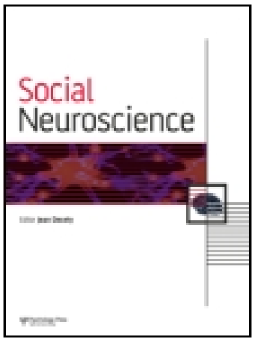

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Culture in social neuroscience: A review

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The aim of this review is to highlight an emerging field: the neuroscience of culture. This new field links cross–cultural psychology with cognitive neuroscience across fundamental domains of cognitive and social psychology. We present a summary of studies on emotion, perspective-taking, memory, object perception, attention, language, and the self, showing cultural differences in behavior as well as in neural activation. Although it is still nascent, the broad impact of merging the study of culture with cognitive neuroscience holds mutual distributed benefits for multiple related fields. Thus, cultural neuroscience may be uniquely poised to provide insights and breakthroughs for longstanding questions and problems in the study of behavior and thought, and its capacity for integration across multiple levels of analysis is especially high. These findings attest to the plasticity of the brain and its adaptation to cultural contexts.

Keywords: Culture; fMRI; EEG.

Recent study of the human brain has consistently highlighted its plasticity and capacity for adaptation (Maguire et al., 2000). Although only recently the brain was considered to be largely static—the product of genes and innate biology—studies have now begun to exhibit how experience and exposure can cause structural and functional changes in the brain's architecture (Han & Northoff, 2008). Learning, therefore, not only changes our thoughts and behaviors, but also our physiologies. One of the most pronounced and systematic forms of learning occurs through the adoption of cultural beliefs and practices. The variation in human behavior stemming from cultural differences has yielded profound effects across multiple domains (Kitayama & Cohen, 2007). It is no surprise, then, that scholars have recently begun to consider the role that culture plays in brain function and development, spawning the new field of cultural neuroscience.

Both cultural psychology and cognitive neuroscience are interdisciplinary fields. Whereas the former is the product of contributions from anthropology, linguistics, sociology, and psychology, the latter represents contributions from neuroscience, cognitive science, biology, comparative psychology, and even physics. The merging of these two heterogeneous fields, then, creates ties between researchers from incredibly diverse backgrounds. Each of the subscribing parties therefore has a stake in the outcomes and execution of this scholarly offspring, with the usual debates about theory and method within any single field thus multiplied manifold (Mateo, Cabanis, Cruz de Echeverria Loebell, & Krach, 2011; Vogeley & Roepstorff, 2009). Just as cultural neuroscience benefits from the varied discourse contributed by scholars from such diverse fields, it also stands to further knowledge in an exceptionally broad way. These advances are only the beginning, and the present review seeks to highlight some that are particularly valuable and relevant to social neuroscience by focusing on what is currently known about how culture influences the neural mechanisms that underlie our everyday behavioral, perceptual, and cognitive processes.

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BEHAVIOR

Cultures place value on certain behaviors and practices and, consequently, these values come to be expressed by members of those cultures. Thus, different patterns of cultural reinforcement give rise to different patterns of behavior. One example is the tendency toward dominance in many Western cultures and toward submission in many East Asian cultures. In the United States, for instance, dominant thinking and behavior are positively reinforced. Americans are encouraged to be independent, assertive, and skeptical of authority (Rothbaum, Pott, Azuma, Miyake, & Weisz, 2000). In Japan, however, subordination is positively reinforced. Japanese individuals are encouraged to be deferent, cooperative, and mindful of their obligations to others (Rothbaum et al., 2000).

One study (Freeman, Rule, Adams, & Ambady, 2009) found evidence that these cultural dispositions not only influence behavior but also brain function. American and Japanese participants passively viewed images of individuals posing dominance and submission during a functional magnetic resonance imaging (fMRI) scan. After the scanning process, the participants completed a self-report measure surveying their personal endorsement of dominant versus submissive values (e.g., “I impose my will on others” and “I let others make the decisions”; Goldberg et al., 2006). Results of the survey corroborated previous studies showing that Americans tend to endorse dominant values and behave in dominant ways, whereas Japanese tend to endorse more submissive values and express more subordinate behaviors. Critically, this was mirrored in the participants’ neural responses. American participants exhibited significantly greater responses in mesolimbic reward regions (e.g., the head of the caudate nucleus) when viewing bodies posing dominance whereas Japanese participants exhibited similar activity when viewing bodies posing submission.

Recent work found similar effects within American subcultures, as well. Telzer, Masten, Berkman, Lieberman, and Fuligni (2010) observed differences between White and Latino participants within the mesolimbic reward system in response to a task in which they were earning money for either their families or themselves. Despite similarities in their actual behavior, Latinos showed greater neural responses in striatal areas when helping family members—consistent with the greater emphasis on the family over the self in Latino culture (Hardway & Fuligni, 2006). The confluence of these inter- and intra-national studies therefore suggests that the basis for these cultural effects upon brain function may be experiential, rather than an innate biological distinction between individuals descending from Europe versus Asia.

PERCEPTION

Not only does culture affect how we behave, it also shapes how we see and interpret the world. Theorists have argued that culture can influence basic vision and attentional processes (Markus & Kitayama, 1991). There is now a body of evidence supporting this, drawing from several domains of social and perceptual neuroscience.

Object and background processing

Several recent behavioral studies have suggested that Easterners attend to the background or situational context whereas Westerners focus on the central object within a scene or background (Kitayama, Duffy, Kawamura, & Larsen, 2003). Such cultural variation in visual attention is believed to occur because of culturally-prescribed differences in processing how percepts are integrated and related. Easterners tend to perceive objects, people, and the situation or context in which they are embedded as mutually interdependent. Thus, they may use holistic strategies for perceiving people and scenes. Westerners, however, are more likely to perceive objects and people as context-independent, consistent with an individualistic ideology, and therefore apply a more analytic perceptual strategy for perceiving entities in their environment (Gutchess, Hedden, Ketay, Aron, & Gabrieli, 2010; Kitayama et al., 2003).

This cross-cultural difference in perceptual tendencies is also reflected in brain activity. For example, a recent fMRI study comparing neural activity between East Asians and Westerners during absolute line judgments (judgments of a line’s size independent of a square that embeds the line) versus relative line judgments (judgments of the line’s size in proportion to the square) revealed distinct patterns of brain activation between the two groups in accordance with the perceiver’s culture (Hedden, Ketay, Aron, Markus, & Gabrieli, 2008). Both groups showed greater activation in a series of frontal, temporal, and parietal regions when performing the culturally non-preferred task, evidencing the need for greater attentional control. Moreover, this effect varied with the East Asians’ levels of acculturation to the United States, showing a more Western pattern of responses with greater acculturation to US culture.

Other studies have provided similar insights into the cultural differences in holistic versus analytic perception. In a task where participants perceived objects paired with scenes, Gutchess, Welsh, Boduroglu, and Park (2006) found that Americans showed greater activation in object-processing regions than did East Asians, who were more likely to show activation in areas associated with processing complex visual configurations (e.g., left occipital and fusiform regions). Relatedly, Goh et al. (2007) observed that older East Asians showed less adaptation in object-processing brain regions compared with Western older adults, suggesting less attention to individual objects (see also Chee et al., 2006; Gutchess et al., 2010; Jenkins, Yang, Goh, Hong, & Park, 2010).

More recently, Aron et al. (2010) found that cultural differences in visuospatial tasks (i.e., those found by Hedden et al., 2008, described above) are moderated by individual differences in personality. Specifically, American and East Asian individuals high in sensory processing sensitivity (SPS)—a trait describing an individual's sensitivity to social and physical stimuli that are also related to the Big-5 traits of neuroticism and introversion—showed little of the expected cultural differences in activation for the culturally nonpreferred task, whereas the previously noted cultural differences were very pronounced among the low-SPS participants. Similarly, Ishii, Kobayashi, and Kitayama (2010) found related effects in a study of congruency between verbal tone and semantic content. They observed that individual differences in social orientation (i.e., independence versus interdependence) were related to the strength of fronto-cortical responses in a late-peaking (450–900 ms) electroencephalography (EEG) waveform when the tone and meaning were incongruent. Thus, it is possible that other variables intrinsic to cultural differences, such as clustering of personality traits by culture, might explain some of the more basic findings that have emerged from the study of cognitive neuroscience across cultures.

Emotion recognition and face processing

Previous behavioral work has suggested considerable cultural variation in the expression and recognition of emotion from facial expressions. A meta-analysis revealed that individuals are better at understanding the emotions expressed by their cultural in-group compared with their cultural out-group (Elfenbein & Ambady, 2002). This effect was partially captured in a study by Chiao et al. (2008). They examined neural responses to the emotional expressions of Japanese and Caucasian targets' faces among Japanese participants living in Japan and Caucasian participants living in the United States. Distinct neural responses were found in response to in-group members, with individuals from both cultures showing greater amygdala activation to fear expressions on the faces of members of their own cultural group. Although previous within-culture work on in-group versus out-group perception has demonstrated an opposite pattern in the amygdala—greater response to out-group and unfamiliar faces (DuBois et al., 1999; Hart et al., 2000; see also Rule, Freeman, Moran, Gabrieli, & Ambady, 2010)—Chiao et al. (2008) explained their findings from the perspective of the ecological validity of understanding in-group members' expressions of fear, specifically, for evolutionarily adaptive purposes. More recent findings by Adams et al. (2010) elaborated on this effect by showing that American and Japanese participants' amygdala responses to fear faces depended on whether the targets' eyes were directly oriented (provoking greater amygdala responses for other-culture faces) or averted (provoking greater amygdala responses for same-culture faces).

Cultural familiarity, or exposure, is known to have an influence on the behavioral perception of emotional expressions (Elfenbein & Ambady, 2003) and may affect the neural response to emotional expressions, as well. For example, Derntl et al. (2009) reported that Asian immigrants to Austria showed a significant response to the emotional facial expressions of Caucasians (i.e., expressions of anger and disgust), but that the strength of this response was negatively correlated with the amount of time they had been in the foreign culture. The authors speculated that these findings might reflect the novelty of stimuli associated with a shorter stay or, otherwise, greater motivation to attend to social cues among immigrants. Similarly, Moriguchi et al. (2005) found that Caucasian immigrants to Japan processed fear expressions differently from Japanese natives, implicating emotion-related versus template-matching (e.g., inferior frontal gyrus) regions, respectively.

There is also evidence that culture affects face perception beyond emotional expressions. For instance, Goh et al. (2010) reported different activation patterns in Westerners and East Asians in the fusiform face area (FFA) when passively viewing faces versus houses. Whereas Westerners showed bilateral activation of the FFA, East Asians' responses tended to be more right lateralized. The authors interpreted these results as reflecting differences in analytic and holistic processing among Westerners and East Asians, respectively, citing hemispheric differences in the processing of faces holistically and by features in the FFA regions. Moreover, given that the FFA and visual-word-form-area (VWFA) have similar spatial coordinates in the right and left hemispheres, respectively (Plaut & Behrmann, 2011), this cross-cultural difference might relate to differences observed in VWFA for orthographic language processing (see below).

Inferring mental states

The ability to understand the intentions of others is one of the hallmarks of human social behavior. Yet, imputing mental states to others (e.g., theory of mind) may depend heavily on the cultural environment. To examine the relationship between culture and neural activation while inferring intentions, Kobayashi, Glover, and Temple (2007) compared 8- to 12-year-old American-English monolingual and Japanese-English bilingual children's brain responses during false-belief and cartoon tasks that tested their ability to infer the intentions and mental states of others. They found activation in the bilateral ventral–medial prefrontal cortex (VMPFC) and precuneus across both groups, suggesting that these areas are important for universal understanding of intentionality. However, they also found cultural specificity in other brain areas. For example, in a previous study by the same investigators, Japanese late-bilingual adults who completed a Japanese theory-of-mind task showed more activation in the right inferior frontal gyrus than either of Japanese bilingual adults completing an English theory-of-mind task or American monolingual adults (Kobayashi, Glover, & Temple, 2006). Results from the 2007 follow-up study on Japanese bilingual children were also in accordance with this finding, suggesting that culture-dependent activations for understanding theory of mind develop from an early age.

Using a second measure of mental-state inference (the Reading the Mind in the Eyes task; Baron-Cohen, Wheelwright, Hill, Raste, & Plumb, 2001), Adams et al. (2010) found that Japanese participants showed more activation in the superior temporal sulcus (STS; an area implicated in previous neuroimaging studies examining inferences of intentions) when they were judging the intentions of Japanese versus American targets from pictures of their eyes. Contrary to this, American participants showed the opposite pattern: more STS activation to judgments of Caucasian versus Japanese targets' eyes. Thus, individuals were more attuned to inferring the mental states of their own cultural in-group, thus providing early insights into how cross-cultural differences in the interpretation of thoughts and behaviors may occur.

COGNITION

Not only does culture affect our attention and what we see in the world, it also exerts a strong influence on how we think about what we perceive. Indeed, many core dimensions of thought are influenced by individuals' cultural orientation (e.g., thinking about oneself versus others; Markus & Kitayama, 1991). Thus, the merging of cognitive neuroscience with cultural psychology is a logical step forward in understanding how culture influences thought.

Language

Language is a central component of what defines and distinguishes cultures. Some of the earliest work in sociolinguistics specifically focused on the influence of linguistic diversity upon thought (Sapir, 1929; Whorf, 1940) and recent studies continue to build support for this (Thierry, Athanasopoulos, Wiggett, Dering, & Kuipers, 2009). One prominent example concerns how Mandarin speakers describe time as being vertical, whereas English speakers describe time as horizontal, which influences the way that speakers from the two groups think about and understand time (Boroditsky, 2001). In addition, different orthographies (i.e., written language forms) can influence the neural representations of language (Paulesu et al., 2001) and the very existence of brain regions localized for written language processing (e.g., the VWFA in the left fusiform gyrus) provide tremendous evidence for the influence of cultural artifacts (e.g., writing) on brain function (see Fiez & Petersen, 1998; McCandliss, Cohen, & Dehaene, 2003).

Memory

Our ability to remember things from the past is fundamental to both learning new skills and accomplishing tasks in the present. Behavioral evidence suggests that many aspects of our memory (e.g., cognitive decline in memory) are shared across cultures at the level of behavior (Conway, Wang, Hanyu, & Haque, 2005). Easterners and Westerners may vary in their degree of encoding for objects at the neural level, however, depending on environmental cues and context (Park & Gutchess, 2006). Gutchess et al. (2006) compared neural activation between East Asians and Americans as they performed an object recognition memory task. East Asians and Americans performed equally well but demonstrated recruitment of distinct brain regions (European-Americans activated more regions implicated in object processing). Thus, people of different cultural groups may recruit distinct neural systems despite expressing similar behaviors.

Representations of the self

The cognitive representation of the self is perhaps one of the best-studied areas of social neuroscience (Northoff et al., 2006). In turn, one of the best-explored areas of cultural psychology regards the consideration of differences in how the self is constructed across cultures (Kitayama, Markus, Matsumoto, & Norasakkunkit, 1997). Individualistic cultures tend to view the self as independent of others, whereas collectivistic cultures view the self as an interdependent entity that is closely inter-related with others (e.g., family members; Markus & Kitayama, 1991).

Given the depth of research about the self in both cognitive neuroscience and cultural psychology, it is not surprising that their combined study has been one of the most prolific areas within cultural neuroscience. Sui, Liu, and Han (2009), for example, reported that British participants were faster to make judgments of their own faces versus those of a familiar other and showed a greater correspondent N2 EEG waveform than Chinese participants performing the same task. Moreover, Zhu, Zhang, Fan, and Han (2007) found that Chinese participants showed activation when thinking about their mothers in the same VMPFC region that is known to respond when thinking about oneself among Westerners (Kelley et al., 2002). This was not the case when thinking about other, unrelated individuals, however. This overlap between the self and mother in the VMPFC seems particular to the maternal relationship, as the effects for other close associates (father or best friend) appear much reduced (Wang et al., 2011). Extending this, Ng, Han, Mao, and Lai (2010) examined the effect of a Western versus Chinese cultural prime on the neural activity of Westernized Chinese bilinguals when making judgments regarding the self, mother, and a non-identified person (NIP; i.e., a significant other in their lives with whom they did not identify, such as a boss). Consistent with the effects of cultural priming on behavior (Hong, Morris, Chiu, & Benet-Martinez, 2000), VMPFC differences between self-processing versus both mother- and NIP-processing were enhanced following the Western cultural prime but were inhibited following the Chinese cultural prime. Similarly, Chiao et al. (2010) primed bicultural participants with individualism and collectivism and observed prime-dependent variance in self-referential processing: VMPFC was more active when thinking about the self contextually following the collectivistic prime, but more active when thinking about the self in general following the individualistic prime.

Finally, recent evidence has suggested that these effects may be moderated by intra-cultural individual differences in interdependent social orientation (Ray et al., 2010) or possibly even religious beliefs (Han et al., 2010; Wu, Wang, He, Mao, & Zhang, 2010). Thus, although the research on the neural underpinnings of self-referential processing is expansive, these recent findings continue to refine our thinking on this topic. Despite its current size in proportion to the literature on cultural neuroscience, there is clearly still much room for this area of research to grow.

FUTURE DIRECTIONS

To date, much consideration of culture in social neuroscience has focused on differences between nations—particularly Western versus East Asian cultures. Yet there is also considerable intra-national cultural variation that may be relevant to understanding the relationship between culture and the brain. Socioeconomic status, for example, exerts a large influence on individuals' ways of thinking, with one study showing that working-class Americans exhibited more context-dependent thinking reminiscent of collectivist patterns found in other nations (Kraus, Piff, & Keltner, 2009). These effects appear to have correlates at the neural level, as Varnum, Na, Murata, and Kitayama (2011) recently showed that individuals with less-educated parents expressed a reduced N400 EEG waveform when encountering trait-violating information about targets, similar to the effects for Japanese participants in a study reported by Na and Kitayama (2011).

Another area with promise for increasing understanding of how culture influences the brain is in the consideration of genetic variation. For instance, collectivistic cultures tend to show a higher prevalence of the short allele of the 5-HTTLPR polymorphism on the serotonin transporter gene, which is associated with increased negative affect and maladaptive mental illnesses such as anxiety and depression. Interestingly, the collectivistic nature of the cultures seems to buffer these effects, actually leading to a lower population-level incidence of several relevant mental disorders (Chiao & Blizinsky, 2010). This suggests an interrelationship between culture and genetic selection, with some genetic traits functioning to increase individuals' survival depending on their cultural context. Similarly, Kim et al. (2011) reported that individuals with a genetic predisposition toward socioemotional sensitivity (i.e., those homozygous for the G allele of the OXTR rs53576 site on the oxytocin receptor gene) were more likely to adhere to social norms of emotion regulation, which diverge across cultures (e.g., to suppress emotion in Korea but express emotion in the United States), and this also affects the degree to which they seek emotional support (Kim et al., 2010). These studies, therefore, add to the literature on how culture interacts with and shapes human biological functioning at multiple levels.

CONCLUSION

The study of culture and biology has historically been stratified within universities and academic subfields, creating a deep conceptual and methodological schism between these different communities of researchers. Snow (1959) once hypothesized that molecular biology could serve as a bridge between the two arenas of thought. However, only modest progress has been made so far, as gene–behavior association studies have been only mildly successful. Perhaps this is because of the exclusion of the intermediary level of analysis—brain structure and function—a lacuna that the emerging subdiscipline of cultural neuroscience has begun to fill. We therefore hypothesize that cultural neuroscience is in an even greater position to bridge the culture–biology gap by pulling perspectives and methodologies from every area of psychology (e.g., cognitive, social, and developmental), as well as from the fields of anthropology, molecular biology, and neuroscience. The tools required to investigate the links between multiple levels of analysis (i.e., from the neuron to the environment) are now available in ways not previously imaginable, and utilizing these tools along with a cultural neuroscience approach to investigating phenomena is likely to have a conceptual impact on a wide range of research areas within psychology. Such results will not only enable us to articulate our conceptions of culture with greater specificity, but also to improve our understanding of its mutually influential relationship with biology.

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