The Influence of Culture on Memory

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Abstract. The study of cognition across cultures offers a useful approach to both identifying bottlenecks in information processing and suggesting culture-specific strategies to alleviate these limitations. The recent emphasis on applying cognitive neuroscience methods to the study of culture further aids in specifying which processes differ cross-culturally. By localizing cultural differences to distinct neural regions, the comparison of cultural groups helps to identify candidate information processing mechanisms that can be made more efficient with augmented cognition and highlights the unique solutions that will be required for different groups of information processors.

Keywords: cognition, culture, memory, strategies, fMRI.

1 Introduction

To achieve the goal of understanding the ways in which computational systems and devices can interface with human cognition, the field of augmented cognition pays particular attention to bottlenecks [1]. Bottlenecks in cognition include limitations in one's ability to simultaneously attend to multiple locations or channels of information, and impairments in the ability to encode, store, and retrieve from memory veridical, detailed representations of information. Because humans are limited information processors, necessarily there are trade-offs in what is attended to and remembered, with some information being prioritized at the expense of other information.

Several studies have examined the ways in which culture can, to some extent, explain individual differences in processes such as attention and memory. Overall, much of the research to date has compared Easterners (typically operationalized as individuals from China, Japan, or Korea) and Westerners (typically including Americans, Canadians, and Western Europeans). These studies suggest that Easterners prioritize information that is holistic, considering functional relationships between elements and relating the self to the group. Westerners, on the other hand, prioritize information about individual items, focusing on objects without regard to their contexts and conceptualizing of the self as an individual entity [e.g., 2, 3-9]. This paper will provide a selective review of that literature with an eye toward identifying mechanisms and their neural correlates that can be optimized through augmented cognition, and it will also consider some challenges to that goal.

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2 Mechanisms of Cross-Cultural Differences in Cognition

What individuals from different cultures prioritize and attend to in their environments likely reflects differences in strategies, which may correspond to separable underlying neural mechanisms. That is, attending to information that is object-based or self-referent, rather than context-based or group-referent, reflects the strategic deployment of cognitive resources. The selection of some aspects of information over others has been shaped by one's cultural milieu, with certain ways of processing information encouraged and reinforced through one's development in a particular cultural context. For example, attention to focal objects or relationships is reinforced through socialization and language acquisition in childhood [as discussed by 3]. Cultural differences in preferences even emerge in different styles of parental interaction during play, with American mothers emphasizing the properties of objects and Asian mothers instructing about relationships [10]. The learned aspect of culture is emphasized further through studies suggesting that cultural differences emerge late enough to reflect the products of socialization [11].

We conceptualize of strategy differences across cultures as potentially occurring due to one of three different mechanisms: 1) Cultural differences could reflect the engagement of distinct cognitive *processes*, such that individuals evoke different strategies (e.g., categorical versus relational) or process different aspects of information (e.g., object versus context). 2) Cultural differences could emerge due to differences in the underlying *content* of what information is stored and correspondingly accessed by individuals in different cultures. 3) Cultural differences could represent varying degrees of *difficulty* across cultures, such that one task is more difficult in one culture than another and therefore requires a greater commitment of cognitive and neural resources. We believe that the first mechanism, cultural differences in engagement of cognitive processes, is the most consistent with the literature thus far, and we will devote the most space in this review to considering this possibility. However, we will also consider the other candidate mechanisms, their implications for the study of cross-cultural differences in the engagement of neural resources, and the potential interface with augmented cognition.

2.1 Cross-Cultural Differences in the Engagement of Cognitive Processes

Cross-cultural differences in the use of cognitive processes have received the most support in the literature to date in explaining cross-cultural strategy differences. One process differing across cultures is a preference for analytical versus holistic processing [e.g., 2, 3-6]. Evidence suggests that Westerners tend to focus on the details, pieces, and parts of information whereas Easterners process information in terms of its context and tend to relate information together. Within this framework, Easterners attend to and remember contextual information whereas Westerners focus on focal objects on their own, without regard to the context [3].

Some of the strongest evidence that cultures differ in the strategies they employ to process information stems from the study of memory. If individuals from different cultures engage distinct information processing strategies, they should then differ in their memory for disparate aspects of the information [see 12 for a discussion of these ideas]. The strategies used to process information upon first encounter should determine what information is preserved in memory and thus most readily accessed with retrieval cues at a later point in time. Cultural differences in memory for distinct aspects of information have been shown in memory for scenes. In one study, after viewing underwater scenes, participants described what they remembered from the animated vignettes. While Americans' descriptions focused predominantly on the prominent fish, the descriptions of Japanese participants included more details about the context [9]. The same pattern also emerged in a more controlled study of recognition memory, in which Japanese participants were more affected than Americans by changing background contexts. Their memory for objects was more impaired when the objects were against novel backgrounds, as opposed to the original ones [9]. The heightened attention to context extends to the perception of emotions in others, with the emotional expressions of other faces in a crowd coloring the interpretation of a central target face for Japanese more than for Westerners [13]. While we consider in the next section how it is difficult to separate differences across cultures in the *content* of memory from the *processes* themselves, we believe that process differences are more likely to explain the findings, accounting for the initial differences in content.

Further evidence that these differences emerge at the level of strategies comes from converging methods. By analyzing measures of where people look when first encountering information and the neural regions that are engaged when processing complex information, we see evidence for what processes and aspects of information are of primary importance to the perceiver. Consistent with behavioral indicators, eye-tracking measures reveal that Americans spend more time fixating on objects and fixate to them sooner than East Asians [14, but see 15]. Neuroimaging measures of brain activity, such as fMRI, indicate that Americans modulate object processing regions more than East Asians when viewing complex scenes, perhaps reflecting visual attention and retrieval of semantic knowledge about objects [6, 16]. By identifying the neural substrates of cultural differences, we find that there is more consistent evidence that cultural differences in the processing of complex scenes may occur due to differences in the processing of objects rather than contexts. These findings from eye-tracking and fMRI measures suggest that when first viewing pictures of scenes, Americans attend quickly to objects and process them in more detail than East Asians. In contrast, there is not evidence for greater neural activation in response to background contexts for East Asians, although they fixate on backgrounds more than Americans. This type of work provides initial clues into how the field of augmented cognition would need to differently account for the influence of culture. As stimuli and information in the environment recruit unique sets of cognitive processes in individuals from different cultures, augmented cognition and human-computer interaction devices would need to account for and build upon these distinct strategies.

It is important to note that cross-cultural differences in the processing of objects and contexts also may permeate several different levels of cognition, including some lower-level attentional and perceptual processes. At the level of attention, East Asians may show more globally distributed attention than Westerners, who may attend more locally. This is demonstrated through responses to spatial configurations of shapes, with East Asians performing better than Americans when configurations were preserved but expanded in space, and worse than Americans when configurations were shrunk in space [17]. There is also evidence that priming an interdependent view of the self leads East Asians to show a stronger Flanker effect than priming with independence, consistent with the expected findings for East Asians versus Westerners (who differ on interdependence/independence) [18]. This effect seems to be linked to early visual perceptual/attentional effects, based on the modulation of the P1 effect, as assessed with ERPs [19]. Furthermore, East Asians perform more poorly on a functional field of view task than Americans [20]. These findings might indicate that East Asians distribute attention more broadly in space than Americans. It is also important to keep in mind that this might impact the resolution of their representations, such that attending more broadly necessitates a reduction in the quality of the representations. Preliminary support for this idea comes from the finding that in the useful field of view task, East Asians perform significantly lower than Westerners. Furthermore, their errors indicate that they identify "random" locations as targets more than Americans, who tend to make errors with neighboring positions [20].

Cultures also differ in their attention to categorical information. Whereas Westerners tend to focus on taxonomic categories, East Asians tend to emphasize functional relationships [e.g., 4, 5, 21, 22-25]. One paradigm employed to address this idea presents participants with triplets of words, asks participants to determine which two belong together, and provide a justification for their pairing. In a set of words such as "seagull," "squirrel," and "nut," Westerners tend to pair "seagull" and "squirrel" together because both belong to the category "animals," whereas East Asians tend to pair "squirrel" and "nut" together because the one serves as a food source for the other [22, 24]. The difference in the types of explanations is consistent with our suggestion that cultures differ in the strategies and cognitive processes they adopt, for it seems that different information is salient and useful for organizing information for each cultural group.

Some of our prior work investigated cross-cultural differences in memory for categorical information. A classic experimental paradigm [26] presents participants with words drawn from several different categories (e.g., "apple", "orange", "banana" as exemplars from the "fruit" category, and "train", "bus", "car" as exemplars from the "modes of transportation" category) and later asks them to list all of the words they remember. When analyzing the order in which the words were recalled, one finds that people tend to spontaneously organize the words by category, even though they were originally presented in an intermixed order. This finding of categorical clustering is particularly useful in identifying strategy differences, which can be separated from the amount of information remembered. Our results show that even though American and Chinese participants may recall similar amounts of information, older Chinese tend to use categorical clustering to organize their recall less than older Americans, indicating that categories provide a more useful strategy for organizing and retrieving information from memory for Americans than Chinese [21].

Recent research also identifies cultural differences in the neural regions implicated in resolving conflict when sorting triplets of words. When instructed to select a particular type of word pair, either categorical (e.g., seagull-squirrel) or relational (e.g., squirrel-nut), on each timed trial from a set of word triplets, East Asians activated more executive control processes, reflected by activity in a frontal-parietal network, while Americans activated more temporal regions, possibly reflecting conflict in the semantic content of information. Because accuracy in selecting the appropriate pair was equivalent across cultures, we interpreted differences in neural activation patterns to reflect cultural differences in conflict resolution, with East Asians adopting more domain-general processes and Americans adopting more domain-specific processes [25]. This pattern of results further indicates that the augmented cognition solutions could be very distinct for one culture compared to another, not just in terms of the types of processes engaged [6, as was the case for cultural differences in object processing, e.g., 16], but also in their implications to generalize across other functions (e.g., domain general vs. domain specific).

2.2 Cross-Cultural Differences in the Content of Cognition

Stores of semantic knowledge undoubtedly differ across cultures based on the types of experiences individuals have with their environments and what is deemed important within their culture. Educational systems may reflect these differences, for example, Chinese education is virtue-oriented and Western education is mind-oriented [27], which would maintain and perhaps extend these differences across cultures over time. Typical experiments assess the content of knowledge by asking participants to list exemplars belonging to different categories or to name pictures. There can be dramatically different responses across cultures, such as participants listing different flowers or animals based on what is native to their environment [e.g., 28]. The process of naming pictures also reveals differences in what items are familiar across cultures, as well as the specificity with which they are known. For example, using the basic level name “dog” compared to a more abstract category name such as “animal” or a more specific, detailed name such as “cocker spaniel” indicates the familiarity with which the object is known, and the level of distinction with which it is helpful to know about the concept [29-31]. Despite these differences in content, it is difficult to distinguish the *content* from the *processes* themselves. For example, we discussed attending more to objects versus contexts in the above section as representing a cultural difference in the cognitive processes engaged when encountering complex information in the environment. However, these initial differences in processing information such that Americans attend to objects and devote additional resources to processing information about their semantic and perceptual properties would then lead to cultural differences in the content of what is stored in episodic memory. While cultural differences in both content and process likely reinforce each other over time, we believe that strategy differences are what lead to eventual differences in content. However, it is admittedly difficult to distinguish strategic processes from content.

It is also notoriously difficult to study individual pieces of knowledge. Differences that have been identified in semantic content are largely based on differences in broader processes. For example, different classes of objects are associated with different properties and types of knowledge, such as the attention to functional and motor properties for tools, as opposed to the focus on perceptual properties that are important for animals [32]. Neuroimaging methods such as fMRI and ERP have traditionally relied on averaging large numbers of trials together in order to have stable and measurable signal, precluding the possibility of analyzing single trials. However, recent developments in methods, such as multivariate pattern analysis, hold promise for identifying differences at the level of the trial. This method can detect distributed patterns of neural activity, rather than being constrained by the requirement to identify activations in one focal area, and can be highly sensitive to detecting differences across conditions and trials [33].

In terms of what this means for augmented cognition approaches, it would be difficult to localize a distinct neural basis to target with neural prosthetics or other interventions, in that the pattern of neural activity is distributed. It also is challenging to separate content from process, which may make it more fruitful to focus efforts on addressing cultural differences in cognitive processes, which are likely to determine cultural differences in content through the selection and reinforcement of different types of information in the environment.

2.3 Cross-Cultural Differences in Task Difficulty

Some recent research has highlighted that one must be careful to distinguish the strategies and processes evoked by a task from the *difficulty* of that task. While it may be tempting to interpret any difficulty in regional neural activity as indicating unique processes recruited in one group compared to the other, it is necessary to interpret the activation in terms of the behavioral performance on the task, as well as in terms of the patterns of neural activity across cultures in other task conditions.

A prime example of this distinction stems from research on cultural differences in the way a focal line is interpreted relative to its frame. In line with cultural differences in attention to contexts versus objects, behavioral studies indicate cross-cultural differences in perceptual judgments of the orientation of a rod relative to its frame. Americans found it easier to ignore the frame and judge the verticality of a rod alone, whereas East Asians were more affected by the position of the frame, which could interfere with their absolute judgment of the verticality of the rod [34]. A modified version of the task, which allowed both the frame and rod to vary, revealed advantages for each culture for different types of problems. Americans were more accurate at reproducing a line independent of its frame whereas Japanese were more accurate when reproducing the line in proportion to the frame [35, but see 36]). Using fMRI to investigate the neural correlates of this task, Hedden and colleagues [37] found that the same frontal-parietal (attentional) network was implicated for Asians and Americans when each was performing their non-preferred tasks. That is, when East Asians made absolute judgments (judging the size of a line compared to a standard one while ignoring the frame), the attentional network was more active than it was for relative judgments (matching the size of a line relative to its frame, compared to a standard template). The finding was reversed for Americans, who engaged the attentional network more for relative than absolute judgments. Even though the behavioral performance was matched across cultures in this study, the neural activity was a more sensitive proxy of which information required more engagement of attentional resources.

When tasks evoke cultural differences due to greater demands for attentional or cognitive resources in one culture compared to another, distinct augmented cognition solutions would be necessary. Rather than demanding unique solutions and devices with which to overcome resource limitations or improve the efficiency of information processing, differing resource demands would seem to require the same approach but applied at different points in time, or tasks, across cultures. It will also be important to determine when tasks require a ramping up or down of the same attentional resources, compared to situations in which qualitatively different processes are recruited to aid information processing. For example, as load increases for working memory tasks such that people are asked to keep 3, 4, or 5 pieces of information in mind, dorsolateral prefrontal cortex is recruited to a greater extent for higher memory loads. In some cases, older adults may recruit these additional resources at lower levels of difficulty than young, and under-recruit the region at high levels of difficulty, compared to young [38]. However, people may adapt to greater task demands by approaching the task in a wildly different way than they did at lower levels of task difficulty, reflecting distinct patterns of neural engagement across the age groups. The literature on the cognitive neuroscience of aging has grappled with this challenge, attempting to determine whether the recruitment of additional neural regions by older adults in many studies reflects compensation, in an attempt to harness additional resources to complete challenging cognitive tasks [39].

Studies that modulate the level of difficulty, systematically increasing and decreasing the demands, will be most helpful in determining when cultural differences reflect differences in attentional difficulty, as opposed to differences in the strategies engaged. They will also be helpful in investigating whether the same processes hold for participants across varying levels of difficulty and ability. It also may be important to consider effects of difficulty over time. While initially cultures may differ in task performance or neural activity, they may eventually converge as they identify or adapt to the optimal strategy. This is consistent with our suggestion that young adults may be able to adopt culturally less-preferred strategies, whereas older adults lack the cognitive resources in order to do so [21]. With enough aid or differential amounts of practice, an augmented cognition system may similarly enhance performance across cultures, but without the initial investment in set-up and training, it may not equally benefit both cultures. In the case of a system that one will interact with daily, people may be able to learn to use it efficiently and overcome the initial costs with training. However, in the case of a system that would be used occasionally, then the match between the culturally-preferred processes and augmented cognition program may pose a larger constraint.

3 Conclusions

While we have discussed ways in which bottlenecks may vary across cultures and some challenges to applying augmented cognition solutions to address these inefficiencies, it is also important to consider the ways in which bottlenecks themselves reveal how information processing systems operate. Some of our current work investigates the ways in which memory errors may differ across cultures, offering a window into what information is distorted or lost in a given culture, reflecting its values [this framework is further discussed in 12]. In this case, it may be that the content of what is remembered per se is less important than what it reveals about the overarching values and goals that are reinforced by a culture (e.g., prioritization of context or the self). Thus, while a faulty memory system could be "patched" with augmented cognition solutions, this would not change the underlying cultural differences that had been reflected in the pattern of memory errors.

Schacter [40] raises an even larger potential concern for augmented cognition in his review of seven classes of common memory errors, concluding that these errors "are by-products of otherwise adaptive features of memory" (p. 182). That is, in addressing flaws and apparent inefficiencies in the system, augmented cognition could create additional challenges for memory. While forgetting information can be an inconvenient failing of memory, for example, remembering every piece of information ever encoded would lead to a massive store of information that would need to be searched in order to retrieve the desired information at the correct point in time. Or addressing the tendency for information in memory to be distorted to fall in line with one's existing knowledge or beliefs might reduce the usefulness of organizing principles that are based on previous experience. Of course, fully optimizing a system would address undesirable outcomes such as these, but the rich function of memory in sustaining a sense of self that varies across individuals and with culture will require complex and elegant augmented cognition solutions.

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