Culture and the Brain

Comparisons Between the West and East Asia

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For many years, culture and biology were seen as parallels. Things that have been there since the start of time, but never examined together. Culture was seldom studied under the scientific approach due to the lack of quantitative methods. Biology was seen as a scientific discipline obeying the laws of physics and an area that can be examined scientifically. The early studies of biology focused on the connections between the brain and behavior, studying the universal mechanisms and behaviors.[1] Cultural psychology, which emerged in the 1980s, did investigate culture and mental states but did not focus on neurobiology.[2] In recent decades there has been a move to bridge this gap in an emerging field called cultural neuroscience. Cultural neuroscience not only aims to find how culture affects the brain and vice versa, but also addresses the larger problem of human research. That is that 90% of the peer-reviewed neuroimaging research that came out before 2009 was done in western populations; but are western populations accurate representations of the world?[3] Cultural science suggests not and aims to remedy this gap. With emerging technologies and more need for culturally aware research, the cultural neuroscience field has produced many interesting findings. This paper aims to examine some of the cultural differences between Westerners and East Asians as they pertain to language, attention, and social perceptions.

Chapter 1. Language

Language is essential to any culture. It is shaped by culture and in turn shapes the culture. Some experts, like Brown, argue that without language culture

1 Joan Y. Chiao, "Cultural Neuroscience: a Once and Future Discipline," *Progress in Brain Research*, 2009, 287–304, https://doi.org/10.1016/s0079-6123(09)17821-4.

2 Chiao, "Cultural Neuroscience."

3 Chiao, "Cultural Neuroscience."

would not exist and that the two are interconnected; they cannot be separated without losing their significance.[4] History is often reflected in the language as well as cultural norms.[5] For example, use of honorifics may be more prominent in cultures that place high importance on respect and hierarchical organization. Through language people communicate their thoughts, perceptions, wants, and needs – something that is highly shaped by culture. When discussing culture's influence on the brain it is also essential to discuss language's influence on the brain as the three are interconnected. In this chapter, I present some background on neurolinguistics and connect them to current neuroscientific opinion on brain differences between Chinese and English speakers.

Language is a complex process that involves many parts of the brain. Processing spoken language, reading written texts, speaking, and formulating sentences are all processes requiring activation of different parts of the brain. Neuroscientists are still working to gain a better understanding on how exactly language is produced and interpreted in our brains.[6] In general, the left hemisphere is thought to be dominant in language related functions as it is responsible for more analytic processing.[7] The right hemisphere is more related to holistic processing and is more involved in melodic processing like music.[8] Most auditory language is processed in the auditory cortices in the temporal lobes.[9] One of the more important parts for language processing appears to be Heschl's gyrus in the primary auditory cortex as it is essential to initial processing of spoken language.[10] Other important regions are Broca's area, which plays a role in speech production and language comprehension; Wernicke's area, which is important to comprehension of speech; and parts of middle temporal gyrus, which are important to semantic processing.[11] While there is scientific evidence for the involvement of areas mentioned above, there are many other regions involved in language processing.

One of the most unique features about the brain is its plasticity, that is, the ability for neural networks to change and adapt. Therefore, different languages shape the brain in many unique ways depending on the particular demands of that language. Valaki et al. found that there are significant differences between lateralization (dominance of one hemisphere over the other) of activity in word

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4 H Douglas Brown, *Principles of Language Learning and Teaching*, 6th ed. (Upper Saddle River: Pearson, 1994).

5 Chuansheng Chen et al., "Cultural Neurolinguistics," *Progress in Brain Research*, 2009, 159–71, https://doi.org/10.1016/s0079-6123(09)17811-1.

6 Angela D. Friederici, "The Brain Basis of Language Processing: From Structure to Function," *Physiological Reviews* 91, no. 4 (October 2011): 1357–92, https://doi.org/10.1152/physrev.00006.2011.

7 Yue Wang, Allard Jongman, and Joan A. Sereno, "Dichotic Perception of Mandarin Tones by Chinese and American Listeners," *Brain and Language* 78, no. 3 (September 2001): 332–48, https://doi.org/10.1006/brln.2001.2474.

8 Wang, Jongman, and Sereno, "Dichotic Perception of Mandarin Tones."

9 Friederici, "Brain Basis of Language Processing."

10 Chen, "Cultural Neurolinguistics."

11 Friederici, "Brain Basis of Language Processing."

processing tasks between English or Spanish speakers and Mandarin-Chinese speakers.[12] English or Spanish speakers tend to have more asymmetrical processing with left-hemisphere dominance while Chinese speakers seem to have more individual variability.[13] The role of left temporoparietal region in language functions has already been established, therefore it is not surprising to find activation in this region. The right temporoparietal region is not as well researched, however current hypotheses suggest its involvement in perception of pitch changes and variations.[14] This could explain higher activation for Chinese speakers as (opposed to English or Spanish), tones and pitches are an essential part of the language. This study, however, is unable to give us the definitive answer as to why Chinese speakers show this variability in activation. What it does establish is that there is a fundamental organizational difference in the brains of Chinese speakers.[15]

Another study looked specifically into lexical tone perceptions and their lateralization.[16] This study challenges the hypothesis of Valaki et al. about the right hemisphere playing an important part in Chinese speakers' tone perception as it shows that for native Chinese speaker's tone is lateralized to the left hemisphere.[17] This is interesting as the same is not true for English speakers, who do not show a particular side dominance in tone perception, suggesting that lateralization to the left hemisphere might be dependent on tonality of the native language.[18] However, Chinese speakers did show variability consistent with Valaki et al., wherein some Chinese speakers showed lateralization to the right hemisphere or no hemisphere dominance.[19]

Tones are not the only feature of the language that result in brain differences. One study found that when Chinese speakers have to break down characters to identify initial consonants (a task that is usually not done in daily life) the processing of the word is mediated by the left inferior prefrontal cortex.[20] This is no different from English speakers. However, when Chinese speakers were asked to perform a task that required syllabic level processing (something done in day-to-day life) the left middle frontal cortex was activated.[21] These findings suggest that the left middle frontal cortex is involved in syllable processing, however this activation has not been

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12 C. E. Valaki et al., "Cortical Organization for Receptive Language Functions in Chinese, English, and Spanish: A Cross-Linguistic MEG Study," *Neuropsychologia* 42, no. 7 (2004): 967–79, https://doi.org/10.1016/j.neuropsychologia.2003.11.019.

13 Valaki et al., "Cortical Organization for Receptive Language."

14 Valaki et al., "Cortical Organization for Receptive Language."

15 Valaki et al., "Cortical Organization for Receptive Language."

16 Wang, Jongman, and Sereno, "Dichotic Perception of Mandarin Tones."

17 Valaki et al., "Cortical Organization for Receptive Language;" Wang, Jongman, and Sereno, "Dichotic Perception of Mandarin Tones."

18 Wang, Jongman, and Sereno, "Dichotic Perception of Mandarin Tones."

19 Valaki et al., "Cortical Organization for Receptive Language;" Wang, Jongman, and Sereno, "Dichotic Perception of Mandarin Tones."

20 Wai Ting Siok et al., "Distinct Brain Regions Associated with Syllable and Phoneme," *Human Brain Mapping* 18, no. 3 (February 21, 2003): 201–7, https://doi.org/10.1002/hbm.10094.

21 Siok et al., "Distinct Brain Regions."

observed in English speakers.[22] Similar studies have found that it is not only simple syllabic tasks that lead to activation in the left middle frontal cortex but also tasks related to word generation, semantic judgement, etc. in Chinese speakers.[23] This study shows that Chinese processing differs from English due to the smallest units of the language (syllables for Chinese and alphabet letters for English).

Lastly, it has been long believed that different linguistic categories (nouns, verbs, etc.) are differently represented in the brain. However, this is complicated by the fact that these representations differ between languages.[24] English and other Indo-European languages seem to follow this trend, but Li et al. found that there is no such differentiation for Chinese speakers.[25] Nouns, verbs, and ambiguous words are processed by a variety of regions (frontal, temporal, parietal, and occipital areas in both hemispheres) with no distinct region for each category.[26] This may be due to unique features of Chinese that lead to brain adaptation, such as many nouns' usage as verbs.[27] Interestingly, lateralization may also be responsible for the differential representation. Similar to Valaki et al. and Siok et al., Li et al. found that there is variability of hemisphere usage in Chinese speakers.[28] English and other Indo-European languages seem to only activate the left-hemisphere, whereas Chinese speakers show both right- and left-hemisphere activation.[29]

Overall, there are still many questions to be answered. Many differences in brain function result from the writing system, tonality, and grammatical differences between the languages of interest. It seems that lateralization of activity between Chinese and Indo-European language speakers is different, however the results are inconclusive as to what extent the lateralization to the right-hemisphere is prevalent and to what function it serves. While I have pointed out many differences, there also seem to be many commonalities among all languages. Bolger et al. showed that some activation of regions is universal among languages.[30] The left superior posterior temporal gyrus, left inferior frontal gyrus, and the left occipitotemporal region are implicated for all writing systems.[31] However, it gets more complicated when it comes to lateralization of activity and in cases of activity in superior temporal gyrus, left anterior dorsal frontal region, and right occipitotemporal cortex.[32]

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22 Siok et al., "Distinct Brain Regions."

23 Siok et al., "Distinct Brain Regions."

24 Ping Li, Zhen Jin, and Li Hai Tan, "Neural Representations of Nouns and Verbs in Chinese: An FMRI Study," *NeuroImage* 21, no. 4 (April 2004): 1533–41, https://doi.org/10.1016/j.neuroimage.2003.10.044.

25 Li, Jin, and Tan, "Nouns and Verbs in Chinese."

26 Li, Jin, and Tan, "Nouns and Verbs in Chinese."

27 Li, Jin, and Tan, "Nouns and Verbs in Chinese."

28 Valaki et al., "Cortical Organization for Receptive Language;" Siok et al., "Distinct Brain Regions;" Li, Jin, and Tan, "Nouns and Verbs in Chinese."

29 Li, Jin, and Tan, "Nouns and Verbs in Chinese."

30 Donald J Bolger, Charles A Perfetti, and Walter Schneider, "Cross-Cultural Effect on the Brain Revisited: Universal Structures plus Writing System Variation," *Human Brain Mapping* 25, no. 1 (2005): 92–104, https://doi.org/10.1002/hbm.20124.

31 Bolger, Perfetti, and Schneider, "Writing System Variation."

32 Bolger, Perfetti, and Schneider, "Writing System Variation."

Chapter 2. Attention, Perception, and Memory

In Chapter 1, I characterized language as being part of culture. In the following chapters, however, this characterization will be mostly put aside and culture will be looked at as social behaviors among a particular group of people with all its complexities and symbols.[33] In this chapter, I will discuss culture's impact on key cognitive processes: attention, perception, and memory.

Researchers have found that culture does affect the way people perceive the world, that is, how they process information. Two different general models have been identified: holistic processing and analytic processing.[34] The former is characterized by attention to context and focuses on "the big picture" as well as attribution of causality to situational factors.[35] The latter focuses on specific objects and is more likely to attribute causality to objects, persons, and their personal characteristics.[36] Traditionally, holistic processing tends to go hand-in-hand with collectivistic values and interdependent self-construal (view of self as being part of a group and defining oneself based on relationships with others); this is most often associated with East Asian (Japanese, Korean, and Chinese) cultures.[37] Analytic processing, individualistic values, and independent self-construal are associated with Western cultures such as the US, Canada, UK, and others.[38] That is not to say that there is no nuance; each of the categories have their own individual and quite different cultures, but laboratory-based research tends to accept and favor categorizations such as collectivistic and individualistic. These different social value systems affect every part of a person's life; therefore, it shapes our brain and cognition in many ways.

Being socialized in a certain environment might predispose someone to favor certain features over others leading to perceptual and/or attentional biases. Kitayama et al. has examined how perceptions of an object differ between cultures.[39] Japanese and American participants were shown a vertical line in a frame, then shown another frame (of the same or different size).[40] They were then instructed to draw a line that is the same length as the original (this was called an absolute task) or same proportion to the picture they saw (relative task).[41] The absolute task evaluates the participants ability to ignore contextual information, as they need not

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33 Juan F. Domínguez D. et al., "The Brain in Culture and Culture in the Brain: A Review of Core Issues in Neuroanthropology," *Progress in Brain Research*, 2009, 43–64, https://doi.org/10.1016/s0079-6123(09)17804-4.

34 Sarah Ketay, Arthur Aron, and Trey Hedden, "Culture and Attention: Evidence from Brain and Behavior," *Progress in Brain Research*, 2009, 79–92, https://doi.org/10.1016/s0079-6123(09)17806-8.

35 Ketay, Aron, and Hedden, "Culture and Attention."

36 Ketay, Aron, and Hedden, "Culture and Attention."

37 Ketay, Aron, and Hedden, "Culture and Attention."

38 Ketay, Aron, and Hedden, "Culture and Attention."

39 Shinobu Kitayama et al., "Perceiving an Object and Its Context in Different Cultures," *Psychological Science* 14, no. 3 (May 2003): 201–6, https://doi.org/10.1111/1467-9280.02432.

40 Kitayama et al., "Perceiving an Object."

41 Kitayama et al., "Perceiving an Object."

pay attention to either of the frames.[42] The relative task tests participants ability to notice contextual information as the frames play an important role.[43] Japanese participants were better at the relative task than Americans, who performed better in the absolute task.[44] That is, Japanese participants performed better when contextual information was needed, and Americans did better when context was not relevant. This finding was replicated in six to thirteen-year-olds tested in the same paradigm which suggests that this pattern develops in early childhood.[45] Interestingly, this pattern of differentiation in performance did not appear in kids younger than six.[46] These findings may suggest that prolonged exposure to culture and socialization in that culture is necessary or that these attention related processes do not fully develop until age six.[47] However, Kitayama et al. notes that immigrants are more likely to show behaviors associated with their host-country culture, suggesting that these perceptual differences can be modulated within a relatively short period of time if exposed as adults.[48]

The findings of Kitayama and the colleagues are not without controversy.[49] They conclude that the differences in framed-line test performance are due to perceptual processes, but this has not been replicated in many studies.[50] A possible way to reframe the findings of Kitayama is to shift focus to attentional biases instead of attributing the results to perceptual processes.[51] This shift is supported by Hedden et al. findings.[52] The fMRI study showed greater activation in frontal and parietal regions of the brain during the culturally non-preferred task.[53] That is, there was greater activation for the absolute task in East Asians and for the relative task in North Americans.[54] Frontal and parietal regions are associated with higher level cognitive functions and cognitive control over working memory and attention. Greater activation in attention related areas seems intuitive, as tasks that are culturally not preferred likely require more concentration.[55] It is important to note that the same network is engaged in East Asians and North Americans but for the opposite tasks. The brain is not wired differently, nor does it perform

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42 Kitayama et al., "Perceiving an Object."

43 Kitayama et al., "Perceiving an Object."

44 Kitayama et al., "Perceiving an Object."

45 Sean Duffy et al., "Development of Cultural Strategies of Attention in North American and Japanese Children," *Journal of Experimental Child Psychology* 102, no. 3 (March 2009): 351–59, https://doi.org/10.1016/j.jecp.2008.06.006.

46 Duffy et al., "Development of Cultural Strategies."

47 Duffy et al., "Development of Cultural Strategies."

48 Kitayama et al., "Perceiving an Object."

49 Kitayama et al., "Perceiving an Object."

50 Ketay, Aron, and Hedden, "Culture and Attention."

51 Kitayama et al., "Perceiving an Object."

52 Trey Hedden et al., "Cultural Influences on Neural Substrates of Attentional Control," *Psychological Science* 19, no. 1 (January 2008): 12–17, https://doi.org/10.1111/j.1467-9280.2008.02038.x.

53 Hedden et al., "Neural Substrates of Attentional Control."

54 Hedden et al., "Neural Substrates of Attentional Control."

55 Hedden et al., "Neural Substrates of Attentional Control."

different functions.[56] Hedden et al. findings also suggest that it is specifically late-stage attentional processing that is affected by culture (as opposed to early-stage perceptual processing).[57]

Chua and the colleagues used a different technique to test attentional biases.[58] They measured eye-movements to determine whether there is a culturally modulated viewing pattern in Chinese and American participants.[59] The research group wanted to find out at what level the previously reported differences between East Asian and Western cultures occur. They hypothesized it could be due to differences in "perception, encoding, consolidation, recall, comparison judgements, or reporting bias."[60] If the study revealed significant results, it would be due to differences in one of the earlier steps (either perception or encoding).[61] The results showed that Americans spent significantly more time looking at the main object in the front and looked at it quicker than Chinese participants who spent more time looking at the background.[62] The study further supports the idea of culture leading to biases in attention. While Chua et al. does not explicitly discuss whether the differences occur during late-stage attentional processing or early-stage perceptual processing, the timing provided in the results section supports the former suggestion.[63]

Another MRI study found that Americans showed greater activation in certain brain regions compared to East Asians when processing images of objects.[64] The study supports the analytical processing preference in Americans. The regions found to have different activation are associated with attention, which provides further evidence for the attentional biases' theory.[65]

Interestingly, Gutchess et al. did not find that the processing differences influenced memory.[66] This is not the case in many other studies.[67] Intuitively,

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56 Hedden et al., "Neural Substrates of Attentional Control."

57 Hedden et al., "Neural Substrates of Attentional Control."

58 Hannah Faye Chua, Julie E. Boland, and Richard E. Nisbett, "Cultural Variation in Eye Movements during Scene Perception," *Proceedings of the National Academy of Sciences* 102, no. 35 (August 22, 2005): 12629–33, https://doi.org/10.1073/pnas.0506162102.

59 Chua, Boland, and Nisbett, "Cultural Variation in Eye Movement."

60 Chua, Boland, and Nisbett, "Cultural Variation in Eye Movement."

61 Chua, Boland, and Nisbett, "Cultural Variation in Eye Movement."

62 Chua, Boland, and Nisbett, "Cultural Variation in Eye Movement."

63 Chua, Boland, and Nisbett, "Cultural Variation in Eye Movement."

64 Angela H. Gutchess et al., "Cultural Differences in Neural Function Associated with Object Processing," *Cognitive, Affective, & Behavioral Neuroscience* 6, no. 2 (June 1, 2006): 102–9, https://doi.org/10.3758/cabn.6.2.102.

65 Ketay, Aron, and Hedden, "Culture and Attention."

66 Gutchess et al., "Cultural Differences in Neural Function"; Angela H. Gutchess et al., "Categorical Organization in Free Recall across Culture and Age," *Gerontology* 52, no. 5 (2006): 314–23, https://doi.org/10.1159/000094613.

67 Angela H. Gutchess and Allie Indeck, "Cultural Influences on Memory," *Progress in Brain Research*, 2009, 137–50, https://doi.org/10.1016/s0079-6123(09)17809-3; Takahiko Masuda and Richard E. Nisbett, "Attending Holistically versus Analytically: Comparing the Context Sensitivity of Japanese and Americans.," *Journal of Personality and Social Psychology* 81, no. 5 (2001): 922–34, https://doi.org/10.1037/0022-3514.81.5.922.

in order to remember something, one needs to notice it first. Therefore, many research groups have found that long-term memory is (just as attention and perception) influenced by culture.[68] In general, people from Eastern cultures may be better equipped to recall context-based information and group-related details compared to Westerner's, who may be more likely to recall self-related and categorical information.[69] This is due to the emphasis each culture puts on those specific details.

Memory is a complex system involving many different regions of the brain. Medial temporal lobes and the hippocampus are two regions that have been heavily implicated in memory.[70] However, medial prefrontal cortex, amygdala, frontal lobe, and sensory regions are involved in aspects of memory such as social information processing and emotional information encoding.[71]

Medial temporal lobes seem to have a crucial role in long-term memory formation and retrieval; therefore, there are no core differences that have been observed between different cultural groups.[72] However, there seem to be differences in memory content. Masuda and Nisbett reported that Japanese participants tended to remember more background details, mention more relationships in the environment, point out behavior, and provide more peripheral information than their American counterparts.[73] Additionally, Japanese participants were less likely to recognize previously seen objects if the background was altered or removed.[74] These results suggest that people from Eastern cultures may be more likely to attach the objects to their backgrounds than Westerners.

Additionally, Ji and the colleagues have reported that culture impacts the way people group things.[75] There are a variety of ways someone may choose to do it. For example, if given the words *seagull-squirrel-tree* a person may group them by taxonomy (*seagull-squirrel*) or theme (*squirrel-tree*).[76] The study found that Chinese participants were more likely to group thematically or based on relationships while white Americans grouped more based on taxonomy or other categories.[77] In older adults, it appears that East Asians are less likely to categorize their memories when recalling compared to their Western counterparts.[78]

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68 Gutchess and Indeck, "Cultural Influences on Memory;" Gutchess et al., "Categorical Organization in Free Recall;" Masuda and Nisbett, "Attending Holistically versus Analytically."

69 Gutchess and Indeck, "Cultural Influences on Memory."

70 Gutchess and Indeck, "Cultural Influences on Memory."

71 Gutchess and Indeck, "Cultural Influences on Memory."

72 Gutchess and Indeck, "Cultural Influences on Memory."

73 Masuda and Nisbett, "Attending Holistically versus Analytically."

74 Masuda and Nisbett, "Attending Holistically versus Analytically."

75 Li-Jun Ji, Zhiyong Zhang, and Richard E. Nisbett, "Is It Culture or Is It Language? Examination of Language Effects in Cross-Cultural Research on Categorization.," *Journal of Personality and Social Psychology* 87, no. 1 (2004): 57–65, https://doi.org/10.1037/0022-3514.87.1.57.

76 Ji, Zhang, and Nisbett, "Is It Culture or Is It Language?"

77 Ji, Zhang, and Nisbett, "Is It Culture or Is It Language?"

78 Gutchess et al., "Categorical Organization in Free Recall."

Overall, it is clear that culture shapes cognition in several important ways, some of which I have discussed. However, it is important to acknowledge that there are many limitations to current studies. Firstly, there are many limitations regarding testing methods. Some studies suggest that the behavior may be the same but the reasoning or the pathway to that behavior differ depending on cultures, however this is difficult to test. This may explain some conflicting results in purely behavioral studies. Additionally, it is often difficult to pinpoint where in the system the culture exerts its effects. When looking into cognition, many of the processes are closely intertwined and current research methods may limit the ability to separate these processes. For example, many attention or perception studies tend to mix those two concepts together, though they are distinct. They also tend to use memory tasks as the preferred attention testing method, which poses some issues. Emerging studies are trying to remedy this with novel techniques, however there is still a long way to go. Lastly, (as many studies have shown) our brains are extremely malleable, and culture is ever-changing. This makes research difficult as personal background, exposure to other cultures, amount of time spent in native culture, adaptation, and many other things may change the way our brains process information.

Chapter 3. Social Perceptions

Chapter 2 discussed events as they relate to personal perception and memory –that is, internal events. Chapter 3 will mainly focus on how culture shapes cognition that relates to social perceptions, interpretations, and interactions. The perceptual processes described previously will be expanded upon in this chapter and definitions like individualistic and collectivist societies will be mentioned in this chapter as well.

As a species that is irrevocably social, we use our perceptions for social affordances.[79] Social affordances refer to the ability to make distinctions between friend and foe, who we should continue building lasting relationships with, how we should behave in certain situations, etc. Some researchers have decided to take an "ecological perspective" in this area.[80] They view perceptions as needed precursors for actions and the sole reason we perceive in the first place. Every person eventually learns to perceive what are *useful* action possibilities.[81] What is considered useful action is up for debate, as what may be appropriate in one culture may not be in another.[82] Culture largely determines the significance and the value of certain stimuli and possible routes of action.[83] I will discuss the differences

79 Jonathan B. Freeman, Nicholas O. Rule, and Nalini Ambady, "The Cultural Neuroscience of Person Perception," *Progress in Brain Research*, 2009, 191–201, https://doi.org/10.1016/s0079-6123(09)17813-5.

80 Freeman, Rule, and Ambady, "Neuroscience of Person Perception."

81 Freeman, Rule, and Ambady, "Neuroscience of Person Perception."

82 Freeman, Rule, and Ambady, "Neuroscience of Person Perception."

83 Freeman, Rule, and Ambady, "Neuroscience of Person Perception."

between cultures in two key components of the social sphere: interpretation of the events themselves and perception of others.

The first major difference is how different cultures tend to interpret social events. Westerners are more likely to focus, categorize, and attribute causality to the main object.[84] They are also more likely to explain certain events by attributing it to individual characteristics or abilities (think back to individualism).[85] For example, if Adam does not get a job after an interview, Westerners are more likely to attribute it to characteristics of Adam (his experience, ability, personality, etc.) rather than outside factors such as the job market. On the other hand, East Asians tend to pay more attention to relationships and changes in the environment; they group objects by their relations with each other and attribute causality with context in mind.[86] Koreans, Japanese and Chinese people are more likely to explain events by referencing environmental and contextual factors.[87] In the example of Adam, they are more likely to consider the harsh job market and surrounding circumstances rather than blaming Adam. This is often referred to as contextualism and goes hand in hand with collectivist values of prioritizing group interests, collaboration, and interdependence.[88] Because of this, East Asians may be less likely to demonstrate correspondence bias.[89] Correspondence bias is the tendency to attribute behaviors to a person's traits and values even when they could be explained by a situation the person is in.[90] An often-used example to test for correspondence bias gives participants an essay on a controversial topic like the death sentence.[91] Some of the participants are told that the writers were free to choose the side which they argue for, and some are told that the sides were assigned.[92] Participants are then asked to what degree they believe that the opinion stated in the essay is that of the writer.[93] People who demonstrate a lot of correspondence bias tend to believe that it is the opinion of the writer even when the writer was assigned the side.[94] It is in fact the case that Korean and Japanese participants are less prone to correspondence bias but only in situations with high salience situational constraints.[95] In situations where the situational constraints have low salience, all,

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84 Richard E. Nisbett and Takahiko Masuda, "Culture and Point of View," *Proceedings of the National Academy of Sciences* 100, no. 19 (September 5, 2003): 11163–70, https://doi.org/10.1073/pnas.1934527100.

85 Nisbett and Masuda, "Culture and Point of View."

86 Nisbett and Masuda, "Culture and Point of View."

87 Nisbett and Masuda, "Culture and Point of View."

88 Incheol Choi, Richard E. Nisbett, and Ara Norenzayan, "Causal Attribution Across Cultures: Variation and Universality.," *Psychological Bulletin* 125, no. 1 (1999): 47–63, https://doi.org/10.1037/0033-2909.125.1.47.

89 Choi, Nisbett, and Norenzayan, "Causal Attribution Across Cultures."

90 Choi, Nisbett, and Norenzayan, "Causal Attribution Across Cultures."

91 Choi, Nisbett, and Norenzayan, "Causal Attribution Across Cultures."

92 Choi, Nisbett, and Norenzayan, "Causal Attribution Across Cultures."

93 Choi, Nisbett, and Norenzayan, "Causal Attribution Across Cultures."

94 Choi, Nisbett, and Norenzayan, "Causal Attribution Across Cultures."

95 Choi, Nisbett, and Norenzayan, "Causal Attribution Across Cultures."

American, Japanese, and Korean participants did not differ in their attributions.[96] In a high salience condition, the participants are made aware of the constraints put on the person they are evaluating by making them do the same task. In a low salience condition, no such task is given.

A number of studies show that when a person is making causal attributions there are three types of information they consider: consistency, distinctiveness, and consensus information.[97] Consistency refers to how often a particular thing happens (e.g., Adam always brings lunch to work (high consistency) vs. Adam seldom brings lunch to work (low consistency)). Distinctiveness refers to how specific to a situation a behavior is (e.g., Adam often spills his coffee on his desk (high distinctiveness) vs. Adam often spills his coffee in various places (low distinctiveness)). Consensus information refers to the general agreement between people (e.g., Many people think Adam is clumsy (high consensus) vs. only his wife thinks he is clumsy (low consensus)). However, consensus information is often underused in western societies, perhaps because it gives weight to situational factors instead of individual traits.[98] For example, even if everyone in Adam's class thinks he is highly intelligent and capable, people may still attribute his lack of luck in finding a job to his personal abilities instead of contextual factors. This may not hold true for East Asians, as a study in Korea found participants using significantly more consensus information.[99] Another group found that Koreans are more sensitive to contextual information when making predictions than their American counterparts.[100]

The differences emerge not only in perception of the situations but also in how East Asians and Westerners differentially perceive others' emotions. Lutz and White speculated that the way people feel their own emotions, express them, and (most importantly) recognize the emotions of others are all influenced by culture.[101] Some cultures are better at recognizing certain emotions while they also tend to "mute" the recognition of others.[102] For example, collectivist cultures may pay less attention and discourage display of negative emotions (such as anger) more often than individualistic cultures do. Additionally, a meta-analysis by Elfenbein and Ambady has concluded that people are better equipped to recognize the emotions of their own cultural group relative to other cultural groups.[103] Additionally, an fMRI study by Chiao et al. has shown that response in amygdala is more robust when fear is shown in a face of a person who is a member of the same cultural group as

96 Choi, Nisbett, and Norenzayan, "Causal Attribution Across Cultures."

97 Choi, Nisbett, and Norenzayan, "Causal Attribution Across Cultures."

98 Choi, Nisbett, and Norenzayan, "Causal Attribution Across Cultures."

99 Choi, Nisbett, and Norenzayan, "Causal Attribution Across Cultures."

100 Choi, Nisbett, and Norenzayan, "Causal Attribution Across Cultures."

101 Catherine Lutz and Geoffrey M. White, "The Anthropology of Emotions," *Annual Review of Anthropology* 15, no. 1 (October 1986): 405–36, https://doi.org/10.1146/annurev.an.15.100186.002201.

102 Lutz and White, "The Anthropology of Emotions."

103 Hillary Anger Elfenbein and Nalini Ambady, "Is There an In-Group Advantage in Emotion Recognition?," *Psychological Bulletin* 128, no. 2 (2002): 243–49, https://doi.org/10.1037/0033-2909.128.2.243.

the participant.[104] This ties into the ecological view that our perceptions occur in order to respond in the way that is most beneficial for our survival. Being sensitive to one's own group and their emotions is ecologically beneficial – fear in a member of your own group may signal danger for them and yourself, therefore people may be better equipped to interpret those signs. Importantly, these responses are not solely race (or nationality) specific and can be attributed to cultural groups, as previous studies have controlled for race and nationality.[105]

Another area that culture may exert its influence on is known as "theory of mind". Theory of mind is the ability of one person to infer another persons' mental states as well as their own.[106] There are some similarities (such as the end goal, and possibly timing) across cultures, but not without controversy. Some research suggests that theory of mind develops around the same age in all children – that is, between ages three and four.[107] Meta-analysis by Liu et al. has found that this is not the case.[108] The developmental trajectories are parallel, but the timing of this development is significantly different between Chinese and Western children.[109] The differences may be as big as two years.[110] Naito and Koyama have further put into question the universality of the timetable by showing that Japanese children tend to lag behind their peers by at least half a year.[111] Both studies are consistent with additional literature suggesting that non-European-American children may have delays in development of theory of mind.[112] However, there are still many studies that do show commonalities between cultures.[113] Interestingly, when theory of mind develops it appears to be comparable between cultures – that is, the delays do not cause long term effects or deficits.[114]

The areas of the brain that have been implicated in theory of mind appear to be similar, though with important distinctions. Medial prefrontal cortex (mPFC) and anterior cingulate cortex (ACC) are two areas that are believed to be equally

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104 Joan Y. Chiao et al., "Cultural Specificity in Amygdala Response to Fear Faces," *Journal of Cognitive Neuroscience* 20, no. 12 (December 2008): 2167–74, https://doi.org/10.1162/jocn.2008.20151.

105 Chiao et al., "Amygdala Response to Fear Faces."

106 Chiyoko Kobayashi Frank and Elise Temple, "Cultural Effects on the Neural Basis of Theory of Mind," *Progress in Brain Research*, 2009, 213–23, https://doi.org/10.1016/s0079-6123(09)17815-9.

107 Freeman, Rule, and Ambady, "Neuroscience of Person Perception;" Kobayashi Frank and Temple "Neural Basis of Theory of Mind."

108 David Liu et al., "Theory of Mind Development in Chinese Children: A Meta-Analysis of False-Belief Understanding across Cultures and Languages.," *Developmental Psychology* 44, no. 2 (2008): 523–31, https://doi.org/10.1037/0012-1649.44.2.523.

109 Liu et al., "Theory of Mind Development."

110 Liu et al., "Theory of Mind Development."

111 Mika Naito and Kayo Koyama, "The Development of False-Belief Understanding in Japanese Children: Delay and Difference?," *International Journal of Behavioral Development* 30, no. 4 (July 2006): 290–304, https://doi.org/10.1177/0165025406063622.

112 Liu et al., "Theory of Mind Development;" Naito and Koyama, "Development of False-Belief Understanding."

113 Kobayashi Frank and Temple, "Neural Basis of Theory of Mind."

114 Freeman, Rule, and Ambady, "Neuroscience of Person Perception."

involved across all cultural groups.[115] While it is true that there have been no cultural differences found in activation of these areas, research shows that mPFC and ACC cannot be solely responsible for theory of mind.[116] People with damage to these areas are sometimes still able to reason and pass tests for theory of mind.[117] This makes the case more complicated, as differences in other hypothesized areas have been noted. For example, the temporoparietal junction is one of the more controversial areas implicated in theory of mind.[118] While some studies have shown it to be universally involved, others have found that the activation is much less robust in Japanese adults.[119] It has only been consistently shown to be activated in American and British people in theory of mind studies.[120]

It is important to note that most of the studies examining theory of mind have used what is referred to as a *false belief* task. This task relies on the verbal descriptions, which, crucially, misses a key detail in inference of someone's mental states – facial expressions.[121] An alternative task has been used by some studies (called the "Reading the Mind in the Eyes" (RME) test) to account for this discrepancy.[122] Adams et al. found that Americans performed this task better with white RME while Japanese people performed better with Asian RME.[123] There was more activation in the posterior superior temporal sulcus (pSTS) when trying to decode same cultural group mental states as compared to the other cultural group.[124] This connects back to the emotion recognition differences discussed earlier and the ecological argument as to why this came to be.

While there is a lot of research looking into differential interpretation of social events, social perceptions, and perception of others between cultures, it is difficult to draw any concrete conclusions. As I have highlighted throughout this chapter, the findings are often inconsistent or contradictory. Some studies show differences in perception of emotion, some do not, some show differences in theory of mind, some do not. I have highlighted the clear differences and discuss some of the less well-established ones. It is difficult to concretely define the differences in such a dynamic field. Additionally, there are many other variables that may account for the difference in findings in many of these studies (such as socioeconomic status, linguistic influences, testing limits, etc.).

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115 Freeman, Rule, and Ambady, "Neuroscience of Person Perception;" Kobayashi Frank and Temple, "Neural Basis of Theory of Mind."

116 Kobayashi Frank and Temple, "Neural Basis of Theory of Mind."

117 Kobayashi Frank and Temple, "Neural Basis of Theory of Mind."

118 Freeman, Rule, and Ambady, "Neuroscience of Person Perception;" Kobayashi Frank and Temple, "Neural Basis of Theory of Mind."

119 Kobayashi Frank and Temple, "Neural Basis of Theory of Mind."

120 Kobayashi Frank and Temple, "Neural Basis of Theory of Mind."

121 Freeman, Rule, and Ambady, "Neuroscience of Person Perception."

122 Freeman, Rule, and Ambady, "Neuroscience of Person Perception."

123 Reginald B. Adams et al., "Cross-Cultural Reading the Mind in the Eyes: An FMRI Investigation," *Journal of Cognitive Neuroscience* 22, no. 1 (January 1, 2010): 97–108, https://doi.org/10.1162/jocn.2009.21187.

124 Adams et al., "Cross-Cultural Reading."

Chapter 4. Implications

Previous chapters examined *how* culture modifies the brain. They investigated past research and examined different evidence for various theories in the field. This chapter examines *why* cultural neuroscience is important and what applications it has in the real world. More specifically, this chapter will examine cultural neuroscience implications for learning and teaching of language, global health, and intercultural communications.

Language and culture are inexplicably tied to each other, so much so that language is often considered part of culture. Both play an important role in shaping one another. Throughout this paper, I have also shown that both culture and language shape the brain. Therefore, knowing how all three connect to each other may provide better insight into how we should teach languages to accommodate the differences. Some features of language such as scripts, tonality, grammar rules, and the more unspoken rules of day-to-day use are often challenging to students when shifting from their first language to a new one. Mechanisms of processing from their mother tongue that students are used to are no longer applicable in the same way. It may be helpful to take into account that there are inherently different mechanisms in processing the target language from those in their native one when teaching languages to non-native speakers. It may take some time for the brain to adjust to the second language by either "rewiring" some processes or in other ways accommodating to achieve the same result that comes naturally to native speakers.

Currently, the dominant theory in language learning is one of assimilation and accommodation.[125] Assimilation implies that the student processes their target language using the same underlying mechanisms as if it was their native one.[126] For example, Chinese students would read English text with the same brain area activation that would be used if they were to read Chinese. Accommodation, on the other hand, would imply that the student learns to process the language in the same or similar way to a native speaker.[127] For example, an English student reading Chinese would show activation in areas that are typically activated in native Chinese speakers. Some languages may lead to assimilative learning while others may demand accommodation. Current research suggests that Chinese students learning English are more likely to use the same regions as they would if they were reading Chinese.[128] However, for English speakers accommodation may be necessary, as they tend to show activation in regions that native Chinese

125 Charles A. Perfetti et al., "Reading in Two Writing Systems: Accommodation and Assimilation of the Brain's Reading Network," *Bilingualism: Language and Cognition* 10, no. 2 (July 2007): 131–46, https://doi.org/10.1017/s1366728907002891.

126 Perfetti et al., "Reading in Two Writing Systems."

127 Perfetti et al., "Reading in Two Writing Systems."

128 Li Hai Tan et al., "Neural Systems of Second Language Reading Are Shaped by Native Language," *Human Brain Mapping* 18, no. 3 (February 21, 2003): 158–66, https://doi.org/10.1002/hbm.10089.

speakers show.[129] These hypotheses have implications for teaching, as they may point to areas that require more attention (for example, focusing on scripts when teaching Chinese in order to allow the brain to accommodate faster). In general, this may inform teachers of the mechanisms behind acquiring a new language. Additionally, it may also be of comfort to learners to know that their brains are capable of successfully assimilating or accommodating new language even if it takes a while and even if these initial brain differences are present.

Additionally, and perhaps more interestingly, because of the tie between culture and language it may be useful to learn the culture when learning the language. A lot of the changes in the brain may be influenced by things that are of cultural importance and that may affect how the language is formed and processed. Cultural values are embedded into and transmitted by the language.[130] Teaching culture may help students better understand these values. Previous research shows that perceptional and attentional processes may adapt to match those of the host culture in immigrants.[131] If these processes that are largely shaped by culture can be changed by immersion, teaching culture may be useful in language teaching as it may prepare students to better understand why the language is formed a certain way.

Studying cultural neuroscience and psychology may also have global health applications. Before the field emerged, most of the theories and research originated in predominantly Western (and male) populations. This means that our knowledge about diseases and disorders comes from those populations. However, neither physical nor mental illnesses are uniform across cultures. As I have established in this paper, culture (among many other things) affects how we perceive the world, others, ourselves, and what we pay attention to. Therefore, it is only natural that culture may predispose certain populations to certain diseases and mental illnesses, or it may alter their profile of them. Having the cultural knowledge and understanding neuroscientific underpinnings of those specific differences may help in two main ways: prevention and treatment.

Knowing that certain populations are at risk may be helpful in allocating resources. For example, some psychopathological disorders are considered "culture-bound" according to the DSM (The Diagnostic and Statistical Manual of Mental Disorders, main guidebook for psychopathological diagnoses).[132] That is, these disorders are thought to only occur within specific cultures. However, a more up-to-date view is more likely to characterize them as different representations or forms of the mental disorders that are already listed in the main part of

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129 Ying Liu et al., "Evidence for Neural Accommodation to a Writing System Following Learning," *Human Brain Mapping* 28, no. 11 (2007): 1223–34, https://doi.org/10.1002/hbm.20356.

130 Li Sun, "Culture Teaching in Foreign Language Teaching," *Theory and Practice in Language Studies* 3, no. 2 (February 1, 2013), https://doi.org/10.4304/tpls.3.2.371-375.

131 Kitayama et al., "Perceiving an Object."

132 Suparna Choudhury and Laurence J. Kirmayer, "Cultural Neuroscience and Psychopathology: Prospects for Cultural Psychiatry," *Progress in Brain Research*, 2009, 263–83, https://doi.org/10.1016/s0079-6123(09)17820-2.

the manual.[133] It is unnecessary to put them into their own categories and is more beneficial to recognize the role culture plays in the presentation of various disorders. Many psychopathological disorders affect attachment to other people, attention, perception, language, emotional regulation among other areas that are coincidentally also shaped by culture.[134] Identifying specific areas of interest and tailoring preventative measures to each culture may serve as a better preventative technique than a one-fits-all model.

Secondly, different treatments may work better for folks with different underlying neural mechanisms. Recently, there has been a large shift in psychology to provide culturally sensitive therapy and counseling. For example, imagine that a patient was diagnosed with a generalized anxiety disorder (GAD), a disorder that largely involves perceptual processes, interpretation of events, and attribution of causality. This patient has distorted views of those events, but they may also be influenced by culture. An American without GAD (or successfully treated GAD) will have a different "baseline" than a Chinese person. For example, the attribution of causality to individuals is more of a Western trait, while attributing events to general circumstances is more ascribed to Eastern cultures. When providing therapy and treatment it is important to consider what the baseline is in the culture that the patient comes from in order to avoid imposing values foreign to that culture or provide treatments that do not resonate with the person. The neural underpinnings of the same disorders or the thinking which contributes to those disorders may be slightly different between cultures and taking that into account may provide better treatment. The same thought process follows for many other psychopathological disorders.

With communities around the world becoming more diverse there is an increasing demand for cultural awareness. Policies enacted in these communities require interethnic considerations to be equitable. Cultural neuroscience may provide insight needed to make those decisions. One area where the rising demand of intercultural communication skills is apparent is the workplace. Unfortunately, oftentimes the training programs for such awareness seem to have adverse effects and even promote stereotyping.[135] Neuroscientific evidence may help make those programs more helpful. For example, previous studies (some of which have been discussed in earlier chapters) show that people are more in-tune with and better able to identify emotions of in-group members.[136] This shows that in-group/out-group problems may not be caused by purely conscious biases, but rather have a more complex neural underpinning that requires more complex education

133 Choudhury and Kirmayer, "Cultural Neuroscience and Psychopathology."

134 Choudhury and Kirmayer, "Cultural Neuroscience and Psychopathology."

135 Wei-Wen Chang, "Approaches for Developing Intercultural Competence: An Extended Learning Model with Implications from Cultural Neuroscience," *Human Resource Development Review* 16, no. 2 (May 15, 2017): 158–75, https://doi.org/10.1177/1534484317704292.

136 Chang, "Developing Intercultural Competence;" Elfenbein and Ambady, "Advantage in Emotion Recognition."

rather than just information about other cultures.[137] There are many other areas that trainings try to address in a way that implies that people are aware of their behaviors and can easily modify certain perceptions. Neuroscience tells us that there are more complex underlying neural mechanisms that are not as easily changed. A lot of the things that are perceived as choices occurring at cognitive level are actually behaviors heavily affected by lower level unconscious perceptual, attentional, and other processes[138]. Considering the complex changes in the brain that are caused by culture, training programs should also find more nuanced ways to encourage cultural competence. This also shows that training programs may require longer and more challenging content to actually change the unconscious mechanisms.

In this chapter, I discussed only a few implications that cultural neuroscience may have in the real world. Additional areas that I have not expanded on, but which may be of interest are neuroeconomics, implications for general learning, bioethics, international relations, among others. However, all this information should be analyzed critically. Policy makers, teachers, companies, and other agents should not overly rely on the neuroscientific findings. While they may inform better decisions and approaches, they can also be used to create unnecessary groups, put people into boxes, and create divisions. The science can be used to minimize intercultural division and conflict, but it can just as well be used to worsen it.

Conclusion

Cultural neuroscience is an ever-growing field. There are still many questions that are left unanswered, however there is already evidence for culture's impact on the brain. Cultural neuroscience is a field that merges and integrates information from many existing disciplines such as linguistics, psychiatry, anthropology, and others in order to explain the phenomena at hand. This field may help create more cohesive communities and provide better tools for intercultural communication.

However, while it is without a doubt an important field to research, the current results should be examined cautiously. A lot of the research that has come out has methodological decisions that may impact our ability to draw conclusions. Specific groups that are selected, age, regions, and tasks that people are tested on should all be questioned and critically examined. Technological constraints also limit external validity. fMRI, a technique often used for neuroscientific studies, may not necessarily provide the complete picture. While to many it may seem like irrefutable evidence, this technique is not a magical answer and can often be misinterpreted. The same is true for many other techniques used in the field. This does not necessarily discount the findings of many studies, but because of the relatively new advancements in the field, caution should be exercised before drawing conclusions.

137 Chang, "Developing Intercultural Competence."
138 Chang, "Developing Intercultural Competence."

Additionally, culture is a fluid thing that is not equally experienced by all members of any given group. Many of these studies sort East Asians and Americans (or Westerners) into these large groups, however it doesn't include the variety of experiences of culture within those groups. East Asians are comprised of Japanese, Koreans, and Chinese people – all with their distinct cultures which can be even further broken down into smaller subcategories based on region, ethnic group, or individual experience. The same goes for Americans (or Westerners). Do all of them have the same culture? Is it fair to analyze them as a monolith just because of some collectivist (or individualistic) values? While it may be impossible to account for all individual experiences of culture, cultural neuroscience should aim to make fewer general groups in the future.

Lastly, many people reading these studies may come to accept these findings as the truth. This is dangerous as it can often be used to promote xenophobic or racist rhetoric or further the divide between different cultural groups. It is important to tread carefully so as not to overgeneralize or overstate the studies' findings. As I have said above, culture is an alive and changing thing and people within a certain culture are still individuals who do not act or think as one, and it is important to remember that when examining cultural neuroscience research. Even the human brain is not unmalleable – plasticity is one of the most fascinating features of the human brain that allows for change.

This should not discourage researchers and students from being interested in the field. There is enough research to agree that there are differences, and it is important for a variety of reasons to examine those differences. However, everyone should keep in mind that culture is not a simple definition. It is not frozen in time and therefore should not be reduced or generalized for the sake of simplicity.