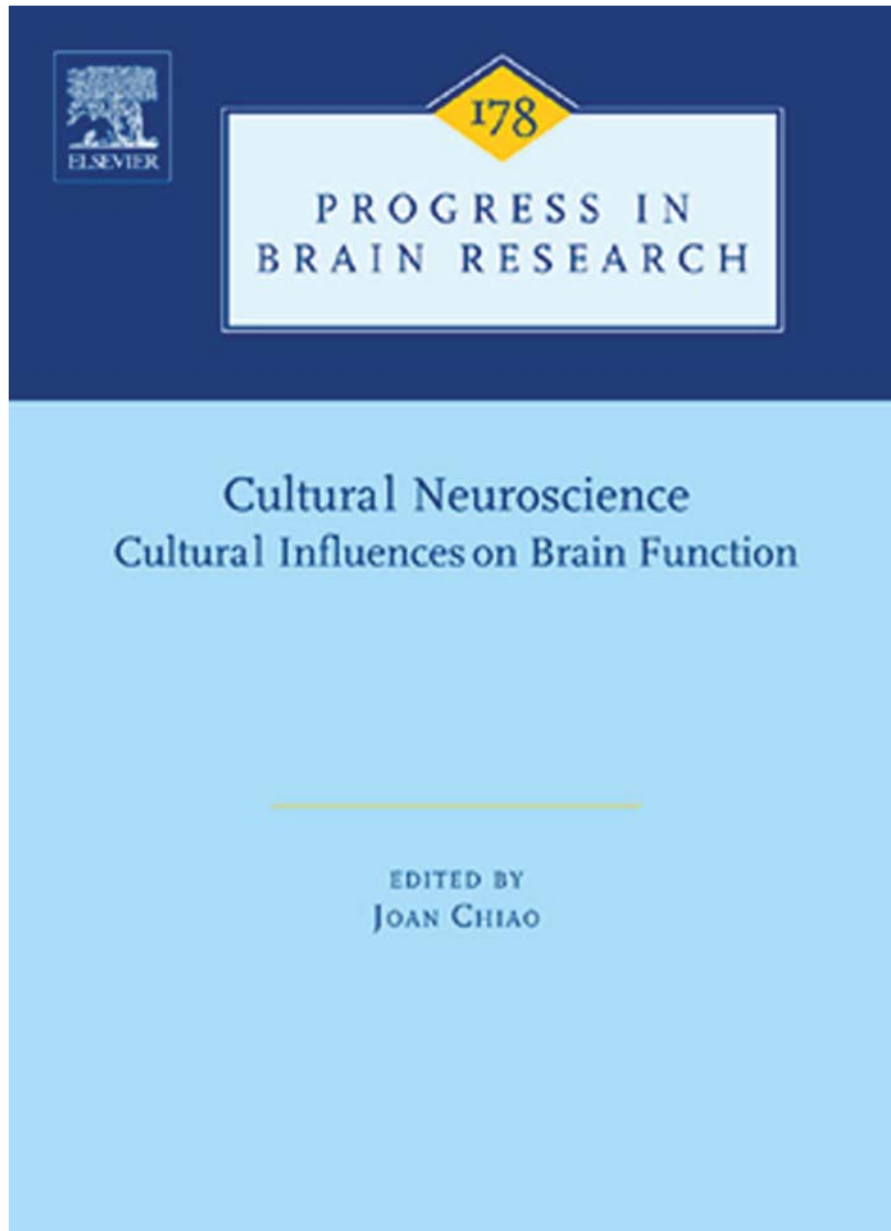


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CHAPTER 9

Cultural influences on memory

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Abstract: Research reveals dramatic differences in the ways that people from different cultures perceive the world around them. Individuals from Western cultures tend to focus on that which is object-based, categorically related, or self-relevant whereas people from Eastern cultures tend to focus more on contextual details, similarities, and group-relevant information. These different ways of perceiving the world suggest that culture operates as a lens that directs attention and filters the processing of the environment into memory. The present review describes the behavioral and neural studies exploring the contribution of culture to long-term memory and related processes. By reviewing the extant data on the role of various neural regions in memory and considering unifying frameworks such as a memory specificity approach, we identify some promising directions for future research.

Keywords: culture; cognition; long-term memory; fMRI

Overview

Recent evidence suggests that culture can operate as a lens, bringing distinct aspects of one's environment into focus, based on cultural priorities, values, and experiences. These cultural differences emerge not only in social domains, such as distinguishing the concept of self from other, but also in cognitive domains, such as processing specific aspects of information. Individuals from Western cultures tend to focus on that which is object-based, categorically related, or self-relevant whereas people from Eastern cultures tend to focus more on contextual details, similarities, and group-relevant information. For example, when asked to describe animated vignettes of underwater scenes, Americans'

descriptions focus on the prominent fish in the scene, whereas Japanese incorporate many more contextual details, such as the color of the seaweed and water, and the relationship of the fish to the other elements in the scene (Masuda and Nisbett, 2001). These different ways of perceiving the world suggest that culture shapes the ways in which individuals attend to and remember aspects of complex environments.

Over the past few years, studies have begun to explore the contribution of culture to long-term memory (e.g., Chua et al., 2006; Gutchess et al., 2006b; Masuda and Nisbett, 2001; Wang and Conway, 2004; Wang and Ross, 2005), and a few studies have begun to explore the effects of culture on neural processes that contribute to memory (e.g., Goh et al., 2007; Gutchess et al., 2006a; Hedden et al., 2008). This review will first consider the contribution of different neural systems to long-term memory formation and retrieval, and then consider the ways in which culture might modify these processes. Relatively

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few studies address cross-cultural differences in memory, let alone using a neuroscience approach. While we review select findings relevant to the memory literature, we will also discuss promising research directions to investigate the influence of culture on memory systems.

Organization of long-term memory

Core memory system: medial temporal lobes

Since the surgical removal of patient H.M.'s hippocampi, the critical contribution of the hippocampus and medial temporal lobes (MTL) to the formation of new memories has been widely recognized (Scoville and Milner, 1957). In recent years, neuroscience methods have further characterized the role of the MTL and identified the ways in which a number of different processes play into the formation and retrieval of memories. For example, MTL are engaged during the formation of new verbal and visual memories (Brewer et al., 1998; Paller and Wagner, 2002; Wagner et al., 1998). Research with H.M. and other amnesic patients illustrates that remote memories are somewhat accessible even with severe MTL damage (Corkin, 2002), although there is some debate over why this occurs. This finding may reflect the time-limited role for the MTL in retrieval: once information is consolidated to cortical regions, the MTL are no longer necessary for retrieval. Others argue that MTL regions are necessary for retrieving some types of information, such as spatial or autobiographical memories that require vivid reexperiencing of the episode (see review by Moscovitch et al., 2006).

Nevertheless, MTL regions are implicated during some retrieval processes. Some research links discrete retrieval processes to separable anatomical subdivisions of the MTL, with the hippocampus thought to contribute to recollection (vivid reexperiencing of events), parahippocampal cortex implicated in some recollection especially for spatial or non-spatial contexts, and perirhinal cortex responding to familiarity (a more general feeling of prior experience with an event) (Eichenbaum et al., 2007). The MTL

also support the retrieval of a complex memory as a seemingly single intact event. In actuality, retrieval relies on the construction of a memory from various features, such as the visual details, sounds, contextual elements, and semantic information about the people and places involved in the event (Schacter et al., 1998, 2007a). These binding processes engage the hippocampus during the retrieval of both veridical accurate memories as well as erroneous false memories (Giovanello et al., 2004; Schacter and Slotnick, 2004).

Contributions of sensory and semantic systems to memory

The involvement of perceptual processes that interpret information from one's environment and individual sensory details underscores the idea that memory is constructive. Encoding visual information engages a host of regions in the occipital cortex, extending into higher-order processing of classes of visual information. Late sensory regions, including the fusiform, lateral occipital complex (LOC), and secondary auditory regions, are implicated in memory for specific classes of features (e.g., Goh et al., 2004; Wheeler et al., 2000). Sensory regions continue to contribute at the time of retrieval, with some evidence suggesting that retrieval relies on the reinstatement of encoding processes. For example, remembering information that had been presented via the auditory or visual modality reengages the same sensory-specific substrates when information is retrieved, even when participants make old/new judgments and do not explicitly recall the perceptual properties of the memories (Wheeler et al., 2000). Recognition of information encountered previously (i.e., true memories) invokes sensory regions of the brain more than false memories (i.e., mistaken beliefs that *new* information was encountered previously) (Schacter and Slotnick, 2004). Likewise, autobiographical memories robustly engage sensory regions, presumably because these personal memories contain rich details and complex visuospatial information (Cabeza and St. Jacques, 2007).

In addition to engaging sensory-specific cortices, encoding and recognition rely on

higher-order modules, such as semantic processes. Semantic memory consists of the storehouse of knowledge one acquires over a lifetime about concepts, ideas, and items in the physical world. This knowledge includes information about form, function, and other properties of objects, as well as miscellaneous facts learned or gleaned from experience. As one interacts with the world and forms new memories, experiences integrate knowledge into semantic memory. Naming objects, thinking about object properties such as form and motion, and contemplating actions associated with objects, engage disparate regions of cortex, including lateral temporal, ventral occipitotemporal, inferior frontal, and motor cortices (Martin and Chao, 2001). Autobiographical memory draws on semantic memory, often subserved by middle temporal gyrus (Svoboda et al., 2006). Retrieving stored knowledge about social concepts also relies on temporal regions, specifically anterior regions near the temporal poles (Zahn et al., 2007).

The engagement of sensory regions and many higher-order processes during memory formation and retrieval does not require conscious processing. Priming and other forms of implicit memory, in which prior experience with an item or event facilitates subsequent processing of that information in the future (such as through speeded reaction times), are especially reliant on the physical features of stimuli and corresponding sensory processes (Schacter et al., 2007c). Schacter et al. (2007c) propose a posterior–anterior gradient in the specificity of the neural response to precise sensory details, with posterior perceptual cortices responding precisely to exact repetitions of items (Vuilleumier et al., 2005) whereas later perceptual regions accommodate some variations. More anterior regions, such as lateral temporal and frontal cortices respond on the basis of conceptual information rather than narrow perceptual properties (Schacter et al., 2007c). Posterior neural regions underlying implicit memory typically show an attenuated neural response, or adaptation, when the same item is represented (Grill-Spector et al., 2006). The specificity of the neural response to an item can differ across hemispheres. Whereas the left

fusiform adapts to the same *or* different exemplar of an item, the right fusiform response is highly specific, adapting only to the original exemplar (Koutstaal et al., 2001). These distinctions between specific properties of memories apply to both explicit conscious recollection (Garoff-Eaton et al., 2006) as well as implicit measures of unconscious previous experience with an item (Schacter et al., 2004, 2007b, 2009).

Contributions of social, emotional, and reward systems to memory

A number of higher-order processing modalities contribute to memory. The medial prefrontal cortex (mPFC) responds to social information and contributes to memory formation during the successful encoding of social pictures into memory, relative to nonsocial pictures (Harvey et al., 2007). The mPFC is particularly engaged when relating information to the self, over, and above relating information to other people (Craig et al., 1999; Kelley et al., 2002; Macrae et al., 2004), and this extends to autobiographical memory (Cabeza and St. Jacques, 2007). Moreover, mPFC activity during encoding is associated with subsequent recognition of self-referential information, suggesting that the region is implicated not only in thinking about the self, but also plays a critical role in memory (Macrae et al., 2004). Similarly, orienting to social information by forming impressions of individuals engages a dorsal region of mPFC, which is not engaged during a nonsocial comparison task (Mitchell et al., 2004). Interestingly, encoding social information does not reliably engage medial temporal regions in the small number of studies reported thus far. Whether medial prefrontal regions alone are sufficient for encoding, or whether the contributions of the hippocampus and other MTL regions have been obscured through the comparison conditions studied thus far will be resolved through future research.

Social and emotional processes undoubtedly overlap on some dimensions, but Harvey et al. (2007) emphasize the distinct bases for the contribution of these processes to memory. Whereas the amygdala contributes to the

encoding of emotional, relative to neutral, pictures, the mPFC responds during the encoding of social information. The role of the amygdala in the encoding and retrieval of emotional information has been established by numerous studies (LaBar and Cabeza, 2006). For emotionally evocative scenes, activation of the amygdala predicts later memory for the scenes (Canli et al., 2000), with evidence that this occurs for negatively and positively valenced information (Hamann et al., 1999). The amygdala also contributes to vivid encoding and retrieval of information, including for autobiographical memory (Cabeza and St. Jacques, 2007). Encoding of visual details engages the amygdala, in concert with fusiform gyrus (Kensinger et al., 2007), and supports “recollection” or “remember” responses, rather than those based on a more general feeling of familiarity (Dolcos et al., 2004; Sharot et al., 2004).

The interface of memory and reward systems has only begun to be explored, but initial findings suggest some intriguing interactions. Activation of reward regions, such as the ventral tegmental area (VTA) and the nucleus accumbens, predicts memory for information associated with high-value rather than low-value rewards (Adcock et al., 2006). Functional connectivity analyses suggest that the VTA, a dopamine-rich midbrain region, works in concert with the hippocampus, indicating a mechanism through which dopamine could modulate memory formation.

Contribution of frontal lobes to memory: modality specificity and control processes

The frontal lobes make myriad contributions to memory processes, consistent with their role in complex cognitive tasks and top-down processing (Miller and Cohen, 2001). Some theories have highlighted hemispheric differences in the frontal lobes' contribution to memory, with distinct modules engaging each hemisphere. Verbal information engages left prefrontal regions whereas visual information engages right prefrontal cortex during encoding (Brewer et al., 1998; Kelley et al., 1998; Kirchoff et al., 2000; Wagner et al., 1998). Depending on the verbalizability of visual

information, such as nameable pictures as opposed to faces, prefrontal cortex may be engaged bilaterally, likely reflecting dual coding of information into both verbal and visual representations (Kelley et al., 1998; Paivio and Csapo, 1973). The material-specific recruitment of prefrontal cortex also occurs during retrieval (Simons and Spiers, 2003). Notably, this hemispheric distinction extends to the MTL (e.g., Kelley et al., 1998).

While ventral regions of lateral prefrontal cortex are sensitive to the modality of materials, the regions contribute to memory through the maintenance and elaboration of information (Simons and Spiers, 2003). In contrast, dorsal prefrontal regions are implicated in controlled processes that draw on working memory and executive functions in order to attend to and select relevant attributes, inhibit distracting information, and maintain goal states (Miller and Cohen, 2001). In terms of memory, these processes aid in the organization and evaluation of information (Simons and Spiers, 2003). The contributions of anterior prefrontal cortex, or frontopolar regions, to memory are less well understood, but some have suggested that the region plays a monitoring function (Buckner and Wheeler, 2001), particularly when information is internally generated (Simons and Spiers, 2003). The distinction between multiple frontally mediated processes is also important in the autobiographical memory literature, with ventral regions engaged during “strategic retrieval, verification, and selection of information from posterior cortical association areas” (p. 2195) and dorsal regions invoked during memory reconstruction, perhaps reflecting the greater monitoring demands for specific personal events (Svoboda et al., 2006). Another distinction in the autobiographical memory literature is between two regions that work together to retrieve detailed personal memories: the lateral prefrontal regions that subservise memory search processes and medial prefrontal regions that underlie self-relevant processes (Cabeza and St. Jacques, 2007).

Several frameworks propose ways in which prefrontal cortex and medial temporal regions interact. Given its role in top-down processing,

prefrontal cortex may contribute more in demanding and effortful retrieval contexts when familiarity alone cannot support retrieval (Simons and Spiers, 2003). These situations may include ones in which people must orient attention, remember precise details of a memory (e.g., source details such as recency or perceptual details), create and use elaborated cues, or are under a large memory load. The precise nature of the contribution of prefrontal cortex to memory will depend on the nature of the top-down demands (Simons and Spiers, 2003). According to theories explaining the nature of interactions between the neocortex and hippocampus during memory consolidation, prefrontal cortex could play a larger role in cue generation and memory search over time, as memories are stored cortically and rely less on the hippocampus (McClelland et al., 1995).

While MTL regions interact with a number of distributed regions, to conclude this section we will contrast the nature of the prefrontal-MTL interactions with the interaction of other regions. Whereas prefrontal cortex contributes during effortful and organizational processes that require “working-with-memory” (Moscovitch and Winocur, 1995), other regions respond to the MTL in a more passive manner. Sensory cortices process and share details with MTL regions, and the parietal lobes respond in a receptive manner to the outputs of the MTL. While the parietal lobes have received less attention in the memory literature than other regions, recent evidence suggests that the region responds to familiarity when information is actually old or perceived as such (Wagner et al., 2005). Although some parietal regions track a feeling of remembering, the amount of detail recollected, and whether a person is actively trying to remember information (Wagner et al., 2005), these processes follow from the outputs of memory processes, rather than dynamically guiding what is remembered, as the prefrontal lobes do.

Specificity of memory

A specificity of memory framework considers the ways in which these memory systems can be

shaped by culture. This concept captures “the extent to which, and sense in which, an individual’s memory is based on retention of specific features of a past experience, or reflects the operation of specialized, highly specific memory processes” (Schacter et al., 2009). A number of behavioral, neuropsychological, and neuroimaging studies reveal a striking specificity to memory processes. For example, true memories (i.e., accurate memory for information encountered previously) contain more sensory information and invoke sensory regions of the brain more than false memories (i.e., mistaken beliefs that new information was encountered previously), whereas imagined information contains information about mental operations and engages corresponding neural regions (Gonsalves and Paller, 2000; Kensinger and Schacter, 2006; Mather et al., 1997; Schacter and Slotnick, 2004). Given the limits on information processing capacity, the specific details encoded and retrieved in memory come at the expense of other details. Comparing the types of details and processes that individuals from one culture prioritize over others offers insight into the type of information given priority in cognition, perhaps reflecting broader cultural values.

The properties of memories and the types of memory errors people commit offer a window into the organization of memory. In terms of types of memory errors, if people falsely remember conceptually related, but not phonologically related items, it suggests that the meaning of the information is critical to the organization of memory, whereas phonological information is not (Chan et al., 2005). Information can be encoded not only in terms of its precise properties (e.g., remembering the unique perceptual features of an item) but also in terms of its gist, or general thematic properties (e.g., a category or verbal label). One example of highly specific memory representation comes from the literature on priming. Priming occurs when prior experience with an item facilitates a response (see review by Schacter et al., 2004). Its effects are implicit: they do not rely on conscious recollection that the item was encountered previously. Although people respond to different exemplars of the same item

(e.g., a different picture of a cat) more quickly than to unrelated items, suggesting facilitation from prior exposure to a related item, the benefit is smaller than it is for a repeated presentation of the original item (Koutstaal et al., 2001). This finding indicates that both conceptual and perceptual processes contribute to implicit memory for items. Individuals could differ in the extent to which they emphasize either of these distinct processes. For example, a culture that emphasizes categories and abstraction of information could prioritize conceptual information, which would lead to greater facilitation of related items. In contrast, a culture that is less likely to categorize may process individual items in more detail, thus emphasizing the perceptual aspects and allowing for little benefit for semantically related items.

The concept of memory specificity can also apply to the distinction between unique domains of memory. One example from the social domain is the distinction between self and other: thinking about oneself is vastly different than thinking about other people. The self is associated with memory enhancements, as well as patterns of errors, that do not characterize memories for other people (Rogers et al., 1977, 1979). Neuroimaging methods provide strong support for this distinction by revealing that self-referencing engages a unique region of the brain. Comparison across cultures provides a test of which modules are universals, contributing critically to memory. It is possible that unique memory modules reflect the priority given to particular types of information during processing; the same modules may not exist across all cultures. For example, the emphasis on the “self” as a unique entity may be a larger Western notion (Markus and Kitayama, 1991). If so, self-referencing would not constitute a distinct module in people from all cultures, nor would it disproportionately benefit memory.

In the remainder of this review, we will discuss ways in which culture may shape memory, relating empirical data and new directions to the memory systems explained in the first half of this review. Although investigating the neural underpinnings of cultural differences in memory could provide critical information to localize the stage(s) at which memory process differ, it is also important

to consider that content, represented by the qualities and features preserved in memories, may diverge the most across cultures. Relative to differences in cognitive operations, differences in the content of memory may not be as strongly localized to distinct regions, which could make the study of the effects of culture less amenable to neuroscience techniques, or at least reliant on precise experimental manipulations.

Influence of culture on memory: neural and behavioral findings

The above review of the brain regions that contribute to memory formation and retrieval suggests several stages at which culture could shape memory. Cultures could differ in the processing of sensory information or in the top-down control processes that guide what information should be attended to and what should be filtered out. Although none of the studies included in a recent review of the literature on neural differences across cultures directly investigate memory processes, some investigate memory-relevant processes (Han and Northoff, 2008). Those studies suggest that generally cultures differ in intermediate stages of memory processes, such as higher-order visual or semantic processes. Because there are relatively few studies that investigate neural differences across cultures, our discussion of the impact of culture on memory includes behavioral findings and speculation on the neural systems that may contribute to the behavioral differences across cultures.

Cultural differences in MTL systems

As discussed in our review of the role of the MTL in long-term memory, the region is critical to the formation and, in some cases, the retrieval of memories. Given the devastating effects of MTL damage on memory, it seems unlikely that the core memory functions of these regions would differ across cultures; indeed, cultural differences have not been reported in MTL function thus far. However, some of the other ways in which the MTL contribute to memory could be malleable

across cultures. For example, recollection and familiarity engage distinct MTL regions; people from different cultures may differ in the types of memory or features of specific memories that are encoded with a rich experience of recollection versus a vague sense of familiarity. This could be particularly true for autobiographical memories, which often consist of vivid contextual detail.

Another way in which MTL function might be expected to differ across cultures is in terms of processing context. Behaviorally, East Asians tend to exhibit a holistic orientation, as a result of the emphasis that Chinese culture places on the collective group and social obligations (Nisbett et al., 2001). In contrast, the emphasis of Greek culture on personal agency contributes to an analytic orientation for Westerners. Studies on cross-cultural differences in orientation to the field/context versus the object converge to suggest that East Asians attend to contextual information, particularly backgrounds in complex scenes, whereas Americans attend to object-based information (e.g., Chua et al., 2005a; Gutchess et al., 2006a, b; Kitayama et al., 2003; Masuda and Nisbett, 2001; Miyamoto et al., 2006; Nisbett and Masuda, 2003). For example, Masuda and Nisbett (2001) reported cultural differences in memory for contextual details, with East Asians recalling more information about background elements of a scene compared to Americans. Although the two cultures did not differ in memory measures for central target objects, East Asians were more impaired than Americans at recognizing the object when the background behind the target object was changed or removed (Masuda and Nisbett, 2001). Based on findings that the parahippocampal gyrus is engaged during the viewing and encoding of complex contexts (Epstein et al., 2001; Epstein and Kanwisher, 1998), East Asians and Americans could be expected to differ in the activation of parahippocampal gyrus. Studies that extended this paradigm, however, did not find differences in MTL function (see Gutchess et al., 2006a, reviewed in next section).

One interpretation of Masuda and Nisbett's (2001) finding is that cultures differ in binding processes, that is, the ability to associate information together into a single representation, such as

learning a name-face pairing or the association of an object with a spatial location. Masuda and Nisbett (2001) suggested that Easterners might bind objects to contexts more readily than Westerners, due to cultural differences in the emphasis placed on contexts, particularly social ones. Binding engages the hippocampus during both encoding and retrieval of bound representations (Giovanello et al., 2004; Jackson and Schacter, 2004). Although binding an object to a background engages the hippocampus in young adults (Goh et al., 2004), cultures do not differ in this process (Goh et al., 2007). Behavioral investigations of source memory, the ability to remember which speaker presented particular information, also fails to identify cultural differences across young or older adults in a process thought to rely on associative memory (Chua et al., 2006). Source memory and object-background binding are impaired with aging, likely due to age-related changes in hippocampal function, but these declines are equivalent across American and Chinese cultures (Chua et al., 2006; Goh et al., 2007).

Cultural differences in sensory and semantic systems

Although neuroimaging studies of context memory did not lead to the expected differences in MTL function, research indicates that processing of the component objects differ across cultures. As reviewed in the memory section, sensory-specific regions of cortex respond on the basis of those features, and these same areas may be reactivated at recognition. Thus, we would expect differences in the activation of semantic and sensory regions that correspond to the features and properties that are most highly prioritized, and thus encoded into memory, when the attended qualities differ across cultures.

Evidence exists for cultural differences of this type. In the neuroimaging study to most directly investigate memory, Gutchess et al. (2006a) investigated encoding of complex photographs in East Asian and American participants by comparing pictures of objects alone, pictures of backgrounds alone, and complex pictures containing

both objects and meaningfully related backgrounds. Americans engaged object processing regions, including lateral temporal cortex, more than East Asians, but negligible cultural differences emerged in background processing regions (Gutchess et al., 2006a). The authors interpreted the cultural differences in these regions as reflecting semantic processing of objects, consistent with behavioral evidence that Americans may be more object-focused than East Asians. The fMRI data converge with eye-tracking data indicating that Americans make more fixations to objects during the first 300ms of picture viewing, compared to East Asians (Chua et al., 2005a). Although the cultural differences in the processing of objects reported in Gutchess et al. (2006a) likely impact what information is encoded into memory, it is important to note that these processes may not be specific to memory. Rather, they could reflect broader differences in the processing of objects across cultures. Further investigations targeting selective memory processes, such as successful versus unsuccessful memory formation, would be necessary to evaluate the contribution of these processes to encoding.

Other studies identify cultural differences in perceptual regions. A second study investigating the processing of complex pictures found cultural differences only for older adults (Goh et al., 2007). Whereas young Singaporean and American participants equivalently engaged regions implicated in the processing of picture elements, older adults differed across cultures in the engagement of the LOC, a region associated with visual processing. The LOC responded less for repeated objects in older Singaporeans than Americans, in line with other evidence for selective cultural differences in object processing. An ERP study identified differences in the P1 component, thought to reflect extrastriate activity in response to spatial attention, during a global/local task (Lin et al., 2008). Global processing requires broader attention to larger shapes or portions of space, whereas local processing requiring more focal attention to parts of shapes (e.g., the difference between a large “S” consisting of smaller letter “E”s). This study adopted a different approach to the study of culture; rather than comparing individuals from

different cultural groups, the investigators manipulated cultural orientation by priming participants to think more independently or interdependently (i.e., in a relatively more “Western” or “Eastern” style). The result converges with other findings to suggest differences in sensory processes, but the temporal precision afforded by ERP suggests an early locus for cultural differences that could not be identified by previous fMRI studies.

Semantic information is greatly shaped by culture-specific learning and experiences, and the contents of semantic memory differ across cultures (Yoon et al., 2004). The exploration of cross-cultural differences in the organization of information by categories versus similarities or relationships shows that Americans exhibit a preference for sorting by categories whereas East Asians prefer to sort by similarities and relationships (Chiu, 1972; Gutchess et al., 2006b; Ji et al., 2004; Unsworth et al., 2005). These preferences affect effortful cognitive processes as well, with Chinese making more errors than Americans when learning rule-based classification (Norenzayan et al., 2002), and American elderly organizing information in memory by categories more than Chinese elderly (Gutchess et al., 2006b). Based on these behavioral differences, neuroimaging studies would be expected to reveal cultural differences in semantic processing regions, such as temporal and inferior frontal regions. Furthermore, the continual acquisition of semantic knowledge throughout one’s life can potentially lead to the magnification of cross-cultural differences over the lifespan, a promising area for future research on universal versus experience-based development of memory (Park and Gutchess, 2006; Park et al., 1999).

Cultural differences in social, emotional, and reward systems

Cultural differences in social processes, particularly in the relationship between the individual and the group, have long been recognized. One useful framework for understanding these differences is the continuum of collectivism–individualism, which suggests that East Asians emphasize

relationships and the group, whereas Westerners value uniqueness and independence (Triandis and Suh, 2002). Cultural differences in relationships with others in society impact the concept of the self, with East Asians defining the self in terms of social obligations and networks in an interdependent manner, while Westerners see the self as unique and separate from others in an independent manner (Markus and Kitayama, 1991). Markus and Kitayama (1991) speculated that the “inner self” would be elaborated and accessible for independent individuals, including information about attitudes and desires. This information may be less accessible in memory for interdependent individuals, with information organized in a more context-specific manner (rather than consisting of traits that are generally true across many contexts). This framework is consistent with the finding that after making general judgments about traits, Westerners (or people primed with the concept of the independent self) exhibit better memory for adjectives or other information related to the self whereas East Asians equivalently remember information related to the self or to a close other (Sui et al., 2007; Wagar and Cohen, 2003; Zhu and Zhang, 2002). Recent fMRI work provides converging neuroscience evidence that the relationship between self and others differs across cultures (Zhu et al., 2007). While both Westerners and Chinese differentiate self from distant, unfamiliar others, only Americans differentiate self from close others (i.e., mother) in terms of mPFC activity. Although the fMRI analyses did not explicitly target encoding processes (a post-scan behavioral recognition test confirmed the cultural differences in memory performance), the same region underlies the encoding of self-referenced information into memory (Macrae et al., 2004). This finding suggests that the cultural difference in mPFC likely have implications for memory. The study of bicultural individuals, such as Asian Americans, provides further evidence for the malleability of mPFC activity and self-concept. Priming different aspects of one’s self (e.g., with individualistic or collective values) alters orientation to context in making self-reference judgments and corresponding mPFC and posterior cingulate activity (Chiao

et al., in press). This finding has implications for the ways in which cultural identity shapes what cues are generated and attended to in order to retrieve information from memory.

Consistent with cultural differences in attention to individuals versus groups and the importance of context, Americans and East Asians differ in their free recall of social interactions. Americans recall more information than Taiwanese participants about the central character relative to other characters, and attribute more intentionality to the characters in their recall of narratives and videos (Chua et al., 2005b). Cultural differences in attention to social contexts also affect judgments of emotion. In their free recall of information, Americans report less emotional content than Taiwanese (Chua et al., 2005b), and conflicting social contexts color the perception of the emotional expression of a target individual for Japanese more than Westerners (Masuda et al., 2008).

Although the neural bases of these cultural influences on emotional memory have not been investigated, other studies identify differences in amygdala activity. Across Japanese and American cultures, the amygdala is more engaged by fearful faces from one’s own cultural group, compared to outgroup faces (Chiao et al., 2008). Based on the amygdala’s contribution to emotional memory, participants might be expected to form more vivid or detailed memories for ingroup than outgroup fearful faces. Other evidence suggests that cultures differ in their preference for high arousal (e.g., excitement) versus low arousal (e.g., calm) positive emotional states (Tsai et al., 2006). High arousal, rather than valence, particularly drives amygdala activity in American samples (Kensinger and Corkin, 2004); it is possible that the connectivity between the amygdala and the hippocampus or frontal regions differs for East Asians who could prioritize low arousal information more than Americans. Note that it remains to be established whether East Asians’ preference for low arousal situations affects information processing.

Some evidence, however, indicates that emotional values influence memory across cultures. When emotional experiences are consistent with values, the information remains in memory

longer, thus allowing it to affect other cognitive processes (Oishi et al., 2007). Interestingly, these data indicate cultural differences in the maintenance of information, in contrast to our focus throughout much of this review on the importance of initial attention to information at encoding and the use of appropriate cues during retrieval.

Drawing on both social and emotional processes, the study of autobiographical memory offers a rich avenue to explore how the content of memory differs across collectivist and individualistic cultures. Caucasian Americans tend to recall more individual, as opposed to more social, memories than Asians. In turn, Asians' memories emphasize social interactions and contain more people than do Caucasians' memories (Wang and Conway, 2004; Wang and Ross, 2005). Wang and Ross (2005) suggest that culture affects both initial encoding processes as well as the way in which memory is reconstructed upon retrieval. Cultural differences emerge in early development, with autobiographical memory and self concept reciprocally influencing each other (Wang, 2006). For example, cultural differences in childrearing practices influence the onset of autobiographical memory, with children raised collectively in reformed kibbutzim reporting later first memories than children raised in more individualistic settings (Harpaz-Rotem and Hirst, 2005). These cultural differences in behavioral measures indicate that the types of social, emotional, and perhaps even sensory processes that contribute to autobiographical memory will differ across cultures based on the contents retrieved from autobiographical memory.

Cultural differences in frontally mediated modalities and control systems

The prefrontal cortex plays a multifaceted role in memory, including the maintenance of information and goal states, elaboration of retrieval cues and information to be encoded, and monitoring of internal states and external information from the environment. The demands placed on prefrontal cortex might lead one to suspect that cultural differences would be manifested in a host of frontally mediated memory processes.

Surprisingly, only one fMRI study to date strongly implicates prefrontal cortex in cultural differences in cognition. Using a line-judgment task in which judgments could be made in a context-dependent (relative to a frame) or a context-independent (absolute) manner, Hedden et al. (2008) identified a robust fronto-parietal network that was engaged during the effortful judgments. In line with prior work suggesting that East Asians found the absolute judgments more difficult whereas Americans found the relative judgments more challenging, the fronto-parietal network was more engaged during the tasks that participants found difficult, which differed across cultures (Hedden et al., 2008). These results illustrate that tasks can differ in their controlled processing demands in line with cultural priorities and the ease with which strategies can be employed.

The study by Hedden et al. (2008) indicates that strategies that are less practiced within a culture load on similar attentional processes, even though cultures differ in which task is more effortful (i.e., absolute or relative judgments). Other studies indicate that the nature of attention may differ across cultures, with East Asians attending more broadly and Americans attending more focally. These differences allow Americans to respond faster to focal changes, whereas East Asians respond faster to global changes, or to those that are more distributed in space (Boduroglu et al., 2009). In the memory literature, the finding that recent judgments of size affect Japanese participants more than Americans is consistent with the attentional literature in that participants are attending more broadly to recent events still held in memory when making an independent judgment on the current trial (Duffy and Kitayama, 2007). Frontal-parietal networks might be expected to underlie these cultural differences in the breadth of attention.

Investigating cultural differences in prefrontal contributions to autobiographical memory seems promising for future work. The distinctions between regions suggest that ventral and lateral prefrontal activity may be more culture-invariant, as these regions contribute to the effortful processes of search and retrieval (Cabeza and St. Jacques, 2007; Svoboda et al., 2006). Dorsal

regions, on the other hand, may be differently engaged across cultures based on which details constitute reconstructed memories and the monitoring demands for those specific details (Svoboda et al., 2006). As reviewed in the previous section, medial regions that reflect self-processing (Cabeza and St. Jacques, 2007) are heavily influenced by culture (Zhu et al., 2007).

Conclusion

While the study of cultural influences in memory is in its infancy, particularly in terms of neural measures, initial studies provide strong evidence that attentional, emotional, and object-based processes differ across cultural groups. A fine line distinguishes the domain of memory from these related processes. For example, memory formation and retrieval depend critically on attention to features of information during encoding and the relevant cues during retrieval. Furthermore, cultural preferences for object versus context, individual versus group-based information, or different emotional states will certainly influence the aspects of experiences that are incorporated into memories, and the component subprocesses used to store and retrieve these memories. A specificity of memory approach draws attention to the different details that are valued and prioritized across cultures, and thus incorporated into memories to varying degrees. Cultural orientations can determine which distinct modules are needed in memory, and whether the organization of memory systems is universal. In this review, we discuss ways in which numerous processes may contribute to cultural differences in long-term memory and how cultural influences may be instantiated neurally, based on our understanding of memory networks in the brain.

We conclude the review by emphasizing the widespread modes of thought and mental states that could exacerbate the influence of culture on the neural underpinnings of long-term memory. For bicultural individuals, testing language influences what information is retrieved from memory (Marian and Kaushanskaya, 2007), a finding that is consistent with effects of language on strategy

use and ease of information processing in other domains (e.g., Boroditsky, 2001; Ji et al., 2004). For fluent bilinguals, first and second languages overlap considerably in the brain (Chee et al., 1999); however, language could interact with other processes, such as memory, to magnify cultural differences through its emphasis on different aspects of information and its recruitment of divergent cognitive and social processes. For example, language could alter the lateralization of encoding and retrieval processes, which exhibit a strong left-verbal/right-visual distinction for participants tested in English. Testing in languages that use characters could modify this organizational scheme for memory systems, although this is not the case for linguistic tasks, in which Chinese characters are processed more like English words than pictures (Chee et al., 2000). Even an experience as simple as incidentally viewing pictures of culturally meaningful symbols can lead bicultural individuals to access vastly different knowledge systems. For example, seeing a picture of the Statue of Liberty can lead individuals to make attributions or express a self-concept in line with their independent American identity whereas seeing a picture of the Great Wall of China can induce these same individuals to behave in a manner consistent with their more interdependent Chinese identity (Hong et al., 2000). That such a subtle experience can invoke a dramatic change in the lens through which one views the world has profound implications for the ways in which information is encoded into and retrieved from memory.

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