Culture and Cognition

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It seems safe to say that most psychologists in the 20th century held strongly to four assumptions about cognition.

1. Basic cognitive processes are universal: every normal human being is equipped with the same set of attentional, memorial, learning, and inferential procedures.
2. The basic cognitive processes work in much the same way regardless of the content they operate on.
3. General learning and inferential processes provide the growing child with all it needs to learn about the world. Content is supplied by these cognitive processes operating on the environment.
4. Since the social, political and economic worlds of different people are different, the content of human minds – theories, beliefs, values, etc. – is indefinitely variable.

These assumptions were fostered by the major theoretical positions of the 20th century. Learning theorists believed that they were looking at procedures that applied not only to all humans but to all mammals and perhaps to other animals as well. A limited number of processes accounted for most learning (though different theorists had different favorites – the reflex arc, the S-R connection, operant conditioning, etc.). Piaget spelled out a list of "formal operations," such as *modus ponens*, the *probability schema*, etc., which he regarded as the fundamental deductive and inductive rule schemas necessary to understand the world. The cognitive revolution, from its earliest incarnation in the work of such theorists as George Miller and Herbert Simon, until nearly the end of the 20th century, essentially embraced Piaget's position of extreme formalism and content independence of inferential rules. Cognitive scientists' endorsement of the formalist, universalistic position was undoubtedly encouraged by the analogy between the human mind and the computer: brain = hardware, cognitive procedures = operating principles and factory-installed software (Block, 1995). This analogy both encouraged the universality assumption and discouraged any assumption that cognitive procedures might be alterable. The heuristics and biases movement of Kahneman and Tversky (1974) and their colleagues in social psychology (Nisbett & Ross, 1980) encouraged the view that procedures such as judgment of probability by the representativeness heuristic, and judgment of frequency by the availability heuristic, were primary, universal, and difficult to alter.

As Richard Shweder (1991) pointed out, the major theoretical stances to one degree or another presume a "central processing device. The processor, it is imagined, stands over and above, or transcends, all the stuff upon which it operates. It engages all the stuff of culture, context, task and stimulus materials as its content" (p. 80). In this chapter we review evidence concerning assumptions about universality and content independence. Some of this evidence has been around for a long time, but most of it is quite recent. We believe the evidence casts substantial doubt on each of the standard assumptions about cognitive processes. In particular, we maintain that there is good reason to believe the following propositions.

1. Some cognitive <u>content</u> is universal: babies are born prepared to develop particular models of the world, including theories of mechanics, theories of natural kinds, and a theory of mind.
2. Universal content of these and other kinds place constraints on the diversity of human thought as well as the range of cultures possible.
3. Some cognitive processes normally regarded as basic are highly susceptible to change even for adults.
4. Cultures differ markedly in the sort of inferential procedures they typically use for a given problem.

5. Cultural differences in cognitive processes are so tied to cultural differences in basic assumptions about the nature of the world that the traditional distinction between content and process begins to seem somewhat arbitrary.
6. Cultural practices and cognitive processes constitute one another. Cultural practices encourage and sustain certain kinds of cognitive processes, which then perpetuate the cultural practices.

Interestingly, in the late 19th century and early 20th century, there were voices arguing that a great deal of cognitive content is part of the natural endowment of humans. These included the philosopher Charles Sanders Peirce and the philosopher-psychologist William James. Even more surprisingly, Wilhelm Wundt (1916), generally regarded as the father of experimental psychology, held the view that the human psyche could not be understood by laboratory techniques alone, but that cognitive processes studied in the laboratory had to be supplemented with evidence from history, ethnography, and linguistics. This is because he also believed that, when cultures and histories diverged, cognitive processes would also diverge:

> [Folk psychology's] … problem relates to those mental products which are created by a community of human life [e.g., language, religion] and are, therefore, inexplicable in terms merely of individual consciousness, since they presuppose the reciprocal actions of many … Individual consciousness is wholly incapable of giving us a history of the development of human thought, for it is conditioned by an earlier history concerning which it cannot in itself give us any knowledge (Wundt, 1916, p. 3).

Thus both the idea that some content is natively endowed and the idea that some processes are malleable have a long and distinguished history within psychology.

COGNITIVE SHAPING OF CULTURAL PHENOMENA

There is mounting evidence that not just any beliefs, or ways of constructing the world, are possible for humans. It turns out that there are substantial regularities in the ways that people label and organize the perceptual and conceptual worlds, and that these characteristic patterns are observable from a very early age. The most convincing evidence deals with infants' understanding of the physical world and of mental life, but there is also persuasive evidence that folk theories of society and religion are constrained by universal cognitive structures.

Folk Theories about the Nature of the World

Much recent evidence suggests that the human infant comes equipped with theories about the natural and psychological worlds. Theories of mechanics and physics (Baillargeon, 1995; Carey & Spelke, 1994; Leslie, 1982; Spelke, 1988; Spelke, 1990), theories of biology (Atran, 1990; Atran, 1995; Berlin, 1992; Berlin, Breedlove, & Raven, 1973; Gelman, 1988) and theory of mind (Asch, 1952; D'Andrade, 1987; Leslie, 1994; Wellman, 1990) appear so early that it seems probable that they have substantial innate components. It is possible to show that infants as young as three months are surprised when events violate expectancies about the physical world that would be based on accurate presumptions about the nature of mechanical causation. Theories about the links between environmental cues, and between environmental cues and internal cues, are also highly "prepared" (Seligman, 1970). For example, omnivorous mammals (including humans) will make the connection between distinctive-tasting food and gastrointestinal illness experienced many hours later (Garcia, McGowan, Ervin, & Koelling, 1968). Much more general links, such as those concerning anticipated temporal contiguity between an event and a prior causal candidate, or between classes of stimuli and appropriate response, also appear to be prepared biologically. For example, dogs readily learn to go left vs. to go right when the signal is a tone coming from a high location vs. a low location, but learn this

distinction with great difficulty if it is the pitch of the tone that differs. Contrariwise, dogs learn "go-no go" readily from the pitch of tones but learn this distinction only with great difficulty from the location of tones. (See Seligman, 1970, for a review of the preparedness literature.)

Regularities in theories about the world, as well as apparent domain specificity of learning mechanisms, serve as building blocks of cultures and place some limits on the range of beliefs and forms of expression that can be found in different cultures. One of the first people to express this view was Claude Lévi-Strauss (1966; 1967) who maintained that people habitually construe meaning using binary contrasts. For example, he showed how myths were constructed using contrasts between nature and culture, good and evil, raw and cooked. It seems that all societies use the human body, including its sexual and excretory processes and the contrast between male and female bodies, to stand as symbols for a variety of relations in both the natural and the social worlds. For example, Needham (1973) showed that there is a widespread tendency to contrast the right hand with the left, and to value the right. We do not know the psychological foundations for these universals, and the mere fact that they are so widespread cannot be taken to mean that their implications are deep. But they do suggest the possibility that the natural contours of the mind place limits on the kinds of symbols and social relations that cultures are likely to invent.

A general theory of the constraints that cognition may place on culture has been proposed by Sperber (1985; 1994; 1996) and his cognitive anthropologist colleagues. This approach seeks to explain cultural features in terms of the "ecology of belief," that is, the distribution of ideas in a population, on the one hand, and psychological constraints on cognition and communication on the other. The basic notion of this "epidemiological" theory is that some ideas, partly because of innate qualities of the human mind, and partly because of prior ecological conditions, are "easier to think," easier to communicate, and more likely to spread to other minds (that is, more "contagious") than are other ideas. Such ideas are learned in all cultures with little or no instruction (Atran & Sperber, 1991) and they spread from one culture to another with relative ease. To explain culture, then, is to explain the socio-cognitive processes by which such contagious ideas spread and stabilize in a population of minds.

The work of Berlin and his associates on folk-biological classification provides an example of cross-cultural uniformity in a content area that most scholars had previously assumed to vary widely. Berlin and colleagues (Berlin, 1992; Berlin et al., 1973) showed that, in spite of wide variation in the plants and animals that any particular group comes in contact with, and despite the fact that many of these plants and animals lack any cultural significance for the particular group, there is marked consistency in the way that people everywhere categorize organisms. In developing this notion, Atran (1990; 1994; 1995; 1998) has argued that all human groups use similar folk-biological categories that are "essence-based" and organized around the notion of species. Rankings of species into lower- and higher-order groups – species, genera, families, life forms, etc., is the same in cultures as different as those of American college students and non-literate Mayans. He maintains that folk taxonomies have strongly constrained the historical development of the species concept and other taxonomic concepts in scientific biology.

It is important to note that the uniformities found in people's categorization habits are not a result of their simply placing plants and animals into categories on the basis of mere perceptual similarity. Gelman (1988) and others have shown that categorization judgments even by young children are heavily theory-guided, and that theoretical beliefs about species relations can override perceptual similarity when children make inductive inferences.

Folk Theories About Religious and Social Concepts

Pascal Boyer (1993; 1994) has provided a treatment of religious beliefs that emphasizes the cognitive foundations of culture. He notes that the religions of many cultures manifest such similar notions that it seems unlikely that these confluences are the result of chance. Most religious systems contain the notion that something non-physical remains after a person dies, and that this spirit becomes an intentional, invisible being. Most religions also hold to the belief that a few individuals are in contact with the supernatural – beings such as gods and spirits (Boyer, 1993). Following Sperber (1985), Boyer holds that regularities in religion are the result of the fact that religious ideas, like other cultural ideas, exploit the properties of the minds that represent these ideas – theories of physics, biology, and mind. The feature distinguishing religious concepts from other cultural concepts is that they typically involve systematic violations of these domain-specific theories, while being otherwise firmly embedded in such theories. For example, a spirit conforms to most of our assumptions about living things, including intentionality, except that it violates a specific aspect of our theory of biology (it survives after death) and physics (it is invisible, and can go through physical obstacles).

Hirschfeld (1996; 1988; 1994) makes similar claims about social categories. He notes that there is good evidence that the development of racial and gender concepts is similar in many groups and may well be largely independent of any explicit teaching about either racial or gender differences. He asserts that "children are prepared to find that humans come in groups, that is, they have social identities" (1994, p. 222). Children's understanding of social categories is an essentialist one which assumes that, just as tigers have an essence that makes them tigers no matter how transformed, humans have racial and gender essences.

The complement of the highly successful and contagious cultural ideas are those that, though often invented in human history, quickly fade. An example from a noncognitive domain is the repeated invention, never successful for long, of a community whose sexual relationships are unrestricted by anything resembling marriage. There are also examples of concepts that are difficult to acquire. For example, scientific notions that do not closely resemble folk ideas can be very difficult to teach. Sophomores who have had physics still reason about some events as if they were adherents of an inertial theory of mechanics (Champagne, Klopfer, & Anderson, 1980; McCloskey, 1983). And every social psychologist knows how difficult it is to disabuse students of certain convictions about human nature. Examples of ideas that are particularly "noncontagious" would be helpful in building a general theory of the cognitive constraints on culture.

CULTURAL SHAPING OF COGNITIVE PHENOMENA

The idea that culture profoundly influences the contents of thought through shared knowledge structures has been a central theme in modern cognitive anthropology. Psychology has provided a set of concepts that are useful for describing these knowledge structures. *Schema*, for example, refers to knowledge structures that govern thought by selective attention, retention, and use of information about a particular aspect of the world. Built into a schema is the specification of how its parts relate to each other and to the whole. For example, the schema for "going to the museum" may include the following interconnected behaviors, "waiting in line, buying ticket, keeping silent, admiring objects, not touching objects," etc. Schemas can be about people, objects, situations, events, and sequences of events. Drawing on this concept, the cognitive anthropologist Roy D'Andrade (1984; 1995) has introduced the idea of cultural schemas, patterns of basic schemas that make up the meaning system of a cultural group. Those cultural schemas that are intersubjectively shared in a group are known as cultural models

(D'Andrade, 1995; Holland & Quinn, 1987; Shore, 1996). Cultural models govern the ways by which people interpret their experiences and guide action in a wide range of life domains. An especially important kind of cultural model is a script (Schank & Abelson, 1977). A script is an event schema that stipulates the people who appropriately take part in the event, the social roles they play, the objects they use, the sequence of actions they engage in. It is easy to see why scripts are crucial to the give-and-take of everyday cultural life, such as the functioning of institutions, the performance of rituals, and playing games. As Katherine Nelson maintains, "Without shared scripts, every social act would need negotiating afresh" (1981, p. 109). 109).

The schema notion helps to organize and explain how it is that the contents of human minds can differ so radically across cultures as it obviously does, but does culture influence the very thought processes by which people cognize the world? Some early anthropologists and psychologists held the view that different peoples indeed reason differently. Wilhelm Wundt, in proposing a cultural psychology to complement experimental psychology, certainly thought so when he wrote, "All phenomena with which the mental sciences deal are, indeed, creations of the social community" (1916, p. 2). The French sociologist Levy-Bruhl (Levy-Bruhl, 1910) believed there was a characteristic "primitive" thought that did not understand the world in terms of causal sequences and tended to merge emotion and cognition. Levy-Bruhl did not regard primitive thought as inferior but merely as different – and not different in a fundamental pragmatic sense: "…in their everyday activity, when they are not being influenced (misled) by their collective representations, 'they' think the same as 'we' would, drawing the same conclusions from the same kinds of evidence" (Cole, 1996, p.17).

The Linguistic Relativity Hypothesis

In George Orwell's novel 1984, the police state introduces a new artificial language, Newspeak, designed to discourage the people from thinking certain kinds of thoughts that are deemed to be dangerous. Can this fictional attempt at thought control succeed in real life? One of the most famous early considerations of the notion that culture influences thought is embodied in the linguistic relativity or Sapir-Whorf hypothesis (Whorf, 1956), the contention that the particular language people speak affects thought. Despite the long-standing interest that this hypothesis has generated in the social sciences, sustained empirical research on it has been infrequent, and many of the past results have been inconclusive. Recently, however, there has been a new surge of systematic, compelling studies that support the linguistic relativity hypothesis.

In an early attempt to address the linguistic relativity hypothesis, Berlin and Kay (1969) examined color classification across cultures. They found that color names are assigned in terms of an orderly hierarchy. In the few cultures where there are only two color names, these are black and white. If a third color is added, it is red. The next tree color terms are likely to be yellow, blue, and green, etc. Berlin and Kay also concluded that, though boundaries of color terms vary across cultures and languages, the focal point of each basic color (e.g., the most prototypical red in an array of reds) is essentially the same. The work of Berlin and Kay has been interpreted to indicate that there is a universal, physiological basis to color classification.

The pioneering work of Heider (subsequently Rosch) (Heider & Oliver, 1972) supported Berlin and Kay's analysis. Working with Dani tribesmen in New Guinea whose language has only two basic color terms, Heider and Olivier showed Dani and English speakers color chips, and then tested for recognition of the chips a few seconds later. Using this procedure, memory for color was largely independent of color vocabulary, and consistent with the proposal of Berlin and Kay, focal colors showed better memory than non-focal colors for both English speakers

(Americans) and the Dani. This work has been generally taken as clear evidence against the linguistic relativity hypothesis. However, it has been criticized on methodological grounds for its narrow scope, and for lack of subsequent studies confirming the findings of the original studies with other tasks or linguistic groups (Hunt & Agnoli, 1991; Lucy, 1997; Lucy & Shweder, 1979; Saunders & van Brakel, 1997).

Recently, thought-provoking new research has emerged that questions the findings of Heider and Olivier (1972), and offers new evidence for the influence of linguistic color terms on color perception and memory. Roberson, Davies, and Davidoff (Robeson, Davies, & Davidoff, 2000) sought to replicate and extend the original studies of Heider and Olivier (1972) with the Berinmo of Papua New Guinea, a hunter-gatherer people who speak a language that has only five color terms. In a series of experiments, they found convergent lines of evidence for linguistic relativity in color perception and memory. (1) Berinmo patterns of naming and memory were statistically more similar to each other than Berinmo memory was to English memory patterns; (2) when the discriminability advantage of focal colors was removed, the memory advantage of focal colors relative to non-focal ones disappeared for both English speakers and Berinmo speakers; (3) category learning for focal versus non-focal colors did not differ. Thus there was no evidence that the Berinmo have an underlying cognitive organization of color that favors the foci of the eight English basic chromatic color categories (with the possible exception of focal red). (4) Overall, Berinmo speakers' performance in color categorization was considerably poorer than that of English speakers, replicating Heider & Olivier's (1972) finding with the Dani. However, Roberson et al. (2000) were able to show that Berinmo and English-speakers did not differ in a similar visual-spatial memory task that did not involve the color domain. This suggests that the poorer memory performance of the Dani and the Berinmo could be explained by the poorer color vocabularies of Dani and Berinmo, rather than unfamiliarity with a formal test situation or lack of formal education, as Heider & Olivier (1972) suggested. Furthermore, Roberson et al. (2000) observed that evidence for the influence of color terms on color categorization can be found even in Heider & Olivier's (1972) data.

An ambitious effort to examine the linguistic relativity hypothesis in number marking has been carried out by Lucy and his colleagues (Lucy, 1992a; Lucy & Gaskins, 1997). Following an early study by Carroll and Casagrande (1958), they examined the extent to which linguistic differences in number marking affect thought. Yucatec Maya and many other languages (e.g., Chinese, Japanese) differ from English in number marking patterns. English numerals directly modify their associated noun (e.g, one candle). Yucatec numerals are always accompanied by a numeral classifier that describes the material of the counted object (e.g., one long thin wax). Does this lead to different patterns of categorizing objects? In non-verbal classification tasks, participants were presented with a triad of objects that differed on material or on shape (e.g., candle, stick, wax). Consistent with the lexical structures of these two languages, Yucatec speakers showed a preference for material-based classification, whereas English speakers showed a preference for shape-based classification.

Another line of research, by Levinson (1996) and colleagues, focuses on linguistic variation in the coding of spatial location. Speakers of English and other Indo-European languages favor the use of body coordinates to represent the location of objects (e.g., "the man is on the right of the house"). In contrast, Guugu Yiimithirr (an Australian language) favors fixed cardinal direction terms ("the man is west of the house"). Is this difference in linguistic convention implicated in cognition? The researchers created non-linguistic tasks that measured performance in locating objects, and manipulated the sensitivity of the two spatial referent

systems to rotation. As expected, speakers of Guugu Yiimithirr were unaffected by the rotation manipulation in locating objects accurately. English speakers, in contrast, were thrown off by the same rotation manipulation, being less accurate in locating the objects.

A well-known experimental attempt to test a linguistic relativity hypothesis is Alfred Bloom's (1981) work on counterfactual or hypothetical reasoning. Bloom noticed that the English language has an explicit linguistic device to code counterfactuals (the subjunctive mode—e.g., "If I were rich, I would travel the world"). Not so in the Chinese language, which instead expresses counterfactual meaning by relying on context, combined with the use of if-then statements. In a series of studies, Bloom gave English and Chinese speakers, as well as Chinese-English bilinguals, controlled counterfactual stories, and found that Chinese speakers did more poorly in counterfactual reasoning than English speakers. However, Au (1983) and Liu (1985) have criticized Bloom's work, raising questions about the accuracy of the Chinese translations of the stories. Furthermore, there is little doubt that Chinese are capable of counterfactual reasoning in everyday life. The Chinese surely could think, "If I were only 5 minutes early, I would not have missed the train!" The question then, is whether or not the lack of a simple linguistic device to mark counterfactuals in Chinese language renders counterfactual reasoning less likely (Hunt & Agnoli, 1991). As we will see later, there is a case to be made that Chinese are indeed less likely to engage in hypothetical or counterfactual reasoning than Westerners, though for reasons that may have more to do primarily with cultural factors rather than differences in grammatical categories.

To summarize, after an initial period of mixed findings, growing new evidence supports the Sapir-Whorf contention that linguistic differences affect thought. Solid evidence has been found for the cognitive effect of linguistic differences in number marking (Lucy, 1992), the coding of spatial location (Levinson, 1996), and even color categorization (Roberson, et al., 2000). The work supporting linguistic relativity has profound implications for psychology, and more specifically, for the cultural mediation of thought. To the extent that societies have diverged in their linguistic conventions, so would cognitive processes, to some degree. Clearly, however, more research is needed to examine the pervasiveness of the influence of language on thought. Furthermore, the tools of experimental psychology can be profitably used to examine in more detail the cognitive processes that mediate the linguistic control of thought. Finally, it is important to distinguish linguistic effects from other cultural effects on thought, for example effects due to social practices, epistemic beliefs, or expertise in a domain. These questions are particularly difficult to untangle because non-linguistic cultural patterns and linguistic conventions that correlate with the same cognitive orientations tend to co-occur in societies.

Mathematical Tools and Mathematical Thinking

Nothing seems more natural than manipulating numbers. Mathematical thinking exists in all societies, and is an essential aspect of everyday reasoning. Human infants appear to be born with a "number sense," an intuitive arithmetic system that allows them to represent quantity in the world (Dehaene, 1997; Wynn, 1990). Because mathematical reasoning appears so early in human cognition and is so widespread, it is easy to lose sight of the fact that every time we manipulate numbers, we exploit a host of cultural tools invented and modified over historical time by cultural predecessors. But just as societies have historically diverged in their use of linguistic conventions, they have also diverged in their use of mathematical concepts, procedures, and symbols. For example, the now widespread base-10 structure (evident in Indo-Arabic numerals and Chinese numerals) was one of many systems invented in different societies around the world (Meninger, 1969), including systems based on 2 (Bushmen of Botswana), 20

(Mayan and Aztec), and 60 (Ancient Babylonian). Languages also differ in the way numbers are named, the extent to which procedural irregularities appear in counting, and in their numerical notation systems, e.g., Arabic numerals versus Roman numerals (Miller & Paredes, 1996). Thus, a question similar to the Sapir-Whorf hypothesis can be asked in the domain of mathematical cognition: to what extent do cultural differences in number naming systems and numerical notation systems affect mathematical thinking?

Following Miller and Paredes (1996), we address this question by breaking it down to three specific questions: First, how does the structure of mathematical symbols affect the initial acquisition of these symbols in children? Second, how does the structure of symbols affect mathematical thinking? Third, how does the structure of symbols affect conceptual understanding of the domain itself, i.e., numbers?

Effects on Initial Acquisition of Mathematical symbols. Miller, Smith, Zhu, & Zhang (1995); see also Miller & Stigler (1987), examined the development of counting in 3-5 year old Chinese and American children. An interesting difference between the Chinese and English languages is that for certain blocks of numbers (especially the 10-20 block), the base-10 structure is less obvious in English than it is in Chinese. Is this structural difference between the two languages reflected in the way children learn to count? The answer is yes. Results revealed a complex pattern of similarities and differences in number acquisition that betrayed the structural differences of English and Chinese counting systems.

The authors found (1) No differences in learning to count from 1-10, where both cultures rely on rote learning, given that base-10 principles do not apply. (2) However, a cultural difference emerged, favoring Chinese children, for counting in the second decade (10-20), where base-10 principles are first learned, and where Chinese has simpler and more consistent names for teens that better reflect base-10 principles. This cultural gap increased from age 4-5. (3) No cultural differences were found for counting from 20-99, where both Chinese and English converge on a common structure of number names. (4) Interestingly, for counting beyond 100, the pattern of cultural difference reversed, now favoring American children. This could be explained by the fact that for the first decade above 100, Chinese introduces a novel element (ling) in number names, which seems to pose some difficulty to Chinese children, resulting in greater error rates. Finally, it is important to note that no cultural differences were found in tasks consisting of object counting and simple mathematical problem solving. Thus, the cultural differences are selective, emerging only when the structural differences in number naming are implicated in the number acquisition task.

Effects on Mathematical Thinking. Paredes (1995, cited in Miller & Paredes, 1996) asked grade school students in China and the United States to mentally add two double-digit numbers (e.g., 27+14). Some participants received the task in Arabic numerals (the number condition), whereas others (the word condition) received it in the orthography of their native language (English or Chinese names for numbers). In the number condition, no differences in accuracy were found, although Chinese children were faster. In the word condition, however, systematic differences in accuracy emerged, reflecting the peculiarities of English and Chinese number naming. For example, Chinese children made more errors that were indicative of inappropriate transferring of algorithms from Arabic numeral system to the Chinese name-value system. American children did not make such errors (but nevertheless made different kinds of errors), because in this particular task number naming in English does not present such opportunities for inappropriate transferring from Arabic numerals.

Similar findings have been obtained with people trained with the abacus, a manual counting device that is popular in East Asia. Thus, compared to American college students, abacus-users make computational errors that reflect the structure of the abacus calculation system, and their calculation speed correlates with the number of steps required in the abacus calculation system (Hatano & Osawa, 1983; Stigler, 1984). Recent research has also revealed that linguistic differences in calendar structure can affect mental calculation of time. Although Chinese and English use the same 7-day week and the same 12-month year, they differ in their naming patterns. Chinese uses a consistent numerical system for naming months and days, whereas English uses names of ancient gods (for naming days of the week) and an irregular combination of gods, kings, and number names. Kelly, Miller, Fang, and Feng (1999) asked children as well as college students in China and the United States to name the day or month that comes a specified time before or after a given day or month. Consistent with the simple numerical structure of the Chinese calendar, the Chinese solved this task by relying on simple arithmetic, whereas the Americans had to resort to reciting calendar names. Consequently, Chinese children and college students calculated time faster than American children and college students. In fact, the magnitude of the differences was so great that for some difficult tasks, Chinese children performed at speeds comparable to American adults!

Effects on Conceptual Understanding of Numbers. Miller and Stigler (1991) compared Chinese children who were abacus experts with American children who were novices. They found that use of the abacus influenced the very nature of their representation of numbers. For example, similarity judgments of numbers revealed a greater reliance on the odd/even dimension on the part of the abacus users, whereas novices placed greater reliance on number magnitude. A developmental trend was also found, such that there was a growing emphasis on the odd/even dimension with age among children who were abacus users. Finally, Miura, Kim, Chang, & Okamoto (1988) found that first graders in China showed greater understanding of base-10 principles than first graders in the United States, presumably because base-10 principles are more transparent in the Chinese number naming system.

CULTURAL-HISTORICAL PSYCHOLOGY

Perhaps the most significant early research program to promote the idea that culture fundamentally shapes thought is that of the influential Russian School of Lev Vygotsky (1978) and Alexander Luria (1971), and their associates in the West, including especially Michael Cole and his colleagues (Cole, 1996; Cole & Scribner, 1974). The Russian School continues to influence a wide range of contemporary research on culture and cognition which we will discuss in the remainder of this chapter. The Russian School stands as a stark contrast to the prevailing assumption of experimental psychology that there are unitary, unchanging, universal cognitive processes that operate across contexts, cultures, and historical periods. At the heart of the Russian School is the idea that cognitive processes emerge from practical activity that is culturally constrained and historically developing.

Cognitive processes operate in sync with tools or artifacts in everyday practical activities. Tools can be symbolic, as in the case of languages, numeric systems, and rules for games; as well as material, as in the case of axes, needles, and bowls. Human cognition has coevolved with tool use for most of recent human evolutionary history. As a result, cognitive structures emerge as individuals interact with tools in everyday practical activity, such as when hunting, playing, weaving, or speaking. This Vygotskian notion that cognition is embedded in practical activity has encouraged a family of contemporary research programs that is generally known as situated cognition (Lave & Wenger, 1991; Resnick, 1994; Rogoff, 1990). Researchers in this tradition

investigate how cognitive activity is intimately tied to the particular social context in which it naturally occurs. This is achieved by examining how cognitive activity interacts with tool use; how it embodies the values and assumptions of a community of learners; and how it is shaped by social interactions, such as between parent and child, teacher and student. The methodological preference is to study knowledge acquisition in its everyday naturalistic setting, such as studies of mathematical thinking among candy-selling Brazilian children (Saxe, 1991), or arithmetic among tailors in West Africa (Lave, 1977). Research has also examined cognitive processes in social functions that are sufficiently complicated, such as navigating ships, that the cognitive implementation of the task by a single individual becomes impossible (Hutchins, 1995; Seifert & Hutchins, 1992). This necessitates a delicate process of joint social coordination in context, so that cognition becomes "distributed" across individual minds and artifacts.

According to the Russian School, human cognition develops in a species-specific medium, that of culture, which is the accumulated pattern of tool-use throughout the historical existence of a group. The various social activities that a child engages in interact with primitive cognitive structures. The child gradually internalizes these social activities and develops ever more complex cognitive structures. Cultural variation in cognition emerges as a result of the different historical developments of societies, leading to different social activities and tools, which then lead to different thought processes that are congruent with the particular historical trajectories of societies. Thus Luria envisioned a historical science of psychology: "Psychological processes, and most of all, higher, specifically human, forms of psychological activity…must be understood as a social phenomenon in origin, mediated in their structure, and consciously and willfully directed in their functioning… psychological processes are of historical character and…psychology must be understood as a historical science…" (1971, p. 272).

A pioneering attempt to study how cultural-historical factors transform thought processes was an expedition to Central Asia by Luria and his colleagues in the early 1930s (1971). The purpose of this project was to examine the effects of massive social and economic reforms in remote regions of Central Asia on the logical reasoning of Uzbek peasants. Luria and colleagues presented simple syllogisms in a quasi-experimental format to four groups of people who were at different degrees of modernization: Non-literate women in remote villages who did not participate in formal economic practices; non-literate men who were engaged in traditional farming; young activists involved in collective farming (some of whom were minimally literate); and women attending teacher training schools (Scribner, 1977). If logical reasoning is a universal property of the mind that is impervious to historical changes, then no differences in logical reasoning would be observed among these four groups. However, to the extent that cognitive structures are transformed by historical change in socio-economic and educational conditions, greater exposure to modernization would lead to more reliance on formal logic.

Luria and his colleagues found marked variation in logical reasoning. The strongest results emerged for syllogisms with contents unfamiliar to the villagers. Villagers living traditional lives had the most difficulty with problems that did not conform to their everyday experience, suggesting that their responses were driven by a concrete, knowledge-based approach to reasoning. In some extreme cases, this pattern led to the refusal of some individuals to engage in the logical reasoning task at all, on the grounds that the contents of the problems were unfamiliar, making the problem in principle unanswerable. For example, one of Luria's unfamiliar problems was, "In the far north all bears are white. Novaya Zemyla is in the far north. What colors are the bears there?" To which one participant responded, "But I don't know what kind of bears are there. I have not been there and I don't know. Look, why don't you ask old man

X, he was there and he knows, he will tell you." (Luria, 1971, p. 271). In contrast, the same unfamiliar problems posed no difficulty to those who had some exposure to schooling.

Several studies on logical reasoning in traditional versus industrialized societies followed the Central Asian investigation of Luria and his colleagues. Most notable are studies conducted with the Kpelle and Vai in West Africa (Cole, Gay, Glick, & Sharp, 1971; Scribner, 1975; Scribner, 1977), as well as with Maya- and Spanish-speaking villagers in Yucatan, Mexico (Sharp & Cole, 1975, cited in Scribner, 1977). Several interesting conclusions can be drawn from the findings of Luria and these more recent studies.

1. In all the traditional, nonliterate societies studied, solution rates for relatively simple syllogisms are somewhat better than chance, around 65%.
2. The best predictor of successful solutions to these syllogisms (indeed, the only one that has been discovered to date) is Western-style schooling. Increases in performance are detected with as little as 2-3 years of schooling.
3. When matched by age and schooling, there is little systematic cultural variation in performance among non-literate cultures. However, performance in such cultures is somewhat lower than comparable industrialized populations, such as the US.
4. The most important generalization is that the characteristic reasoning pattern in traditional societies is a preference for concrete thinking based on direct personal knowledge. Experimental evidence, as well as ethnographic accounts of everyday life, clearly show that the low solution rates do not betray an absence of logical reasoning ability. Rather they indicate an unwillingness to *play the game of logic*, which dictates a hypothetical stance that is often inconsistent with personal knowledge. This fact is evident when the villagers are asked to justify their responses. Justifications overwhelmingly appeal to direct personal knowledge external to the logical problem itself. In the rare cases where justifications do mention the structure of the argument, performance is high. This is true across individuals, as well as for each individual. Thus, whenever an individual agrees to play by the rules of logic, the capacity for logical reasoning with simple syllogisms is impeccable (Scribner, 1977).

However, as will become clear later in this chapter, this preference for concrete reasoning is not limited to non-literate societies. Relative to Western populations, highly educated, industrialized East Asian populations in China and Korea also prefer concrete, intuitive, knowledge-based reasoning. Thus the preference for formal logical reasoning prevalent in Western cultures may be only partly the result of the introduction of modern institutions such as industrialization. Other cultural factors that have been historically tied to the Western intellectual tradition, such as adversarial debate, contractual relationships, theoretical science, and formalization of knowledge may account for the development of formal logical reasoning as a rhetorical system central to these activities (Becker, 1986; Lloyd, 1990; Nisbett, Peng, Choi, & Norenzayan, in press).

Cultural Differences in Risk Preference and Probability Judgments

In a series of studies, Weber and Hsee (Hsee & Weber, 1999; Weber & Hsee, 1999; Weber, Hsee, & Sokolowska, 1998) have examined cultural differences in risk preference (e.g., choosing between a smaller sure gain option versus a larger risky option). They have studied primarily Americans and Chinese. Contrary to the predictions of both American and Chinese participants (and popular stereotypes) that Americans would be more risk-seeking and Chinese more risk-averse in their financial decisions, they found the opposite: more risk seeking among the Chinese. However this difference was specific to the financial domain. In the social domain, the pattern reversed, Chinese being less risk seeking. Congruent cultural differences also

emerged when the authors analyzed the risk seeking (or risk avoiding) advice implied in Chinese and American proverbs.

Hsee and Weber (1999) propose a "cushion hypothesis," according to which people living in a collectivistic society (such as China) are more likely to receive financial help when in need than people living in an individualistic society (such as America). In a sense, a collectivist social order provides a "mutual insurance" or "cushion" against financial losses. As a result, Chinese perceive the same financial situation as being less risky than Americans. However, the same collectivist cushion that protects the Chinese from financial loss, cautions them from taking social risks, as interpersonal harmony is of paramount importance in a collectivist society. In further support of this hypothesis, Hsee and Weber found that the cultural difference in risk preference in the financial domain was mediated by the larger size and better quality of the Chinese participants' social networks. The cultural difference was also found to result from different perceptions of the riskiness of the options, not from different risk-value tradeoffs (Hsee & Weber, 1999). Yates and others have found similar differences between Americans and Chinese in overconfidence, with Chinese being more overconfident in standard general knowledge tests than Americans (Wright et al., 1978; Yates, Lee, & Bush, 1997; Yates, Zhu, Ronis, & Wang, 1989).

Reasoning from Folkbiological Categories

The study of folkbiological categorization and category-based reasoning across cultures is of great relevance to both anthropologists and psychologists. As Malt (1995) has observed, folk biology may shed light on a central question of anthropology and psychology: to what extent is categorization determined by (a priori) structure in the mind, and to what extent is it determined by structure in the world? Furthermore, cross-cultural research on folkbiological reasoning may disentangle the universal and culture-specific aspects of categorization and category-based reasoning.

Research on folk biology shows both similarities and differences across cultures (Medin & Atran, 1999). Similarities in the nature of categories, discussed earlier, may be observed because over the course of human evolutionary history, specifies-specific, dedicated cognitive structures may have evolved to support reasoning about nature and natural kinds, a domain that has been of great importance to human survival. Alternatively, similarities may emerge because similar challenges in different societies may have led people everywhere to discover the same strategies in dealing with the natural environment. Differences can emerge because cultures may differ in their particular geographic or subsistence needs, values and practices related to nature, and expertise in folkbiological knowledge, which may lead to different ways of reasoning about nature and natural kinds.

In the last decade, an interdisciplinary team of psychologists and anthropologists has been investigating cross-cultural similarities and differences in folkbiological reasoning primarily between the Itzaj Maya of Guatemala and American college student populations (Atran, 1995; Coley, Medin, & Atran, 1997; Coley, Medin, Proffitt, Lynch, & Atran, 1999; Lopez, Atran, Coley, Medin, & Smith, 1997). Criticizing the exclusive reliance in cognitive psychology on American college student populations, this research program has tested the cross-cultural generalizability of psychological models of categorization and category-based reasoning, while infusing the anthropological study of folk biology with psychological theories and methods.

The Itzaj Maya people, a native Amerindian group living in the Peten region of Guatemala, are the last descendants of the traditional Maya who were conquered by the Spanish

Conquistadors in the 16th century. They continue to live a traditional lifestyle, relying heavily on the rainforest for their livelihood. They are the cultural inheritors of a very rich body of folkbiological knowledge, and, in contrast to urban American populations, exercise this knowledge on a daily basis.

One of the main findings emerging from this research is that, despite vast cultural differences in folkbiological knowledge and despite exposure to different kinds of species, the Itzaj and American college students display highly similar patterns of folkbiological classification (Lopez et al., 1997). As discussed earlier, this suports the claim that there are cross cultural regularities in the ways in which people around the world classify living things (Atran, 1990; Atran, 1995; Berlin, 1992). However, classifying living things is one thing, reasoning from these categories is quite another. Against the background of cross-cultural commonalities in classification stands an intriguing set of cultural differences in inductive reasoning. One such difference is in the way "basic-level" categories relate to inductive reasoning.

Psychologists and anthropologists agree that humans privilege one level in the folkbiological taxonomy – the "basic level," that is, the most salient, useful, and information-rich level (Berlin, 1992; Rosch, Mervis, Grey, Johnson, & Boyes-Braem, 1976). Basic level categories are the most frequently referred to in everyday speech, and may be the first learned by children. They are more informative than more general categories, and not much less informative than more specific categories. Anthropologists studying the folk biology of traditional societies, including the Itzaj Maya, have observed that the basic level corresponds to the folk-generic level, roughly equivalent to the species level in scientific taxonomy (e.g., oak). However, the basic level for urban Americans seems to be superordinate to that of traditional societies, corresponding to life forms (e.g., tree). Given this important difference, an obvious question is the relationship between basic levels and inductive inference across cultures: would Itzaj inductions privilege the folk generic level, and urban American inductions privilege the life-form level?

Coley et al. (1997) measured patterns of inference among Itzaj and Northwestern University undergraduates. Participants were asked to rate the relative strength of inferences from taxa of one subordinate rank to taxa of the appropriate superordinate rank (e.g., "All oaks have disease X. How likely is it that all trees have disease X?). Results indicated that both groups privileged inferences to the folk generic level (e.g., white oak to oak) over those to other levels (northern white oak to white oak, oak to tree). For the Itzaj, this reflects a correspondence between the basic level and the inductively privileged level (both are at the folk generic level). In contrast, urban American students show a discrepancy between the basic level (life form) and the inductively privileged level (folk generic). Thus, for urban American students, there is a dissociation between knowledge (what level is salient) and expectation (the presumed inductive potential of a level). Coley et al. speculate that the convergence of knowledge and expectations for the Itzaj (and presumably other traditional peoples) "may well represent the default case for human understanding of living kinds under normal (evolutionarily attuned) environmental conditions." (1997, p. 108). In contrast, it may very well be that the urban American discrepancy between knowledge and expectation reflects a "devolved" or degenerated folkbiological knowledge, the result of a century or more of diminished contact with nature (Coley et al., 1999). Interestingly, evidence from written material between the 16^{th}-20^{th} centuries shows a sharp decline in references to folkbiological categories in the 20^{th} century, indicating that this "devolution" of folkbiological knowledge may represent a broader pattern characterizing modern urbanized Western societies (Wolf, Medin, & Pankratz, 1999).

In fact, urban Americans' impoverished contact with nature appears to have profound implications for cross-domain reasoning as well. Carey (1985) has proposed an influential argument that children until the age of 10 do not possess a folkbiological framework. Instead, they project their folkpsychological understanding on the natural world in general. As a result, young children's understanding of biological phenomena is anthropocentric and intertwined with folkpsychological notions. In support of this argument, Carey presented evidence from studies of preschoolers in Cambridge, Massachussetts, indicating that projections of unknown properties from humans are stronger overall than projections from other animals; projections from humans to mammals are stronger than projections from mammals to humans; and most surprisingly, projections from humans to bugs are stronger than from bees to bugs! Together, these findings suggest that children privilege humans for their inferences about the natural world.

However, Carey's evidence has a major limitation: it comes exclusively from a North American urban population. Are the Cambridge children's human-centered inferences reflective

of a universal cognitive tendency or a culturally patterned response? To answer this question, two recent studies examined biological reasoning among urban American children and rural Menominee Indians of northern Wisconsin (Coley, Medin, Ross, & Atran, 2000) as well as among rural Yucatec Maya children (Atran, Medin, Lynch, V., & Ucan Ek', 2000). The urban American children of Coley et al. (2000) again made projections that were human-centered, by and large replicating Carey's (1985) findings. However, contrary to Carey's argument, Menominee and Yucatec Maya children did not privilege humans over other animals. They did not make stronger projections from humans than from other animals; they did not make stronger projections from humans to mammals or humans to bugs than from mammals to other mammals or from bees to bugs. Thus, urban American children's anthropocentric bias seems to be a reflection of a particular cultural circumstance – lack of sufficient exposure to nonhuman species – rather than a universal tendency in causal understanding. Folk psychology guides folk biology only in the absence of a well-developed folkbiological framework, as is the case in urban American culture.

Another set of folkbiological studies has investigated the cross-cultural generalizability of an influential model of category-based induction, the Similarity Coverage Model (SCM) (Osherson, Smith, Wilkie, Lopez, & Shafir, 1990). The SCM seeks to explain perceived strength of inductive arguments, such as:

Robins have ulnar arteries
Penguins have ulnar arteries
All birds have ulnar arteries

According to this model, the perceived strength of an inductive argument depends on two factors: (1) similarity, which is the degree of similarity between premise categories and the conclusion category, and (2) coverage, the degree to which premise categories "cover" the inclusive category, i.e., the lowest-level category that includes both the premise and conclusion categories (in the above example, robins and penguins provide a wide "coverage" of the category *bird*). Of particular interest are three phenomena predicted by the SCM: similarity, typicality, and diversity. According to the similarity hypothesis, the more similar the premise(s) to the conclusion, the stronger the argument (e.g., ROBIN/SPARROW > PENGUIN/SPARROW). According to the typicality hypothesis, the more typical the premise(s) of the conclusion category, the stronger the argument (e.g., ROBIN/BIRD > PENGUIN/BIRD). According to the diversity hypothesis, the more diverse the premises, the stronger the argument (e.g., ROBIN, PENGUIN/BIRD > ROBIN, SPARROW/BIRD). Whereas the similarity phenomenon hinges on the similarity principle of the SCM, and the typicality phenomenon is likely to be driven by both the similarity and coverage components, the diversity phenomenon is driven by the coverage component alone.

Lopez et al. (1997; see also Coley et al., 1999) investigated these three phenomena predicted by the SCM, with Itzaj Maya villagers and University of Michigan undergraduates. Whereas both groups showed the similarity and typicality phenomena, a striking cultural difference emerged for the diversity phenomenon. Michigan undergraduates preferred the more diverse argument 96 percent of the time. In contrast, the Itzaj Maya showed counter-diversity, choosing the more diverse argument only 35 percent of the time. The experimenters then examined whether this cultural difference could be explained in terms of differences in expertise in the natural world. The Itzaj maintain daily contact with the animals of the forest, and possess a vast store of knowledge about the ecological relations that exist among species. In contrast, the Michigan undergraduates have little knowledge about their local natural habitat. The

justifications that participants provided for their responses were consistent with this explanation. Whereas the American undergraduates explained their responses in terms of diversity, the Maya respondents provided explanations that were based on causal knowledge about animals and the environment. Often the Itzaj participants rejected the more diverse premise as implausible, based on their specific ecological knowledge of the species in question, for example, their knowledge of the likelihood of two species coming in contact with each other, or the range and commonness of species in a particular environment.

Follow-up studies examined reasoning about trees among American tree experts. Some tree experts with everyday interaction with trees (park maintenance personnel in Illinois) were shown to reason just like the Itzaj Maya, relying on ecological/causal knowledge. As a result they also failed to show the diversity phenomenon (Medin, Lynch, Coley, & Atran, 1997). This evidence bolsters the interpretation that expertise in a domain may block diversity-based reasoning in that domain. Put another way, diversity-based reasoning may be triggered only in the absence of direct knowledge in a domain.

The parallels are striking between ecological reasoning in folk biology among the Itzaj and tree experts, and knowledge-based reasoning in response to logical problems in traditional societies. These findings raise the compelling possibility that a wide range of reasoning processes in many domains, widely held to be universal in cognitive psychology, may be triggered by aspects of urban, technologically-advanced, non-traditional cultural life in Western societies, rather than stemming from universal cognitive tendencies impervious to cultural life.

Cultural Differences in Field Dependence

Differences between urban industrialized groups and traditional populations, comparable to those found by Medin and Atran and their colleagues, have been found by Witkin and Berry (1975) in the domain of perception – with the twist that some traditional populations are more similar to industrialized groups than they are to other traditional populations. Witkin and his colleagues developed an ambitious program in which they demonstrated that there are substantial individual differences in the extent to which people "differentiate" an object from the field in which it appears (Witkin, Dyk, Faterson, Goodenough, & Karp, 1974; Witkin et al., 1954). People who do this readily are called "field independent" and people who do so with more difficulty are called "field dependent." They had a number of tests to examine field dependence including the Embedded Figures Test, which shows people's ability to separate a simple object from a more complex background, and the Rod and Frame Test. In the latter test, participants look into a long box, at the end of which is a rod surrounded by a frame. The participant's task is to indicate when the rod is vertical. The rod and the frame can be tilted independently of one another. Field dependence is indicated by the extent to which the position of the frame influences judgments about the position of the rod.

Witkin and his colleagues argued that field dependence is in part the result of an orientation toward people. An outward orientation toward the social environment encourages an orientation toward the field in general. Consistent with this proposal, Witkin and his colleagues found that more socially oriented people were more field dependent than were more introverted people (Witkin, 1969). They also found that Orthodox Jewish boys, who live under substantial social constraints and with strong social role obligations, were more field dependent than more secular Jewish boys, who were in turn more field dependent than Protestant boys (Adevai, Silverman, & McGough, 1970; Dershowitz, 1971; Meizlik, 1973). Both sets of findings were obtained even when IQ was controlled.

Witkin and Berry (1975) examined different societies and found that there were substantial differences among them in field dependence. Farmers, who live in societies where they must coordinate their actions with others, were found to be more field dependent than were people who hunt and gather, or herd animals for a living. The latter sorts of livelihoods require less coordination with the actions of those of others and social, political, and economic role relations tend to be relatively simple. Industrialized peoples have levels of field dependence comparable to those of mobile hunter-gatherers and herders. Like mobile peoples, industrialized peoples have substantial freedom in their work lives and relative simplicity in role relations. There are of course alternative explanations available for these results, but taken on their face they are consistent with the proposition that culture affects perception at a deep level.

Teaching Different Modes of Reasoning

One way of getting at the question of the degree of fixededness of basic cognitive processes is to see whether training techniques can be effective. Nisbett and his colleagues (Nisbett, 1992; Nisbett, Fong, Lehman, & Cheng, 1987) studied this question and found that a variety of forms of inductive reasoning and inferential rule systems are surprisingly malleable. For example, it is possible to teach statistical rule systems such as the law of large numbers (LLN), even in brief sessions and with highly abstract materials, and show that such training markedly affects participants' solution of a wide variety of problems (Fong, Krantz, & Nisbett, 1986). With training, college students may become more likely to apply LLN to events they typically think about in probabilistic terms, such as lotteries, to events that they would sometimes think about in a probabilistic fashion, such as sports events or academic performance, and to events that they normally do not think about in probabilistic terms at all, such as displays of personality trait-related behavior. Surprisingly, it is possible to teach people LLN in highly concrete terms in a given domain and get just as much improvement in non-trained domains as in the trained domain. For example, participants trained in the abilities domain improve in their capacity to apply LLN to the probabilistic and social domains just as much as in their ability to apply it to the abilities domain (Fong et al., 1986). This and other evidence suggests far more domain independence of inductive rules than was posited by theorists from Thorndike (1913) to Newell and Simon (1972), who believed that training effects would remain content- and problem-specific.

If it is possible to obtain effects of training even in brief laboratory sessions, it is scarcely surprising that immersion in a systematic course of study profoundly changes the way people reason. Thus, two years of graduate study in psychology markedly increases ability to apply LLN, the self-selection principle, the control group concept, and other inductive rules to an indefinitely large range of everyday problems (Lehman, Lempert, & Nisbett, 1988) (Medical training improves these abilities somewhat. Training in chemistry and law, which do not teach such inductive rules, results in no improvement whatever.)

Similar training effects are found with cost-benefit analysis. Even a brief training session allows people to apply the sunk cost principle (the injunction that one should not feel obligated to consume something that no longer has positive value just because one has paid for it) and the opportunity cost principle (every action may entail loss of the opportunity to take some other action that might have greater value) (Larrick, Morgan, & Nisbett, 1990). Extensive training in cost-benefit analysis, in the form of Ph.D.-level training in economics, profoundly alters the way people think about virtually any problem to which it can be applied – from a decision about whether to do one's own home repairs to the nature of one's views on international policy (Larrick, Nisbett, & Morgan, 1993). It scarcely seems an exaggeration to say that economists

reason in a way that sets them apart markedly even from their fellow academics, let alone from the population in general.

Interestingly, it is far more difficult to affect deductive reasoning principles, for example, *modus ponens, modus tollens*, or syllogistic reasoning, whether by brief training, by a college course in logic, or even by Ph.D. training in philosophy (Morris & Nisbett, 1992). (Though the latter at least does markedly improve one form of reasoning ability, namely facility in generating counterexamples.) These findings suggest that some inferential rule systems are more graceful, that is, are more readily incorporated into reasoning styles, than others. There is a perhaps interesting analogy to be drawn here between rule gracefulness and idea contagiousness.

HOLISTIC VS. ANALYTIC REASONING

If it is possible to alter radically the inductive reasoning and choice principles of adults within a given culture by means of training, then it begins to seem plausible that people in different cultures, if trained from a very early age in different cognitive approaches to the world, might differ even more substantially.

Recently Nisbett and his colleagues have pursued proposals by scholars in a number of disciplines including history, ethnography, and philosophy of science, who maintain that East Asians and Westerners reason in very different ways. These different forms of reasoning have been summarized by Nisbett and his colleagues (Nisbett, 1998; Nisbett et al., in press; Peng & Nisbett, 1999) as holistic vs. analytic reasoning, which they define in the following way.

> [H]olistic thought [involves] an orientation to the context or field as a whole, including attention to relationships between a focal object and the field, and a preference for explaining and predicting events on the basis of such relationships. Holistic approaches rely on experience-based knowledge rather than abstract logic and are *dialectical*, meaning that there is an emphasis on change, a recognition of contradiction and the need for multiple perspectives, and a search for the "Middle Way" between opposing propositions. [A]nalytic thought [involves] detachment of the object from its context, a tendency to focus on attributes of the object in order to assign it to categories, and a preference for using rules about the categories to explain and predict the object's behavior. Inferences rest in part on decontextualization of structure from content, use of formal logic, and avoidance of contradiction. (p. xx)

This distinction between styles of thought is not entirely novel to psychologists. James and Piaget made similar distinctions between relatively associative thinking, whose computations reflect similarity and contiguity, and relatively analytic thought which relies on more abstract, symbolic representational systems, and whose computations are a reflection of rule structure. Sloman (1996) has recently reviewed evidence for this distinction in the cognitive realm. The distinction that Witkin and his colleagues (Witkin et al., 1974; Witkin et al., 1954) made between "field dependence" and "field independence" in the perceptual realm, discussed above, resembles the cognitive distinction. The definition of Nisbett and his colleagues is meant to include both conceptual and perceptual aspects of the distinction. The distinction also applies to the belief systems that they regard as underlying those differences.

Ancient Chinese and Greek Science

Evidence for the distinction between holistic and analytic thought comes from the study of ancient Chinese and Greek philosophy, mathematics, and science (Becker, 1986; Chan, 1967; Cromer, 1993; Fung, 1983; Hansen, 1983; Liu, 1974; Lloyd, 1990; Moser, 1996; Nakamura, 1964/1985; Needham, 1962; Zhang, 1985). The belief systems or metaphysics of these two highly sophisticated cultures were markedly different. To the Chinese, matter was continuous

and interpenetrating, events were the result of an interaction between the object and the field, and neither formal categories nor formal logic played much of a role in mathematics or science. Consistent with these philosophical views, the Chinese understood action at a distance from at least the 6th century B.C.: they realized the true reasons for the behavior of the tides and had substantial knowledge of acoustics and magnetism. And whereas the Chinese made advances in arithmetic and algebra, they made very few contributions in geometry, which requires deduction, especially the rule of noncontradiction.

In contrast, though the Greeks were leagues behind the Chinese in technological achievements, it was they who invented science, defined as the explicit causal modeling of events based on a formal system of rules and categories. However, at least in part because of the nature of their metaphysical beliefs which focused on the object at the expense of the context, the Greeks did not understand that all action is a result of the interaction of an object in a field of forces. Hence Aristotle maintained that a stone sinks when placed in water because it has the property of gravity and a piece of wood floats because it has the property of levity. On the other hand, Aristotle invented formal logic, allegedly because he was annoyed at the bad arguments heard in the marketplace and the political assembly. Aristotle's syllogisms are abstract reasoning schemas whose violation indicates that one has a bad argument by definition.

Deriving Systems of Thought from Social Systems

What might have produced the differences in metaphysics and epistemology? Following scholars in several fields (Becker, 1986; Cromer, 1993; Nakamura, 1964/1985), Nisbett and his colleagues argued that the social systems of the two countries encouraged their respective orientations. China was an agrarian society with strong obligations and clear role relations specifying how to deal with family, clan, and village, and with tight vertical control extending down from the king through the village magistrate. Action was carried out in the context of many role relations. Harmony with one's fellows was a primary end of the society (Munro, 1969). In contrast, the economy of Greece owed more to herding, fishing, trading and piracy than to cooperative agriculture. Greeks were more individualistic and democratic, and in debate a commoner could challenge even a king.

A goal of harmony would tend to encourage attention to the field as a whole whereas the individualistic stance might allow for the luxury of attending to the object alone. Attention to the field would encourage finding relationships between events in the field, whereas attention to the object might encourage attending to the attributes of the object in order to be able to categorize it and apply rules to it. The harmony goal would tend to discourage debate whereas individualistic, democratic societies can afford to engage in it. The consequence of pursuit of harmony is an emphasis on heuristics such as dialecticism which seek the "Middle Way" and the resolution of opposing positions. The consequence of the practice of debate is an emphasis on logical consistency and the avoidance of contradiction.

The social worlds of East and West today reflect to a substantial degree their origin in Chinese and Greek culture, respectively. East Asians are more collectivistic in their socialization practices, values, and social behavior, than people of European culture, who are in turn more individualistic. In studies in which participants are asked to spontaneously describe themselves, East Asian students generate self-descriptions that are more likely to reflect their social identities ("I am a Keio student,") or refer to relationships ("I am a brother.") Americans generate self-descriptions that reflect abstract personality traits ("I am curious") more often than Japanese participants (Cousins, 1989). Markus, Mullaly, and Kitayama (1997) found in one study that 50% of Japanese self-descriptions included references to ingroup members, in contrast to only

24% for Americans. Similar findings are obtained for Chinese (Bond, 1996) and Koreans (Rhee, Uleman, Lee, & Roman, 1996). Western advertisements, more than Korean ones, emphasize individual values ("Make your way through the crowd") as opposed to collectivist values ("Ringing out the news of business friendships that really work"), which are more common in Korean advertisements (Han & Shavitt, 1994). Singaporeans and Japanese prefer to work harmoniously, and relatively anonymously, with others rather than to be in situations where personal recognition is afforded (Hampden-Turner & Trompenaars, 1993). Social harmony is valued over debate and frank discussion in the East, to a far greater extent than in the West (Becker, 1986; Iwao, 1996). For reviews of the literature on social psychological differences between Eastern and Western peoples, see Bond (1996); Fiske, Kitayama, Markus, & Nisbett, (1998); Hofstede (1980); Hsu (1953; 1981); and Triandis (1989; 1995).

Cognitive Differences between East Asians and People of European Culture

If the social differences between Easterners and Westerners resemble those of former times, and if the social differences influence cognitive processes, we might expect to find cognitive differences among contemporary peoples that parallel those found in ancient times. Nisbett and his colleagues have undertaken a series of investigations that support several expectations in line with this hypothesis.

1. East Asians attend more to the field than do Westerners, and attend more to the relationship between the field and the object, and perceive relations among events more accurately than do Westerners.
2. Easterners and Westerners respond differently to being given control in a situation. When situational elements that normally signal control are present, Westerners believe they have more control, their performance improves more, and their confidence increases more than does that of Easterners.
3. Westerners explain the behavior of objects, including that of people, in terms of presumed properties of the object itself whereas Easterners tend to see behavior as due to the interaction of the object with the field. Westerners are more susceptible to the "fundamental attribution error" than are Easterners.
4. Easterners see more complexity in the world – more potential causal factors at work – than do Westerners. Partly as a consequence they find it easier to explain any given outcome and are more susceptible to "hindsight bias," or the I-knew-it-along effect.
5. Westerners organize the world into categories and covering rules more than do Easterners whereas Easterners are more inclined to organize in terms of similarities and relationships.
6. Westerners are better able to decontextualize content and structure than are Easterners and hence make inferences about argument validity more accurately than do Easterners.
7. When presented with apparent contradictions, Westerners resolve the situation by deciding which of the two propositions is correct, whereas Easterners are inclined to find some truth in both propositions. Westerners thus emphasize noncontradiction, whereas Easterners value the "Middle Way."

In reporting the research testing these expectations, we will not mention details of the participant populations. We note only that most (but not all) experiments were conducted with college students, that East Asian participants were either Chinese, Korean or Japanese, tested sometimes in their own countries in their native languages and sometimes in the U.S. in English, and that the great majority of "Westerners" studied were Americans.

Attention and Control

Atttention to object vs. field. Masuda and Nisbett (2001) showed underwater scenes to Japanese and American participants. Each scene consisted of rocks, plants, inert animals, small fish, and "focal" fish – which were larger, brighter and faster moving than the others. Immediately after observing the scenes, participants were asked to describe what they had seen. Japanese typically began by referring to the context ("it looked like a river") whereas Americans usually began by referring to the focal fish. Americans and Japanese made equal numbers of statements about the focal fish, but Japanese made about 70 percent more statements about the field and twice as many statements about relationships involving inert objects in the background. Participants were subsequently shown a number of objects, some of which had been in the original scenes and some of which had not, and were asked to identify whether they had previously seen the object or not. Some of the objects were shown in their original environments and some were shown in environments not seen before. This manipulation made no difference to the accuracy of Americans, but the performance of Japanese were less accurate when the background was different. Thus object and field appeared to have been "bound" for the Japanese (Chalfonte, 1996; Hedden et al., 2000). When object was removed from the context, memory for the object was poorer.

Perception of relationships in the field. In a study by Ji, Peng, and Nisbett (2000) Chinese and American participants were asked to view a split computer screen. On the left side of the screen there appeared one of two different arbitrary objects such as a table, a pointing finger, etc. Immediately after one of two other arbitrary objects appeared on the right. The degree of association between what appeared on the left and what appeared on the right was set at values equivalent to correlations of .00, .40, and .60. The Chinese saw more covariation than the Americans, they were more confident of their judgments, and their confidence was better calibrated with the actual covariation than was that of the Americans. In addition, the Americans showed the typical primacy effect (Yates & Curley, 1996), with early-seen covariation being overweighted in judgments of correlation. In contrast, Chinese judgments showed no primacy effect.

In a variant of the covariation task, participants were given "control" over the setup. They were allowed to choose which object to show on the left of the screen and were allowed to choose the intertrial interval. Although these manipulations had no effect on the degree of actual covariation, Americans responded by seeing more covariation and becoming more confident about their judgments, relative to Chinese (who actually tended to see less covariation and to become less confident).

Field dependence. If Americans attend more to the object and less to the relations between the object and the field, we would expect them to be less field dependent than Asians. To test this possibility, Ji et al. (2000) gave the Rod and Frame Test to Chinese and Americans matched for SAT math score. As anticipated, Chinese were found to be more field dependent and less confident of the accuracy of their judgments.[1] In a variant of this task, participants were given control of the movement of the rod. Americans became more confident of the accuracy of their performance when given control whereas the Chinese did not.

Object or substance? There is actually evidence that East Asians do not see objects where Westerners do. Iwao and Gentner (1997) showed objects and substances to Japanese and Americans of various ages and described them in ways that were neutral with respect to whether they were seeing an object or a substance – for example an object such as a pyramid made of cork. Participants were told to "look at this *dax*" or the investigators said "this is my *blicket*". Then they showed the participants something of the same shape as the object presented but

which was made of a different substance (for example, a pyramid made of white plastic) and something else which was made of the same material in a different shape (for example, pieces of cork). Iwao and Gentner then asked participants to point to the *dax*.

Americans were much more likely to choose the common shape as the "dax" or "blicket," or whatever, than were the Japanese, indicating that the Americans were coding what they saw as an object whereas the Japanese were more likely to code what they saw as a substance. When shown an object, more than two-thirds of four-year old American children chose another object whereas fewer than a third of Japanese four-year olds did. The differences between American and Japanese adults were equally large. Only children under two failed to show the cultural difference.

The Iwao and Gentner (1977) results imply the radical conclusion that Asians and Westerners literally see different worlds. Like ancient Chinese philosophers, modern Asians see a world of substances – of continuous masses of matter. Like ancient Greek philosophers, modern Westerners see a world of objects – discrete and unconnected *things*.

Causal Explanation, Prediction, and "Postdiction"

Americans are more inclined to decontextualize the object from its context than are East Asians. We might therefore expect that Americans, like ancient Greek scientists, would be inclined to explain events by reference to properties of the object and that East Asians would be inclined to explain the same events with reference to interactions between the object and the field. There is much evidence indicating that this is the case (for reviews see (Choi, Nisbett, & Norenzayan, 1999; Norenzayan & Nisbett, 2000)). Miller (1984) showed that Americans were likely to explain both events that "had a good outcome" and events that "had a bad outcome" by invoking presumed properties the actor. Hindu Indians explained the same events by reference to situational and contextual factors. Similarly, Morris and Peng (1994) and Lee, Hallahan, and Herzog (1996) have showed that Americans explain murders and sports events respectively by invoking presumed dispositions of the individual whereas Chinese and Hong Kong citizens explain the same events with reference to contextual factors.

Norenzayan, Choi and Nisbett (2001) found that Korean participants were more responsive to contextual factors when making predictions about how people in general would be expected to behave in a given situation and, much more than American participants, made use of their beliefs about situational power when making predictions about the behavior of a particular individual. Cha and Nam (1985) also found that Koreans used more situationally-relevant information than Americans in making causal attributions. Importantly, Norenzayan et al. (2001) found that Koreans and Americans endorsed beliefs about the causes of behavior that accorded with their explanations and predictions. Koreans placed more credence in situational and interactional theories than did Americans. The East Asian focus on the field and the American focus on the object can be apparent even when the East Asian attributions are dispositional in nature. Menon and colleagues (Menon, Morris, Chiu, & Hong, 1999) found that East Asian dispositional explanations of events (for example, scandals in organizations) were more likely than those of Americans to refer to *group* dispositions.

Explanation patterns are different even for non-social events. Morris and Peng (1994) and Hong, Chiu, and Kung (1997) showed participants cartoon displays of fish moving in relation to one another in various ways. Chinese participants were more likely to see the behavior of the individual fish as being produced by external factors than were Americans, whereas American participants were more inclined to see the behavior as being produced by internal factors. Peng and Nisbett (2000), et al., in press) showed that for ambiguous physical events involving

phenomena that appeared to be hydrodynamic, aerodynamic, or magnetic, Chinese were more likely to refer to the field when giving explanations (e. g., "the ball is more buoyant than the water") than Americans were. The attributional differences therefor probably should not be regarded as mere belief differences about local aspects of the world, but rather as deep metaphysical differences that transcend rules about particular domains that are taught by the culture.

Choi and Nisbett (1998) examined circumstances in which both Americans and Koreans mistakenly attributed behavior to dispositions of a target actor. The target was required to write an essay upholding a particular view, and participants tended to assume that the target actually held the views he was compelled to express. But when participants were put in the situation themselves, and were required to write an essay on another topic, Americans continued to assume that the essay reflected the target's true attitudes whereas Koreans recognized the influence of situational constraints, and therefore realized that the essay was not necessarily a product of the target's attitudes.

Sensitivity to the role of contextual factors, and attention to the field, may have their drawbacks. In a series of experiments, Choi and Nisbett (2000) found that Koreans were more susceptible to the *hindsight bias*, that is, the tendency to believe that one could have predicted some outcome that in fact one could not have predicted. Choi and Nisbett argued that the Asians' greater susceptibility to this bias mightbe due to a tendency to attend more to contextual factors and to a tendency to causally model events less explicitly. (An explicit model makes it easier to see that a given outcome could not in fact have been predicted.) Choi, Dalal, and Kim-Prieto (2000) found that Koreans do indeed consider more factors to be relevant when analyzing a given situation than Americans do.

Similarity and Relationships vs. Categories and Rules

A number of studies indicate that East Asians organize the world in rather different ways than do people of European culture. East Asians tend to group objects on the basis of similarities and relationships among the objects whereas Americans tend to group on the basis of categories and rules. In an early study by Chiu (1972), Chinese and American children were shown sets of pictures of three objects, for example, a man, a woman, and a child, and were asked to choose which of two objects were alike or went together. American children tended to choose the objects linked by category membership, and thus chose the man and the woman "because they are both grownups." Chinese children tended to emphasize relationships and thus chose the woman and the child "because the mother takes care of the child." Ji and Nisbett (Ji, 2000; Ji & Nisbett, 2000) found that adults showed similar tendencies when asked about the association between words. Asked how strong the association was between words in a set, Chinese were more likely to find the association strong if there was a relationship between the words, either functional (e.g., pencil-notebook) or contextual (e.g., sky-sunshine) whereas Americans were more likely to find the association strong if the objects belonged to some category (e.g., notebook-magazine).

Norenzayan and colleagues (Norenzayan, 1999; Norenzayan, Nisbett, Smith, & Kim, 2001) presented East Asians, Asian Americans and European Americans with target objects and asked them to report whether the object was more similar to a group of objects to which it shared a strong family resemblance, or to a group of objects to which it could be assigned on the basis of an invariant rule. Thus, a schematic flower could be assigned to a group whose members it resembled most closely, or to a group whose members all had a straight stem (as opposed to a curved one). East Asians were more likely to regard the target as most similar to the group with

which it shared a strong family resemblance whereas Americans were more likely to regard the object as more similar to the group to which it could be assigned on the basis of the deterministic rule. Asian Americans' judgments were in between those of the other two groups.

Testing the Osherson, et al. (1990) model of induction, Choi, Nisbett and Smith (1997) found that Koreans, like Mayans and American tree experts, were less likely to make inductive inferences that were responsive to diversity of category exemplars than were Americans. In the case of Koreans, however, the lack of responsiveness to category diversity could not have been due to greater expertise. Instead, the unresponsiveness to category diversity was shown to be due to the sheer lack of salience of categories. When categories were made highly salient, Koreans made inductive inferences like Americans.

Given that East Asians make less use of categories and less use of rules, we could expect that rule-based category learning might be particularly difficult for them. In order to test this, Norenzayan and colleagues (2001) used a paradigm developed by Allen and Brooks (1991) in which participants are taught how to categorize cartoon animals as being either from Venus or from Saturn. The animal was from Venus if it had any three of five features listed; otherwise it was from Saturn. After learning how to categorize the animals, participants, who were East Asian, European American, or Asian American, were shown a set of new animals that they had not seen before, but which strongly resembled a previously-seen animal. These new animals either belonged to the same category as the previous animal on the basis of application of the rule or did not. If the new animal belonged to the same category as the previous exemplar it resembled, all three groups performed at the same level. But if the new animal belonged to a different category, and thus correct classification could be made only on the basis of disregarding exemplar similarity and application of the rule, East Asians made twice as many classification errors as either European Americans or Asian Americans. Reaction times also indicated that East Asians found the task more difficult than either European Americans or Asian Americans.

It is likely that linguistic practices support the cognitive differences we have just described. Tardif (1996) has found that, unlike American infants who learn nouns (names for objects) at a much more rapid rate than they learn verbs (words describing relationships), Chinese infants actually learn verbs at a more rapid rate than nouns. The same is true for Korean infants (Choi & Gopnik, 1995). The pace of learning is in turn undoubtedly affected by what the parents are directing the child's attention toward. American mothers use several times as many noun phrases in their speech to their infants than do Chinese mothers (Gelman & Tardif, 1998).

Logic vs. Dialectical Reasoning

Like traditional peoples, East Asians are less likely to decontextualize propositions and reason about them using formal rules than are Westerners. East Asians also have an orientation toward reasoning about "logical" problems that is highly sophisticated and sometimes raises questions as to whether Western decontextualization is always the most effective way to reason.

The "typicality" effect in deductive reasoning about categories (Sloman, 1993) has been examined by Norenzayan and his colleagues. Similar to the typicality phenomenon in category-based induction (Osherson et al., 1990), the typicality effect is the tendency of people to be more willing to infer that a property is true of a member of a given class to the extent that it is typical of its class. Thus, when told that "All birds have ulnar arteries," people are more willing to infer that eagles have ulnar arteries than that penguins have ulnar arteries. Norenzayan et al. (2001) found that East Asians were more susceptible to this effect than European Americans (with Asian Americans in between).

Experimental psychologists have also found a "belief bias" in logical reasoning: more plausible conclusions are judged as more logically valid than less plausible ones (Revlin, Leirer, Yop, & Yop, 1980). Norenzayan et al. (2001) found that the belief bias was greater for East Asians than for Americans. This difference was not due to any difference in logical reasoning ability between the Americans and the Koreans. Koreans made validity judgments in the same way as Americans did when the propositions were formal and abstract. Thus the difference between the two groups apparently resides in the willingness to decontextualize meaningful propositions sufficiently to be able to apply logical rules to their underlying structure.

Many philosophers of science and ethnographers have pointed to a type of "dialectical" reasoning held to be characteristic of East Asians (Liu, 1974; Lloyd, 1990; Needham, 1962/1978; Peng, in press; Zhang & Chen, 1991). The orientation underlying this approach may be described (in a rather un-Eastern fashion) as a set of three principles.

- *The principle of change*: reality is a process that is not static but dynamic and changeable.
- *The principle of contradiction*: Partly because change is constant, contradiction is constant. Thus old and new, good and bad, exist in the same object or event.
- *The priniciple of relationship or holism*: Because of constant change and contradiction, nothing in human life or in nature is isolated and independent but instead everything is related to everything else.

Taken together, these principles imply an attitude toward contradiction that is very different from that found in the West. Contradiction is to be expected and not necessarily resolved. Propositions that appear contradictory on the surface may both contain some truth, and a constant goal is to search for the "Middle" Way between extremes.

Peng and Nisbett (Peng, 1997; Peng & Nisbett, 1999) derived a number of predictions from the set of principles above. Chinese collections of proverbs were found to have a larger proportion of "dialectical" proverbs containing contradictions ("too humble is half proud") than do English collections, and Chinese undergraduates were found to like dialectical proverbs more than American undergraduates. Chinese were more likely to prefer arguments having a dialectical or holistic character rather than a logical structure than were Americans. When asked to deal with inter- and intrapersonal conflicts, Chinese were more likely to say that both sides had some merit whereas Americans were more likely to say that one side or the other was correct.

When presented with a plausible proposition, both Chinese and Americans assented to it, but when participants were presented with both the plausible proposition and a less plausible proposition that appeared inconsistent with each other, Chinese and Americans responded in utterly different ways. Chinese became less confident about the plausible proposition, but Americans became even more convinced of the correctness of the plausible proposition! The Americans' behavior is hard to justify on normative grounds, but is understandable given Western insistence that a proposition must be true or false. Westerners' arguments against the weaker proposition would serve to strengthen belief in the more plausible proposition. In still a third condition, participants were given only the less plausible proposition and asked to evaluate it. Again, Americans and Chinese judged the proposition as equally likely to be true. When beliefs about the less plausible proposition in this condition were compared with those in the two-proposition condition, it was found that Americans' belief in the less plausible proposition were unaffected by seeing the more plausible proposition. But Chinese participants actually increased their belief in the less plausible proposition when they saw it contradicted by the more plausible proposition! They ended up believing that both propositions were equally plausible, a

tendency that is hard to defend on normative grounds. This remarkable tendency can be understood as the result of Chinese desire to seek the "Middle Way" and to find the truth in apparently contradictory propositions.

Finally, Briley, Morris, and Simonson (in press) asked participants to choose among three consumer products which bore the following relation to one another: product A was superior to products B and C on one dimension and product C was superior to products A and B on a second dimension. In the control condition, Chinese and American participants were equally likely to choose product B, which was intermediate on both dimensions. In the experimental condition, participants had to justify their choices. This prompted the Americans to select one of the more extreme choices, either A or C, which could be justified by the invocation of a single principle. In contrast, the Chinese were more inclined to choose the intermediate object, justifying their choice by saying that both dimensions were important.

CONCLUSIONS

It seems increasingly clear that thinking develops in a cultural context, and that cultural processes markedly affect the functioning of human minds. Yet for most of their brief history, the fields of experimental psychology and cultural anthropology proceeded as if the study of mind and culture were neatly separable, unrelated scientific projects (Sperber, 1995). Most psychologists assumed that universal cognitive processes could be uncovered that were independent of cultural and historical variation in human lives, and most anthropologists assumed that principles of cultural life could be understood without regard for the properties of the human minds that give rise to collective phenomena. Ironically, the mutual relevance of individual psychology and cultural psychology was recognized by Wundt just as the two fields of experimental psychology and cultural anthropology were growing into separate academic disciplines:

> Thus, then, in the analysis of the higher mental processes, folk psychology is an indispensable supplement to the psychology of individual consciousness…Nevertheless, it must not be forgotten that just as there can be no folk community apart from individuals who enter into reciprocal relations with it, so also does folk psychology, in turn, presuppose individual psychology … (1916, p. 3).

The evidence reviewed in this chapter highlights the complementarity of psychology and anthropology, and questions the assumption of the independence of cultural and cognitive processes. The apparently species-specific contents of human thought – theories of mechanics, biology, and mind, as well as domain-specific learning mechanisms – make culture possible and constrain its variation. On the other hand, many "basic" cognitive processes are highly susceptible to cultural variation.

A prime example of how domain-specific theories provide the building blocks of culture, and constrain its variation, is provided by the way religious beliefs are constructed. Most religious beliefs known to anthropologists seem to exploit psychological expectations inherent in theories of mind, biology, and physics, in specific and systematic ways. The anthropologist Pascal Boyer (1993, 1994) has in fact proposed a "cognitive recipe" of religious belief, specifying the possible ways by which religious beliefs may be constructed out of systematic and graded violations of the set assumptions in these theories. Spirits, shamans, prophets, and other concepts of the supernatural emerge from this framework. These domain-specific theories not only provide the cognitive material for religious beliefs, but they may determine which beliefs are likely to be cross culturally widespread or rare. In doing so, the theories place constraints on the range of possible variation in religious beliefs.

How exactly are cognitive processes susceptible to cultural variation? To be sure, there are basic process primitives that the human child is born with. People everywhere are likely to possess cognitive structures such as the ones that realize exemplar-based categorization, inductive and deductive reasoning, long-term memory, covariation detection, etc. However, without denying the existence of these basic processes, there are at least three important avenues through which cognition is shaped by cultural variation (Norenzayan, 2001). In increasing order of theoretical importance: differences in cognitive accessibility, differences in what cognitive process a given problem selects, and differences in the actual cultural invention of complex cognitive structures out of universal cognitive primitives.

There may be cultural differences in the cognitive accessibility of thought processes. 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. The result is that a given cognitive process may be equally available in principle, but differentially accessible in different cultures. Thus, East Asians are more likely than Westerners to organize the world in terms of similarities and relationships, to explain events situationally, and to rely on knowledge-based reasoning. Westerners are more likely to organize the world in terms of rule-based categories, explain events dispositionally, and rely on formal, decontextualized reasoning (Nisbett, et al., 2001).

Differential cultural expertise with a given cognitive process, or differential familiarity with a given domain, may yield an even more dramatic class of cultural variation in cognition: people may habitually rely on qualitatively different cognitive strategies to solve the same problems of everyday life. Thus, even if all cultures possessed essentially the same basic cognitive toolkit, the tools of choice for the same problem may be altogether different. In many studies comparing American and East Asian reasoning, the same problem triggered qualitatively different cognitive responses in these two groups (Nisbett, et al., 2001). For example, confronted with apparently contradictory propositions, East Asians responded by trying to find the truth in both whereas Americans responded by trying to decide which proposition was true. Research on logical reasoning among traditional peoples also reflects this kind of cultural difference. Whereas Western participants approach many kinds of problems by decontextualizing them and applying logical rules, Uzbek peasants and the Kpelle approach the same problems by reasoning from their knowledge of the argument contents (Cole et al., 1971; Luria, 1931). Different levels of knowledge about a domain may also lead to the use of different cognitive strategies to solve the same problem. This is apparent in the folkbiological reasoning of the Itzaj Maya, who may be considered experts in the folkbiological domain, as well in the reasoning of American tree experts. Whereas American college students reason according to the diversity principle in making category-based inferences, the diversity principle is blocked or overridden in the reasoning of the Itzaj and that of tree experts, who approach the same problems by relying on ecological knowledge-based reasoning (Medin et al., 1997). (Alternatively, one might say that ecological reasoning is not available for Americans whose knowledge of the biological world is so elementary that they must resort to formal strategies).

Finally, actual possession of particular cognitive processes may differ across cultures in that different cultures may invent composite cognitive structures out of universal primitive ones, thus performing feats of cognitive engineering, as suggested by Dennett's (1995) characterization of culture as a "crane-making crane" (p. 338). The invention of symbolic systems such as calendars, number naming conventions, pictographic writing, alphabetic writing, Arabic numerals, and formal logic provide examples. Beginning in the West in the 17th century,

statistical, methodological and cost-benefit rules having applicability to scientific reasoning as well as to policy analysis and everyday judgment and decision-making began to be developed. There is great variation among members of Western society today in the degree of understanding and use of these rules. Similarly, Chinese philosophy developed the ancient Taoist notions of yin and yang into sophisticated ways of reasoning about change, moderation, relativism, and the need for multiple viewpoints.

As the mutual interdependence of culture and cognition becomes better understood, "crane-made cranes" such as these will tell us much about the cultural foundations of the cognitive tools of everyday life. The continued cross-cultural examination of cognition will also help us discover true cognitive invariances across cultures. As cultural diversity and intercultural contact become increasingly commonplace in societies around the world, psychologists and anthropologists can do much to learn about the cognitive implications of human cultural diversity, as well as learning about the cognitive foundations of culture.

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[1]Several studies compared the field dependence of East Asians and Westerners using Witkin's Embedded Figures Test (EFT), in which a small figure is shown to participants and they are then asked to find it in a larger, more complicated figure. Typically no difference is found or a slight difference is found favoring East Asians (Bagley, 1995; Huang & Chao, 1995). As Bagley (1995) has pointed out, however, this result is ambiguous, because the figures used in the test resemble the characters in Chinese and other East Asian writing systems. In order to examine whether it was indeed writing systems that might be responsible for the lesser field dependence of East Asians examined using the EFT, Kühnen et al. (2000) compared various Western populations with Malaysians, a highly collectivist East Asian population, who, however, have a Latin writing system. They found the Malaysians to be substantially more field dependent than any of the other three groups.