Handbook of Cultural Developmental Science

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Marc H. Bornstein

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Cognition

MICHAEL COLE and XAVIER E. CAGIGAS

Introduction

To understand the role of culture in cognitive development, it is helpful to consider the processes involved in terms of three levels of social grouping: human beings as a mammalian species, societies (thought of as the population of a particular geographical and political region that exhibits common cultural features), and cultural practices (thought of as recurrent ways of accomplishing valued social activities in concert with some group of one's proximally circumscribed social unit). These levels are not independent of each other. It is helpful to think of each "smaller" unit of cultural analysis as embedded within the more inclusive levels both spatially (in terms of the number of people involved) and temporally (in terms of time span over which the given cultural feature or formation has existed). Just as geopolitically defined populations can be thought of as branches of a tree of human life extending back to *Australopithecus*, so the different cultural practices within a society represent variations in the ways that people organize their everyday lives within the set of possibilities to be found in highly similar ecological circumstances. Consequently, specifying the linkages among specific cultural practices within more inclusive sociocultural formations and the linkages of those sociocultural formations within historically formed modes of life is a major ongoing challenge to the study of culture and cognitive development.

Our presentation is organized as follows. We begin by providing working definitions of the core concepts of culture, cognition, and development—the phenomena that must be related to understand the role of culture in cognition. We then consider cognition at each of the levels of social grouping associated with culture: cultural universals as they relate to human beings as a biological species, the level of large populations and social groups, and the level of cultural practices within social groups. We end by considering the crucial issue of arriving at a more systematic understanding the generality of cultural patterns across populations, their sources, and their consequences for cognition.

Culture, Cognition, and Development: Some Definitional Considerations

In its most general sense, the term "culture" as applied to human beings refers to the socially inherited body of past human behavioral patterns and accomplishments that serves as the resource for the current life of a social group (D'Andrade, 1996). Although scholars usually agree on the notion that culture constitutes the social inheritance of a population, anthropologists have historically emphasized culture either as "something out there" (the "man made part of the environment"; Herskovitz, 1948) or as "something inside the head" (as "what one needs to know to participate acceptably as a member in a society's affairs"; Goodenough, 1994, p. 265).

At present, many anthropologists and psychologists seek to transcend this dichotomy between "ideal" versus "material." For example, Geertz (1973, p. 45) wrote that his view of culture begins with the assumption that "human thought is basically both social and public—that its natural habitat is the house yard, the market place, and the town square. Thinking consists not of 'happenings in the head' (though happenings there and elsewhere are necessary for it to occur) but of trafficking in...significant symbols—words for the most part but also gestures, drawings, musical sounds, mechanical devices like clocks."

Our own proposal for transcending the ideal–material dichotomy with respect to culture and development is to think of the cultural medium in which human beings live as an environment transformed by the artifacts created by prior generations, extending back to the beginning of the species. As we are using the term, an artifact is an aspect of the material world that has been modified over the history of its incorporation into goal-directed human action (Cole, 1996). By virtue of the changes wrought in the process of their creation and use, artifacts are *simultaneously ideal (conceptual) and material.* They are ideal in that their material form has been shaped by their historical participation in the (successful, adaptive) social interactions of which they were previously a part and which they mediate in the present. They are material in that they are embodied in physical artifacts, whether in the morphology of a spoken, written, or signed word, or in a solid object such as a pencil. D'Andrade (1986, p. 22) made this point when he wrote: "Material culture—tables and chairs, buildings and cities—is the reification of human ideas in a solid medium." The basic function of these artifacts is to coordinate human beings with the physical world and each other; in the aggregate, culture is then seen as the species-specific *medium* of human development that organizes and configures the human nervous system for interaction with the world.

This conception of artifacts extends to what Wartofsky (1973) refers to as secondary artifacts, representations of primary artifacts and their modes of use. Secondary artifacts play a central role in preserving and transmitting the kinds of social inheritance referred to as recipes, beliefs, norms, conventions, and the like. This extension brings the mental entities psychologists refer to as schemas or scripts into contact with the notion of artifact. The term schema is ordinarily used by psychologists to refer to a mental structure that represents some aspect of the world. When thinking about culture and cognition, Bartlett's (1932) notion of schemas as conventions is useful because it emphasizes that schemas are simultaneously aspects of material practices and mental structures/functions. Scripts are an especially important kind of schema for purposes of thinking about the role of culture in cognitive development because they represent the everyday, culturally organized activities that people engage in. A script is an event schema that specifies the appropriate people who participate in an event, the social roles they play, the objects they use, and the sequence of actions and causal relations that they apply.

Both Bruner (1990) and Nelson (1981) accord an important role to such event representations in cognitive development. Nelson (1981, p. 101) referred to scripts as "generalized event schemas"; scripts provide "a basic level of knowledge representation in a hierarchy of relations that reaches upward through plans to goals and themes." In her work on children's acquisition of event representations, Nelson highlighted other important properties of scripts as artifacts. First, such event schemas serve as guides to action. When individuals participate in novel events, they must seek out an answer to the question, "What's going on here?" For example, once a person has even a crude idea of what the appropriate actions associated with going to a restaurant are, she or he can enter the flow of the particular event with partial knowledge, which gets enriched in the course of the event itself, facilitating later coordination. "Without shared scripts, every social act would need to be negotiated afresh" (Nelson, 1981, p. 109). Nelson also pointed out that children grow up within contexts controlled by adults and hence within adult scripts. By and large, adults arrange the conditions for children's actions, including the culturally appropriate goals,

rather than engage in direct teaching. In effect, they use their notion of the appropriate script to provide constraints on the child's actions and allow the child to fill in the expected role activity in the process. In this sense, "the acquisition of scripts is central to the acquisition of culture" (Nelson, 1981, p. 110).

According to Bruner (1990), scripts are best considered constituents of a narrative. In his view, it is narrative, the linking of events over time, that lies at the heart of human thought. The re-presentation of experience in narratives provides a frame ("folk psychology") that enables humans to interpret their experiences and each other. If it were not for such narrative framing, "we would be lost in a murk of chaotic experience and probably would not have survived as a species in any case" (Bruner, 1990, p. 56). Luria's (1974) notion of kinetic melody further illustrates how, like narrative, the purposive aspect of action organizes and forms an integral part of movement. A kinetic melody represents not only the coordination of various afferent and efferent neural systems, but also the amalgamation of these with meaningful, skilled movements learned over time that allow one to interact with and act on the world. A kinetic melody, therefore, embodies the interpenetration of the cultural and the neural, providing an interwoven, dynamic unit of analysis that transcends reductionism and opens the way to analysis of the ecological complexity of human experience.

We have spent the bulk of this discussion on the concept of culture because it is central to the purpose of this chapter, but similar complexities apply to the notions of cognition and development. Generally, the term cognition applies to the process of acquiring knowledge or the products of that process designated by such terms as perceiving, attending, remembering, reasoning, linguistic ability, and so on. Equally generally, development applied to human beings refers to changes over time (generally, "growth" over time in a variety of capacities). Each of these concepts, no less than the concept of culture, is thoroughly saturated with theoretical commitments. For present purposes, we background such considerations to highlight the role of culture in the process of cognitive development, treated in as neutral a fashion as possible.

Culture and Cognitive Development: Universal Processes

Because of evidence for the presence of culture among the hominid precursors of modern humans for many hundreds of thousands, if not millions, of years prior to the emergence of *Homo sapiens*, it is not appropriate to juxtapose human biology and human culture. The human brain and body have co-evolved over a long period of time with our species' increasingly complex cultural environment (Richerson and Boyd, 2005). The implications of the co-evolution of human culture and human biology have been succinctly summarized by Geertz (1973, p. 68) who argued that, as a result of their tangled relations in the course of human phylogeny, culture and biology are equally tangled in the course of human ontogeny:

> Rather than culture acting only to supplement, develop, and extend organically based capacities logically and genetically prior to it, it would seem to be ingredient to those capacities themselves. A cultureless human being would probably turn out to be not an intrinsically talented though unfulfilled ape, but a wholly mindless and consequently unworkable monstrosity.

At the time, Geertz was arguing from scanty data, but contemporary studies of hominization have made clear the general principle that the contemporary human brain co-evolved with the accumulation of culture. Based on contemporary neuroscientific evidence, Quartz and Sejnowski (2002, p. 58) declared that culture "contains part of the developmental program that works with genes to build the brain that underlies who you are." Donald (2001, p. 23) made the same point in slightly different terms: "Culture actually configures the complex symbolic systems needed to support it by engineering the functional capture of the brain for epigenesis."

According to this same logic, culture does not act independently of biological processes during the child's development. Rather, to use a currently fashionable phrase, one needs to speak of "bio-cultural constructivism" (Li, 2006). Both culture, the historically accumulated artifacts that constitute the human-made part of the environment that greets a newborn at birth, *and* biological processes with a long phylogenetic history operate simultaneously in ontogeny to create the conditions for all of development, including its cognitive aspects.

With these considerations in mind, it should be clear that culture plays a central role in cognitive development, regardless of which particular culture a child is born into by virtue of the common history of *Homo sapiens*. Culture's role is complementary to the role of biological processes during ontogenetic development that are heavily constrained by infants' long phylogenetic history.

First, and most obviously, culture provides a vast storehouse of partial solutions to problems that human beings have frequently encountered and solved previously. Put differently, culture provides a vast storehouse of "tools to think and act with." Although such tools/solutions routinely need modification because humans must constantly deal with changing environmental, technological, and social circumstances, human infants do not encounter a world created de novo just for them. Rather, it is a world culturally "pre-pared" to provide them with cognitive resources, just as phylogeny has "pre-adapted" them to require and acquire such resources.

Second, the world that greets the newborn is a social world, populated by persons who have already acquired a great deal of the cultural knowledge that the child is going to have to acquire and whose behavior is itself shaped by this knowledge. The entire pattern of the child's early experiences of the world takes place in an intricately choreographed set of events, mediated by the artifacts that embody the society's cultural heritage. These cultural resources include means for organizing babies' experiences so that the babies will, in turn, come to occupy the same role in the social group that their parents and older kin are currently playing, and they will take their turn at organizing the experience of a next generation of children who will make possible the social group's continuation.

Our emphasis on culture as preceding the child and as a set of resources/experiences arranged for the child by adults who are heavily invested in the child's development provides the background for a third way in which culture plays an essential role in children's development. It requires the active efforts of children to acquire the necessary cultural knowledge to become competent members of the social group, thus reducing their dependence on the ministrations of others and maximizing their own potential to conduct their lives on their own terms. In short, children must learn to mediate their own behavior through the same cultural resources that their elders use to enable them to continue as members of the social group. From this perspective, cognitive development is a process of children learning to control the world and themselves by appropriating the cultural resources made available to them at birth by their families and community; if the process is successful, they will eventually change and perchance add to that set of cultural resources under the unforeseeable conditions of their own adult lives.

In summary, when considering the universal features of culture in human development, what one sees is a three-sided process in which the social inheritance of the past is made available to children at birth in an ongoing process of enculturation that requires that both the social world and the child actively engage with their social inheritance to enable the child to become a competent adult member of the social group.

Cultural Contributions to Cognition in Biological Context

What the earlier account leaves out is the initial biological state of the newborn when the child emerges into the culturally organized postnatal environment. As summarized in Cole

and Hatano (2007), a number of developmentalists have converged around the idea that a full account of cognitive development requires synthesis of information about phylogenetic/biological and cultural constraints present at birth, both of which change dynamically over time during ontogenesis. Early-appearing phylogenetic contributions are of two kinds. The first are psychological processes that are organized in terms of "core" or "privileged" domains or "skeletal constraints" with identifiable precursors in nonhuman primates. Such processes display characteristic domain boundaries and task specificity. Each represents a particular class of entities for a particular set of purposes (Spelke, 2000). Widely accepted candidates for such core domains providing skeletal constraints for cognitive development include naive physics, mathematics, psychology (theory of mind), and biology (Wellman and Gelman, 1998). In these privileged domains, humans are genetically prepared to acquire knowledge systems that depend on essential physical features of the world, as well as competencies evident in embryonic form in common ancestor species such as language and number.

In addition to such domain-specific constraints, researchers have also identified powerful general learning mechanisms. Even infants possess the ability to identify sequential dependencies in the speech stream (Saffran, Aslin, and Newport, 1996) or in the mechanical movement that occurs when one object collides with another (Baillargeon, 1994). Moreover, humans are conceptual learners from early on. To mention a few such processes, they are able to (1) build concepts coherent within a larger system (Mandler, 2004); (2) understand a set of antecedent-consequent pairs in terms of unobservable, mediating forces (Tomasello, 1999); and (3) "bootstrap" (i.e., create a new system of representation that is more powerful than those present; Carey, 2004).

These general learning mechanisms are also products of evolution, but not in response to task-specific adaptation. They are heavily dependent on enlarged frontal and prefrontal cortices that may have evolved through uniquely human ways of living, such as posing and solving complex interpersonal and social problems, learning and using culturally inherited artifacts, and adapting the natural environment to their needs (Quartz and Sejnowski, 2002).

Whatever the phylogenetic constraints that characterize knowledge acquisition in core domains, such knowledge is woefully inadequate to fully explain normal adult human functioning; they are skeletal, not structurally complete (Gelman, 2000). Ontogenetic development of the human mind also requires repeated participation in culturally organized practices. Cultural practices are a bridge between phylogeny and ontogeny. On the one hand, the cultural history of a child's social group provides the kinds of practices that are available, their relative frequency, and their accessibility as proximal environments for development. On the other hand, developing individuals have increasing ability to choose the practices they enter into and to change their own features through participation. However, even when participants have no choice but to participate in a cultural practice and have no desire to actively improve their skills, repeated participation enhances the cognitive skills needed to perform well in these practices. This simple principle of neuro-associative learning suggests a possible mechanism for the perpetuation of core cultural practices and how such practices may take root within the individual.

Practices vary greatly both within and between social groups. In some cases, people acquire skills to perform competently only in a specific practice, whereas in other cases, they acquire a rich and well-structured body of knowledge and associated skills. Among these knowledge-rich domains, they may further acquire conceptual knowledge, based on which they can modify known procedures flexibly, invent new procedures, and employ their knowledge in a wide variety of practices. Moreover, for some domains of human activity, gaining cognitive competence may require years of experience in solving problems in the domain, experience that often takes the form of "deliberate practice" requiring sustained concentration (Ericsson, Krampe, and Tesch-Romer, 1993); alternatively, it may be achieved readily and promptly, based on a small number of experiences.

The amount of time and effort required to gain expertise in a given cultural practice or with respect to a particular cognitive domain (depending on whether one is dealing with a core domain and its skeletal principles or a domain of social practice for which no obvious skeletal principles appear) is currently uncertain. It seems plausible that in core domains, acquisition to a level broadly characteristic of the adult population should be relatively rapid and effortless, whereas acquisition of cultural practices that bear no clear relation to any known core domain would be slower and more effortful and require specialized arrangements for their acquisition. So, for example, natural languages appear to be acquired rapidly without any explicit instruction (in fact, young language learners may acquire a natural language even when doing so is discouraged, as in the case of deaf children placed in oralist schools run by hearing people; Padden and Humphries, 1988). By contrast, learning to read English or fly an airplane is rarely accomplished without explicit instruction and a great deal of practice. Human beings evolved to acquire natural languages. It required tens of thousands of years for them to invent written languages or to construct and fly airplanes, and to this day, such knowledge is not universal.

The Level of Large Populations: Culture Styles of Cognition

By far the most frequently studied level of culture–cognition relations involves comparisons between populations, often associated with an entire society or nation and sometimes even entire civilizations (such as Nisbett and colleagues contrasting the cognitive properties of societies descended from the Greek tradition with those of East Asian origin; Nisbett and Masuda, 2003).

A key assumption of many who conduct research at this level of cultural generality was famously formulated by the anthropologist Benedict (1934, p. 53):

> A human society must make for itself some design for living. It approves certain ways of meeting situations and certain ways of sizing them up. People in that society regard these solutions as foundations of the universe. They integrate them no matter what the difficulties. Men who have accepted a system of values by which to live cannot without courting inefficiency and chaos keep for long a fenced-off portion of their lives where they think and behave according to a contrary set of values. They try to bring about more conformity. They provide themselves with some common rationale and some common motivations. Some degree of consistency is necessary or the whole scheme falls to pieces.

Benedict's belief in the coherent patterning of psychological life by the cultural environment was expanded during the last half of the twentieth century into a large program of cross-cultural work that has been termed an "eco-cultural" psychology (Berry, 1976; Greenfield, Keller, Fuligni, and Maynard, 2003; Whiting and Whiting, 1975). The basic logic of this approach is to relate cultural patterns on the one hand to the physical circumstances of the group on the other. These ecological circumstances are assumed to give rise to configurations of economic activity/technology and social organization (kinship and the divisions of labor of adults), which in turn influence childrearing practices that shape the psychological characteristics of the children. The children, as a result of the patterned process of socialization they have undergone, are assumed to internalize the characteristics of their elders, and in this way, given cultural patterns are maintained over generations, allowing for changes in circumstances that can be expected, at a greater or lesser rate, to instigate cultural changes that will in turn lead to patterned cognitive changes referred to as "cognitive styles" (often thought of as the preferred way a person processes information). In principle, cognitive styles (unlike abilities) are conceived of in terms of bipolar dimensions, so that having a particular cognitive style refers to a tendency to behave in a certain manner.

A variety of terms has been used to characterize cognitive styles associated with cultural patterns. Berry et al. (1986) used the contrast terms "field dependent" and "field independent."

More recent research in this tradition has used such contrasts as "individualism/collectivism," "analytic/holistic," and "independent/interdependent (Kitayama and Cohen, 2007). Although the specifics of the different approaches vary, as reflected in the various tasks that they use to assess their core cognitive styles, they all agree that cognitive styles apply across a wide spectrum of traditional psychological categories including perception, attention, reasoning, categorizing, self-construal, social inferences about others, and so on. This extended understanding of culturally linked cognitive styles has led to a large literature of individualism and collectivism (e.g., independence/interdependence), which further suggests that as a person matures in a particular cultural and historical context, she or he develops a different way of relating to others by either giving primacy to the group the person is a part of (i.e., collectivist) or to herself or himself as an individual separate from the group (i.e., individualist). As a result, the person's self-construal (i.e., how she or he relates to self, others, and the environment) can either be individualistic and field independent or collectivist and field dependent.

The early work of Berry, Witkin, and their colleagues focused on the idea of a cultural/cognitive relation based on the idea that some people are more "field dependent" than others (e.g., some people are more heavily influenced by the context in which stimuli are presented or events occur than others who are considered "field independent;" Berry, 1976). Field dependence in the perceptual and cognitive realms was operationally defined and experimentally tested using the Rod and Frame Test (RFT) and the Embedded Figures Test (EFT). The RFT consists of a rod inside a frame, both of which are moveable, and the participant must adjust the rod to a true vertical position as the position of the frame is changed. Degree of error (the number of degrees away from 90 degrees) provides the measure of field dependence. The higher the score, the more field dependent the participant is considered to be. The EFT requires finding simple forms that are embedded in larger figures. The score is the average time in seconds to detect the simple forms, as well as the total number of correctly disembedded figures within a fixed amount of time. Greater time and more incomplete tasks reflect greater difficulty in analyzing a part separately from a wider pattern (an object from its context) or, alternatively, a greater tendency to perceive complete patterns rather than their separate components. In the social realm, it was assumed that field-independent people also experience themselves as separate and distinct from others, depend on internal referents, and are more autonomous in their social relationships relative to field-dependent people, or, in more recent terminology, that people's reasoning about themselves and others is either more focused on an autonomous agent or an agent whose actions are importantly contingent on the social group.

Berry tested his ideas by gathering data from 18 subsistence societies ranging from West Africa to Northern Canada and Australia as well as 3 industrialized groups. He used data from the Human Relations Area Files to code information about ecological, acculturative, and cultural elements to obtain evidence concerning key elements of the eco-cultural model. He administered tests of cognitive style in the cognitive and social domains to assess cognitive style. Then, the relations between variables were calculated using correlational, analysis of variance, and multiple regression techniques. The results were interpreted as strong evidence in favor of his eco-cultural model relating environment, social structure, cultural practices, and cognitive style.

However, this work encountered skepticism based on a variety of methodological factors, and a large-scale test of the model designed to overcome these objections failed to support the model (Berry et al., 1986), so for some years, the general idea of cognitive styles related to cultural configurations languished. However, the basic idea was subsequently revised and has become one of the most widely encountered approaches to studying culture and cognition currently in use (see Kitayama and Cohen, 2007).

Nisbett, Peng, Choi, and Norenzayan (2001) have focused on the idea that differences in cognitive style can be observed by comparing the performance of Asian and European Americans

in a variety of experiments that capitalize on this difference in self-construal or cognitive style. They found that it is relatively more difficult for European Americans to detect changes in the background of scenes, suggesting that they are less field dependent, whereas it is more difficult for Asians to detect changes within objects in the foreground of a scene, suggesting that they are more field dependent. Simons and Levin (1997) also demonstrated that Asians more accurately detect change in the environment or context, whereas European Americans selectively detect changes in objects in the foreground using the "change blindness" paradigm. When an object in the background was removed or added after a brief delay, Asians were aware of the change more often, whereas European Americans did not notice changes in the background. Other research has attempted to explain these findings by suggesting that different cultures show different patterns of attention, with some incorporating more contextual information relative to others in their decision-making processes (Ji, Peng, and Nisbett, 2000; Masuda and Nisbett, 2001). More specifically, Asians tend to focus their attention on the interrelations between objects and the contexts in which they are embedded in visual space, whereas European Americans attend primarily to the object in the foreground and its salient characteristics, echoing previous studies on differential level of perceptual field dependency. Experimental evidence for this includes the fact that, when objects are taken out of the original context in which they were presented, European Americans have little difficulty identifying the object as familiar whether it is presented in isolation or with a new background, whereas Asians have greater difficulty identifying these same objects when they are presented with a novel background as opposed to in isolation (Ji et al., 2000; Masuda and Nisbett, 2001). Other researchers, making no mention of the demographic makeup of their sample, have suggested that, although semantic congruency between objects in the foreground and background increases accuracy, a bias toward processing objects in the foreground exists in the way humans perceive and categorize stimuli (Davenport and Potter, 2004). Nisbett and colleagues, nevertheless, contend that Asians do not simply fail to process the object in the foreground, but rather that they incorporate the spatial context and somehow bind it to their representation of the object.

For example, a recent study showed that patterns in eye movements correlate with observed differences in cognitive style (Chua, Boland, and Nisbett, 2005). Specifically, the eye movements of American (the ethnic makeup of this sample was not specified) and Chinese participants were measured while they viewed photographs of a focal object superimposed on a complex background. Examination using eye-tracking equipment revealed that American participants fixated more on focal objects and tended to fixate on the focal object more quickly after initial presentation of the photograph. By contrast, Chinese participants made more saccades to the background than did the Americans and took longer to direct their gaze specifically toward the focal object. Thus, cultural differences can be observed both at the behavioral level of performance and on a measurable physiological level.

A functional magnetic resonance imaging (fMRI) study (Grön, Schul, Bretschneider, Wunderlich, and Riepe, 2003) showed that, although behavioral performance (i.e., total recall and learning slope) was identical between European Americans and Chinese on a visual learning task that required repetitive memorization of geometric patterns and repetitive active recall, the two groups demonstrated different patterns of neuronal activation. Specifically, initial learning within the Chinese group activated bilateral frontal and parietal areas (i.e., the dorsal stream for analysis of spatial features), whereas the European American group recruited posterior ventral regions, especially the fusiform gyrus and hippocampal complex (i.e., the ventral stream for object identification). Later in learning, a crossover effect was observed such that European Americans began to exhibit dorsal activation and Chinese participants began to exhibit ventral activation before returning to the initially observed baseline pattern. The authors interpreted these results as demonstrating that differences in cultural upbringing influenced participants to

initially approach stimuli in their default attentional style (i.e., trying to encode the geometric figures as a whole for the European Americans and trying to encode the visuospatial lay of the land in Chinese). The shift in processing strategy observed midway through the learning process seems to represent an attempt to more fully consolidate the percept to be learned by engaging the complimentary analyzer (i.e., either the ventral or dorsal stream). Once the memorization of the figures had been stabilized in long-term memory, participants returned to their default attentional style.

The fact that both European American and Chinese groups are able to recruit both the ventral and dorsal streams in different ways suggests a certain amount of flexibility in how culture comes into play when processing visual information. It is not the case, for example, that the more individualist culture always engages the ventral stream and the more collectivist culture always engages the dorsal stream. In like manner, Hong, Morris, Chiu, and Benet-Martínez (2000) have shown that cultural style alone cannot fully explain the dynamic nature of differences both between and within cultural groups. Through a series of priming studies aimed at bicultural individuals, they demonstrated that a group's cultural style can be manipulated by manipulating the cultural artifacts available to them. As a result, they suggest a more mediational account of cultural cognition and make the case for a culture by situation interaction model that they coined a "dynamic constructivist approach to culture" (Hong and Mallorie, 2004).

In summary, despite some inconsistencies in the data and the continued presence of critics and skeptics, there is accumulating evidence to support the idea that members of different cultures perform differently on cognitive tasks in a patterned manner consistent with the idea of a culturally linked cognitive style. Moreover, there appear to be differences in how members of different cultures recruit different neural systems when performing the same tasks.

Cultural Practices as the Source of Variations in Cognition

The third level at which it has proven productive to study the relation of culture and cognition is the level of cultural practices—"actions that are repeated, shared with others in a social group, and invested with normative expectations and with meanings or significances that go beyond the immediate goals of the action" (Miller and Goodnow, 1995, p. 7). Cultural practices can be thought of as the proximal units of culturally organized experience. This idea is expressed by Shweder et al. (1998, p. 871) when they wrote that whatever universal cognitive characteristics humans share as a species, these features "only gain character, substance, definition and motivational force...when they are translated and transformed into, and through, the concrete actualities of some particular practice, activity setting, or way of life."

Authors who emphasize the idea of cognitive styles associated with cultural patterns characteristic of large populations also assert the importance of cultural practice. So, for example, Nisbett and Masuda (2003, p. 11169) assert that "the differences in attention, perception, and cognition that we have shown are driven by differences in social structure and social practices." Elsewhere, Nisbett and Norenzayan (2003, p. 28) noted that, "Societies differ in the cultural practices that they promote, affording differential expertise in the use of a cognitive strategy, or differential knowledge about a domain." However, they do not directly study cultural practices; rather their experimental studies model the presumed generalized cognitive outcomes of cultural practices described by others.

By contrast, those who do directly study cultural practices as the proximal locus of culture–cognition relations are more likely to combine direct ethnographic descriptions with experimental methods that model the practice they observe (Cole, 1996; Greenfield, 2004; Mejia-Arauz, Rogoff, and Paradise, 2005). For example, Greenfield and Childs (1977) went to a Mayan community in the state of Chiapas, Mexico, where they studied the cognitive and social consequences of learning to weave. Their work included careful descriptions of the weaving

process engaged in by women and young girls who were being apprenticed into weaving. They analyzed the patterns of the weaving products produced as well as experimental tests of children's ability to reproduce weaving patterns using sticks of varying width and color using a model of the traditional loom. In the 1990s, they returned to the same village and conducted parallel observations of parents (former child subjects) inducting their children into weaving and the consequences of the changed weaving practices and products that had arisen over the years (Greenfield, 2004). In contrast to the late 1960s, by the mid-1990s, this Mayan community had shifted from an economy based primarily on subsistence agriculture and relatively secluded from the modern state to one based more heavily on involvement in the money economy and trade and much more frequent interaction with people and trade from outside of the village and the local region, including trade in woven cloth and the profusion of new patterns to which they were exposed. The instructional mode characterizing the mother–child weaving sessions in the 1960s and 1970s consisted of mothers hovering close by and guiding the children with their own hands and bodies, using little verbal instruction. The entire system appeared to focus on maintenance of the "one right way" of the weaving tradition, which consisted of a limited, relatively simple set of weaving patterns. In the 1990s, mothers who were more involved in the modern economy (for example, women who wove products for sale) instructed their children verbally from a distance, sometimes using older siblings to take over instruction, and the children learned by a process characterized by a good deal more trial and error and self-correction of errors. At this later date, there was no longer a small set of simple, "correct" patterns, but an efflorescence of patterns, indicating the increased respect paid to individual innovation that comes with a trial-and-error approach to learning. This proliferation in turn depended on, and contributed to, changes in weaving practices.

Accompanying these historical changes in economic practices and complexity of woven products were changes in the way children represented weaving patterns in the experimental task that used sticks of varying width and color to reproduce weaving patterns. For example, instead of using three white sticks to represent a broad band of white cloth, a single broad white stick was more likely to be used in the later historical period, and those who attended school were more likely to be able to create novel patterns. These historical changes were accompanied by an unchanging pattern of representational development related to age; older children in both historical periods were more able than younger children to represent more complex visual patterns, a fact that Greenfield interpreted as an indication of universal developmental processes accompanying culturally contingent ones.

Scribner and Cole (1981) studied the cognitive consequences of literacy and schooling among the Vai, a tribal group residing along the northwest coast of Liberia. Although standard ethnographies of the Vai made them appear to be similar in most respects to their neighbors, they were remarkable because they had been using a writing system of their own invention for more than 100 years. Their literacy was acquired without any formal schooling.

The research was carried out in three overlapping phases. First, to understand the local organization of literacy, members of the research team conducted a survey of the social correlates of literacy and schooling that spanned all of Vai country and the Vai section of the capital, Monrovia, and conducted an ethnography of daily life in a single Vai village. They added a battery of psychological tests that had produced evidence of schooling effects on cognitive development to the survey to answer the most straightforward question one might pose: Does Vai literacy substitute for schooling in producing improved cognitive performance on learning, classification, and problem-solving tasks?

From this preparatory research, they learned that three kinds of literacy are to be found among the Vai: literacy in Vai, literacy in Arabic (mostly, but not entirely, to read from the Qur'an), and literacy in English, which was acquired in school. Neither Vai nor Qur'anic literacy

substituted for schooling with respect to psychological test performance; in general, those who had been to school performed better on the test battery, especially when asked to explain the basis of their performance (metacognitive awareness). The survey and ethnographic observations indicated that, unlike literacy acquired in school, Vai literacy involves no mastery of esoteric knowledge or new forms of institutionalized social interaction. It also does not prepare the learner for a variety of new kinds of economic and social activity in which mediation of action through print is essential. It is used primarily for keeping records and writing letters to kin living in other parts of the country. Learning is almost always a personal affair carried out in the course of daily activities (most often, when a friend of relative agrees to teach the learner to read and write letters).

In the second round of research, instead of seeking evidence of "cognitive change in general," the investigators sought to test the widespread notion that practice in reading and writing changes a person's knowledge of the properties of language itself. The tasks in this "metalinguistic survey" included the ability to define words, to engage in syllogistic reasoning, to distinguish between an object and its name, to make judgments about the grammaticality of various utterances, and to explain what was wrong in the case of ungrammatical utterances. Only the grammaticality task yielded a positive influence of Vai literacy. From observations of Vai literates engaged in their daily activities, the researchers knew that discussions of whether a phrase contained in a correspondence letter was in "proper Vai" or not were common, so it seemed most plausible to attribute Vai literates' skill in this area to their practices when writing and reading letters. But the investigators wanted to find a variety of everyday tasks where people used written Vai to carry out culturally valued activities. From an analysis of a large corpus of letters, they discovered that, although the contents were likely to be relatively routine and hence easy to interpret, they nonetheless contained various "context setting" devices to take into account the fact that the reader was not in face-to-face contact with the writer. They reasoned that extended practice in letter writing to people in other locales ought to promote a tendency to provide fuller descriptions of local events that might be needed for interpretation. This notion was tested by creating a simple board game similar to games common in the area but different enough to require rather explicit instructions. Vai literate and nonliterate people learned the game and then described it, either to another person face-to-face or by dictating a letter to someone in another village in enough detail for that person to be able to play the game based on the instructions alone. Vai literates were far better at this task than nonliterates, and among Vai literates, the degree of experience in reading/writing was positively associated with performance.

Vai literates also excelled at analyzing spoken words into syllables and at synthesizing syllables into meaningful words and phrases (for example, the word for chicken [tiye] and paddle [laa] when combined yield the word waterside), so by combining pictures, it was possible to make entire "sentences." The same kind of result was found when tasks were modeled on Qur'anic literacy practices, wherein children learned to recite the Qur'an by adding one word at a time to the first word of a passage. In an "incremental recall" task in which lists of words are built up by starting with a list length of one item and adding one item per trial, Qur'anic literates excelled. By contrast, when the order of the items changed from trial to trial (free recall), school literates performed better than Qur'anic literates.

Because this research included experimental procedures modeled on alternative literacy practices and schooled people performed more poorly than Vai literates in certain key cases, a richer understanding of the role of literacy in cognitive development offered itself. Formal schooling is constituted as a set of practices including the use of written texts no less than Vai or Vai forms of Qur'anic literacy. There is no more reason to attribute cases where schooled people excelled at tasks to their ability to read and write per se than there is in the cases where Vai or Qur'anic literates excelled. For example, the fact that schooling promotes skill in the verbal

explanation of problem-solving processes seems most naturally explained by noting that such skills are demanded by typical teacher–pupil dialogue in classrooms (Griffin and Mehan, 1980). Teachers often require students to respond to questions and demands such as, "Why did you give that answer?" or "Go to the blackboard and explain what you did."

A third example of cross-cultural research that focuses on the level of cultural practice has been carried out by Rogoff and her colleagues who have focused on the proclivity of children from many low-technology, traditional cultures to learn by carefully observing what their peers and elders are doing (Rogoff, Paradise, Meija-Arauz, Correa-Chávez, and Angelillo, 2003). In a typical study, the researchers arranged for 6- to 8-year-old children to observe a 10-year-old child being instructed on how to accomplish an origami paper folding task by a bilingual experimenter (Mejia-Arauz et al., 2005). The children were either from Mexican heritage or European American heritage homes living in a coastal town in California. Half of the Mexican heritage children had mothers with less than a high school education, whereas half of them had mothers with more than a high school education. All of the European American heritage children had mothers with more than a high school education. Based on evidence from many traditional (indigenous) societies, Mexican heritage children were expected to observe more intently and ask for fewer explanations than their European heritage counterparts. This was confirmed, at least, for the Mexican heritage children whose mothers had attained lower levels of education. However, those Mexican heritage children whose mothers had gone beyond high school behaved more like their European American counterparts than their peers. They did not engage in as much intent observation, and they asked for a good deal more verbal explanation. These results led Mejia-Arauz et al. (2005, p. 290) to conclude that:

> Participation in school may socialize specific practices that then gradually become part of indigenous and indigenous–heritage people's own ways of doing things when former schoolchildren become parents, supplanting a traditional emphasis on learning by observation.

A final example of how cognitive skills develop when a society creates artifacts and cultural practices to support more complex cognitive achievements comes from studies of involvement in the use of an abacus in Japan (Hatano, 1997). An abacus is an external memory and computational device. It can register a number as a configuration of beads, and one can find the answer to a given calculation problem, in principle, by manipulating the beads. People can learn how to operate an abacus in an elementary but serviceable manner in a few hours when they participate in deliberate instruction. Advanced training is geared almost entirely to accelerating the speed of the operations involved. Values respecting the speed of calculation are shared among abacus operators.

As a result of extensive training, abacus operation tends to be gradually interiorized to such a degree that most abacus masters can calculate accurately and even faster without a physical abacus present than with the instrument itself. During mental calculation, it appears that they can represent an intermediate, resultant number on their "mental abacus" in the form of a mental image of the configuration of beads, onto which (mentally) they enter, or from which they remove, the next input number. In other words, abacus experts can solve calculation problems by mentally manipulating the mental representation of abacus beads. The interiorization of the operation is an important mechanism for accelerating the speed of calculation because the mental operation is not constrained by the speed of muscle movement. Thus, expert abacus operators use the real abacus only when they calculate very large numbers that cannot be represented on their mental abacus. Abacus operators calculate extraordinarily rapidly (Hatano, 1997). When mixed addition and subtraction problems are presented in print, experts manipulate 5 to 10 digits per second. Remarkable speed is also observed for multiplication and division.

The case of gaining expertise in abacus operation (both material and mental) exemplifies the sociocultural nature of expertise (Hatano, 1997). Pupils who attend abacus classes are usually first sent there by their parents while in elementary school. The parents often believe that the exercise will foster children's diligence and punctiliousness as well as enhance their calculation and estimation ability. Young pupils are motivated to learn abacus skills to get parental praise, especially by passing an exam for qualification.

The students' motivation changes when they join an abacus club at school or become a representative of the abacus school, in other words, when the operation is embedded in a different kind of practice. Abacus enthusiasts compete in matches and tournaments, as tennis or chess players do. Also like these players, abacus club members not only engage in exercise at least a few hours every day, but also seek knowledge of how to improve their skills. Their learning is strongly supported by the immediate social context of the club and the larger community of abacus operators.

Abacus operators are also socialized in terms of their values, for example, regarding the importance of abacus skills and their status in general education, as well as their respect for the speed of calculation mentioned earlier. In fact, the community of abacus educators and players constitutes a strong pressure group in the world of education in Japan. In this sense, gaining expertise is far from purely cognitive; it is a social process (Lave and Wenger, 1991), and it involves changes in values and identities (Goodnow, 1990). The experts' values and identities are undoubtedly forms of "culture in mind," acquired through internalization. They serve as the source of motivation for experts to excel in the target domain.

Expertise in mental abacus operation also induces changes at neural levels. For example, using event-related fMRI, Tanaka, Michimata, Kaminaga, Honda, and Sadato (2002) showed that, whereas ordinary people retain series of digits in verbal working memory (revealed as increased activation in the corresponding cortical areas including the Broca's area), mental abacus experts hold them in visuospatial working memory, showing activations in bilateral superior frontal sulcus and superior parietal lobule. Hanakawa, Honda, Okada, Fukuyama, and Shibasaki (2003) demonstrated, also using fMRI, that the posterior-superior parietal cortex was significantly more activated while mental additions were performed among mental abacus experts than nonlearners of abacus.

Conclusion

These are only bare outlines of contemporary approaches to culture and cognitive development. It now seems well established that culture is more than an "add on" to a phylogenetically determined process of cognitive development. Culture matters. In Geertz's terms, it is an "ingredient to the process" of cognitive development because the biological and cultural heritages of human beings have been part of the same process of hominization for millions of years. Claims for this interdependence are bolstered by modern brain imaging techniques that amply demonstrate that culturally organized experience, whether organized at the level of societies as a whole or at the level of cultural practices, has clear influences on brain organization and functioning.

An issue that requires a good deal more thought concerns the connections among cultural patterns, cognitive styles, and cultural practices. On this point, there is as yet no firm agreement among scholars. Many adhere to the notion that broad cognitive styles, although acquired in specific cultural practices, are based on society-wide, historically accumulated designs for living, so that it makes good sense to speak of East Asian versus European or American cognitive styles that shape human cognition in virtually all domains of human experience from conceptions of the self to forms of perception, attention, problem solving, and social interaction. Even some who focus on cultural practices as the proximal locus of cultural influences on cognition believe that such practices are significantly shaped by overall cultural patterns that can be

contrasted in terms of overarching binary oppositions such as interdependent versus independent cultural/cognitive styles.

Others place more emphasis on cultural practices as the primary locus of cultural variations in cognitive development and take the view that the degree to which patterns of behavior learned in specific cultural practices become general in a cultural group is the result of the linkages between cultural practices that are never totalizing in their effects. Thus, for example, the range of literacy practices among the Vai is restricted relative to the range of practices associated with literacy in technologically advanced societies. The reasons for this restricted range among the Vai may be many, including absence of a technology of mass production, legal restrictions placed by the central government on the use of Vai script in civil affairs, adherence to a religion that uses a completely different writing system and a foreign language, and so on. Scribner and Cole's (1981) activity-based, cultural practice approach emphasized that, if the uses of writing are few, the skill development they induce will also be limited to accomplishing a narrow range of tasks in a correspondingly narrow range of activities and content domains.

However, when technological, social, and economic conditions create many activities where reading and writing are instrumental, the range of literacy skills can be expected to broaden and increase in complexity. In any society where literacy practices are ubiquitous and complexly interrelated, the associated cognitive skills will also become more widespread and complexly related, giving the (false) impression that engagement in schooling induces generalized changes in cognitive development.

With respect to the differences between Mexican heritage and European American heritage children's proclivity to learn through intent observation, formal, literacy-based schooling is usefully considered as a complex set of cultural practices. Involvement in those practices induces practice-specific learning, but it may also "seep into" practices of the home and community. Hence, one sees changes in children's proclivities to engage in learning through intent observation, not because of a society-wide difference in cognitive style that shapes their involvement in specific practices (folding paper to make objects) but because of the interconnection of home and school practices in the lives of their parents, whose own lives were changed by the practices they engaged in as youngsters. As Rogoff and Angelillo (2002) describe their approach, their aim is to examine a pattern of approaches to learning that relates to a constellation of cultural practices. This approach to culture, focusing on multifaceted and coherent cultural practices rather than on variables "independent" of each other, allows examination of cultural patterns that would be obscured if all but a few differences between communities were "controlled."

The challenge for students of culture and cognitive development is to work out more systematically the degree of generality of cultural patterns across practices, their sources, and their consequences for cognition. This work has been put on a firmer foundation as a result of the research carried out in recent decades, but there is still a long way to go before we can claim a firm understanding of the intricate ways in which culture and cognitive development relate to each other.

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