



Perceptual and mnemonic differences across cultures

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Abstract

In this chapter, we selectively review the literature investigating how culture affects memory and perception. The chapter tries to capture some of the ways that culture and life experience can shape perception, including adaptive changes that are shaped by the characteristics of one's environment. In its treatment of memory, the chapter focuses on the ways in which culture may influence the amount of specific information that is contained in memory for autobiographical episodes as well as objects, and evaluates potential mechanisms that could account for these effects. The chapter's treatment of perception and culture includes a novel proposal: that cultural biases in preferential processing of particular spatial frequencies, an idea that thus far has primarily been tested in face processing, could account for cultural differences in memory specificity. Finally, we discuss the type of evidence that would be needed to fully evaluate this proposal and theories of cultural influences more generally.



1. Perceptual and mnemonic differences across cultures

Dating to the earliest systematic observations of human cognition, researchers have recognized and struggled to account for individual differences in performance. The notion of the “personal equation,” derived from astronomical observations made by Nevil Maskelyne in 1796, captured the idea that each observer differed in some way from others (Boring, 1950, Chapter 8). Over the years, individual differences in cognition have been linked to many different variables, including genetics (Posner, Rothbart, & Sheese, 2007), acquired expertise (Ericsson, 2017), and working memory capacity (Engle, 2002, 2018), to name just a few. In the past 2 decades, researchers have increasingly recognized the importance of yet another source of individual differences: culture (e.g., Chiao, 2009; Grossmann et al., 2012; Gutchess et al., 2006; Han & Ma, 2014; Hedden et al., 2002; Ji, Nisbett, & Su, 2001; Kitayama & Uskul, 2011; Markus & Kitayama, 1991; Masuda & Nisbett, 2001; Na et al., 2010; Nisbett, Peng, Choi, & Norenzayan, 2001; Stevens, 2012). As there is relatively limited research on the influence of culture on psychological processes, our goals for this chapter are to selectively review some of the existing findings, propose some novel connections among the processes shaped by culture, and, above all, stimulate further research in these areas.

The consideration of culture is a relatively novel direction for the study of *cognition*. Most of the existing theories and frameworks are shaped by the research framework of social psychology, which embraced the consideration of culture sooner and has had a stronger hand in shaping the direction of cross-cultural research thus far. For example, the ways in which one thinks about oneself, self-construal, is thought to be richly shaped by the social environment and the ways in which one relates to their social circle and group memberships. Cultural differences in self-construal posit that Western cultures, including the United States, Canada, United Kingdom, Australia, and Western Europe, have more independent representations of the self, such that the self is considered to be an entity distinct from others. In contrast, Eastern cultures, including China, Japan, and Korea, and sometimes Southeast Asia and South Asia, have a more interdependent representation of the self, in which the self is considered in terms of social roles and connections with others (Markus & Kitayama, 1991). Thus far, self-construal has been a dominant framework for the study of culture, with influences on processes such as emotional expression (Tsai, Sun, Wang, & Lau, 2016), impression formation (Saribay, Rim, & Uleman, 2012), and life satisfaction (Suh, Diener, & Updegraff, 2008).

Yet recent work has begun to illuminate that the assumption that the social world shapes mind and brain may not be the only way to account for many of the cross-cultural differences in cognition. In the present chapter, we will argue that lower-level, perceptual processes could account for differences in memory across cultures. Investigations of culture and cognition typically emphasize how culture impacts either perception or memory, treating the two separately. We decided to deviate from that model, treating the two in concert. We take this path because we recognize that virtually no assay of perception is uninfluenced by some aspect of memory. Conversely, memory depends so heavily on perception that one distinguished memory researcher has characterized memory as “perception plus time” (Kahana, personal communication, March 2019). In addition, there are striking parallels between memory and perception. Memory is reconstructive, drawing on contextual and other supplementary cues to build a memory for recall. Similarly, perception draws on inferences to solve the inverse problem, for example, reconstructing a three-dimensional world from the two-dimensional projection on the retina using cues such as occlusion and relative size. As a result, these seemingly different processes are both open to culture-related influences.

Obviously, the brain shapes both perception and memory. Events that go unregistered by the brain will go unperceived; and events whose traces have been lost will go unremembered. But what influences shape what the brain can and cannot do? Examining those influences provides a framework within which we can focus our exploration and, at the same time, highlights the challenges to fully understanding culture’s influence.

Responding to both genetic and environmental influences, the human brain undergoes continuous changes—before and shortly after birth, of course, but also throughout the lifespan. Inspired by the pioneering work of [Hubel and Wiesel \(1962\)](#) on the impact of visual rearing conditions, basic researchers as well as clinicians have understood the powerful neural impact of interactions with the sensory environment. That is, rearing conditions have powerful impacts on multiple neural systems. Of course, adaptation to environmental conditions does not cease at any point in life. Throughout the life span, the human brain continuously adapts—in ways large and small—to the sensory environment and to feedback from experiences in that environment, that is, learning.

Our approach to the study of culture draws on these notions of plasticity, in that the brain is continually sculpted by learning and life experiences, strengthening and rewriting neural connections ([Li, 2016](#); [Park &](#)

Gutches, 2006). The process repetitively unfolds over time with culture, brain, and behavior continually influencing each other in dynamic loops (Chiao, Cheon, Pornpattanakul, Mrazek, & Blizinsky, 2013; Han & Ma, 2015). We conceptualize culture as the experiences shared by individuals in a given group. These experiences include linguistic habits, values, practices and customs.

How to define cultural groups is a topic of considerable debate. In this paper, cultural group will largely be defined as the comparison of East versus West, which typically compares East Asians from China, Japan, and Korea, to Westerners from America, Canada, the United Kingdom, and Western Europe. Throughout, we attempt to reflect the language used in the papers we review, which reflects the definition of the sample (e.g., whether the sample is Chinese or drawn from multiple East Asian countries) and the breadth of the claims (e.g., interpreted as applying to Americans versus Westerners as a whole). Cultural groups are typically defined by a person's country of origin and where s/he has spent the majority of his/her life. Cross-site studies compare people residing in their native countries (e.g., Americans versus Japanese) whereas single-site studies compare native residents of a country to those people who have immigrated there recently (e.g., native Canadians not of Asian ethnicity versus Chinese who immigrated to Canada within the past 5 years, often for undergraduate or graduate study). We recognize that these distinctions are merely a starting point for studying culture, and represent broad brushstrokes across cultural identities that differ in more nuanced ways across subregions or subpopulations, let alone between countries. When testing is conducted in one location, that also fails to account for self-selection effects, in terms of who chooses to relocate to another country and how they compare to those individuals who remain in the country of origin.

In addition, the time frame in which a culture is studied is an essential consideration in defining culture. Cultural practices, norms, and perspectives on the world can change over time (e.g., due to sociopolitical change). Considering dynamic changes can serve as valuable tests of mechanisms (e.g., see discussion of the Himba and urbanization later in this chapter), yet research on cross-cultural differences in cognition rarely explores change over time.

This omission in the study of cognition extends to considering acculturation as well as cross-generational effects of culture. Certainly developmental processes are at play. Are there particular time periods of one's life when one is most likely to internalize a new host culture, or when one is unlikely

to change as a result of immersion in a new culture? Is cultural learning consistent across different ages? Beyond the timespan of a life, there is some evidence of cultural influences across generations (e.g., comparing Chinese tested in China to first or second generation Chinese-Americans tested in the United States) (Elfenbein & Ambady, 2002). Even with this more careful consideration of cultural exposure, complex effects of environment are rarely assessed, for example, through rich measures of how much families practice and convey cultural traditions from the country of origin (even if defined based on ancestors rather than one's personal past) compared to the cultural traditions of the host country. The current state of the literature does not capture these nuances, thus typically representing an entry point into the study of culture by using country of origin and residence as a proxy for all of the multifaceted and variable aspects of "culture."

Due in part to this treatment of culture, the exact mechanisms through which culture influences cognition also are under considerable debate. It is difficult to experimentally isolate and manipulate a single factor when the influences of culture are so all-encompassing and repeatedly reinforced over many years lived within a cultural setting, particularly when potentially heterogeneous subgroups are amalgamated together. We will discuss some mechanisms through which culture could influence information processing and cognition, and discuss some of the key challenges to studying culture.

In this chapter, we review evidence for cultural differences in memory, and consider potential mechanisms that could account for the development of individual differences. We suggest ways in which lower-level cognitive and visual factors could account for cultural differences in memory, and discuss the type of work that is needed to fully investigate the contribution of top-down social processes and bottom-up visual processes on cognition.



2. Influences of culture on memory

To illustrate the ways in which culture can influence memory, we start with an example in which sweeping sociopolitical forces emphasized learning of culturally-relevant symbols. Recognizing a conspecific is as important to humans as it is to members of other species. Face recognition, which is essential in that process, depends upon finding a match between the face and its representation in memory. The typical laboratory study of this ability presents either a previously seen face or a novel face, and asks participants to judge whether the face is "old" or "new." Mao Tse Tung dominated political and cultural life in the People's Republic of China (PRC) for decades.

During the latter years of his leadership, images of Mao in posters, photos, and moving images on film and television were omnipresent. As a result, Chinese adults were exposed to his images since early childhood, which made his face highly familiar. To examine the fidelity of facial memory produced by perhaps tens of thousands of exposures to Mao's face, [Ge, Luo, Nishimura, and Lee \(2003\)](#) tested the recognition memory of participants who were born and grew up in the PRC. Their memory of Mao's face exhibited what Ge et al. described as hyperfidelity. The participants could spot minute, intentional distortions of Mao's face (e.g., the distance between his eyes). In fact, PRC participants were more accurate in recognizing small distortions from memory alone than either East Asians from outside the PRC or Caucasians were in recognizing such distortions using perception of physically present, side-by-side photos. Arguably, in other cultures, too, repeated exposure to culturally significant images or artifacts could induce memories of great fidelity, a possibility that certainly deserves further study.

Most of the work we will review in this section downplays contributions of stimulus familiarity by either focusing on the processes and features of memory, rather than the content per se, or attempting to equate the content through controlled study episodes. The [Ge, Luo, Nishimura, and Lee \(2003\)](#) study, however, serves as a reminder of the ways in which everyday memory may differ from memory processes tested in the laboratory, particularly given the importance of familiarity, which may trump other cultural influences on memory.

2.1 Autobiographical memory

Some of the most robust findings of cultural differences in memory rely on comparing autobiographical memories, those memories of past episodes from one's own life. For example, remembering the party for your 10th birthday or your child's graduation ceremony from college would be examples of autobiographical memories. These types of memories are marked by rich visual imagery and a temporal sequence of events that can be replayed. Differences emerge across cultures in the *content* of autobiographical memories. These are in-line with cultural differences in independent versus interdependent construals of the self: Americans shared more memories in which they served as the central character, coded based on the proportion of mentions of self versus others, and Chinese shared more memories that had a relational group-orientation, coded based on the number of mentions

of social interactions (Conway, Wang, Hanyu, & Haque, 2005). These different features also emerged across Caucasian- and Asian-Americans for recalling autobiographical memories from their personal past but also when recalling a story learned in the lab (Wang & Ross, 2005). Moreover, there were cultural differences in the specificity of the memories, with Caucasian Americans tending to recall more specific episodes that occurred in one moment in time (e.g., one particular holiday party) but Asian Americans recalling more general memories of re-occurring events (e.g., traveling to grandmother's house every year for the holidays). This cultural difference in specificity between European Americans and Chinese extends to imagining future personal events (Wang, Hou, Tang, & Wiprovnick, 2011), as shown in Fig. 1.

Interestingly, the implications of recalling autobiographical memories with high amounts of detail vary across cultures. Whereas a substantial body of research on Westerners implicates overgeneral autobiographical memory as a risk factor for depressive symptoms (Dalgleish & Werner-Seidler, 2014; Söderlund et al., 2014) recent work in Chinese and Asian American young adults suggests the opposite: that retrieving autobiographical memories with more specificity is associated with higher reports of depressive symptoms and negative affect (Wang, Hou, Koh, Song, & Yang, 2018). Thus, the specificity of autobiographical memory may play a rather different role in mental health in different cultural contexts, with Wang and colleagues arguing this reflects the fit of a person within their cultural setting (e.g., those with a memory style inconsistent with their culture will have poorer psychological well-being).

2.2 Episodic memory for objects

The ways in which autobiographical memory reflects the self and social conventions for conversation and narrative style, as we will discuss in the next section, make it somewhat unsurprising that the contents and features of autobiographical memories differ across cultures. But what about when people from different cultures encode the same externally-presented items under the same conditions and make standardized decisions about the contents of their memory? Such an approach equates the content of information to be encoded and retrieved, and matches retrieval demands.

A series of studies has investigated cultural differences in the detail with which object information is remembered. Whereas Americans and East Asians might both recognize that they previously studied a picture of an

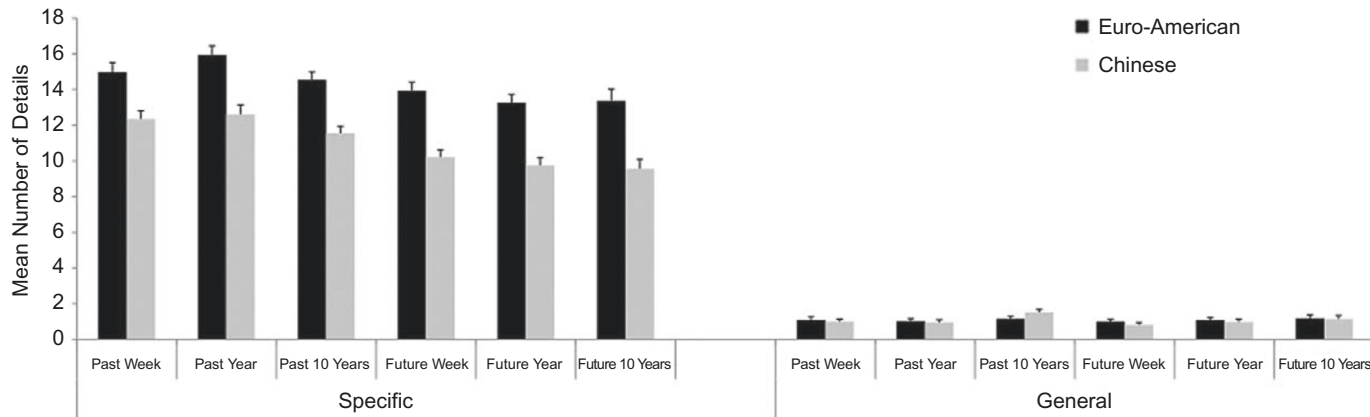


Fig. 1 Cross-cultural differences in autobiographical memory. Compared to Chinese, European Americans retrieve more specific autobiographical memories and imagine more specific future events, regardless of the time period (week, year, 10 years). In contrast, the cultures do not differ in general memories. Here, specificity is operationalized as episodic details relevant to a central event, and general is operationalized as non-episodic information (e.g., semantic information; events that extended beyond a specific time and place). Figure reprinted with permission from Wang, Q., Hou, Y., Tang, H., & Wiprovnick, A. (2011). *Travelling backwards and forwards in time: Culture and gender in the episodic specificity of past and future events*. *Memory* 19, 103–109. <https://doi.org/10.1080/09658211.2010.537279>.

ice cream cone, Americans are more attuned to the precise visual details of the item (i.e., specific memory; whether the exact same picture of an ice cream cone appears on the recognition test). Americans have higher levels of recognition for previously seen “same” items than East Asians (Millar, Serbun, Vadalia, & Gutchess, 2013). In contrast, cultures do not differ for general memory for items. That is, Americans and East Asians are equally able to recognize that an ice cream cone was studied earlier, regardless of the precise perceptual details. These patterns are shown in Fig. 2. Cultural differences in memory specificity are robust, emerging for items presented with or without a background (Millar et al., 2013), for information that was neutral or emotional (Mickley Steinmetz, Sturkie, Rochester, Liu, & Gutchess, 2018), for encoding under different instructions (Paige, Amado, & Gutchess, 2017), and when accounting for individual ratings of emotional intensity or congruency of the items and context (Mickley Steinmetz, et al., 2018). The advantage in specificity for Americans can extend to backgrounds as well as objects (Mickley Steinmetz et al., 2018), although this tendency for cultural differences does not always emerge as strongly for backgrounds (Millar et al., 2013).

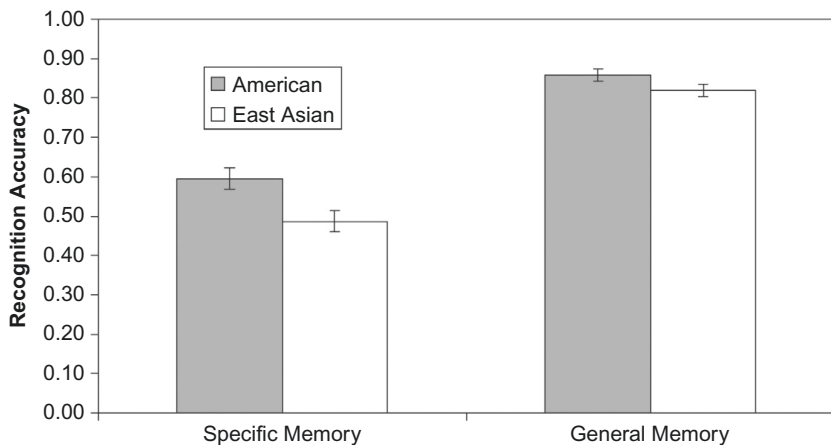


Fig. 2 Cross-cultural differences in episodic memory for items. Compared to Chinese, European Americans recognize items with more specific details whereas the cultures do not differ in general memories. Here, specificity is operationalized as recognizing the specific item studied earlier (e.g., recognizing one specific ice cream cone), and general is operationalized as knowing an item of that type was studied earlier (e.g., recognizing that an ice cream cone was studied earlier, regardless of perceptual details). Figure reprinted with permission from Millar, P. R., Serbun, S. J., Vadalia, A., & Gutchess, A. H. (2013). Cross-cultural differences in memory specificity. *Culture & Brain* 1, 138–157. <https://doi.org/10.1007/s40167-013-0011-3>.

2.3 Candidate mechanisms

Although there have been robust demonstrations of cultural differences in the specificity of memory, the mechanisms are not well understood. There is some evidence that the self-concept and social forces can shape the qualities of autobiographical memories, but it is unclear whether these same factors contribute to cultural differences in object memory. In this section, we will consider some of the candidate mechanisms.

2.3.1 *Self and social mechanisms*

As is the case for much of cross-cultural research, the source of the differences in memory specificity is typically thought to be social. One important component could be the self-concept. Cultural differences in autobiographical memory have been associated with differences in the emergence of the self. Americans report first autobiographical memories that occur nearly 6 months earlier than those of Chinese. As the emergence of autobiographical memory ability is thought to reflect the development of a concept of an autonomous self, the earlier emergence of autobiographical memory could reflect the emphasis on self and individuality in Western cultures (Wang, 2001, 2006). Likewise, adopting an individual differences approach supports the notion that the self is reflected in what is remembered, as those individuals who describe themselves in a more self-focused manner convey memories that are more specific and self-focused (Wang, 2001). According to this perspective, the way one thinks about oneself via the self-concept could determine the importance of remembering and conveying specific details. Emphasizing one's uniqueness may rely on noting the distinctions and points of contrast with others, which could rely on attention to specific details.

To supplement an individual differences approach, the role of self-concepts and cultural mindsets can be experimentally tested using priming. Individuals temporarily bring different concepts of the self to mind; this can be achieved by asking individuals to think of themselves in different ways, such as emphasizing their individualistic sense of self (e.g., what makes you unique?) or their collective self (e.g., what are your group memberships?). For bicultural individuals, this also can be achieved by making either their Asian or American identity salient. In terms of the effects on autobiographical memory, priming can alter the individualistic versus collectivistic content of autobiographical memories, as well as the number of characters and interpersonal interactions retrieved in the memory (Wang, 2008; Wang & Ross, 2005).

One component key to developing both the self and autobiographical memory is communication style. Research has examined the ways in which parents interact with children to shape their narratives and reminiscences (Nelson & Fivush, 2004). Such interactions work to reinforce and emphasize the retrieval and elaboration of certain details, in the case of Westerners, and relational aspects, in the case of Easterners (Wang, 2006). Thus, parent-child communication represents one way in which cultural values can be transmitted and internalized at a young age.

2.3.2 Cultural traditions of thought

Cultural differences in cognitive style are another potential mechanism that could account for differences in the specificity of memory. Differences in cultural traditions of thought focus on Chinese and Greek societies, which historically differ markedly in philosophical and scientific traditions (Nisbett, 2003; Nisbett et al., 2001). Chinese culture, thought to shape much of Eastern thought, places great emphasis on the obligations to others and the importance of the group, whereas Greek culture, argued to shape much of the Western style of thought, emphasized independent agency. These differences are reflected in the herding tradition for Greeks, in which individuals work independently, and the farming tradition for Chinese, in which cooperation is beneficial. Styles of logic differed, with Greeks emphasizing rules and analysis of parts whereas Chinese emphasized continuity and dialectical thinking, in which seeming contradictions can be resolved harmoniously. Through this perspective, cultural differences in cognitive style were thought to arise from differences in holistic versus analytical styles of information processing, and differing levels of attention to the field versus the object.

Subsequent work adopted an approach that targeted the influence of specific types of agricultures on cognitive styles. Beyond differences across regions of the world in herding versus farming traditions, farming can be further divided into wheat versus rice agricultures. This distinction is important because growing rice requires more cooperation to develop irrigation networks and a much larger investment of labor, compared to growing wheat. In a study comparing regions of China with different agricultures, the tendency for interdependent, holistic thinking emerged more for rice-growing than wheat-growing regions (Talhelm et al., 2014).

A more analytic perspective can be related to an object-focus, in which objects are separated from their underlying context. In contrast, a more holistic perspective prioritizes context, interpreting objects in terms of their

environment. Distinctions between analytic and holistic processing styles have been suggested to account for cross-cultural differences in attention and memory for complex information. For example, after viewing vignettes of fish swimming in underwater scenes, Easterners described background information (e.g., the color of the water, the relation between items) far more than did Westerners, who tended to focus on the focal objects. Moreover, Easterners' memory for objects from the scenes was more disrupted by changes to the background than was Americans' memory (Masuda & Nisbett, 2001). Additional evidence for greater processing of objects by Westerners stems from a fMRI study revealing greater activation in several object processing regions during the viewing of complex scenes, consisting of an object placed on a background, for Westerners compared to Easterners (Gutches, Welsh, Boduroglu, & Park, 2006). In addition, adaptation to familiar, repeated objects was attenuated in Eastern compared to Western older adults (Goh et al., 2007). This finding converged with others to suggest greater sensitivity to objects for American older adults, though this cultural difference did not extend to younger adults.

Based on these distinctions, an analytic processing style, as opposed to a holistic one, could induce a focus on detail, including an influence on what information is captured in memory. A Western analytic orientation could lead to de-contextualizing information and emphasize breaking it in to parts, which could enhance attention to details. Because cognition occurs in complex environments, there are necessarily tradeoffs, or bottlenecks, in what information is attended to and selected for further processing. Cultural background determines some of these tradeoffs, acting as a lens to help direct and prioritize details and objects for Westerners and context and relationships for Easterners (Gutches & Indeck, 2009; Gutches, Schwartz, & Boduroglu, 2011).

2.3.3 Environmental affordances

The structure of the physical environment also could signal what information is important, based on what stands out as novel and distinctive and what blends into the background. These aspects of complex environments could direct attention and prioritization of information for future processing. Comparison of photographs of scenes from small, medium, and large cities in the United States and Japan revealed that outdoor Japanese scenes tended to contain more objects than the American scenes, regardless of the size of the municipality from which the scenes came (Miyamoto, Nisbett, & Masuda, 2006). Although one might have expected that the object-focus

in Americans would be reflected in an object-rich environment, the findings may suggest that the large number of objects in the Japanese scenes actually operate to bias attention away from individual objects. After all, in an object-rich environment, individual objects are no longer as meaningful and do not attract as much attention. Thus, a relatively object-poor environment may afford greater attention to individual objects. (see [Section 3.5](#) for further discussion of this study).

2.3.4 Response bias

It could be the case that cultures simply differ in their preference for detail. In this case, Westerners remember details more because they prefer them. According to this possibility, Westerners would both express a preference for more detail as well as preferentially encode and retrieve more detail from memory. To reconcile this with the findings presented above regarding environmental affordances, it may be that the object is the wrong level of analysis to consider and instead, cultural differences should emerge with Western cultures having more details and features *within* each object. This idea can be evaluated using data from cultural products. One study adopted such an approach, finding that Easterners' webpages and conference posters contained more details, or were more information-rich, than those by Westerners ([Wang, Masuda, Ito, & Rashid, 2012](#)). Thus, these findings seem to argue against the possibility that the more specific memory in Westerners simply reflects a preference for detail.

A related possibility is that cultural differences in memory for details is primarily a function of response bias. That is, rather than differing in the ability to discriminate old from new information in memory, memory performance reflects how stringent or lenient one is in deeming information "old." There is some evidence for this possibility, as a signal detection approach to analyze some of our data indicated a less stringent response criterion for Americans than Chinese ([Paige, Amado, et al., 2017](#)). That is, Americans could have a stronger tendency to claim information is presented with the same details as items seen before, rather than precisely discriminating old from new details. However, this is inconsistent across our studies, with some evidence for cultural differences in the ability to discriminate "same" from "similar" information ([Leger & Gutchess, 2019](#)), rather than a cultural difference in response criteria. These mixed findings could indicate that multiple mechanisms contribute to cultural differences in memory specificity, with some impacting the fidelity with which information is retained in memory traces and others impacting the ways in which one interacts with

tasks and decisions. One might predict that perceptual mechanisms would contribute more to sensitivity in memory whereas stable cultural values or moment to moment variation in one's self-construal or mindset would play a larger role in response biases.

2.3.5 Evaluating the mechanisms

Factors related to the self and social interactions may well shape the information contained in autobiographical memory, to the extent that these narratives serve as reflections of the self-concept and what one desires to communicate to others about oneself and one's alliance with social norms (e.g., conveying episodes in detail). However, it is harder to account for why these interpersonal factors would account for differences across cultures in the specificity of memory for objects and scenes. It is possible that such tendencies in autobiographical memory extend to other aspects of episodic memory, but there would be expected to be limits to how much these tendencies are reflected in unconscious, or implicit, memory or lower-level memory processes.

Methods that illuminate the role of independent versus interdependent self-construals using experimental manipulations of cultural mindset have not been effective thus far in memory studies with objects. In our hands, priming manipulations have not impacted what type of information is remembered; inducing Americans to think of the self in a more independent versus interdependent manner, using the same types of manipulations that have proven successful in other studies, does not mimic cultural differences in memory (Garner, 2015; Lee & Gutchess, 2010). It may be that priming a cultural mindset does not have long-lasting effects that persist throughout encoding and retrieval phases of memory that unfold over several minutes. Indeed, our studies contained a high number of trials that could allow priming effects present at the beginning of encoding or retrieval to dissipate. Or it may be that other factors (e.g., emotional content, self-relevance, semantic content) exert stronger impacts on what is remembered, compared to the influence of one's temporary frame of mind. In contrast to the findings for autobiographical memory, direct support is lacking to indicate that social factors underlie cultural differences in memory for objects. However, stronger tests are needed, including comparisons across autobiographical and object memory (e.g., do the same individuals who produce the most detailed autobiographical memories also remember objects in the most detail?), use of individual difference measures of cultural values, and stronger manipulations of cultural mindset.

There also is a lack of support for the notion that cultural differences in relative attention to objects versus backgrounds contributes to the amount of detail contained in memory. Americans tend to remember objects, as well as backgrounds, in more detail than Easterners (Mickley Steinmetz et al., 2018; Millar et al., 2013), so the cultural differences in specificity are not limited to objects. We also did not find evidence for any relationship between scores on the Analysis-Holism Scale (Choi, Koo, & Jong An, 2007) and memory performance (Garner, 2015), although we have not used this scale in conjunction with a paradigm that explicitly investigated memory specificity.

The influence of environmental factors on memory specificity has yet to be probed. This includes approaches testing whether different systems of agriculture (e.g., rice versus wheat farming) impacts the amount of detail retained in memory, although this framework is often considered to reflect a social focus on collectivism versus individualism. However, it is possible that environmental affordances play a role in directing attention to detail. Such mechanisms are very difficult to test, as their effects have developed over a lifetime of experience, or perhaps as a function of early experience. There has been some success using priming to temporarily re-direct attention within scenes, such that exposing Americans to high-density scenes (which are more typical of Japanese environments) can heighten the focus on context (Miyamoto et al., 2006). Thus, at the very least it may be possible that short-lasting exposure to different types of environments could influence other cognitive processes.

Despite the challenges to identifying the mechanisms that account for cross-cultural differences in memory specificity, there are some important constraints to consider when thinking about what types of processes can account for these cultural differences. Developmental evidence suggests that 3- and 4-year-old American children are more object-focused and attentive to parts, compared to Japanese children who exhibit a more relational focus (Kuwabara & Smith, 2012, 2016). Therefore, it seems that these cultural differences emerge early in life, and before children are exposed to formal educational systems or are literate, though we do acknowledge that exposure to systems of written language in the environment could play some role at even an early age (e.g., given that character spacing and features could be denser or direct attention to finer details in one language compared to another).

In our recent work, we have started to consider whether early life visual experiences that differ across cultures could contribute to long-lasting differences in perception and memory throughout the lifespan. Our reasoning is informed by neural data suggesting that these cultural differences indicate

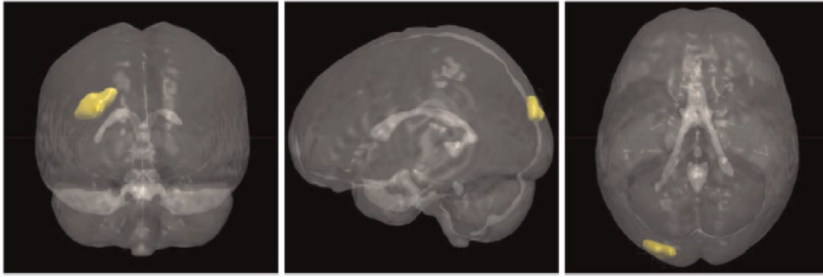


Fig. 3 Activity in visual cortex differs across cultures. The region in occipital cortex, spanning Brodmann areas 18 and 19, in which the pattern of neural activity reliably differs across cultures during the viewing of pictures of objects. *Figure reprinted with permission from Ksander, J. C., Paige, L. E., Johndro, H. A., & Gutches, A. H. (2018). Cultural specialization of visual cortex. Social, Cognitive, and Affective Neuroscience 13, 709–718. <https://doi.org/10.1093/scan/nsy039>.*

effects of cognitive or perceptual processes rather than social ones. In a recent fMRI study investigating cultural differences in memory specificity, left fusiform and hippocampal activations differed across cultures (Paige, Ksander, Johndro, & Gutches, 2017). These regions responded more for same than similar items, and this difference was larger for East Asians than for Americans. Taking the analyses a step further and beyond the domain of memory, we attempted to classify participants according to cultural group based on patterns of neural activity during the viewing of pictures of objects. The only region to emerge in which object representations differed between East Asians and Americans was in left occipital cortex, in BA 18/19 (Ksander, Paige, Johndro, & Gutches, 2018; see Fig. 3). The emergence of this region indicated pervasive differences in the coding of information across cultures in secondary visual cortex. In the next section, we will review the history of studying culture's influence on visual processes. Our aim is to examine possible links between perceptual processes and cultural differences in the specificity of memory.



3. Influences of culture on perception

The senses are our lifelines to the physical environment and to our social environment as well. Sensory information allows us to evaluate the state and possible changes in our environment, take actions appropriate for our goals, and predict the consequences of potential actions. Although *physical stimuli* are crucial for perception, it has long been recognized that they are far from the sole determinants of perceptual experience.

For example, about 10 centuries ago, the Arab scientist Al Hazen wrote about the ways that perception is shaped by variables such as attention and goals (Howard, 1996). In the centuries since, perceptual researchers have adopted and accepted that idea, particularly in their acknowledgment that any perceptual experience is ultimately an inference, an educated guess, not an unfailing guide to every aspect of a stimulus (Gregory, 1997; Helmholtz, 1886/1962; Kersten, Mamassian, & Yuille, 2004).

Fig. 4 calls out a few ways that culture can influence visual perception. Consider the street scene shown at the figure's left side. Suppose an onlooker has a task—find and speak to some friend who may be there. To accomplish that, the viewer's gaze selects an object to focus on, in this example a person who looks like her friend. That selection is based on the viewer's knowledge of what the scene is (a street in a town), what is likely to be in that scene (cars, shops, and pedestrians), where various objects are likely to be (people on the sidewalk and not climbing up the side of a building), plus some memory of what her friend looks like. The point is that we draw upon memory and prior knowledge when we use our vision to guide a decision about whether it is safe to do something as simple as crossing the street, or about whether our friend is present or not. And we learn from the consequences of our perceptual decisions, updating, as needed, our assumptions about the scene in front of our eyes. Perhaps, the friend has a new hairdo and glasses, so that our memory of her has to be revised. Notice that the information falling on the retinas of the eyes provides a start to the process, but many other factors play their roles as well. And this is where culture comes into the picture.

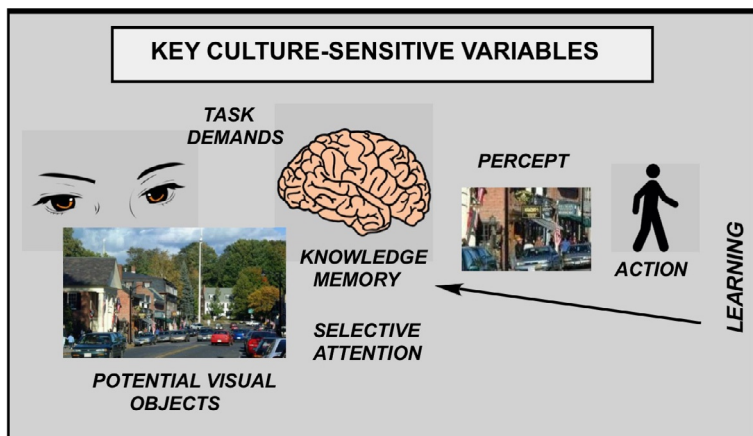


Fig. 4 Key culture-sensitive influences on visual perception. See text for explanation.

3.1 Direct versus indirect genetic influences on culture

Like other organs and components of the human body, the capabilities of our sense organs and brain depend upon their genetic endowments. Some forms of color vision deficiency, such as so-called red-green color blindness, are common, particularly among males (because the relevant genes are located on the X-chromosome). These mild genetic abnormalities usually have only moderate impact on everyday activities. That contrasts to the consequences of a total inability to distinguish among colors, achromatopsia, which is rare and is associated with several other ocular problems, including extremely poor visual acuity and extreme sensitivity to bright light. Although across the world achromatopsia is rare, in one culture it is fairly common, and unlike common forms of color deficiency, affects both males and females. On the Pingelap Atoll in the South Pacific, nearly 10% of the population—a prevalence thousands of times what is found elsewhere—has no ability whatsoever to distinguish colors. They can distinguish among different brightnesses, but color discrimination is out of reach. Their other ocular abnormalities have serious consequences. “Most of those born with (the disorder) never learn to read, because they cannot see the teacher’s writing on the board; they have less chance of marrying—partly because it is recognized that their children are likelier to be affected, partly because they cannot work outdoors in the bright sunlight, as most of the islanders do” (Sacks, 1997, p. 46).

A far more common ocular defect throughout the world is myopia, a condition that makes it difficult to see distant objects clearly. Myopia has clear genetic origins, but is influenced by environmental and life style factors as well. For example, taking breaks after 30 min of continuous reading and performing at least 2 h of outdoor activity per day afford some protection against worsening myopia (Huang, Kawasaki, Liu, & Wang, 2019). Testing groups of young Italians who had mild-to-moderate myopia (refractive error less than -5.0 diopters) revealed that relative to non-myopic controls, the myopes showed significant visual attentional deficits (Turatto et al., 1999). They were slowed down on both Posner’s cueing task (Posner, Snyder, & Davidson, 1980) and on a simple visual search task. These deficits emerged even though vision was corrected, indicating that early experiences before vision is corrected could nevertheless lead to long-lasting changes in visual attention. Although the myopes were less efficient when attention was externally cued, interestingly they showed essentially no deficit on a voluntary (endogenous) attention task. Importantly for studies of cultural influences on perception, myopia is widespread among certain Asian populations; for example, more than 85% of university students recently

studied in Nanjing were myopic ([Huang et al., 2019](#)), many severely so. If the results from the Posner curing task replicate, one would anticipate that cultures with a high proportion of myopes would be characterized by potentially consequential slowing of responses to attentional shifts in response to external signals, particularly unexpected signals in the periphery of the visual field. These attentional effects aside, myopia's disproportionate prevalence in particular cultural groups should be taken into account by researchers interested in culture's influence on visual perception. Every test participant, regardless of cultural background, should be carefully refracted and be optically well corrected during testing.

3.2 Cultural differences in color perception

Starting from a study of classical Greek literature ([Gladstone, 1858](#)) and anthropological data ([Geiger, 1880](#)), scholars have been interested in how culture and color perception are connected. Interest in this connection is fed in part by a near-universal human curiosity about whether what we see is the same as what other people see. However, when it comes to answering such questions, the details of test conditions and the tasks used to produce answers are extraordinarily important. Because both color perception and culture are each so complex on their own, results on possible connections between the two have to be evaluated with extra care. A particularly salient demonstration of this point comes from one study of the linkage between color perception and culture, notably, cultural differences as expressed in linguistic habits. [Mitterer, Horschig, Müsseler, and Majid \(2009\)](#) presented a series of yellow-to-orange discs and asked German and Dutch subjects to categorize each one disc as yellow or orange. To test cultural differences, discs were shown superimposed on the middle position of a traffic light that customarily has red in the top position and green in the bottom. The color of the light in a traffic light in the middle position differs slightly between Germany and Holland. In Germany, the middle light is yellow (*gelb*), while in Holland, the middle light is orange (*oranje*). Consistent with the difference between the two countries' practice, German subjects categorized more of the yellow-to-orange test discs as yellow than did their Dutch counterparts. This is an intriguing result, but does it mean that German and Dutch test subjects *see* color differently? Not necessarily. As [Firestone and Scholl \(2016\)](#) point out (p. 11), "it seems just as plausible that the subjects were simply following convention, assigning the yellow-orange discs the socially appropriate names for that context."

Excepting people who have a genetic abnormality of their photoreceptors (like the profoundly “color blind” individuals discussed earlier in the chapter), the physiological bases of color vision are thought to be universal for members of our species. However, that does not mean that genetically “normal” people from different cultures necessarily see the world in the same way. Before light can reach and stimulate the retina’s complement of photoreceptors, it must pass through and be filtered by pre-retinal structures whose characteristics may vary among cultures. Specifically, the spectral characteristics and overall density of the ocular media, particularly the lens, are altered by exposure to ultraviolet rays in sunlight (particularly UV-B radiation) and/or dietary carotenoids (Bornstein, 1973). These factors alter the density of “yellow” pigmentation of the ocular media, which reduces the short-wavelength light that reaches the retina. Converging measures, including color naming and both psychophysical and electrophysiological data, suggest that this reduced stimulation of short-wavelength sensitive cones affects ability to distinguish among different stimuli in the short-wavelength region of the spectrum (440–490 nm). As a result, there is a relatively strong argument for cultural differences in the physiological determinism of color perception (Bornstein, 1973).

Because color naming is the easiest way to assay color perception, it is the most common approach used in studies of culture and color perception. However, color naming behavior falls well short of capturing every aspect or dimension of color experience. Additionally, linguistic behaviors (e.g., color naming) are more susceptible to cultural conventions and learning than are color vision phenomena determined at an earlier stage of visual processing. For example, when random color samples are presented one at a time, the number of color samples that can be named with perfect consistency over repeated, random presentations is limited to as low as a dozen (Boynton & Olson, 1987). However, with contiguous (or near-contiguous) samples presented together, subjects can discriminate among well over a hundred subtly different hues (Bornstein, 1973), even more if stimuli are allowed to vary in brightness as well as hue. This gap between a dozen and more than one hundred names reflects differential reliance on memory and language (naming). In 1956, Whorf formulated an influential hypothesis about the connection between language and cognition (and importantly for our purposes, perception). One version of Whorf’s formulation, the so-called “weak hypothesis,” holds that language does not determine cognition, but merely shapes the way that cognitive information is used. Translating this to the case of color perception, language does not determine color vision, but can influence the way that color information is used.

One study provides a beautiful demonstration the important distinction between language and color perception. The study focused on the perceptual impact of differences between Russian and English language names for colors associated with the spectrum's short-wavelength (blue) portion. Unlike English, Russian makes an obligatory distinction between lighter blues (*goluboy*) and darker blues (*siniy*), and unlike English, seems to have no overarching term for blue. Winawer et al. (2007) asked whether this linguistic difference would lead to differences in color perception. A match-to-sample task with English and Russian speakers used as stimuli 20 different color samples that spanned the *siniy*/*goluboy* border. As depicted in Fig. 5 (Panel A), three stimuli were presented simultaneously on each trial; participants selected which of the two comparison squares matched the color of a standard square. One of the two comparison stimuli was a perfect match to the standard; the other comparison stimulus was chosen either to lie on the same side of the *siniy*/*goluboy* border as the standard, or on the other side. This generated non-matching comparison stimuli that either (i) fell into the same *siniy* or *goluboy* category as the standard stimulus or (ii) fell into the category opposite that of the standard. If linguistic effects on matching

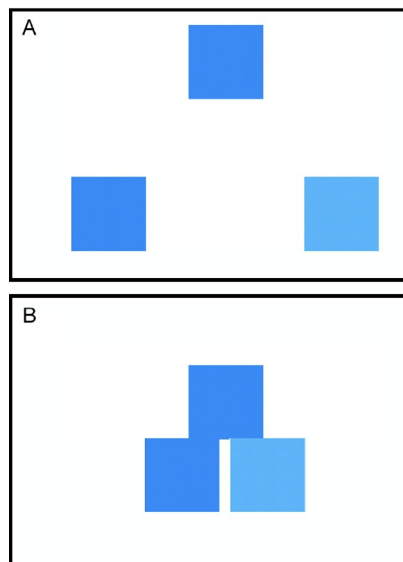


Fig. 5 Language and Color Matching. Panel A. Spatially separated stimuli used by Winawer et al. in demonstration of language's impact on color match. See explanation in text. Panel B. Alternative configuration in which abutting stimuli eliminates the impact of language. Panel A taken from J. Winawer, et al. (2007), *Russian blues reveal effects of language on color discrimination*, PNAS 104 (19) 7780–7785. Copyright (2007) National Academy of Sciences, U.S.A.

to sample were specific to the categories encoded in the language spoken by subjects, Russian, but not English, speakers should be more impacted when both color samples fell into the same, as opposed to different, linguistic categories that existed in Russian. That is precisely what the response time results showed. The separation between the stimuli, about five degrees visual angle (center to center), may have enabled linguistic categories to influence, not perception directly, but the speed of subjects' decisions about a match. According to this view, language's impact would be at a late decision stage, not an early perceptual stage. As Winawer put it, "If you have two codes, one visual and one verbal, and you are making a comparison across time or across space, then the dual code can speed your performance when it's helpful (cross-category comparison)" (Winawer, personal communication, May 2019). Of course, when the two codes are not in agreement, comparisons over time or across space would be slowed, just as the researchers found. Although Winawer et al. (2007)'s stimuli were separated across space, they were not separated over time. A follow-up study eliminated the spatial separation as well. When the stimuli on each trial were abutting (as shown in Fig. 5, Panel B), the effect of the *siniiy/goluboy* distinction vanished (Witthoff, 2007). To quote again from Winawer, "By making the stimuli abut, there is no need for a verbal code—you directly see the boundary."

Earlier in the chapter, we noted that our definition of a culture entails not only a culture's geographic location and environment, but also the time frame within which the culture is examined. After all, multiple factors can promote cultural change. A culture can and does evolve over time, which is certainly the case for a culture's language and its color naming habits, such as the color names used by members of a culture (Lindsey & Brown, 2014). As researchers attempt to study connections between culture and perception, a culture's shifting sands have to be taken into account.

3.3 Culture-sensitive visual task demands

Fig. 4 identifies "task demands" as among the avenues by which culture could impact perception. That point needs some explanation. Cultures differ in the demands they make of their members, and fulfilling those demands, particularly ones that require considerable practice and effort, can change individuals in multiple ways (Park & Huang, 2010). Neuroscience has shown that extended practice on some task can substantially alter the brain. A powerful example is the way that extensive practice playing a string instrument alters the brain (Elbert, Pantev, Wienbruch, Rockstroh, & Taub, 1995).

But the brain is not the only organ that exhibits task-dependent plasticity; the eye, too, adapts. Take one culture-related example of this fact. Because of the optical properties of water are similar to those of the eye's cornea, when it is underwater, the naked human eye loses about two-thirds of its refractive power. As a result of this reduced vision, without access to goggles, members of a culture that depends upon retrieving food from the sea floor would be hampered in that task. A group of people called the Moken inhabit islands near Thailand. They spend much of their lives on the sea in simple, handcrafted boats, from which they dive for food on the ocean floor. Remarkably, the Moken are able to dive to depths of more than 15 m, without goggles or scuba gear, and still see remarkably well. Struck by the Mokens' uncanny ability to see clearly under water, [Gislén et al. \(2003\)](#) measured the underwater visual acuity of Moken children, and found it was twice that of age-matched European children. Further examination showed that this ability was related to changes in the Mokens' eyes: their pupils could constrict to the maximum physiologically possible (increasing the eye's depth of field), and they could maximize their accommodation (increasing the refractive power of the eye). The researchers speculated that the Mokens' remarkable ocular changes provided important benefits to them in lives completely dependent upon the sea. A few years after their initial study of the Mokens, the same researchers demonstrated that the Mokens' superior underwater vision reflected ontogenetic changes rather than inherited changes in the eye ([Gislén, Warrant, Dacke, & Kröger, 2006](#)). After a month of extended underwater training, followed by several months of underwater activities, a group of European children showed underwater visual acuity comparable to that of the Moken children tested previously. Moreover, the European children's improved acuity seemed to depend upon the same ocular changes that had been seen in their Moken counterparts.

3.4 Culture-sensitive influences on perceptual hypotheses

The street scene at the left side of [Fig. 4](#) is a reminder that in everyday situations, sensory cues are not processed in isolation; they usually come with a history of experiences and learning. The cars in that scene do not carry signs advertising their speed or how long it would be until they reach the crosswalk. Instead, the perception-based decision to walk across the street entails hypotheses based on prior experiences—estimates of a car's speed, the likelihood it might stop at the crosswalk, and so on ([Gregory, 1997](#); [Helmholtz, 1886/1962](#); [Ma, 2012](#)). One avenue for exploring how hypotheses impact

perception is to study responses to stimuli designed to induce visual illusions. The rationale for using visual illusions for insight into cultural influences on perception was captured nicely by Gregory (1997): “The recognition that perception entails experience-based hypotheses has animated researchers to study cultural influences on perception using performance with geometric illusions for test material. Errors of perception (phenomena of illusions) can be due to knowledge being inappropriate or being misapplied.” So it is understandable that illusions have been much used in investigations of vision’s cognitive processes.

Cross-cultural tests with geometric illusions date back well over 100 years, to Rivers’ (1901) observations with the Müller-Lyer illusion. With the most common form of stimulus for that illusion, participants see two lines, one terminated with “fins” or “tails” that form an acute angle, and another terminated with “fins” or “tails” that form obtuse angles. When the lines are of equal length, participants tend to judge the line with obtuse angle terminators longer than the line with acute angle terminators. Finding that European participants showed larger illusion responses than did indigenous inhabitants of an island off Australia, Rivers suggested that the two groups’ differential experience with rectilinear environments was the cause. Half a century later, this result was confirmed and expanded when Segall, Campbell, and Herskovits (1963) tested more than 1500 participants, including children and adults, from the Philippines and North America, and from multiple sites in Africa. Their results largely confirmed what Rivers had found, which they also attributed to participants’ differential daily experience with the many man-made rectilinear buildings in their visual worlds. As they put it, participants’ differential experience could be “related to the tendency to interpret acute and obtuse angles on a two-dimensional surface as representative of rectangular objects in three-dimensional space. This inference habit is much more valid in highly carpentered, urban European environments, and could enhance or even produce” the illusion.

Segall and colleagues followed Rivers’ lead again by also testing participants with the Horizontal-Vertical illusion. In that illusion, the length of a vertical line tends to be over-estimated relative to that of a horizontal line. Cultural groups that produced larger Müller-Lyer illusory responses tended to produce smaller Horizontal-Vertical illusory responses, although the correlation was far from perfect, supposedly because different environmental influences were at work for the illusions. Specifically, Segall et al. (1963) explained the Horizontal-Vertical result as “the result of an inference habit of interpreting vertical lines as extensions away from one in the horizontal

plane.” That habit presumably would have differed among the groups they tested because of their differential exposure to flat, open terrain. After all, the test groups’ physical and cultural environments comprise the settings in which individuals live and learn to make perceptual distinctions about variables such as relative distance and size.

Pollnac (1977) probed this environmental explanation of the Horizontal-Vertical illusion further, testing 21 small-scale fishermen who lived on an island off the coast of Costa Rica and went to sea on small boats in order to fish. At the time of testing, all of them had to judge distances on the open waters without the aid of any navigation devices, basing their judgments solely on visual estimates of distance and time elapsed to go from one location to another. Tests were conducted with two different stimuli both of which had been used previously to measure the illusion: a pair of intersecting lines that formed a backward **L**, and a pair of intersecting lines that formed an inverted letter **T**. The backward **L** configuration produced only a weak effect (as others had seen previously), but the more robust stimulus, the inverted **T**, not only produced a healthy illusion, but the size of the illusion was strongly correlated with the number of years of experience as a fisherman ($r = -0.628$). So the more time spent in the flat marine environment, the more susceptible a participant was to overestimating the length of the vertical line.

There are a number of reasons to be cautious about unquestioning acceptance of results from these and other influential cross-cultural studies with geometric illusions. To illustrate, we can focus on possible issues connected to the many sets of results with Müller-Lyer illusion. First, in a careful, controlled study with 159 participants, the test-retest reliability of that illusion was poor, 0.08 in one experiment, and 0.20 in a second one (Grzeczowski, Clarke, Francis, Mast, & Herzog, 2017). Second, the magnitude of the Müller-Lyer illusion was not correlated significantly with the magnitude of another illusion, the Ponzo illusion (Grzeczowski et al., 2017), which is also thought to reflect pictorial depth cues that project retinal images geometrically similar to those projected by three-dimensional objects. Third, as mentioned earlier, the magnitude of the Müller-Lyer illusion was defined by judgments that compared the relative sizes of two lines, one terminated with obtusely angled fins and one terminated with acutely angled fins. Deregowski (2013) pointed out that just one of the two stimuli is configured in a way that is actually consistent with the retinal projections cast by “carpentered” objects. Specifically, “the interfin angles (the smaller of the two angles made by the fins) of the Müller-Lyer figure must lie between

90° and 180° for the figure to be similar to a projection furnished by a cuboid.” Consistent with Deregowski’s point, the illusion can be measured separately for Müller-Lyer figures with acutely and obliquely angled fins. Comparing the perceived length of each against a straight, fin-less line made it clear that the two stimuli, obliquely angled and acutely angled fins, exert distinct effects, which differ in magnitude (Sekuler & Erlebacher, 1971). To complicate matters further, it may be that the angled fins, so critical for the culture-related pictorial depth cue explanation, may not actually even be necessary to produce the illusion (Woloszyn, 2010), so the case for cultural impact on illusions at least this one illusion, seems inconclusive.

Finally, theories linking culture-related visual experience to the Muller-Lyer illusion must overcome demonstrations that several species of non-human animals seem to experience that illusion much as humans do (Pepperberg, Vicinay, & Cavanagh, 2008; Sovrano, da Pos, & Albertazzi, 2016; Suganuma, Pessoa, Monge-Fuentes, Castro, & Tavares, 2007).

3.5 Culture-sensitive differences in distribution of attention

As mentioned earlier, for at least 1000 years it has been understood that attention plays a crucial role in perception. Although there remains some disagreement about what attention actually entails and about how it is implemented, researchers have shown that compromised attention can severely diminish perception (e.g., Mack & Rock, 1998; Simons & Schlosser, 2017; Taylor, 2017). Several different variables can influence the deployment of attention, and some of these variables are influenced, in some way, by cultural norms. For example, people who live in an urban setting like the one shown in Fig. 4 early on learn the value of shifting attention to the left and right before crossing the street. So the physical environment occupied by some culture can encourage characteristic habits of attention, as illustrated by one particularly elegant study. We have already considered evidence that living in unusual physical environments, such as marine environments, alters perception, as well as briefly mentioning ways in which physical environments can differentially afford processing of information. We will now further explore the latter idea, explaining how subtle differences between environments can promote distinctive habits of attention, and how these habits can affect perception.

In order to compare the typical physical environments occupied by average Japanese and Americans, Miyamoto et al. (2006) randomly sampled and photographed several types of public institutions in comparable small,

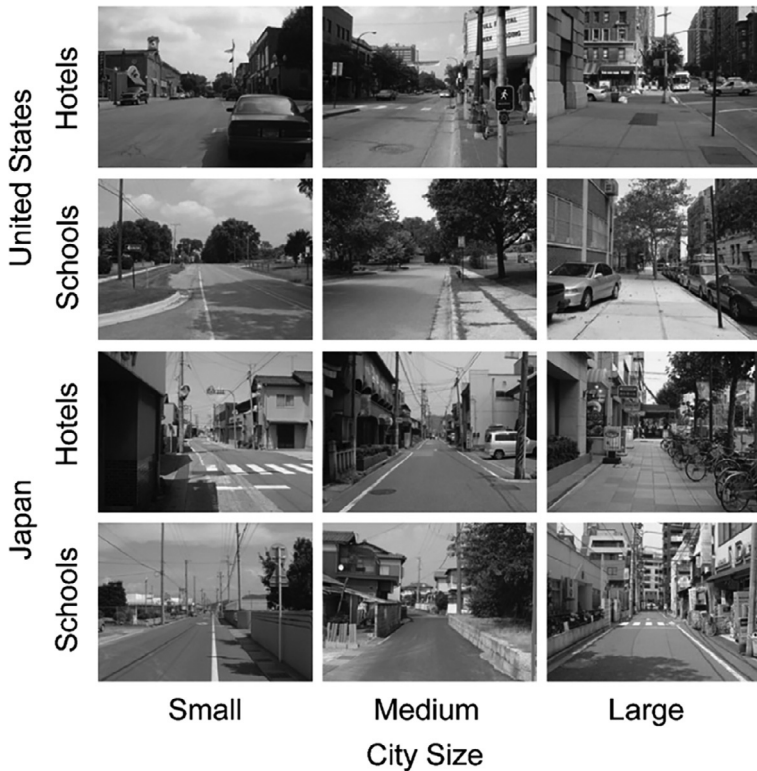


Fig. 6 Cultural differences in scene complexity. Examples photographs of American schools and hotels (upper rows) and Japanese schools and hotels (lower rows) used in study by [Miyamoto, Nisbett, and Masuda \(2006\)](#).

medium, and large cities in both countries. [Fig. 6](#) shows a few of the resulting photographs. Miyamoto et al. used two methods, one subjective and one objective, to capture potentially important differences among the Japanese and American environments. To generate subjective estimates, they had judges from both cultures rate the photographs on several different characteristics, including how chaotic or organized the scene appeared to be, and how many different objects were visible in the scene. From the ratings, the researchers derived a composite score, which confirmed that Japanese and American environments differed significantly, particularly when the environments were those of large cities. To generate objective measures of the images, a computer image processing program analyzed the photographs, producing for each an estimate of the number of different objects that were in each photograph. The result was clear: The Japanese perceptual

environments tended to contain more objects, again, with the cultural differences being exaggerated for larger cities. So both subjective and objective measures point to a systematic difference between the two cultures' environments: In comparable settings, Japanese environments tend to include more items than American environments. Although Miyamoto et al. did not directly measure the spatial distributions of items in the two cultures' environment, the laws of physics tell us that two items cannot occupy the same space at the same time. So Miyamoto et al.'s results imply that objects in Japanese environments are more likely to be spread out, distributed across the environment rather than concentrated at one location.

Next, these researchers examined how the culture-related difference in items' spatial distributions might affect perception. For that purpose they devised a paradigm comprising two stages: first, a form of priming (Tulving & Schacter, 1990), and, second, a change blindness test (Rensink, 2000; Simons & Levin, 1997). Because participants in change blindness experiments are not told ahead of time *what* might change, the task taps into a basic component of perception, one that is important in everyday activities: the ability to spot when something in the environment has changed. In the study's initial priming phase, participants were shown photographs of either a Japanese environment or an American environment. The purpose was to prime or sensitize participants either to environments known to contain just a few items, or an environment that held more, spatially distributed items. These priming stimuli had been tested previously, but with different participants. The change blindness phase measured participants' recognition of a change between two presentations of a culturally neutral scene. In some cases, the change entailed a focal (central) object, in other cases, the changed object was more contextual, such as the location of a truck. Approximately half the participants were undergraduates at an American university ($n = 30$), about half were undergraduates at a Japanese university ($n = 32$).

Two results are especially important for understanding how culture influences perception. First, Japanese participants were significantly more likely than their American counterparts to spot a change in an object that was located away from the very center of a photograph; second, for both groups of participants, having been exposed to (primed with) a photograph of a complex (Japanese) environment containing many items made them more likely to spot a change in an object located away from the test photograph's center. These results suggest that culture exerts at least two different but related influences, which play out on different time scales. The overall

difference between the two groups of participants points to some longer-term, more stable influence; the immediate effect of a priming stimulus on subsequent change detection suggests that the longer-term influence can be modulated, at least temporarily, by short-term exposure to an environment. Finally, Miyamoto et al. acknowledge that their study leaves an intriguing question unanswered, namely, why do Japanese, and presumably Asians more generally, seem to prefer and to construct relatively complex environments?

3.6 Perceptual changes with cultural change

We have already seen evidence that living in unusual physical environments alters perception. Now we will consider a few studies of people whose environment is radically different from those of cultures discussed so far. The Himba, about 50,000 people who inhabit harsh desert conditions in northern Namibia and Zambia, comprise a remote semi-nomadic culture with minimal influences from outside their group. The photos in Fig. 7 depict the landscape of the Himba's traditional land (A), and some Himba dwellings (C). Like other indigenous peoples, the Himba are not immune to change as the world moves toward greater urbanization (Dye, 2008). Although that change is likely to disrupt the Himba's traditional way of life, it does open an opportunity to study how culture-related perceptual characteristics change in response to lifestyle change. Several research groups have recently exploited this opportunity, including looking into the way that urbanization alters the Himbas' basic perceptual functions and attention biases.

Earlier, we discussed differences between the attentional habits of Americans and Japanese. Overall, the literature suggests that compared



Fig. 7 Typical scenes in the world of the Himba. The typical scenes show (A) a landscape in northwestern Namibia, the Himba homeland; (B) a Himba encampment (the stick fence in the background serves as a corral for the livestock); and (C) a dung-and-stick hut typical of Himba dwellings. From Biederman, I., Yue, X., & Davidoff, J. (2009). Representation of shape in individuals from a culture with minimal exposure to regular, simple artifacts: Sensitivity to nonaccidental versus metric properties. *Psychological Science* 20, 1437–1442. <https://doi.org/10.1111/j.1467-9280.2009.02465.x>.

to Westerners, such as Americans, people from East Asia, including Japan, show what has been termed a global bias. This refers to the tendency to give greater priority to global, contextual information in a variety of cognitive tasks, not just when detecting changes in a visual scene (Miyamoto et al., 2006), but also in recalling what they had just seen (Masuda & Nisbett, 2001). On a variety of tasks, traditional, non-urbanized Himba demonstrate a striking degree of bias toward processing local rather than global features, a bias that diminishes with exposure to an urban environment.

Take two examples, starting with brightness contrast, a low-level visual phenomenon in which the perceived brightness of one region is altered by variation in the luminance of a surrounding region (Blake & Sekuler, 2006). This phenomenon arises from local physiological interactions within the visual system. Linnell, Bremner, Caparos, Davidoff, and de Fockert (2018) measured this effect in Westerners, as well as in two groups of Himba, one living in the traditional manner, and one somewhat urbanized. Remarkably, the groups differed in the strength of what has been taken to be low-level visual effect: traditional Himba showed a considerably greater contrast effect than did the other groups. Along with results from the same participants on another low-level visual phenomenon, White's illusion (White, 1979), the researchers suggested that urbanization altered the tendency for local processing, causing the urbanized Himba to integrate luminance across a wider swath of the field. Using very different perceptual tasks, Caparos et al. (2012) demonstrated a complementary result: a local perceptual bias among traditional Himba that diminished with urbanization. Relating just one of their experiments will illustrate this point. That experiment measured the magnitude of a geometric illusion in four different groups of participants: traditional Himba, urbanized Himba, urban British, and urban Japanese. The urbanized Himba group comprised individuals who had lived in a traditional Himba village before moving to a nearby town in early adulthood. All groups were tested with the Ebbinghaus illusion, depicted in Fig. 8A. The results for each group are shown in Panel B of that figure. With increasing urbanization, the groups' illusion size grew, meaning that participants were increasingly able to ignore the irrelevant surrounding discs when judging the size of the central disc. From these and other results, the researchers concluded that exposure to an urban environment promotes a global bias when participants deploy visual attention.

It is important to exercise caution in evaluating possible connections between the characteristic of the environment in which the Himba—or any group—live and their perceptual world. After all, perception is a

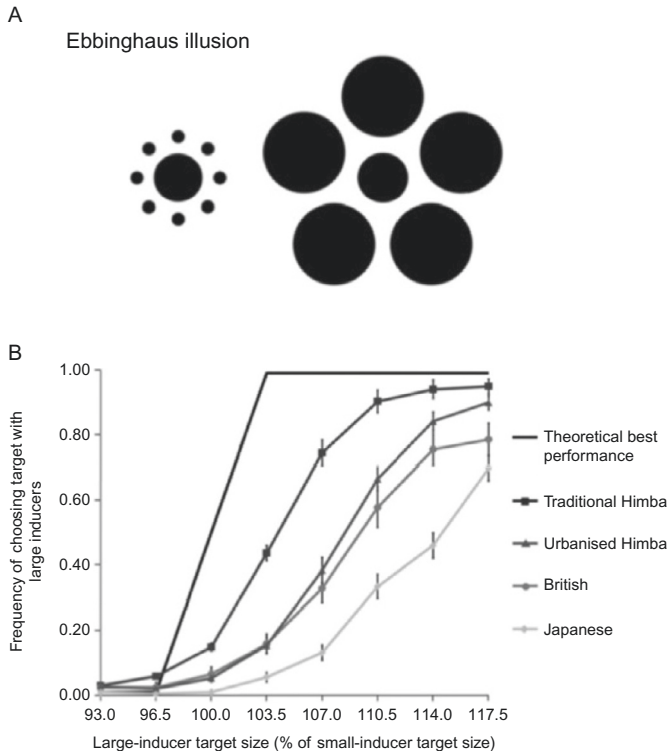


Fig. 8 Panel A: Illustration of the Ebbinghaus illusion. The participant's task was to compare the size of the left and right central discs. Panel B: Results for the groups tested on the Ebbinghaus illusion. Shown also are the expected results from a theoretical perfect observer who would be able to judge the size of the center disc without being at all affected by the surrounding discs. *Figure adapted from Caparos, S., Ahmed, L., Bremner, A. J., de Fockert, J. W., Linnell, K. J., & Davidoff, J. (2012). Exposure to an urban environment alters the local bias of a remote culture. Cognition 122, 80–85. <https://doi.org/10.1016/j.cognition.2011.08.013>.*

complex process whose outcome depends upon many interacting variables, as Fig. 4 suggests. For example, one notably rigorous comparison of shape perception by non-urbanized Himba and by American university students failed to show any difference on match to sample tests of shape perception (Biederman, Yue, & Davidoff, 2009). Using stimuli carefully graded in perceptual similarity, the researchers found that, with a variety of different stimulus types, the two groups did not differ from one another. Additionally, observers are not automatons without control over the task-dependent deployment of resources needed for perception. In fact, although multiple studies confirm the Himba's strong tendency toward local processing, when

task demands make it advantageous, those same test participants certainly can and do demonstrate more global attention (Caparos, Linnell, Bremner, de Fockert, & Davidoff, 2013). Finally, the distinction between local and global processing bias may be more complex than previously thought. That distinction, which has motivated much research, seems so obvious and commonsensical that it has long been a part of ordinary, non-scientific discourse and thought. For example, the Oxford English Dictionary cites a 16th C. English language warning against hyper-local processing, essentially a caution against missing the forest, the big picture or context, for the trees, the constituent details.^a Clearly, the theoretical distinction between local-global processing has been a useful driver of much research. But, as is the case for most cognitive and perceptual processes, the difference between local and global processing is not monolithic. Instead, it reflects a shifting, dynamic, task-sensitive result of multiple perceptual abilities and biases (Chamberlain, Van der Hallen, Huygelier, Van de Cruys, & Wagemans, 2017).

3.7 Social influences on perception across cultures

Returning to our earlier consideration of social factors that might contribute to cultural differences in memory, what about the intersection of social factors and perception? Much of the research in this area has investigated cultural differences in viewing facial expressions of emotions. The “grammar” of faces, the combination of different facial movements to convey an emotion, differs across cultures such that Caucasians have more distinct combinations of expressions than East Asians (Jack, Garrod, Yu, Caldara, & Schyns, 2012; Jack & Schyns, 2017). While face grammar impacts the stimulus basis of what is to be perceived, there is also evidence for cultural differences in perceivers’ gaze patterns, that is, what perceivers look directly at. Some of the findings suggest that the pattern of eye movements differs across cultures when scanning a face, with East Asians focusing on the eyes whereas Westerners sample facial information more widely (Jack, Blais, Scheepers, Schyns, & Caldara, 2009; Jack, Caldara, & Schyns, 2012). Note that this account is not universally accepted (Yan, Andrews, & Young, 2016; Yan, Young, & Andrews, 2017). Cultural differences in gaze patterns have been extrapolated to suggest that East Asians may use extrafoveal information more than Westerners (Caldara, Zhou, & Miellet, 2010).

^a 1546 J. HEYWOOD Prov. II. iv. (1867) 51 “Plentie is nodeintie, ye see not your owne ease. I see, ye can not see the wood for trees.”

Intriguingly, these cultural differences seem to be pervasive, with the majority of British-born individuals of Chinese heritage showing the “Eastern” pattern of eye movements and only a minority showing a “Western” pattern (Kelly et al., 2011). The authors took this as evidence that social experience (e.g., growing up in the United Kingdom) does not alter the pattern of eye movements from the typical pattern expected for individuals from Chinese cultural backgrounds, although they did note the potential influence of early-life influences, as the participants reported little exposure to Western culture before beginning school. Thus, cultural differences may persist despite long-term exposure to another culture throughout childhood and early adulthood.



4. Integration of the study of perception and memory across cultures

Given the surprisingly long and rich history of studying cultural effects on perception, which aspects of vision might account for cross-cultural differences in memory specificity?

The candidate explanation we find most intriguing to potentially account for the effects on memory is evidence for cultural differences in the relative use of low versus high spatial frequency information. This work indicates that East Asians tend to use low spatial frequencies, associated with coarser, more global information, whereas Westerners tend to use high spatial frequencies, associated with fine details and more local information during face processing (Blais, Jack, Scheepers, Fiset, & Caldara, 2008; Caldara et al., 2010; Estephan et al., 2018; Im et al., 2017; Kelly, Miellet, & Caldara, 2010; Miellet, Vizioli, He, Zhou, & Caldara, 2013; Rodger, Kelly, Blais, & Caldara, 2010; Tardif et al., 2017). In one set of experiments, Chinese and Canadian participants viewed faces that had been filtered for different frequencies of spatial information. As shown in Fig. 9, results indicated that Canadians used more high spatial frequency information than Chinese participants (Tardif et al., 2017). More recent work reveals that the cultural differences in the prioritization of different spatial frequencies can emerge as early as 34ms and persist over time, implicating early visual processes (Estephan et al., 2018).

These findings indicate that across cultures, people could differ in their attention to, or have cortex differentially tuned to, particular spatial frequencies. Cross-cultural distinctions in sensitivity to particular ranges of spatial frequencies could impact the visual processing of objects and memory for

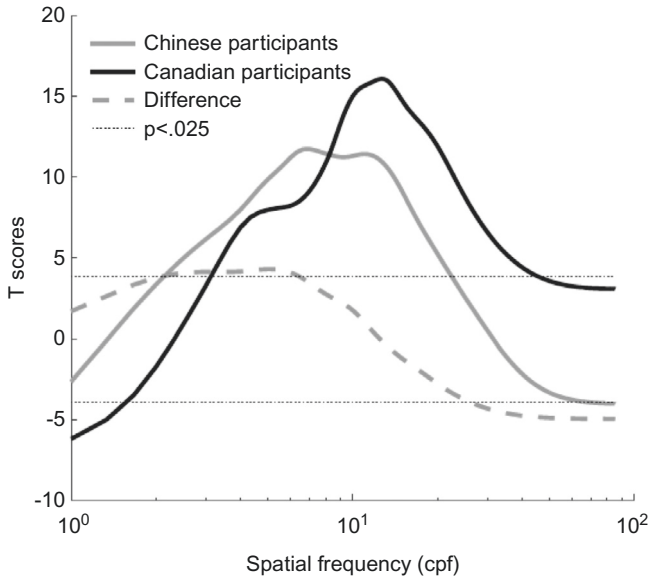


Fig. 9 Cross-cultural differences in the use of different spatial frequencies. During the viewing of faces, Canadian participants used high spatial frequencies to a greater extent than did Chinese participants. Figure reprinted with permission from Tardif, J., Fiset, D., Zhang, Y., Estephan, A., Cai, Q., Luo, C., et al. (2017). *Culture shapes spatial frequency tuning for face identification*. *Journal of Experimental Psychology: Human Perception and Performance* 43, 294–306. <https://doi.org/10.1037/xhp000028>.

them. Although one study investigated cross-cultural differences in eye movements to objects (Kelly et al., 2010), the experimental approach of filtering images for different spatial frequencies has yet to be adopted for the study of culture. Given that faces include a range of spatial frequencies and may engage distinct neural regions (Kanwisher, 2017; Kanwisher, McDermott, & Chun, 1997), research with faces may not generalize to other visual stimuli. In addition, much of the work thus far emphasizes emotion (Jack et al., 2009; Jack, Caldara, & Schyns, 2012; Jack, Garrod, et al., 2012; Jack & Schyns, 2017; Suzuki et al., 2011), making it all the more important to expand the approach to studying objects or other lower-level visual information that should not differ in meaning or familiarity across cultures (e.g., Gabor patches). Another important consideration for future work is addressing the potential confound of myopia, which is more common in some Eastern cultures (as discussed in Section 3.1), and could also account for a global processing bias.

Although we focus on the ways in which perceptual biases could translate into memory differences across cultures, it is important to note how the

interplay between vision and attention could impact memory, as indicated in Fig. 4. One specific way this could play out with implications for culture is that the processing of high versus low spatial frequency information may be differentially associated with different hemispheres (Piazza & Silver, 2014, 2017). The left hemisphere preferentially attends to and processes local information (e.g., details) whereas the right hemisphere exhibits a global (e.g., larger scale) processing preference (Flevaris, Bentin, & Robertson, 2011). This laterality difference has been shown to be stronger for Americans than Koreans in a study of coding emotion from arrays of faces briefly presented to the visual field corresponding to the left or right hemisphere (Im et al., 2017). Another cultural difference relevant to attention is the ability for East Asians to perform better than Americans on a change detection task when spatial configurations were preserved but expanded in space. In contrast, Americans performed better when configurations were preserved but shrunk in space (Boduroglu, Shah, & Nisbett, 2009). Such findings could indicate cultural differences in the breadth of attention. These attentional processes could impact memory if preferential processing of particular spatial frequencies in one hemisphere leads to prioritization of information to be encoded and consolidated in memory. Indeed, the change detection paradigm involves memory for stimuli over a brief time window, but perhaps similar attentional processes could impact long-term memory.

Returning to our finding of cultural differences in the pattern of neural activity in left occipital region BA 18/19 corresponding to object representations (Ksander et al., 2018), the location of this region in visual cortex could reflect cultural sensitivities to different image features. Some work (Freeman, Ziemba, Heeger, Simoncelli, & Movshon, 2013; Ziemba, Freeman, Movshon, & Simoncelli, 2016) indicates this region is particularly sensitive to textures, rather than the lower-level visual properties of stimuli (e.g., line orientations) to which V1 responds. Such findings could reflect cultural differences in the prioritization of different spatial frequencies when viewing real-world objects, but such an explanation requires a direct test.

Even if support is found for a link between spatial frequencies and memory, the question of what causes these cultural differences still remains. Early life visual experiences such as written language (Dehaene & Cohen, 2007; Horie et al., 2012), built environments (Miyamoto et al., 2006), density of environments (Chee, Zheng, Goh, Park, & Sutton, 2011), or other experiences (Kuwabara & Smith, 2012, 2016) could mediate the influence of culture, and could tune the visual system's preference for particular ranges of spatial frequencies (Piazza & Silver, 2014, 2017). Ultimately, answering this question will continue to be a difficult problem to solve, as it is difficult to

experimentally manipulate the complex long-acting forces of culture. But identifying the level at which culture influences memory (e.g., via low-level perception? Via attention? Via long-term memory systems themselves? Interactions among all of these?) would provide important constraints on how we think about the relevant mechanisms and the ways in which culture shapes the brain and mind. They would also allow researchers to generate more nuanced predictions about when and how effects of culture should manifest.



5. Conclusions

Although many intriguing differences across cultures have emerged in perception and memory, and potential connections between some of these processes are tantalizing, we are far from a unified understanding of the influences of culture on cognition or the underlying mechanisms. We close the chapter by recommending several approaches for future research, including how we should expand the scope of our own inquiries into the topic.

Thus far, much of the work has adopted an approach of contrasting “extreme” groups, comparing Easterners and Westerners, broadly defined (as discussed earlier). This approach must be both expanded and narrowed. By *expanded* we mean in terms of systematically comparing multiple cultural groups thought to differ on a single dimension, be it on a factor such as independence (e.g., comparing multiple countries differing in level of independence) or as a factor of cultural exposure over generations (e.g., comparing new immigrants to individuals whose families immigrated one or two generations ago). By *narrowed*, we mean better accounting for individual differences within a “culture,” broadly defined (e.g., country). Both of these approaches would help to substantiate relevant mechanisms, by selecting a relevant variable and studying it in a more parametric fashion, rather than merely comparing two groups that could differ on a number of dimensions. Some work has had success in using individual difference measures, such as self-report measures of levels of individualism and collectivism, and found that patterns of performance correlate with these measures but such findings have been rare in the perception and memory literatures.

Another approach to consider is in the comparison across measures. Much of the cognitive research on culture has focused on one task, or a single domain, such as memory, rather than considering effects expected to extend across memory and perception. Theories of cultural impacts on cognition should be able to make stronger predictions about how culture would

impact a host of related tasks, and what the boundary conditions might be. One of the studies to adopt such an approach administered 10 measures of independent versus interdependent self-construal and 10 measures of analytic versus holistic thinking (Na et al., 2010). Although the cultural groups—East Asians and Westerners—differed on the measures at the group level, the measures were unable to detect consistent differences within a group. That is, an individual who scored highly on independence on one measure did not necessarily do so on the other measures of independence. Thus even though understanding individual differences is necessary in order to identify the factors that predict who should show a larger or smaller “footprint” of a particular cognitive style associated with culture, these results suggest that it will not be easy to harness such an approach.

As we alluded to earlier, other approaches critical to advance understanding of cultural effects on cognition are the study of acculturation and change over time. In some cases, cultural change can allow for naturalistic experiments, such as the study of the Himba who moved to cities, in order to understand how experiences viewing different types of landscapes impact perception. Studying individuals at different points, or throughout, acculturation to a new culture also provides a rich opportunity to study the effects of exposure to novel environments on cognitive processes. Even common student experiences such as study abroad may provide such an opportunity. In order to study acculturation processes and cultural changes over time, it will be necessary to consider developmental trajectories and the possibility of “critical periods” during which culture may particularly impact cognition. Such work would require longitudinal approaches as well as large sample sizes, given the variability in individuals’ ages, educational backgrounds, and experiences, even within a single immigrant population (e.g., emigrating from Guatemala, rather than considering across different countries of origin and languages). However, the growth in team science approaches and the globalization of the research enterprise make such work more possible than ever before.

Finally, insights on these topics will not be possible without measures that are sensitive assays to serve as reliable, valid measures of constructs. Testing the predicted impact of culture across tasks and domains (e.g., perception and memory) will offer strong evidence for theories, and converging methods (e.g., psychophysical measures of perception, memory performance, and measures of brain activity) can help to triangulate the locus of such effects (e.g., cultural differences in low-level visual processes or memory systems).

Although there are many challenges to the study of cultural differences in cognition, we hope that this chapter motivates further study on the topic. There is much opportunity due to the gaps in the approaches adopted thus far as well as the potential for far-reaching effects of culture in a variety of cognitive domains.

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