., A positron emission tomography (PET) study of autobiographical memory retrieval. In: Neuroimaging and Memory(ed. Jonathan, K. F.), East Sussex (UK): Psychology Press, 1999, 679—702.
23. Fink, G. R., Markowitsch, H. J., Reinkemeier, M. *et al.*, Cerebral representation of one's own past: Neural networks involved in autobiographical memory, Journal of Neuroscience, 1996, 16: 4275—4282.
24. Maguire, E. A., Neuroimaging studies of autobiographical event memory, Philosophical Transactions of the Royal Society of London (Biology), 2001, 356: 1441—1451.
25. Lepage, M., Ghaffar, O., Nyberg, L. *et al.*, Prefrontal cortex and episodic memory retrieval mode, Proc. Natl. Acad. Sci. USA, 2000, 97: 506—511.
26. Tulving, E., Episodic memory: From mind to brain, Annual Review of Psychology, 2002, 53: 1—25.
27. Dolan, R. J., Feeling the neurobiological self, Nature, 1999, 401: 847—848.
28. Ross, J. A., The self: From soul to brain, Journal of Consciousness Studies, 2003, 10(2): 67—85.
29. Gilliham, S. J., Farah, M. J., Is self special? A critical review of evidence from experimental psychology and cognitive neuroscience, Psychological Bulletin, 2005, 131(1): 76—97.