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Understanding culture and the brain: from behavior to neuroscience

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Cultural differences in human behavior have been widely documented and interpreted by various psychological theories that emphasize cognitive or affective mechanisms. However, it remains a challenge to provide a coherent neuroscience understanding of culturally discrepant behaviors. Cultural neuroscience research has shown increasing evidence for culturally specific patterns of brain activity such as stronger activity in the dorsal medial prefrontal cortex, lateral frontal cortex and temporoparietal junction in East Asians but stronger activity in the anterior cingulate, ventral medial prefrontal cortex, bilateral insula and temporal pole in Westerners. These findings help to create a coherent neural account of behavior differences between Western and East Asian cultures.

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Cultural differences in behavior

People are often surprised by witnessing how others behave unexpectedly when traveling across cultures. In one culture parents may split bills with their adult children after having dinners at a restaurant whereas this never happens in another culture. A child may sleep in an independent bedroom after birth in one culture whereas a child may share a bedroom with his/her parents until early adulthood in another culture.

Apart from these daily observations, cultural differences in behavior have been widely documented by psychological research in laboratories. For example, Chinese compared to Canadian toddlers spent more time in direct physical contact with their mothers during free play and took longer time before they approached to strangers to play together [1], indicating cultural differences in behavioral inhibition in early childhood. In a perceptual task requiring judgments on orientations (left versus right) of faces, American college students responded equally faster to their own faces regardless whether their own faces were presented alternately with their friends' or supervisors' faces [2]. Nevertheless, for Chinese college students, responses to their own faces were significantly slowed by the presence of their supervisors' faces compared to their friends' faces [3,4]. These findings implicate that how to perceive the self depends on social contexts to a greater degree in Chinese than in Americans. During a communication game that required taking perspective from a partner, Chinese relative to American participants were more tuned into their partners' perspective and Americans often completely failed to take their partners' perspective [5], suggesting that Chinese culture more effectively affords the use of the ability of perspective taking to interpret other people's actions. Cultural differences also exist in emotion-related behavior [6]. Interpersonal verbal and nonverbal communication was characterized by high-arousal emotion such as cheerfulness and enthusiasm in Americans but was featured with attention to others' unexpressed feelings or low-arousal emotion in Chinese and Japanese [7]. Japanese also reported higher scores of emotion suppression than did the Americans [8]. During parent–child interaction mothers in American and other Western cultures tended more often to increase their children's level of arousal by playing and chatting whereas mothers in East Asian cultures (e.g., Japan) were more likely to rock and lull their babies to reduce their levels of arousal [9,10].

Cultural differences in brain activity

Psychologists have developed various theoretical accounts of cultural differences in human behavior that emphasize cognitive or affective processes. For example, Markus and Kitayama [11,12] proposed that Westerners hold an independent self-concept that is not affected by social contexts and others and drives individuals to attend to self-related information. In contrast, East Asians hold an interdependent view of the self that is sensitive to information related to significant others and attend to intimate others as much as they do to the self. Tsai [6] suggested that American and East Asian cultures encourage different ideal affect, that is, the affective states that people strive for or ideally want to feel. Relative to East Asian cultures, American culture promotes high-arousal positive affective states (e.g., excitement, enthusiasm) more but low-arousal positive affective states (e.g., calm, peacefulness) less. Psychological theories are also proposed to explain cultural differences in causal attribution

[13] and in perception/attention [14]. While these theories have been used to interpret cultural differences in human behavior, it is a challenge to provide a coherent understanding of culturally discrepant behaviors from a neuroscience perspective.

Cultural neuroscience approach

Human behavior is underpinned by brain activity that has been demonstrated to be highly flexible and can be modified by life experiences [15]. Therefore, the well-documented cultural differences in human behavior are attributable to cross-cultural differences in brain activity. Cultural neuroscience is a newly developed interdisciplinary field that investigates whether and how cultural contexts and experiences interact with and shape the functional organization of the human brain and to what degree the observed cultural differences in human behavior can be attributed to distinct neural underpinnings across cultures. Cultural neuroscience research takes culture as a shared dynamic environment (e.g., social institutions) and knowledge system (e.g., value, belief, and rule) that allows the brain to lay out its potential capacity to fit into different sociocultural contexts. Cultural neuroscience research integrates brain imaging such as event-related brain potential (ERP) and functional magnetic resonance imaging (fMRI) with cultural psychology, social cognitive neuroscience, and neuroscience research of neural plasticity [16–18].

A methodology has been developed in cultural neuroscience to uncover cultural influences on the human brain. A stream of the methodology is to compare brain activities recorded from two or more cultural groups using varieties of brain imaging [19••,20–22]. This transcultural neuroimaging approach allows researchers to reveal unique patterns of neural activity in response to culturally specific stimuli and to uncover neural activities that are engaged in a specific task and differentiate between different cultures. This approach provides neuroimaging evidence for an association between culture and brain activity and enables researchers to explore whether the observed cultural differences in brain activity are mediated by a specific cultural value. Cultural priming is another method developed by cultural neuroscientists to investigate how brain activity is modified by recent use of specific cultural values and beliefs [23••,24••]. This approach is based on the idea that an individual may have multiple cultural systems and is able to switch between different cultural systems in response to specific social contexts and interactions [25]. This approach allows researchers to examine the variation of an individual's brain activity as a consequence of recently use of cultural knowledge in laboratories when covariants confronted by transcultural neuroimaging research are very well controlled. Consistent findings of how an individual's brain activity is modulated by primed cultural values and how brain activity varies across individuals from different cultures help to establish a causal link between culture and brain [19••,24••].

There has been increasing cultural neuroscience evidence for differences in brain activity between East Asian and Western cultures during varieties of cognitive and affective processes including perception [26–28], attention [29••,30], causal attribution [31], semantic relationship processing [32], music processing [33,34], mental calculation [35], recognition of one's own face [20,36], self-reflection on personality traits [19••,21,22,37–38,39••], perception of bodily expressions [40], mental state reasoning [41,42], empathy [43], and trait inference [44]. Cross-cultural differences in brain activity are characterized by different patterns. Brain activity can be modulated by a specific task in one cultural group but not in another cultural group [19••,31,45]. Modulations of brain activity by task demands may show opposite patterns in two cultural groups [29••,40]. A more complicated pattern of cultural modulations of brain activity is that one culture compared to another culture shows increased activity in some brain regions but decreased activity in other regions [39••].

Cultural priming research also accumulates evidence that priming one compared to another cultural values modulates the neural activity during pain perception [46], visual perception [47], self-face recognition [23••], self-referential processing [22,24••,48], motor processing [49], and resting state activity [50]. Most of the findings based on cultural priming are in congruence with the results of transcultural neuroimaging studies and further support a cause-effect relationship between specific cultural values and culturally specific patterns of neurocognitive processes.

Han and Ma conducted a quantitative

enhanced neural activity in the brain areas related to self-relevance encoding and emotional responses during social cognitive/affective processes.

How do cultural neuroscience findings help us to understand cultural differences in behavior? East Asian cultures are characterized by enhanced activity in the social brain network underlying perception and inference of others' mind in the dMPFC and TPJ. The hyperactivity in the these brain regions may provide a neural basis of increased sensitivity to contextual social information including others' mental states. This pattern of brain activity may then result in improved social performances by successively taking others' perspective, mediate influences of social relationships on social behavior, and facilitate accounts of behavior based on social contexts [3,5,11]. East Asian cultures also show increased lateral frontal activity that satisfies the need of self-control and emotional regulation and helps to maintain the low-arousal positive emotional states in East Asians [6]. In contrast, Western cultures are linked to enhanced activity in the social brain network that underlies coding of self-relevance in the vMPFC that allows enhanced self-focus and makes people behave independently [2]. Western cultures also give rise to increased activity in the social brain network that supports emotional responses in the dorsal ACC and insula, which may help to maintain the high-arousal positive emotional states in Westerners [6]. Taken together, it is likely that Western/East Asian cultures influence people's behavior by modulating the weight of different nodes of the social brain network, which in turn leads to culturally specific cognitive/neural strategies (e.g., self- versus other-focus, or keeping high- versus low-arousal states) and allows individuals to fit into their sociocultural environments and behave in culturally appropriate ways during social interactions.

Future research

As cultural neuroscience research requires expensive equipment such as MRI scanner and cross-cultural comparison of brain imaging results, it is developing rapidly mainly in East Asian, North American, and Western Europe. This brings on the unbalanced development of the field, and consequently, current cultural neuroscience research mainly provides neuroimaging findings that enhance our understanding of cultural differences in behavior between the Western and East Asian societies. We have known little about patterns of brain activities that help us to assess the neural basis of behavior differences between other cultures such African and Arab societies. It is undoubtedly important to understand people's behavior in these cultures that are perceived differently from those in the Western or East Asian cultures because of the increasing number of social/commercial activities across these cultures. Future cultural

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Finally, although current cultural neuroscience research has demonstrated modulations of brain activity by cultural experiences, it remains unspecified how cultures interacts with neural mechanisms at cellular and molecular (e.g., neurotransmitter) levels. To clarify these questions is extremely important for understanding human specific neural plasticity and has critical practical significance. For instance, it has been taken for granted that medicines tested in one cultural group also work for other cultural populations. However, it is unclear whether a drug affects brain activity in a similar vein across different cultures. This should be taken considerations in future research.

Ac ed e e

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Re e e ce a d ec e ded ead

Papers of particular interest, published within the period of review, have been highlighted as:

- • of special interest
- •• of outstanding interest

1. Chen X, Hastings PD, Rubin KH, Chen H, Cen G, Stewart SL: **C d ea a de a d be a a , b C e a d Ca ad a dd e : a c -c . . a d** . *Dev Psychol* 1998, **34**:677-686.

2. Liew SL, Ma Y, Han S, Aziz-Zadeh L: **W a a d , e b : c . . a d e e ce ca e a c d a e e - ace ec C e a d A e ca** . *PLoS ONE* 2011, **6**:e16901 http://dx.doi.org/10.1371/journal.pone.0016901.

3. Ma Y, Han S: **Se - ace ad a a e d a ed b ca , ea B e ec e - ace ec** . *J Exp Soc Psychol* 2009, **45**:1048-1051.

4. Ma Y, Han S: **W , S d a e , e e , a , e ? A S c S e a ca , e e ad a a e d S c ace ec** . *J Exp Psychol Hum Percept Perform* 2010, **36**:619-633.

5. Wu S, Keysar B: **T e e ec c . . e Se Sec e a** . *Psychol Sci* 2007, **18**:600-606.

6. Tsai JL: **Idea a ec : c . . a ca a d be a a c e e ce** . *Perspect Psychol Sci* 2007, **2**:242-259.

7. Wierzbicka A: *Emotions Across Languages and Cultures: Diversity and Universals*. Cambridge University Press; 1999.

8. Matsumoto D: **A e c . . a d e e ce e e a ed a ed b Se a . a ?** *J Cross Cult Psychol* 2006, **37**:421-437.

9. Morikawa H, Shand N, Kosawa Y: **Ma e a Seec S e a a Ja Sa a d . e U ed S a : e a S a c , a d e e e** . *J Child Lang* 1998, **15**:237-256.

10. Minami M, McCabe A: **R ce ba a d bea , : Ja Sa e a d N , A e ca a a a e Sa e** . *J Child Lang* 1995, **22**:423-445.

11. Markus HR, Kitayama S: **C . . e a d , e e : S ca c , e a d a** . *Psychol Rev* 1991, **98**:224-253.

12. Markus HR, Kitayama S: **C . . a d e . A c e a c** . *Perspect Psychol Sci* 2010, **5**:420-430.

13. Choi I, Nisbett RE, Norenzayan A: **Ca a b ac c . . : a a a d e a** . *Psychol Bull* 1999, **125**:47-63.

14. Masuda T, Nisbett RE: **A e d , ca e a a ca : c Sa , ec e e Ja Sa e a d A e ca** . *J Pers Soc Psychol* 2001, **81**:922-934.

15. Huttenlocher PR: *Neural Plasticity: The Effects of Environment on the Development of the Cerebral Cortex*. Cambridge, MA: Harvard University Press; 2002, .

16. Chiao JY, Ambady N: **C . . a e c e ce: Sa e a , a d d e ac e e a a** . In *Handbook of Cultural Psychology.* Edited by Kitayama S, Cohen D. New York: Guilford Press; 2007:237-254.

17. Han S, Northoff G: **C . . e e e e a b a a c : a a c . a e a , a SS ac** . *Nat Rev Neurosci* 2008, **9**:646-654.

18. Han S, Northoff G, Vogeley K, Wexler BE, Kitayama S, Varnum MEW: **A c . . a e c e ce a SS ac , e b ca a e , e a b a** . *Ann Rev Psychol* 2013, **64**:335-359.

19. Zhu Y, Zhang L, Fan J, Han S: **Ne a ba c . . a e ce e eS e a** . *Neuroimage* 2007, **34**:1310-1317.
•• The authors record brain activity using fMRI from Chinese and Westerners during reflection on personality traits of oneself and one's mother. They show overlapping activity in the medial prefrontal cortex during trait judgments on the self and mother in Chinese but stronger medial prefrontal activity during trait judgments on the self than mother in Westerners.

20. Sui J, Liu CH, Han S: **C . . a d e e ce e a ec a e - ec** . *Soc Neurosci* 2009, **4**:402-411.

21. Chiao JY, Harada T, Komeda H, Li Z, Mano Y, Saito D, Parrish TB, Sadato N, Iidaka T: **Ne a ba d d a c a d c ec c e e** . *Hum Brain Mapp* 2009, **30**:2813-2820.

22. Chiao JY, Harada T, Komeda H, Li Z, Mano Y, Saito D, Parrish TB, Sadato N, Iidaka T: **D a c c . . a e c e a eS e a , e e** . *J Cogn Neurosci* 2010, **22**:1-11.

23. Sui J, Han S: **Se -c . a S d a e a b a e -a a e** . *Psychol Sci* 2007, **18**:861-866.
•• This is the first fMRI study that illustrates modulations of brain activity by cultural priming. The authors present fMRI evidence that the right frontal activity in response to one's own face is enhanced by independent vs. interdependent self-construal priming.

24. Ng SH, Han S, Mao L, Lai JCL: **D a c b c . . a b a : a MRI d , e be e a eS e a e a d , ca , e S e c . . e S** . *Asian J Soc Psychol* 2010, **13**:83-91.
•• The authors show fMRI evidence that exposure to symbols of Chinese vs. Western cultures increases the medial prefrontal activity in response to others in bicultural individuals.

25. Hong Y, Morris M, Chiu C, Benet-Martinez V: **M c . . a d : a d a c c c a SS ac c . . e a d c** . *Am Psychol* 2000, **55**:709-720.

26. Gutchess AH, Welsh RC, Boduroglu A, Park DC: **C . . a d e e ce e a c a c a ed , b ec S ce** . *Cogn Affect Behav Neurosci* 2006, **6**:102-109.

27. Goh JO, Chee MW, Tan JC, Venkatraman V, Hebrank A, Leshikar ED, Jenkins L, Sutton BP, Gutchess AH, Park DC: **A e a d c . e d a e b ec S ce , a d b ec ce e b d , e e a a a ea** . *Cogn Affect Behav Neurosci* 2007, **7**:44-52.

28. Goh JO, Leshikar ED, Sutton BP, Tan JC, Sim SK, Hebrank AC, Park DC: **C . . e d e e ce e a S ce ace a d , e e a a c e** . *Soc Cogn Affect Neurosci* 2010, **5**:227-235.

29. Hedden T, Ketay S, Aron A, Markus HR, Gabrieli DE: **C . . a e ce e a b a a e a c** . *Psychol Sci* 2008, **19**:12-17.
•• The authors scan European Americans and Asians using fMRI during visuospatial tasks requiring absolute or relative judgments. They describe evidence that frontal and parietal activations are greater during culturally nonpreferred judgments than during culturally preferred judgments.

30. Lewis RS, Goto SG, Kong LL: **C . . e a d c e ea A a A e ca a d E Sea A e ca d e e ce P3 e e - e a ed S e a a d e -c . a** . *Pers Soc Psychol Bull* 2008, **34**:623-634.

31. Han S, Mao L, Qin J, Friederici AD, Ge J: **F c a e a d c a d a e edа Se a a d Sa e a ac a ca ed ca a a b**. *Neuropsychologia* 2011, **49**:83-91.

32. Gutchess AH, Hedden T, Ketay S, Aron A, Gabrieli JD: **Ne a d e e ce e S ce e a c ea Sa ac c e**. *Soc Cogn Affect Neurosci* 2010, **5**:254-263.

33. Nan Y, Knösche TR, Friederici AD: **T e Se ce S ca Sa e c e: a c -c a ERP d**. *Brain Res* 2006, **1094**:179-191.

34. Nan Y, Knösche TR, Zysset S, Friederici AD: **C -c a c**