Cognitive Styles across Cultures

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The term "cognitive styles" has an established meaning and an emerging one. Beginning in the 1940s, a few psychologists developed an interest in "style," which referred to a characteristic way in which an individual handles information: perceiving, analyzing, interpreting, processing, organizing, representing, deciding, and so forth. Styles were said to be one's preferred ways of expressing one's abilities. Style research generated a large number of "dimensions," a few of which came to be recognized by laypeople; for example, holistic–analytic, field dependence–independence, and the 16 "types" of the Myers–Briggs type indicator.

Although it was not viewed as a problem by the established style researchers, the majority of their studies were being carried out using subjects from the "WEIRD" cultures: Western, educated, industrialized, rich, and democratic—and many of their subjects were American undergraduates. In effect, their findings were an ethnography. This cultural imbalance gradually was redressed, not only by psychologists but also by cognitive anthropologists, sociologists, and neuroscientists.

As the turn of the century approached, the animating challenge became to determine whether and to what extent culture or, more broadly, environment plays a role in thinking and behavioral patterns. Studies of culture's impact on cognition were burgeoning; interest in style dimensions began to recede. As this encyclopedia goes to press, the cascade of findings, especially those emerging from cutting-edge neuroimaging techniques, are yielding exciting implications for our understanding of human beings—not in isolation but as environmentally and culturally situated.

Established lines of inquiry into cognitive styles

Interest in styles arose because of people's common experience of recognizing that a close acquaintance exhibits, across many situations, an idiosyncratic way of perceiving and thinking, a consistent "how" of getting things done. Psychologists believed that what generated one's style was her cognitive apparatus: hence, "cognitive style." Another frequent term was "intellectual style."

Early researchers tried to state with precision what style is and isn't. Some held that style is not related to gender or age. (In those days, culture wasn't considered.) Many thought of style as lying at the interface of personality and cognitive ability. Others, however, noted that style instruments often used "right" and "wrong" answers to assess performance; they argued that no convincing difference separated style from ability. Still

others made this distinction: Ability is assessed by how well one completes a task; style is assessed by *how one goes about* completing that task. Fast-forward to today, when cognitive style is conceived as an individual's consistent pattern of adaptation to his environment and life experiences, developed in line with his innate predispositions and abilities, and modifiable in response to changing external circumstances.

Early research led to a plethora of style "dimensions," demonstrated by literally dozens that were proposed beginning in the 1940s. One leading style authority regretted the absence of a common conceptual framework and pointed to the balkanization of research groups—a situation occurring because each research team, to verify its freshly conceived dimension, developed its own measuring instrument.

Examples of style dimensions proposed during 1940–2000

Most style dimensions proposed during 1940–2000 can be categorized into three general types: personality-centered, cognition-centered, and activity-centered.

The personality-centered category comprises a widely recognized style dimension: the theory of psychological types. It entered, and remains in, the public's awareness through its extensively used instrument, the Myers–Briggs type indicator (MBTI). The theory itself, based on the work of Carl Jung, posited four dimensions in how people approach daily life. *Introvert–extravert* concerns one's characteristic manner of interacting with others. *Intuiting–sensing* describes one's perceptual tendencies. *Thinking–feeling* is about the basis on which one usually makes judgments. *Perceiving–judging* labels how one tends to interpret information. The resulting 16 combinations provide a shorthand way for individuals to classify themselves; for example, "ESTJ" is extravert-sensing-thinking-judging. A controversy that has attended the MBTI concerns the extent to which this way of comparing personality styles is cross-culturally valid.

The cognition-centered category comprises the majority of style dimensions proposed prior to 2000. Initially, the best known among these was *field dependence–field independence*, which addresses a difference in how people perceive the external world and deal with space. Those who typically perceive a visual field in a holistic, integrated way are field dependent; those who usually focus, within the field, on separate objects and activities are field independent. In the embedded figures test, for example, the subject is shown a simple figure (e.g., a triangle), then is given a complex drawing in which that figure is an obscured element; a field independent subject will be better able to find the simple figure. Detractors noted that, in practice, field independence almost always was viewed as preferable; they argued that, therefore, this dimension assessed cognitive ability, not style.

Examples drawn from the many other dimensions in the cognition-centered category include:

- *leveling–sharpening*, the tendency of some people to exaggerate and remember perceived differences (sharpening), while others minimize and forget differences (leveling);

- *impulsive–reflective*, the inclination of some to react to options relatively thoughtlessly and quickly (impulsive), while others respond after taking time for deliberate thought (reflective);
- *abstract–concrete*, the affinity of some for noticing and thinking about attributes, ideas, events, and relations (abstract), while others tend to focus on tangible objects here and now (concrete);
- *verbalizer–visualizer*, the penchant of some for mentally processing information in the form of words (verbalizer), while others prefer to process information depicted as images (visualizer);
- *external focus–internal focus*, the proclivity of some for contact with others and stimulating activities (external), while others are self-contained and content with the familiar (internal).

Around 1990, concern mounted that the proliferation of styles—above are listed merely six of dozens—might lead to the assigning of different names to similar dimensions. A proposal was made that the six dimensions above could be combined into these two overarching dimensions:

Wholist–analytic dimension	*Verbalizer–imager dimension*
field dependence–independence	abstract–concrete
leveling–sharpening	verbalizer–visualizer
impulsive–reflective	external–internal focus

The wholist–analytic dimension focused on the extent to which one deals with whatever is before him as an inclusive, integrated whole, or as a collection of discrete parts. The verbalizer–imager dimension addresses the extent to which one tends to think using words and to be oriented socially (verbalizer), or tends to think using images and to be more self-contained (imager).

Cognition-oriented style research during 1940–2000 rarely paid attention to cross-cultural factors. But in 2012, an attempt to adopt a cultural perspective occurred when Li-Fang Zhang and Robert Sternberg began by referencing their own attempt from years earlier to state an overarching synthesis of "thinking styles," which had grouped them into three broad types:

- *Type I styles*, a preference for tasks with a low degree of structure, obliging one to process information complexly and with freedom to be creative; also termed "legislative style";
- *Type II styles*, a preference for prestructured tasks, enabling one to process information in a straightforward way with conformity to established procedures; also termed "executive style";
- *Type III styles*, which have the characteristics of Type I or Type II depending on the situation.

Zhang and Sternberg then used Geert Hofstede's original four dimensions to represent the range of behavioral variations across cultures. After comparing each of

Hofstede's dimensions with their Type I and Type II styles, they hypothesized that the two sets of constructs were related:

Type I (legislative) thinking styles	low power distance
	low uncertainty
	  avoidance
	individualism
	masculinity
		← →	high power distance
			high uncertainty
			  avoidance
			collectivism
			femininity
				Type II (executive) thinking styles

Zhang and Sternberg then expanded their Type I and Type II categories to embrace five other dimensions:

Type I thinking styles	field independence reflective style perceiving personality type intuitive personality type deep approach to learning	← →	field dependence impulsive style judging personality type sensing personality type surface approach to learning	Type II thinking styles

Zhang and Sternberg viewed this as a "hypothesis" and discussed reasons why its alignment with culture might be difficult to confirm. They concluded that field dependence–independence related moderately well to Hofstede's dimensions, while approaches to learning related poorly.

The activity-centered category of style dimensions is concerned with the kinds of activities that one engages in while carrying out job responsibilities or learning in a classroom. The field of business and management began taking an interest in styles around 1970, focusing on topics such as decision-making styles. But in terms of public involvement, no style-related topic has led to more intense debate, or to more commercial advertising, than the topic of learning styles.

Examples of learning style dimensions proposed during 1940–2000

Interest in learning styles dates from the 1970s, when education-oriented researchers realized that the proliferation of cognitive styles was not helping their cause. But even though they went their own way, their efforts proceeded from the same assumption as that of the cognitive style researchers: that style is inborn, a fixed (or only slightly modifiable) property of an individual. Learning style research also yielded an overabundance of models: 84 were tallied in 2012.

One way of conceiving learning styles became especially influential: that of David A. Kolb, who in 1984 proposed an "experiential learning cycle." Kolb viewed learning as a process whereby the individual acquires knowledge by, first, perceiving and grasping new information lodged within experience and, second, mentally processing and transforming that information. Kolb posited that, for grasping new information, two

dialectically related modes are available: *concrete experience* and *abstract conceptualization*. For processing grasped information, two other dialectically related modes are available: *reflective observation* and *active experimentation*. Kolb envisioned experiential learning as cyclical. He implied that prototypical learning begins with concrete experience, then reflective observation, then abstract conceptualization, then active experimentation, then back to concrete experience. But so long as a learner engages in all four modes, he may activate them in any order.

From an intercultural perspective, a noteworthy fact about Kolb is that he stepped away from the mindset of individual psychology. Though he viewed the elements of his learning cycle as being based on an individual's preferences, he believed that learning style is not a psychological trait but a dynamic state that depends, in part, on one's life experiences and on the demands of one's environment, which is shaped by the pervasive influence of culture.

In a 2009 article, Kolb and coauthor Simy Joy proceeded to explore whether, and in what ways, culture has an impact on Kolb's learning styles, and the effect of culture in comparison with that of other demographic variables. Joy and Kolb's investigation explored 15 hypotheses; the two most fundamental were these:

- In terms of grasping new information that one encounters, members of various cultures will differ in their preferences for abstract conceptualization and concrete experience.
- In terms of processing the grasped information, members of various cultures will differ in their preferences for active experimentation and reflective observation.

The data containing measures of individuals' learning style preferences (plus demographic information) were gathered from records of online users of the Kolb learning style inventory. Cultures were operationalized as countries; one country was selected from each of the Global Leadership and Organizational Behavior Effectiveness (GLOBE) Study's ten "culture clusters"; practical concerns reduced the number of countries to seven. The most significant findings were these:

- Variance in people's preferences for grasping via abstract conceptualization or concrete experience was explained primarily by area of specialization; culture ranked second.
- Variance in preferences for processing via active experimentation or reflective observation was explained by age, followed by area of specialization; culture's significance was marginal.

Much learning style research was animated by a belief that classroom teaching could become more effective if teachers would tailor their delivery to match each student's preferred way of receiving information. The matching hypothesis drove research at all levels, from kindergarten through graduate school. Among the style dimensions tested was a distinction among students said to learn best in either a *visual*, *auditory*, or *kinesthetic* manner (VAK), to which was later added students who learn best in

a *read–write* manner (VARK). Some concepts began to gain popularity beyond the research community, significantly among entrepreneurial businesspeople.

These trends received encouragement from a 1983 book by Howard Gardner in which he discussed as "intelligences" human capacities that psychologists previously had been referring to as "talents" or "abilities," such as musical-rhythmic, logical-mathematical, and so forth. The lay public was accustomed to assuming that "intelligence" is what enabled students to excel in school. Gardner's new terminology encouraged people to begin believing that a student's struggle with a weak intelligence could be remedied if her teacher would specifically cater to one of her strong ones. The matching hypothesis gained credibility.

Psychologists with no stake in the entrepreneurial ventures growing around the learning style concept began examining the evidence; after 2000, these inquiries multiplied, with major literature reviews being carried out in the UK and US. These investigations reached similar conclusions:

- It is accurate to claim that people have *preferences* about how they receive new information.
- Many of the research findings that supported the matching hypothesis came from developers of commercially marketed learning style assessments.
- No study conducted under rigorous experimental conditions strongly supported the matching hypothesis. Several suggested that learning is more effective when there is a mismatch.
- Some evidence was found revealing that teachers tend to evaluate more favorably those students whose styles match their own, and are more likely to identify them as "gifted."
- Mistaken beliefs about learning styles among educators and the public arise, in large part, from confusing styles with abilities. Teachers should attend to each student's abilities.
- Some teaching approaches are better for certain subjects; for example, painting is best taught visually, poetry is best taught verbally. Teachers should attend to the nature of what is being taught.

The learning style debates occurred largely within the US, the bastion of individual psychology. Meanwhile, an alternative way of conceptualizing learning styles emanated from outside the US. The impetus came from Sweden, where researchers had asked students to read articles, then to describe what they had learned and how they had gone about learning it. The students' learning, it was discovered, depended upon their *conscious intentions*. If a student approached the task as a disagreeable necessity in order to pass an exam, what he gained was little more than some facts. If a student approached the task as an opportunity to understand a new, useful perspective, what she gained would be familiarity with themes, interconnections, implications, and so forth. Following additional research in Scotland and Hong Kong, the first approach was termed *surface*: intention to reproduce. The second was called *deep*: intention to understand. A third, *achieving* or *strategic*, was applied to students whose intention was to attain top grades.

The significance of the three "approaches to learning" is, first, that they are not viewed as fixed individual traits, but rather in terms of a here-and-now interactive relationship between a student immersed in a certain social and cultural environment, and a learning task with study demands and implications for the future. The interacting system is the focus, not the learner. The learner is assumed to be free to approach different learning tasks with shifting intentions depending on numerous factors, some internal, but many external to him-/herself. Second, this model has been investigated across cultures and educational levels, and close associations have been revealed between the three approaches and academic success: The achieving approach leads to the highest grades, a deep approach is sometimes associated with higher grades, and the surface approach leads to mediocre grades. So far, such findings have been reported by studies completed in Asia, Australia, the Middle East, Europe, and North America.

Cognitive research is broadened by fresh perspectives

Situated cognition: A fresh theoretical perspective

A characteristic of most pre-2000 research into cognition was that it treated the individual's mind as the unit of analysis. Social, cultural, and environmental situations were thought of as being "out there" waiting for a mind to reach out and interpret, react to, or act upon them. This view was challenged by Russian psychologists Lev Vygotsky (1896–1934) and Alexei Leont'ev (1903–1979). The school of thought they initiated became known as "situated cognition."

Influenced by Karl Marx's belief that tool-use is what distinguishes humans from all other animals, Vygotsky noted that humans use not only physical tools but also "intellectual tools" such as number systems and language. The great majority of intellectual and physical tools are received from one's preceding generation (and one's own generation if free to devise new and improved tools). Physical tools extend, enhance, refine, and accelerate humans' physical capabilities. Intellectual tools confer a parallel range of benefits on human mental capabilities.

The term "situated" emphasizes that each newborn arrives into the nurturing company of parents and others who are participating in a specific social and cultural situation. From them the newborn gains familiarity with relationships and objects, knowledge and myths, processes and norms, and much more, termed "cultural-historical artifacts." Each infant's mind, far from developing in isolation, grows to maturity while immersed in an interactive situation populated with handed-down meanings and practices, which initially enter the infant's cognition via the "intermental" plane of social interaction. As they become familiar and internalized, they take root in the child's "intramental" plane of individual thought, shaping and expanding the child's innate cognitive capacities. In sum, Vygotsky's theory holds that every act of an individual's reasoning is *an act of participation in shared cultural meanings and practices.*

Leont'ev went a half-step further with this analysis. Like Vygotsky, Leont'ev viewed cognitive development as a matter of a child's becoming an ever-more skilled participant in her culture's meanings and practices. But Leont'ev maintained that a child never comes into *direct* contact with cultural-historical artifacts. Instead, the child's experience and understanding are mediated, moment by moment, by her culture's meanings and practices. So her cognitive tendencies are best described as the characteristics of "the child-in-cultural-practice" because those tendencies cannot be understood separately from the child's social and cultural situation. (Note that this view comes close to holding that "mind" is a property of groups.)

One of the schools of thought that arose within the Vygotskian tradition is called "distributed cognition," which disputes that cognition occurs wholly within an individual's skull. Distributed cognition views thought as encompassing the thinker's environment, recognizing other humans and cultural-historical artifacts as resources for reasoning. Research during the 1990s offers an illustration. Officers and crew as they brought a ship into harbor were observed. The process interactively involved human beings, who were enacting roles invented and perfected throughout centuries of maritime procedure, and a variety of tools developed across an equally long period of time. Some tools applied 20th-century technology; others such as maps used skills developed millennia ago. Tools and humans formed a single system that completed a complex task.

Sociocultural systems: A fresh historical perspective

At the turn of the 21st century, scholars based in the East and West undertook the challenge of determining whether and to what extent culture or, more broadly, environment plays a role in shaping the characteristic thinking and behavioral patterns of groups. A key leader of this effort was Richard Nisbett of the University of Michigan. In a 2001 journal article, he and three colleagues termed their focus *sociocognitive systems* and proposed that the social organization and practices of a society have a measurable effect on the cognitive processes of its members

- by enculturating members to focus their attention on certain features of the environment, and
- by socializing members to value certain patterns of communication while avoiding others.

Sociocognitive systems develop and solidify over long stretches of time. Understanding their functioning requires understanding of a diverse range of knowledge about civilizations in the distant past. Since much is known about ancient China and Greece, they became the focus.

Ancient Chinese civilization was based on agriculture of a kind that necessitated sustained cooperation and interdependence. Society in ancient China was politically and hierarchically organized, with a value system that focused on social order and harmony (memorably captured by Confucius's dictums). Each individual was immersed in a benign social organism in which ethical conduct was stressed, being defined in

terms of reciprocal role obligations and absence of confrontation. If anyone thought of "rights" or "agency," these were the community's. These emphases on mutual obligations, hierarchy, harmonious relationships, and cooperation imbued the Chinese with a collectivist mindset and keen awareness of the contextual factors in their lives.

These dynamics in the lives of the ancient Chinese, it is hypothesized, led to *holistic* patterns of perception and thought in which one's predisposition is to attend to the entire field, and to the relationships among the multiple items and factors in that field. Explanations and predictions are made in terms of those contextual relationships—"ropes in a net"—not in terms of isolated items or factors. Knowledge is amassed through experience; logical reasoning contributes very little. Characteristics of the Chinese mindset include an expectation of varying perspectives, openness to change and contradictions, and a dialectical pattern of thinking that seeks not to choose one option over another but to find a "Middle Way" that takes all options into account.

Ancient Greek civilization was not based on agriculture (the topography was inhospitable); much more prevalent were fishing and herding. Political organization was decentralized and its authority structure was weak. As the cradle of democracy, ancient Greece fostered a tradition of debate, which encouraged individuals to formulate original ideas and persuade others to adopt them. Greece also was a crossroads of world trade, from which new ideas filtered in. In this milieu, individuals recognized that they had choices, that their social obligations were flexible, and that they possessed personal agency. The Greeks became imbued with an individualist mindset, complemented by a comparatively weak awareness of contextual factors in their lives.

It is hypothesized that the dynamics of ancient Greece led to *analytical* patterns of perception and thought in which one learns to attend to separate items and factors within a field, then to focus on the one that appears most prominent. Little attention is given to the field itself or to relations among its constituent items. This tendency directs one's interest to the central item's attributes or properties (e.g., Plato's universals) and, on that basis, assigns it to a category. For instance, a cow might be categorized as a "farm mammal," a subcategory of "animal." In trying to systematically understand the world, the Greeks developed taxonomies of categories and rules applicable to categories. To guide their debates, they devised formal logic; one of its principles is the law of non-contradiction, which fosters dichotomization. Conclusions and predictions are made via logical deductions about an item's attributes (some Greek philosophers mistrusted the five senses). Most importantly, the item's surrounding context or field is largely ignored.

Six of the most important mindset differences are summarized in Table 1.

Experimental research supports the influence of sociocultural systems

Psychologists have long recognized the tendency of many people toward "fundamental attribution error" (FAE): attributing other people's behavior to their personality traits and/or internal dispositions while ignoring the role of situational factors. FAE was first demonstrated with American subjects in 1967, long before psychologists became interested in culture. Not until 1984 was evidence produced that FAE might be a Western characteristic. A study found that Hindus usually explained others'

**Table 1**   Comparison of Chinese and Greek mindsets.

	Chinese mindset	*Greek mindset*
Social organization	hierarchy; interdependence; role obligations; harmonious social order	weak authority, weak social constraints; personal autonomy; confrontational debate
Sense of control	agency resides in hierarchy or group	agency resides in autonomous individuals
Attention paid to	entire field and context; web of relations	prominent focal item and its attributes
Mental grouping	on basis of experience, group items in reference to their interrelationships	on basis of their attributes, group items into categories; make rules and taxonomies
Predictions and causal explanations	attending to web of relations, causal factors sought throughout environment	using categories and rules, causal factors sought in focal item and its attributes
Habits of thought	draws on experience; dialectical and non-dichotomizing; consensus-seeking "Middle Way" respects all options	draws on attributes, categories, and rules; logical and dichotomizing; objective is to determine the one option that is preferred

behavior in terms of situational factors, while Americans explained similar behavior by citing the actor's personal traits. Subsequent experiments strongly associated FAE with the Western (especially American) mindset—and revealed that those who cite personal traits to explain others' behavior usually cite *situations* to explain their own behavior.

Evidence regarding FAE was one of many demonstrations that individuals' psychological processes lead them to varying interpretations of the external world. Another early indicator came from the research that generated the concept of field dependence–independence, which engendered the idea that personality variables influence how people perceive the supposedly "objective" environment. An early experiment for exploring perceptual differences was the embedded figures test, discussed previously. Another was the rod-and-frame test: In a dark room, the subject observes a glowing rod inside a glowing square frame. The researcher can change the tilt angles of both rod and frame; the angle of the rod is also controlled by the subject. With the frame slightly tilted, the subject is asked to adjust the rod to be perfectly vertical. If the subject positions the rod to slightly tilt, she reveals that she is field dependent.

Field dependence–independence research continued for years before anyone investigated whether the findings might be influenced by a subject's sociocultural system. Eventually, it was found that East Asians made many errors in positioning the rod to be perfectly vertical, revealing that they were attending more to the field (frame). Americans made fewer errors in positioning the rod, indicating that they were able to consider the rod in isolation from its field. To confirm this finding, Japanese researchers devised the framed-line test, illustrated in Figure 1.

In the framed-line test, a subject is shown a square frame with a vertical line extending from its top one-third of the way downward. She then is shown a new square of a
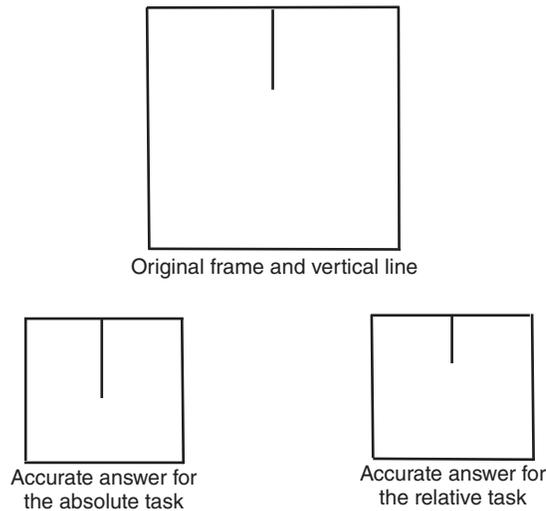
Figure 1 The framed-line test. Republished from Nisbett & Miyamoto (2005) with permission of Elsevier.

different size, without the vertical line, and is asked to draw in the vertical such that either (a) it is exactly the same length as the original vertical (the "absolute task"), or (b) it has the *same proportion* to the new square as the original vertical did to its square (the "relative task").

The framed-line test replicated the findings of the rod-and-frame test. Error scores showed that American subjects were more accurate when completing the absolute task, evidence of analytic (field independent) perception. Japanese subjects were more accurate when completing the relative task, evidence of holistic (field dependent) perception. It was observed also that the Japanese subjects attended more to the field and remembered more about it.

During the early 2000s, other experimental procedures were carried out to explore the impact of sociocultural systems on perception and thinking. For instance, American and Japanese subjects were shown pairs of animated vignettes of an airport scene in which there were a few foreground objects plus several background objects. For each pair, subjects were shown one vignette, then a second one that differed from the first in a few details. Each vignette pair could be watched four times. Subjects were then asked to note each change they observed. This and similar experiments confirmed that the Japanese detected more changes in the field and in relations among objects in the field; Americans detected more changes in the foreground objects. The researchers noted that the differences they found were quite large, sometimes close to one standard deviation.

These and numerous other findings are summarized in Table 2.

Efforts to reveal the drivers of cognitive differences have cast a far wider net than can be discussed here. American and East Asian societies are but one pair among many societies that have been compared, with similar results. Explanatory factors other than the sociocultural one have been probed to learn whether, and to what extent, they

Table 2   Relationship between sociocultural systems and cognitive patterns.

Tendencies of interdependent sociocultural systems		*Tendencies of* independent sociocultural systems
Collectivism and in-group harmony are valued		Individualism and autonomy are valued
One's social identity overlaps with others'		One's social identity is personal and bounded
Achievement for one's ingroup is admired	← →	Achievement by individuals is admired
One engages in group-referenced self-criticism		One engages in self-enhancing activities
Agency and rights belong to whole community		Agency and rights belong to each individual
Tendencies of holistic *cognitive patterns*		*Tendencies of* analytic *cognitive patterns*
Attention to field and its interrelationships		Attention to focal item(s) and its attributes
Categorization via relationships, similarities		Categorization via attributes, yielding taxonomies
Attributions based on situations, forces	← →	Attributions based on the actor's dispositions
Dialectic thought considers forces and factors		Analytic thought considers each separate part
"Middle Way" thinking is accommodating		Logical thinking seeks one option over others

account for differing cognitive patterns. Among the alternatives explored are wealth, class, language, recency of industrialization, degree of democratization, intellectual traditions (e.g., Aristotelian vs. Confucian), and genetics.

Emerging lines of inquiry into cognitive styles

One of the significant differences between studies during the 1940–2000 era and studies since then is that protocols during the earlier period relied heavily on survey—and usually self-report—measures, whereas emerging lines of inquiry are relying heavily on controlled experimental methods and cutting-edge neuroimaging technologies. Contemporary investigators are eager to learn whether these new methods will also reveal cultural variations in cognitive processing, and to what extent they will confirm the insights of the survey, self-report measures.

An emerging insight is that it's probably too reductionist to view culture-sensitive differences in terms of one dimension: holistic versus analytic. Another is that professional culture also plays a key role in shaping an individual's style. A four-dimensional perspective has been suggested:

- *Context independence versus context dependence*, the tendency to perceive events as part of, or separate from, their contexts. Context independence typifies Westerners and scientists, while context dependence typifies East Asians and professionals in the humanities and social sciences.
- *Intuitive versus rule-based scanning*, the tendency to scan a heuristically identified, diverse range of the available information, or to scan a rule- and analysis-identified, narrow range. Intuitive scanning typifies East Asians and visual artists; rule-based typifies Westerners and scientists.
- *External versus internal locus of control*, the tendency to locate control of information-processing outside of, or within, oneself. An external locus of control is characteristic of East Asians and visual artists; an internal locus of control is characteristic of Westerners and scientists.
- *Compartmentalization versus integration*, the preference for a compartmentalized, step-by-step approach to information-processing, or an integrative approach. The first typifies Westerners and professionals in the sciences and humanities, the second East Asians and visual artists.

The most intriguing hypothesis being explored by emerging studies is this: Most people live over decades at one location, engaging repeatedly in the activities typical of that environment, its culture, and their daily occupations. These patterns of behavior result in corresponding brain activations, repeated countless times, which configure the brain's pathways and result in *measurable systematic alterations* in the brain's neural connectivity.

Evidence that a brain can be physically altered by one's repetitive patterns of behavior came from a 2000 study of London taxi drivers. Using magnetic resonance imaging (MRI) technology, the drivers' posterior hippocampi (which store spatial representations) were compared with those of a control group whose work required no spatial navigation. The drivers' posterior hippocampi were significantly larger relative to those of the controls; furthermore, each driver's hippocampal volume correlated with his tenure in that occupation.

Representative of recent research is a study completed in Beijing. With Western and Chinese subjects connected to a functional magnetic resonance imaging (fMRI) device, the researchers asked them, as the control condition, to offer a judgment about a public figure. Then they asked each subject for a self-referencing judgment. Relative to the control condition, self-referencing judgments produced strongly increased activations in each subject's medial prefrontal cortex (mPFC), a brain area with an integral link to personality and social behavior. Both Chinese and Western subjects showed high mPFC activity. Finally, the researchers asked each one to offer a judgment about his/her mother. During their mother-judgments, the Chinese subjects again showed a substantial activity increase in the mPFC. The Western subjects showed none. This confirms that a feature of East Asian cultures that distinguishes them from Western cultures is high interdependence, including a shared sense of "self," among ingroup and family members.

Unresolved questions are being answered with the help of neuroimaging technologies. For instance, it's known that Americans are prone to FAE; East Asians are not.

Unknown is whether Asians exhibit low FAE because (a) their situational sensitivity eclipses their attention to others' internal attributes, or (b) they pay no attention to internal attributes. An answer emerged from a study in which Asian American and European American subjects were attached to a device that measures event-related potential (ERP), an electrophysiological response to a stimulus. They were asked to examine several photos of faces, each paired with a behavioral description. Then they were reshown the facial photos, each followed by a trait word that was either congruent or incongruent with the trait implied by the previously linked behavior. For the European American subjects, incongruous traits produced an ERP response significantly higher than congruous ones. For the Asian Americans, this effect was totally absent, a finding strongly suggesting that Asians characteristically pay no attention to others' internal attributes.

Findings such as these indicate that cultural variations can be demonstrated more clearly via neuroimaging techniques than by traditional measures. Long ago, survey and self-report findings had suggested that Asians, vis-à-vis Westerners, feel closer to their mothers and pay less attention to others' internal attributes. But the lopsidedness of these sociocultural differences could not be known until neuroimaging techniques could measure brain responses to experimental stimuli.

Emerging research has transformed our understanding of the relationship between culture and the brain. In a 2011 article, Shinobu Kitayama and Ayse Uskul posited that the influence of repeated behavioral sequences on the brain is *direct*, that is, unmediated by symbolic representations. The culture–brain interface, these researchers contend, is far more "hard" and behavioral than was previously believed. In their memorable phrase, neurons that are fired together get wired together.

"Cognitive styles": This term and the US-centric, psychologist-led, 20th-century research directions it signified are now being overshadowed by international, cross-disciplinary teams wielding amazing capacities to peer into on-the-job brains. One thing is certain: It's no longer possible to simply assume that any cognitive process or style is a universal human characteristic.

SEE ALSO: Cultural Assumptions in China and the United States; Individualism and Collectivism; Neuroscience of Intergroup Communication; Personhood Beliefs across Cultures

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