Brain, Behavior, and Culture: Insights from Cognition, Perception, and Emotion

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Abstract Recent developments in cultural neuroscience have provided insights showing that human brain function can vary along cultural lines. In the present article, we review the contributions of cultural psychology to the study and understanding of human cognitive neuroscience by focusing on three key areas of importance: cognition, perception, and emotion. We first review what is known about the influence of culture on the brain with regard to some basic cognitive processes: language, mathematics, memory, and perspective-taking/theory of mind. We then review cultural influences on the neuroscience of perception, focusing on the perception of objects, scenes, and social cues. Finally, we review the role of culture in the understanding of emotion recognition from a cognitive neuroscience perspective. Together, these three components of human behavior and brain function serve to illustrate how a unique understanding of cognitive neuroscience can be gained from the study of culture.

Psychology as an empirical discipline emerged as recently as the late nineteenth century, perhaps marked by Wilhelm Wundt's establishment of the first psychological laboratory in 1879. The consideration of culture's influence on the mind and behavior was present even in these early days, as Wundt himself is considered one of the first cultural psychologists (see Heine 2008). Despite a series of starts and fits, however, the study of psychology across cultures as it is known today did not take hold until the latter half of the twentieth century. This is largely because of the focus on behaviorism, and later cognition, that dominated mainstream psychological thinking during much of the period between. Yet the groundwork for what are presently the foundations of cross-cultural psychology were active throughout those times, even if only on the margins of psychology – spilling over from disciplines

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such as cultural anthropology (e.g., Benedict 1934) and sociolinguistics (e.g., Whorf 1956).

The goals of studying psychology across cultures can be largely simplified as understanding similarities and differences between groups with culture standing as the moderating variable in between. For example, a study by Zebrowitz et al. (1993) showed that European-Americans, African-Americans, and Koreans all showed relative agreement in their perceptions of various personality and physical traits from faces belonging to all three groups. Thus, we might say that impressions of facial attractiveness, for instance, are fairly constant across cultures – a face that is found attractive in one culture is generally found attractive in another, foreign culture (see also Cunningham et al. 1995). In a second study, though, Peng et al. (1993) found that, although Americans and Koreans agreed in their perceptions of the rate of speech of American and Korean speakers – they both agreed who was speaking slowly and who was speaking quickly – they disagreed about what meaning that held. Specifically, Americans attributed higher status to individuals who spoke quickly, whereas Koreans attributed higher status to individuals who spoke slowly. Thus, their perceptions were the same but their interpretations were strikingly different.

Some of the most seminal studies in cultural psychology have investigated cross-cultural similarities and differences in a similar fashion. For instance, Hofstede (1980) conducted a large international survey of employees of the company IBM living in numerous cultures. From the data he collected on the workers' self-reported values, he was able to parse a handful of critical dimensions that seemed to describe major differences between cultures, such as distinctions of individualism and collectivism. Another classic study of cultural differences is derived from Witkin and Asch's (1948) measure of field dependence known as the rod-and-frame test. Described simply, participants are presented with a rod within a frame both of which are capable of being moved. The test requires that the participant aligns the rod to a certain angle as the frame is moved. Field independence is described as the successful capacity to orient the rod to the proper angle regardless of the position of the surrounding frame. Field dependence, in contrast, is believed to be in effect when the position of the frame influences where the participant places the rod. That is, perception of the rod's position is relative to the field that is created by the frame. Witkin and Berry (1975) reviewed cross-cultural differences in performance on the rod-and-frame test and reported that individuals who work together collectively (such as farmers) tended to show greater field dependence than did individuals living in industrialized areas where they were more likely to live and work in a more independent or individualistic fashion.

Indeed, in a more recent but influential study, Ji et al. (2000) showed a dissociation between East Asians and Westerners (Americans) on the rod-and-frame test that was reflective of overall differences in holistic versus analytic processing. Americans were found to be field-independent, able to focus on the rod while ignoring the frame. East Asians were found to be field-dependent, highly influenced by the frame's position in judging the angle of the rod. Thus, perhaps because of differences as basic as individualism and collectivism between the two cultures (see

also Witkin and Berry 1975), Americans expressed isolated perception and thinking of a single entity (the rod) whereas East Asians expressed integrative perception and thinking of the whole by incorporating literal frames of reference (the physical frame) into their perceptions.

Contemporary work in cross-cultural psychology has continued to broaden our conceptions of other fundamental aspects of behavior and thought in other ways. In one impactful theoretical paper, Markus and Kitayama (1991) provided distinctions of how the self is understood differently in many East Asian versus many Western (e.g., American) cultures. In brief summary, they described how Westerners may think of individuals as independent and constant entities, with the self and others existing quite distinctly, whereas East Asians may think of the self and close others as much more interdependent and existing in relation to particular contexts; i.e., the notion that one does not exist separately from others but in relation to others. Hence, Westerners may be more likely to see themselves as possessing fixed traits regardless of what situation they are in (e.g., "I am a respectful person"), whereas East Asians may be more likely to incorporate the context in assessing their behavior (e.g., "I am respectful with my family"). As a result, East Asians appear more likely to incorporate the situational context and their relationships with others into their self-concepts, basing their views of themselves upon integration of others.

As cultural psychology has continued to grow, it has gained ever more breadth. Rather than cultural psychology existing as the product of spilling over from the fringes of other fields, such as anthropology, cultural psychology has now begun to itself spill over into new disciplines, such as cognitive neuroscience. A currently emerging field is what is known as cultural neuroscience (Ambady and Bharucha 2009; Chiao and Ambady 2007; Han and Northoff 2008). Work in cultural neuroscience has begun to link the differences that have been observed in thought and behavior along cultural lines to what is known about the functions of the brain related to those behaviors. One central example is a recent study by Zhu et al. (2007), which extended Markus and Kitayama's (1991) descriptions of differences in the self between Western and East Asian cultures. Specifically, Zhu et al. (2007) found that the medial prefrontal cortex (mPFC), a brain region previously known to be involved in representations of the self (e.g., Kelley et al. 2002), showed differential activity when individuals thought about themselves versus others for both Western and Chinese participants. Critically, however, when Chinese participants – but not Western participants – thought about their mothers, this also activated the mPFC region. The Chinese participants' overlapping activation in mPFC during thoughts about themselves and their mothers provides evidence for Markus and Kitayama's (1991) descriptions of interdependence in the self-concept of East Asians, whereas Western participants' distinct activation in mPFC during thoughts about themselves and their mothers provides evidence for Markus and Kitayama's (1991) descriptions of independence in the self-concept of Westerners.

The still nascent field of cultural neuroscience is therefore well poised to provide supporting evidence as well as novel insights into the role of culture in thought and behavior. Two domains in which this potential has already begun to blossom are in

the contributions of cultural neuroscience to cognition and perception, including the perception and recognition of emotion.

1 Contributions to Cognition

Culture exerts a strong influence on how we think. Indeed, many of the fundamental, core aspects of human cognition are known to vary according to an individual's cultural group membership. These influences span from largely intrapersonal thoughts, such as mathematic processing, to highly interpersonal thoughts, such as communication and considering another's perspective. The confluence of the study of culture with the brain bases of cognition has therefore provided a rich opportunity for a better understanding of how culture shapes thought.

1.1 Language

Perhaps the area of human behavior most marked by cross-cultural differences is language. Language is, indeed, one of the most tangible markers of culture and is perhaps one of the greatest dividers by which cultures remain distinct from one another. As cultures change and evolve, the way in which individuals within a culture communicate both mirrors and guides its changes. These changes and differences are believed to be adaptations to the needs of the people that make up a culture (e.g., Romaine 1994). As such, it has been purported that language provides unique insight into the ways that individuals within a culture think.

One of the most prominent intersections of the study of language and culture exists in the Sapir–Whorf hypothesis. Sapir and Whorf theorized and provided evidence for the influence of one's language upon one's thought (see Sapir 1929; Whorf 1956). An example of this can be found in Boroditsky's (2001) recent work on speakers of Mandarin and English. Mandarin conceptualizes time as running vertically (up and down) whereas English conceptualizes time as running horizontally (left and right). These differences shaped the speakers' habits in terms of thinking about time (e.g., Mandarin speakers were quicker to say that March preceded April when primed with a vertical array consistent with their representation of time), but they were also malleable; that is, English speakers showed evidence of thinking of time vertically after brief training to do so. Thus, although language may have an influence upon tendencies in thought, it does not necessarily constrain thought in a fixed manner.

In terms of brain function, there are data showing that culture can influence the representation of language for both spoken and read speech. For instance, Bolger et al. (2005) conducted a meta-analysis of neuroimaging studies for reading words across different languages and cultures. They found that, despite commonalities across languages in the activation of the visual word form area (VWFA) – an area in

the left fusiform gyrus that is selective for reading words (e.g., McCandliss et al. 2003) ideographic writing systems like Chinese were marked by greater activation in the bilateral visual cortices than were alphabetic writing systems like English. Similarly, variations in the brain regions involved in dyslexia has been found across different languages, presumably because of the differences in orthographic (writing) systems (Paulesu et al. 2001). Indeed, the selective representation for written words in the VWFA is, itself, an example of neural adaptation to culture given that writing is one of the fundamental markers of cultural construction and has only existed for a small percentage of humans' existence as a species.

Similarly, Pallier et al. (2003) reported evidence for both cultural universality and cultural specificity in the brain response to spoken speech. Both Korean adoptees to France and native French speakers showed similar responses to sentences spoken in Korean, French, or other foreign languages. The native French speakers, however, showed greater activations when hearing French sentences than did the French-Korean adoptees. In addition, Kovelman et al. (2008) showed that bilinguals exhibited different patterns of brain activity compared to monolinguals, with both groups exhibiting responses in Broca's area but bilinguals showing unique activations in the dorsolateral and prefrontal cortices.

1.2 Mathematics

Cross-cultural differences in the brain response to mathematical calculations are believed to also be influenced by a speaker's language. For instance, Tang et al. (2006) compared native English and Chinese speakers' neural activity as they performed numerical and non-numerical tasks. Similar to the differences in reading found for speakers of alphabetic versus ideographic orthographies, the English speakers showed greater activation in Wernicke's and Broca's language areas and the Chinese speakers showed greater activation in areas involved in visuospatial processing. Thus, mathematical calculations may rely on phonological processing for speakers of alphabetic languages who may be retrieving the mathematical concepts somewhat verbally but may rely on visual processing for speakers of ideographic languages who are less accustomed to associating specific symbols with specific sounds. The language in which mathematics is learned may therefore influence how it is processed, though further work will be needed before a definitive understanding of these differences may be reached.

1.3 Memory

Human memory is one of the most distinguishing and fundamental capacities that we possess as a species. Our ability to remember is essential to learning, adapting to the environment, and overcoming challenges. Being such a core aspect of human

growth and survival, behavioral studies have shown that our ability to remember is relatively constant across cultural lines, yet some differences do exist. Park and Gutchess (2006) found that East Asian and Western individuals encoded objects into memory differently depending on environmental context, much like the differences observed between holistic and analytic processing reported by Ji et al. (2000) using the rod-and-frame test.

In elaboration of this effect, Gutchess et al. (2006) conducted an fMRI study in which East-Asian Americans and non-Asian Americans performed a memory task that included objects and scenes. Although both groups performed equally well, they showed differences in the brain regions they used to complete the task. In particular, non-Asian Americans showed enhanced processing in areas related to object processing (such as bilateral middle temporal gyrus, left superior parietal/angular gyrus and right superior temporal/supramarginal gyrus), though no striking differences emerged between the two groups for the processing of scenes. These data may therefore reflect what is known behaviorally about Westerners' focus on independent objects (such as the rod in the frame), whereas East-Asian Americans may be processing both the scene (e.g., the frame without a rod) and the complex scene (e.g., the frame with a rod) somewhat similarly. Future research may seek to explore these phenomena further to better understand the precise nature of this difference in brain activation, particularly given that both types of processing resulted in equivalent performance on the task.

1.4 Perspective-Taking

The ability to understand others' thoughts is one of the most defining attributes of human behavior (e.g., Saxe and Baron-Cohen 2006). This "thinking about thinking" is often referred to as "theory of mind" as it requires the theorizing that others have minds like one's own and that one may therefore be able to use one's own mind to understand what is occurring in others' minds (see Gallagher and Frith 2003, for a review of theory of mind). Naturally, the ability to infer what is going on in others' minds can be mitigated by the assumptions inherent in one's own culture and the adjustments needed to be made when inferring the state of mind for persons belonging to a different culture.

In one test of this, Kobayashi et al. (2006) presented false-belief and cartoon tasks to American and Japanese children while measuring their brain responses using fMRI. An example of such a task would be that someone places an object into a cupboard in the presence of an observer. The observer then leaves and the object is moved from the cupboard into another location. The test, then, is to see whether the child will understand that the observer still thinks the object is in the cupboard (since this is where the observer saw it placed) or if the child will mistakenly apply his or her own knowledge about the object's true, current location to the observer. If

the child expresses a theory of mind, she should be able to take the perspective of the observer and assume that he will look for the object in the cupboard. In this instance, Kobayashi et al. (2006) found that the American and Japanese children both showed common responses in the ventromedial prefrontal cortex (vmPFC) and precuneus. Thus, children from both cultures recruited the same brain regions when taking the perspective of others.

A second study of perspective-taking in adults showed similar commonalities. Employing a task known as the "reading the mind in the eyes" test (Baron-Cohen et al. 2001), Adams et al. (2010) found that both American and Japanese participants showed responses in the superior temporal sulcus (STS) – a region previously implicated in understanding others' intentions – when inferring the mental states of others. The particular task involved presenting American and Japanese participants with photos of American and Japanese faces, cropped so that only the eyes were visible. Participants were then asked to select from two choices the adjective that best described the target's mental state. This task is believed to require the perceiver to take the perspective of the target in order to infer his or her state of mind. Hence, individuals who lack mental inference abilities (such as patients with neurological damage) show severe impairment in choosing which adjectives best describe the targets' mental states (Adolphs et al. 2002).

Although both the American and Japanese participants showed activation in the STS during this mental inference task relative to simply judging the sex of the targets' eyes, each group showed stronger activation for members of their own culture relative to members of the other culture. Specifically, Japanese participants showed a stronger response in the STS when inferring the mental states of other Japanese targets than they did when inferring the mental states of American targets. Conversely, American participants showed a stronger response in the STS when inferring the mental states of other American targets than they did when inferring the mental states of Japanese targets. Thus, although the pattern of responses was similar and congruent across cultures, it was moderated by the relationship with the culture of the target being perceived.

2 Contributions to Perception

Perhaps one of the most apparent influences of culture is its effect on how we perceive and interpret the world. Culture can influence how we perceive and interpret higher-level constructs, such as ourselves and others (e.g., Markus and Kitayama 1991; Zhu et al. 2007) and it can also influence how we perceive and interpret more basic, lower-level information, affecting vision and attention (e.g., the rod-and-frame test; Ji et al. 2000). Given that the visual system is perhaps the most thoroughly studied topic in the cognitive neurosciences, the intersection of culture and the cognitive neuroscience of vision holds great explanatory power for understanding cultural differences in thought and behavior.

2.1 Object and Background Processing

Culture can have profound effects upon what things we see and how we see them. As already introduced above, behavioral studies have shown that East Asians are more likely to perceive objects and scenes as wholes, with their component parts interrelated to one another, whereas Westerners are disposed towards perceiving objects and scenes according to their distinct parts, considering them to be separate independent entities. Consequently, East Asians may attend more to the background in a scene whereas Westerners may attend more to the objects in a scene.

In evidence of this, Kitayama et al. (2003) created an adapted version of the rod-and-frame test. Rather than present participants with a moveable rod and frame and asking them to consider their relative angles, they instead printed lines within boxes and asked participants to attend to the lines' lengths. Participants were then instructed to reproduce a line of the same length either by drawing a line of the same absolute length of the original line or by drawing a line of the same proportional length with reference to the line's distance from the printed box/frame. Consistent with the previous work using the traditional rod-and-frame test (e.g., Ji et al. 2000), Americans were more accurate at reproducing lines of the correct length when asked to attend to absolute size and Japanese were more accurate at reproducing lines of the correct length when asked to attend to relative size. These differences suggest cultural variation in visual attention that may occur because of differences in how percepts are integrated and related to one another across cultures.

Hedden et al. (2008) provided further understanding for these effects by conducting a modified version of this task while scanning American and East Asian participants using fMRI. Participants were instructed either to make absolute or relative judgments of the lines as a means of judging whether they matched a previously presented line and box stimulus. When participants performed judgments that were inconsistent with their cultural orientation (i.e., East Asians making absolute judgments and Americans making relative judgments), they showed activation in a robust and widespread network of frontal and parietal brain regions involved in the exertion of attentional control. Thus, performing the task in a manner that is believed to be incongruent with the preferred independent (American) and interdependent (East Asian) method of perception required great effort and cognitive control. These data therefore demonstrate the strong influence of culture on the development of perceptual preferences.

Other studies have provided similar insights. For instance, Goh et al. (2007) found that elderly East Asian, Singaporean participants showed less of an adaptation response in the object-processing areas of the brain compared to older Western adults. That is, Westerners who were presented with images of an object placed in various scenes showed reduced neural activation to the object with subsequent presentations (they adapted to seeing the object). In contrast, East Asians who were presented with images of an object and scene continued to show an equally strong neural response during subsequent presentations of the same object, with all

iterations showing a response as if they were seeing the object for the first time. Consistent with Gutchess et al.'s (2006) findings that East Asians and Westerners process objects and scenes differently when encoding them into memory, these findings suggest that Westerners are allocating greater attention to objects (i.e., they are noticing them and adapting to them) than are East Asians, whose attention may be directed elsewhere (such as to the background or to consideration of the object's relationships to other percepts). However, Goh et al. (2007) only observed these effects among older adults and not among young adults. Therefore, further work will need to examine these phenomena in more detail before firm conclusions can be reached.

2.2 Social Cues

A corpus of research has investigated the similarities and differences involved in perceiving social cues across cultures. As mentioned above, Zebrowitz et al. (1993) investigated the perceptions and attributions made to same-culture and other-culture faces for a host of traits and found fairly strong consistency in how both same-culture and other-culture faces were perceived by African-American, European-American, and Korean perceivers. Similarly, Albright et al. (1997) observed that American and Chinese perceivers agreed in their perceptions of extraversion and agreeableness for the faces of same-culture and other-culture faces, and Cunningham et al. (1995) observed consistency between American and Taiwanese perceivers in judgments of facial attractiveness. Finally, Rule et al. (2010) found that American and Japanese perceivers agreed in their judgments of personality traits (dominance likeability, and trustworthiness) and facial maturity from the faces of American and Japanese political candidates. In addition, their judgments were significantly related to the percentage of votes that the candidates received in their respective elections. The traits that predicted these outcomes, however, differed: traits related to power (dominance and facial maturity) significantly predicted the American candidates' success whereas traits related to warmth (likeability and trustworthiness) significantly predicted the Japanese candidates' success. In turn, when American and Japanese participants were asked to indicate how likely they believed it was that members of each culture would vote for a given candidate, their judgments only predicted the election outcomes for targets from their own culture. Therefore, although there is consistency across cultures in the perception of many traits, what is done with this information may be relative to the individual cultures.

One trait of particular importance to social behavior is dominance (Mazur 2005). Dominance can be readily observed from nonverbal cues (Schmid Mast and Hall 2004) and exerts particularly strong effects upon the way that individuals interact, as well as the establishment of status hierarchies (Schmid Mast 2001). Moreover, dominance is consistently recognized across cultures (Rule et al. 2010). Given the cultural differences in the treatment of status between collectivistic and

individualistic cultures, it therefore seems possible that cues to dominance and submission might hold different meanings for members of collectivist (e.g., East Asian) and individualist (e.g., Western) cultures. Indeed, in the USA, there is more encouragement to be dominant, as dominant thinking and behavior is positively reinforced. Conversely, in Japan, there is more encouragement to be submissive, as paternalism and subordination are positively reinforced (e.g., Bhappu 2000; Jung et al. 1995). Americans are therefore encouraged to be independent and assertive, whereas Japanese individuals are encouraged to be sociable and cooperative (e.g., Moskowitz et al. 1994), reflecting dominance and subordination, respectively.

One study directly tested whether differences in expressions of dominance and submission may elicit differences in neural responses from members of a collectivistic culture (Japan) and an individualistic culture (the USA). Freeman et al. (2009) presented American and Japanese participants with outlines of bodies posing dominant and submissive postures and administered a survey assessing the participants' personal tendencies towards dominance or submissiveness after the scan. Americans reported a proclivity towards expressing dominant behavior, whereas Japanese reported a proclivity towards expressing submissive behavior. Moreover, the neuroimaging results revealed that the head of the caudate nucleus and the mPFC, two important components of the mesolimbic reward system, showed stronger responses to dominant stimuli in the American perceivers and stronger responses to submissive stimuli in the Japanese perceivers. Lastly, activity in the right caudate and mPFC correlated with the participants' self-reported behavioral tendencies towards dominance and submission, such that stronger responses in the caudate and mPFC to dominant stimuli were associated with more dominant individuals and stronger responses in the caudate and mPFC to submissive stimuli were associated with more submissive individuals.

Perceptions of dominance and submission from the nonverbal displays of others were, respectively, more rewarding for individuals who themselves were characterized by those behaviors. Moreover, regardless of individual differences in preferences for dominance and submissive dispositions, cultural group membership was also associated with stronger neural responses for the type of behavior that was more endorsed by the perceiver's culture (i.e., Americans found dominant stimuli more rewarding and Japanese found submissive stimuli more rewarding).

3 Contributions to Emotion Recognition

One area of perception that has been particularly well studied cross-culturally is that of emotion recognition. Perhaps the most fundamental contribution to our understanding of the expression and recognition of emotions across cultures is Ekman and colleagues' account of the universality of emotion displays and recognitions across diverse nations, both highly industrial and incredibly rural (e.g., Ekman 1980; Ekman et al. 1969). This work led to the development of the concept of the five basic emotions: anger, fear, happiness, disgust, and sadness.

Subsequent behavioral work has expanded what is known about the expression and recognition of emotions across distinct cultures. One influential account was a meta-analysis by Elfenbein and Ambady (2002) that uncovered a significant cultural ingroup advantage in emotion recognition. That is, although almost all emotion recognition judgments surveyed were found to be categorized significantly better than chance guessing (about 58% accurate, overall), there was a statistically significant increase (about 9% greater, on average) in the ability to recognize the emotional expressions of members of one's own group versus the emotional expressions of members of a different group. One explanation offered for this effect is that the ability to read the emotions of ingroup members would provide an adaptive advantage and would facilitate social interaction. In addition, the increased ability to recognize the emotions of one's ingroup could be the result of increased exposure and experience with ingroup members versus outgroup members – what is called the "familiarity breeds accuracy" effect (Elfenbein and Ambady 2003).

One neuroimaging study investigated the ingroup advantage in emotion recognition. Chiao et al. (2008) presented American and Japanese participants with American and Japanese faces posing angry, fearful, happy, or neutral expressions. Both American and Japanese participants showed significantly greater bilateral amygdala response to the perception of fear faces when posed by same-culture, ingroup faces as compared to fear expressions posed by other-culture, outgroup faces. Thus, American participants showed a stronger amygdala response to fearful American faces and Japanese participants showed a stronger amygdala response to fearful Japanese faces. Notably, no significant differences were observed for anger, happy, or neutral expressions. In accordance with an evolutionary perspective on emotion recognition, however, this finding is sensible. Fear expressions may be some of the most important for communicating with ingroup members. Expressions of fear may provide information about dangers in the environment; thus, they would be particularly valuable for ingroup members who, through similarity and shared experiences, might also be vulnerable to such potential threats. In addition, expressions of fear may be particularly valuable for evoking the help of others (see Marsh et al. 2005). Thus, it would again be adaptive to recognize fear signals from ingroup members, as they might motivate helping behavior that would contribute to the survival of the group.

4 Conclusion

Growing out of the very beginnings of the empirical study of psychology, cultural neuroscience is a field with great promise. As we have shown here, the many advances in cultural psychology that have benefitted our understanding of the role of culture in human thought and behavior are now themselves becoming the beneficiaries of critical insights from cognitive neuroscience. These insights have thus far allowed for a deeper understanding of the processes that underlie the cross-cultural similarities and differences previously observed in behavioral work. In

addition, they hold great potential for an increased understanding of how culture influences behavior, the mind, and the brain. Together, then, cultural neuroscience not only presents critical and helpful information for understanding the mind and behavior but also presents information relevant and useful for understanding the neural basis of many psychological processes, as well as a more complete picture of the plasticity and adaptive capacity of the brain's response to its culture and environment. Thus, though still in its infancy, cultural neuroscience shows considerable potential for what it may offer in the decades to come.

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