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Chapter 3
Indigenous Chinese Epistemologies as a Source of Creativity

David Yun Dai

Introduction

Indigenous Chinese Epistemologies as a Source of Creativity

The last two centuries or so have witnessed the huge success of the reductionist epistemology in modern science in the West. As a painful reflection, many Chinese scholars have attempted to explain how indigenous elements in the Chinese cultural beliefs impede similar advances ("自然辩证法通讯"杂志社; Communications on Dialectics of Nature 1983). However, the high power of modern science and technology also seems to have created an illusion of its omnipotence, whereas in fact it is not without its own pitfalls. In this article, I argue that while modern analytic science has been the engine that has driven new discoveries and inventions for more than two centuries, its shortfalls have also revealed themselves, particularly its inadequacy in accounting for complex, emergent, dynamic phenomena, such as real-time weather changes, complex bio-chemical processes, and social behaviors. In this regard, indigenous Chinese epistemologies of dynamism and holism provide valuable heuristics and tools for managing complexities and uncertainties that abound in reality, and even for new scientific insights, as they did in modern history.

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The Needham Question: Indigenous Culture as an Impediment to Scientific Creativity

Up to the 16th century, China had enjoyed prosperity as well as great success in science and technology compared to the backwardness of Europe. However, why did modern science occur in Europe, not in China? This is the famous Needham Question. Decades of efforts have been devoted to addressing this question ever since Needham raised the question in his ground-breaking book "*Science and Civilization in China.*" Many explanations pertain to differences in social and political systems (e.g., 金观涛, 樊洪业, 刘清峰; Jin et al. 1983); some focused on how cultural-psychological factors might have stood in the way of modern scientific thinking (e.g., 刘吉; Liu 1983). A most recent book on the topic appeared in 2009, entitled "*Legacy and Rebellion: Why Modern Science Occurred in the West*" (reviewed by 余英时; Yu 2009). Chen argued that the right question is not why China failed to produce modern science, but why and how the Western tradition gave rise to the modern science as we know of. Then what is modern science? Chen suggested that the milestones of the modern science include the works of Kepler, Galileo, and Newton, with physics and mathematics as its ultimate foundation (more elaboration in the next section).

Whether the Needham Question is a pseudo-question or not (Yu 2009), reflections on impediments of indigenous culture for scientific creativity are a valuable exercise. For instance, Franklin (Chen-Ning) Yang, a Nobel laureate in physics in 1957, commented that traditional Chinese thinking shows distinct weaknesses in deductive logic, an essential element for modern science. He also criticized the tendency in the Chinese tradition to associate efforts of scientific inquiry, such as Chinese medicine, with metaphysics exemplified in 《易经》 (Yi Jing or I Ching, "the Book of Changes"), which prescribes an Ying-and-Yang dialectic or logic for changes of the universe (see Yang 2005). Yang's warnings quickly drew criticisms from the champions of the Chinese way of thinking and living (see 毛嘉陵; Mao 2005). It is important, for the sake of intelligible discussion of pluses and minuses of traditional cultures for modern scientific thinking, to discern what exactly are essentials of modern scientific thinking exemplified by Kepler, Galileo, and Newton. Furthermore, it is crucial to understand the strengths and limits of modern science as a way of thinking and knowledge construction so that we don't tout it as the only way of gaining authentic, reliable knowledge.

Triumphs and Perils of Reductionism in Modern Science

In my characterization, reductionism lies in the heart of modern science. Reductionism can be seen as both a philosophic orientation (e.g., the Pythagorian notion of the universe operated based on mathematical relations and regularities), a methodological approach (e.g., isolation of variables or basic elements through experimentation), The most successful story of reductionism in history is classical

physics, which achieves a level of mathematical and empirical certainty unrivaled by any other disciplines. Thus physics is the envy of not only other physical sciences as such chemistry and earth science but biological and human sciences as well (e.g., economics and psychology). Although reductionism manifests itself in many ways (see Searle 2004 for a general discussion of reductionism), I identify three main tenets of scientific reductionism:

(A) *Elementism or atomism*: Reducing complex matters into their basic operating elements (i.e., building blocks) through analytic techniques (including partition and experimentation), for example, atoms and sub-atomic elements in physics, chemicals in chemistry, cells, tissues, and organs in biology, neurons and neurotransmitters in neuroscience, viruses, bacteria, and antibodies in medicine (i.e.,).

(B) *Positivism*: Mapping out the relations and causality of these isolated components in terms of mathematical regularities, verified through experimentation.

(C) *Deductive logic*: Generating a set of first principles that govern the operation of these elements in a variety of situations. Newtonian physics, with its first principles, has attested to the magical power of reductionism. As a matter of fact, it was so powerful that brilliant physicists such as Planck and Einstein all aspired to unify physical sciences under an even more basic, foundational theory. Planck, for example, warned that "physical research cannot rest so long as mechanics and electrodynamics have not been welded together with thermodynamics and heat radiation" (in Holton 1981, p. 18).

In short, analytic technology (experimentation), quantification (mathematization), and deductive logic (generality) are three basic constituents of scientific reductionism. Despite the unsuccessful attempt at a unified field theory in Einstein's later life (Kumar 2010), reductionism has proved highly effective when used in physics, but less so in biology and life science (Gottlieb 1998), and increasingly controversial in psychology (see Koch 1992) and economics (see Akerlof and Shiller 2009). As a matter of fact, it is facing increasing challenges even within the fields of mathematics and physics in light of new understandings of complexity (see Cornwell 1995; Prigogine and Stengers 1984). In the following section, I will discuss some of the triumphs and difficulties scientific reductionism has experienced in physics, medicine, and economics, with a caveat that the discussion is by nature illustrative rather than comprehensive.

Modern analytic science has enjoyed huge success in understanding both micro physics and astrophysics, enabling us to build computer chips as well as sending space shuttles to designated orbits with high precision. Yes, first principles have proved insufficient for working with physical realities that have complex structural and functional self-organization and endure dynamic changes over time (e.g., certain chemical bonding processes, dynamic formation of crystals). To illustrate the point, Newtonian physics seems to have worked out everything we need to know about gravity, yet it is not as helpful in predicting the trajectory of a falling leave, for which a different science is needed (e.g., aerodynamics). Meteorology is another example of tackling real-world complexity for which first principles are not very helpful; even with the real-time satellite information and simulation of changes based on carefully formulated mathematical equations, long-range prediction of weather conditions is still difficult to do due to complex real-time interaction of multiple factors. The famous example of Butterfly Effect illustrates non-linear dynamic change that defies any reductionistic prescription.

Reductionistic approaches to biology and life science have also produced enormous success in finding cures for many diseases and preventing endemics through finding proper vaccines. But it is still baffled by the complexity of even a seemingly simple phenomenon of metabolism or protein synthesis. The reductionistic temptation of seeking answers to health problems from the human genomics project is likely to lead to disillusion, as the genesis of many health problems is likely to be diverse and complexly determined. The modern bio-chemical model of medicine is good at attacking local problems whose nature and boundary are well defined (brain tumor, or leukemia), but not as good at attacking problems whose origins and boundaries are ill-structured (e.g., hypertension, which might be symptomatic of a range of problems; see Spiro et al. 1988, for a discussion of ill-structured problems). More broadly, the bio-chemical model of diseases and illness in the Western medicine espouses a dualist position on the mind-body issue and thus does not treat the health problem at hand as complexly determined, for which psychological factors (e.g., stress) are often involved.

Reductionistic approaches to human conditions and changes have yielded disciplines of psychology and economics. For the former, the doctrine of controlled experimentation makes it more akin to physics. For the latter, the doctrine of mathematical formulations gains itself a higher status of science compared to other social sciences. However, while experimentation in psychology historically has produced a fragmented psychology (Bruner 1983), the oversimplified assumptions of economic rationality and measurement continuity create an illusion of the ubiquity of economic principles so generated, which may appear mathematically elegant but vastly overlooks the complexity of human cognitions and motivations (Akerlof and Shiller 2009).

Taken together, reductionism in modern science faces serious challenges because it fails to capture the complex and dynamic nature of many physical, biological, and psychosocial processes. Its doctrine of controlled experimentation, which takes thing apart to see how each piece works, falls short because the sum of the parts does not equal the whole. Its doctrine of mathematization breaks down in the face of emergent properties, qualitative differences, and measurement discontinuities. And finally, its doctrine of deductive logic fails as things get more complex and dynamic (and involving randomness as well; see Dai 2005, for more discussion).

Epistemic Stances and Cognitive Strategies

When discussing the influence of Greek thought (e.g., Democritus and Pythagoras) on the Western axiomatic thinking that carries formal, deductive logic in its full force as to eliminate all contradictions, Hideki Yukawa, the first Japanese who won a Nobel Prize in physics, commented that Orientals, particularly the Chinese do not seem to be as strong: "a thoroughgoing rationalism eludes them" (Yukawa 1973, p. 56). However, Yukawa quickly pointed out that the Chinese (and Japanese) seem to excel in intuition (or the Japanese *kan*). It is probably oversimplistic to argue that Chinese are more intuitive and Westerners are more analytic. A deeper question is why the Chinese places more trust in intuition and the Westerners in analysis. Here lies the crux of the matter: These cultures have developed differing epistemologies. As a saying goes, the Chinese are too rational to be rationalists. They suspect that over-analysis of a phenomenon would kill the whole. Intuition by nature is holistic, thus retaining the gist of the matter at hand, as fuzzy-trace theory (Brainerd and Reyna 1990) explains. Henri Poincaré, another renowned mathematician and physicist, said that "it is by logic we prove; it is by intuition we invent…Logic, therefore, remains barren unless fertilized by intuition" (quoted in Miller 1996, p. 351). But even this characterization of scientific endeavor misses the point of why intuition plays a vital role in science and other human practices. By analysis (the basic reductionist tactic), we naturally adopt a divide-and-conquer strategy, taking a system apart and looking at one thing at a time. In contrast, by intuition, we get a sense of how an object works as a whole. Intuition by nature is boundary-crossing and often analogical (mapping the workings of a concrete, familiar object onto an abstract, unfamiliar one). Many scientific discoveries were made that way (see Holyoak and Thagard 1995; Miller 1996). Sometimes it is even achieved through empathy; as a Nobel laureate chemist said, when he was trying to understand the inner workings of a chemical process, he often imagined himself living through the life of a chemical. Therefore, the question is not whether an analytic, reductionist or intuitive, holistic approach is better, but where and when they help us get a firmer grip on realities, intellectually and practically. To do this, it is meaningful to resort to the notion of worldviews, which can be traced back to Pepper's (1942) world hypotheses.

Pepper opposed the objectivity premise of logical positivism by arguing that there is no such thing as "pure" factual data free from interpretation. He outlined four worldviews or conceptual systems formism, mechanism, contextualism, and organicism that serve as "root metaphors" for interpreting a variety of natural phenomena and world affairs. Of the four metaphors, the first two are reductionist and the last two are non-reductionist. Similarly, Dennett (1987) identified three epistemic stances: understanding and predicting behavior of an object as *physical*, as involving *design*, or as *intentional*. Treating an object as physical is the most concrete; things can be predicted based on mass, velocity, energy, force, etc. The domains of physics and chemistry take this *physical stance*, a distinct reductionistic stance. In comparison, looking at an object from a design point of view is more abstract: we infer its structures, functions, and purposes. Disciplines that characteristically take a *design stance* include biology and engineering, which help us understand, for example, how a bird is designed, in a evolutionary sense, for flying, or how a clock is designed, mechanically or electronically, to tell time. The design stance can be reductionistic when design is considered innate or preordained, but can be non-reductionistic if a design is dynamically shaped through development and use (i.e., self-organized). The most abstract stance is *intentional stance*: we have to infer desires, thoughts, and feelings or various mental states in order to make good predictions about the behavior of a given object. Minds and some software have this intentional property. Intentions are emergent from person-situation interactions and thus contextual and reductionistic. Utilities of the three epistemic stances are not just about their predictive efficacy with particular objects or behaviors; a proper epistemic stance helps us grasp the inner workings of a thing, and an improper stance obscures its essence. Joseph Needham, for example, in his research on embryo development, found the Western mechanical model wanting, and resorted to Chinese organismic thoughts for inspiration (王, Wang 2005). Thus, I am not discussing possible cross-cultural differences in cognitive styles per se such as holistic versus analytic, which might exist between the East and West (see Masuda and Nisbett 2006). I am focusing on differences in epistemologies: what we believe are the reliable and viable ways or strategies to apprehend the realities.

Indigenous epistemologies are folk and informal beliefs and ideologies embedded or encrypted in a culture's natural language and social practices. Although they are implicit (Peng and Nisbett 1999), they can be systematically expounded by scholars of an indigenous culture, as in Taoist writings and classic texts on Chinese medicine. In the following section, I discuss indigenous epistemologies reflected in Chinese medicine, the game of Go, and Taoism.

Indigenous Epistemologies of Change and Dynamism as a Source of Creative Insights

Chinese medicine, the game of Go, and the Taoist philosophy have more than two thousand years of history. Moreover, they are still very much alive and well in the contemporary Chinese culture. Chinese medicine is still an institutionalized practice in China; the game of Go is still quite popular as a national pastime as well as profession, not only in China but in Japan and Korea, among other places. Taoist writings are still in school texts as well as featured on national TV. I suggest all three provide a rich source of epistemological insights regarding how to understand and deal with the dynamic, changing nature of the world in which we live.

Chinese medicine. Chinese medicine reveals a distinct indigenous aspect of the Chinese epistemology that emphasizes the intuitive grasp of inner workings of a human body. Thinking in Western medicine is thinking in basic entities that constitute the body, such as cells, tissues, organs, and chemicals. In contrast, thinking in Chinese medicine is thinking in manifest states of a living person (e.g., pulses, tongue colors, complexions) and probable causes (Zhu 2005), which may be called "symptomatic thinking" "象的思维." (Wang 2005, p. 151). Instead of getting blood cell counts or measures of critical bio-chemical indicators, symptomatic thinking would lead to a hypothesis of how the body as a whole "malfunctions" that

produces the symptoms rather than reducing the problem to some material causes, deficiencies, or disorders. Using a number of key concepts (e.g., the central concept of "qi" 气 or energy, its ups and downs, and ying-yang dynamics), Chinese medicine explains how the harmony and balance of dynamic states get disturbed. While the conceptual system derived from Chinese metaphysics, which has questionable origins in ancient mysticism, the functionality of these concepts makes them good tools for characterizing a person's state of health and well-being. It treats the person as a whole, and thus avoids the pitfalls of Western medicine, which tends to treat local problems (标) without getting to the roots of most medical problems as fundamentally a regulatory one at the system level (本).

Epistemically, the conceptual system in Chinese medicine is not really a system of "objective realities" out there, but represents a doctor's perceptual simulation of how a living being functions or malfunctions, and thus retains its dynamic properties, which would be lost when a medical problem is subjected to a purely bio-chemical analysis. For example, the system of channels and subsidiary channels (经络系统) is a unique invention of Chinese medicine that led to acupuncture, among others, as a treatment technique. The material existence of such a system is controversial for the lack of solid evidence. However, search for its anatomic locality might miss the point, as the system can only be understood more dynamically in its functionality and pathways (Zhu 2005). A more viable approach is to test whether treatments based on such a theory yield desired effects in a controlled experiment. From a practical point of view, the conceptual system used in Chinese medicine represents a form of embodied cognition; it is not a system of representations of anatomic structures and functions and bio-chemical systems but a system of representations of perceived or intuited functional states of a living person. It better fits with Clark's (1997) vision of cognition: "The internal representations the mind uses to guide actions may thus be best understood as action-and-context-specific control structures rather than as passive recapitulations of external reality" (p. 51).

Compared to the universal or nomothetic approach adopted by Western medicine, Chinese medicine insists on an idiographic approach, treating each patient as having his or her own unique health history and trajectory. As Chen Yinque (陈寅恪), a famous scholar of sinology, said, "Chinese medicine has cures for diseases, but not universal principles to follow." (quoted in Yu 2009). From a nomothetic point of view, the same cholesterol level or blood pressure measure should have the same interpretation across individuals. From an idiographic point of view, however, it carries different meanings for different individuals. This insistence on individuality is consistent with the holism: the cholesterol level or hypertension is meaningful and interpretable only in the context of the individual as a living system with its unique pattern of symptoms and probable causes. The emphasis on individuality also makes Chinese medicine more akin to an art than a science, as it relies more on case-based knowledge and expert intuition and judgment rather than general rules and principles, and biological and medical statistics.

The holistic emphasis of Chinese medicine also makes the mind-body relationship more intimate. In the Cartesian dualism, mind is separate from body; it can only use its power to understand the body; but by no means can it influence bodily processes. In ancient Chinese medicine as well as philosophy, mind and body are intimately connected through "qi". Highly sophisticated techniques of mental concentration (i.e., meditation, 打坐) and breathing ("qigong," 气功) have been developed to literally move the body energy ("qi", 气) and regulate the physical and biological processes (e.g., slowed metabolism). The boundary between mind and body is crossed when intentional regulation of bodily processes is exercised.

All in all, the Chinese medicine provides an understanding of bodily functions that is distinctly non-reductionistic. What is interesting from an epistemological perspective is its insistence on maintaining a dynamic view of a living system as consisting of various changing states of bodily functioning, and its insistence on "qi" as the central concept of such a living system, rather than bio-chemical elements that make up the system. What sustains health is not the sum of these elements functioning in an isolated way but the emergent higher-order properties (e.g., unbalance of ying and yang) out of the complex interaction of these elements. Cognitively, well-trained medical intuition, rather than general rules and principles, plays a key role in diagnosis.

The game of Go. Like Chinese medicine, Go is an ancient Chinese game with a distinct modern appeal: its complexity. The goal of the game is to compete for space or territory. It is played by two players adding stones in turn on a 19 × 19 grid board, with a state space of roughly 10^{170}, compared to 10^{50} in chess. What makes the game fascinating is that it starts with an empty board, which evolves from an unconstrained, undetermined nothingness to ever increasing complexity as stones are placed on the board to form and compete for territories. The game was seen as analogous to the cosmos in the ancient literature (see 何, He 2003, pp. 3–4, for the remarks of 班固 Ban Gu 32–92, ad). Interested Westerners are often taking an analytic approach to the game of Go, such as figuring out the deep mathematical rules of the end game (Berlekamp and Wolfe 1997), or solving a smaller-scale game of Go mathematically (van der Werf; see http://erikvanderwerf.tengen.nl/). For the Chinese, ancient and modern alike, finding a solution to the game of Go once and for all has never been an attractive idea. Wu Wenjun (吴文俊), a renowned mathematician, warned that mathematically tackling the game of Go may be fundamentally wrongly headed (Wu 1993). In other words, they are somehow wary of radical reductionism, such as a mathematical solution to the game of Go. Instead, the Chinese are more interested in how to cope with the enormous complexities and uncertainties the game poses to the player.

Similar to Chinese medicine, the community of Go players has developed a rich repertoire of concepts and heuristics to deal with game situations that are more or less ill-defined. One of those key concepts is *taste*, bad taste, good taste, awesome taste, lingering taste, etc. It is a fuzzy concept meant to capture undetermined or undetermined good and bad possibilities with particular game positions. It is a similar kind of symptomatic thinking used in Chinese medicine that permits detection of opportunities and vulnerabilities without getting unnecessarily to the

details when situations not fully unfolded. It reflects the principle of cognitive economy as prescribed by fuzzy-trace theory (Reyna 2008; Reyna and Brainerd 1995).

In chess, leverage points and tipping points are relatively clear (e.g., positional advantage, or materials loss). In Go, they are much more subtle; detailed analysis and extensive look-ahead do not help much in critical decision making (e.g., war or peace, containment or invasion). Shi Dingan (施定庵), the author of A Guide to Principles of Go, used water flowing through a riverbed to describe a playing style that goes with the flow of the game rather than forcing a play (Shi 2003). Wu Qingyuan (吴清源), one of the best Go players in history, compared his own trust in intuition concerning move selection with the highly analytic approach used by Minoru Kitani (木谷实), another top player in history, and had this to say:

> I, from the very beginning, held it to be true that human beings are not omnipotent; no matter how much calculation we do, we would still not get the clear results and answers…If you put too much faith in calculation, you might lose sight of the global dynamics of the game (Wu 2003, p. 60)

Following up on the best hunches and verifying the most promising lines seem to be a successful coping strategy in the face of numerous possibilities and uncertainties. A fascinating tactic of reducing uncertainties and facilitating decision making used in the game is Testing the Opponent's Response (试探应手); that is, when a situation is murky and unclear, try to force the opponent to make a move first that helps clarify the situation, before you make a decision as to in what direction you want to move the game.

Another area in which Go poses a serious challenge is evaluation of gains and losses. In chess, for example, what constitutes gains and losses, advantages and disadvantages is relatively clear. That is why Deep Blue, the computer chess that arguably beat a world champion, can easily implement a couple of evaluation parameters. For the game of Go, gains and losses are always intertwined. Immediate gains may have a hidden loss down the road, local territories may be gained at the cost of global strategic positioning. The player has to maintain a delicate balance between short-term gains and long-term development, efficiency and safety, tactical and strategic considerations. In history, "ten principles," a set of heuristic rules, were developed to guide players. They were designed to deal with, rather than eliminate, complexities and uncertainties.

In sum, the game of Go provides rich insights as to how to deal with ill-structured problems (Spiro et al. 1988) and make rational decisions in the face of enormous complexities and uncertainties.

Taoism. Why is it that the Chinese do not seem to care as much about "ultimate truth?" There could be many reasons, such as they are more likely to show pragmatic interests rather than purely intellectual ones in dealing with the world (李泽厚, Li Zehou, Li 2008). But one epistemic reason is the perceived impermanence of the cognized truth, as expressed by Laozi (老子):

> The way can be charted is not a constant way; an identity that can be named is not a constant identity. (道可道, 非常道; 名可名, 非常名).

Diametrically different from the Greek thought that seeks an essence or fixed identity for everything, Taoists were convinced that if there is anything constant in the universe, that is change, and that the human cognitive apparatus (e.g., language and thinking), however sophisticated, cannot capture all the nuances of the pervasive and ubiquitous changes.

Quantum mechanics provides a classic example of why the Taoist humility is justified. It is said that Niels Bohr's theory of complementarity was in a way inspired by the Chinese philosophy, particularly the complementarity of Ying and Yang, which Bohr used as a symbol of complementarity. The complementarity principle, in its most general form, states that some objects have dual or multiple properties that appear to be contradictory but actually reflect the complementary nature of things. I venture to argue that the complementary principle Bohr developed was revolutionary as far as the epistemology of science is concerned. This revolution was at least in part inspired by Taoism, among other influences. Here was how.

First of all, complementarity itself, as Bohr made it very clear in what is now known as Copenhagen Interpretation, is an intuition of how the university manifests itself. It is a model-based intuition of the workings of the atomic world, rather than an axiomatic truth. By declaring complementarity on the particle-wave duality regarding physical properties of electrons and photons, Bohr insisted that its paradoxical or seemingly contradictory nature is not to be explained away by a deeper unity (or essence), but rather should be seen as how the universe shows its non-deterministic, probabilistic nature. While Albert Einstein unrelentingly sought the singular axiomatic truth (e.g., his attempt at unified field theory) to eliminate the contradictions and redeem a deterministic universe (recall his famous line: "God does not play dice with the universe" in response to Bohr and Heisenberg). The complementarity principle made Bohr side with Laozi that indeed the way that can be charted is not a constant way; the nature would show its other face as well.

Second, electrons behave either like particles or like waves under differing experimental conditions, but do not display wave-like and particle-like properties simultaneously under any experimental condition. It resembles Heisenberg's uncertainty principle that when measuring an electron there is a tradeoff between the precision of its position and momentum; one cannot get a good measure of both simultaneously. This led Bohr to declare "the impossibility of any sharp distinction between the behaviour of atomic objects and the interactions with the measuring instruments which serve to define the conditions under which the phenomena appear." (quoted in Kumar 2010, p. 244). In other words, equipments and instruments we use always influence what gets observed and measured. This argument challenges the deeply entrenched positivist assumption that the observed is independent of the observer. It (along with Pepper 1942) affirms the Taoist conviction that, very often, the certainty and objectivity of knowledge is purchased at the cost of overlooking the complexity and uncertainty of the world. To paraphrase Laozi's remarks, "The truth discovered by the right instrument not a constant truth."

Third, formal logic fails in capturing the complexity and changing nature of the universe at the micro or macro level. Concepts themselves undergo changes rather

than always holding their identities. For example, concepts like particle and wave have different referents in classical physics than at the quantum level. In articulating truth through language, it is often difficult to capture the nuances of the truth. This is the distance Bohr identified between clarity and truth, echoing Laozi that "An identity that can be named is not a constant identity." This is ultimately why an intuitive solution based on a broader, more inclusive perspective, such as the complementarity solution to the participle-wave duality, is often better than an axiomatic one, which is stringent in formal logic but narrow and exclusive in perspective.

In sum, it was not merely the aesthetic appeal of the Ying-Yang logo but the deep complementary logic behind it that resonated with Niels Bohr while attempting to fashion an explanation of the puzzling issue of the particle-wave duality. As I said earlier, holism and dynamism (emphasizing change) is at the heart of Chinese epistemology. Zhuangzi, another major figure in the history of Taoism, shows through a fable how a mechanistic, reductionistic view kills the integrity of a dynamic system (or life).

> The Emperor of the South was called Swift and the Emperor of the North, Fast. The Emperor of the Center was known as Chaos (混沌). One time, the emperors of the North and South visited Chaos's territories. Where they met with him. Chaos made them heartly welcome. Swift and Fast conferred together as to how they could show their gratitude. They said, "All men have seven apertures-the eyes, the ears, the mouth, and the nose-whereby they see, hear, eat, and breathe. Yet this Chaos, unlike other men, is quite smooth with no apertures at all. He must find it very awkward. As a sign of our gratitude, therefore, let us try making some holes for him." So each day, they made one fresh hole; and on the seventh day Chaos died. (Zhaungzi:, 庄子《应帝王》 "混沌")

The logic of the Swift and Fast is a mechanical one: once we get a handle on all parts of a machine, we can get it running. However, it violates the logic of Chaos that the dynamic whole runs by its own logic and cannot be reduced to functions of its parts. Hideki Yukawa, on his mulling over this story, commented that scientists often try to find more particles, more basic form, beyond what have been already found, a natural reductionist temptation. However,

> it is more likely that the most basic thing of all has no fixed form and corresponds to none of the elementary particles we know at present. It may be something that has the possibility of differentiation into all kinds of particles but has not yet done so in fact. Expressed in the familiar terminology, it is probably a kind of "chaos." It was while I was thinking on these lines that I recalled the fable of Chuangtse (Yukawa 1973, pp. 65–66).

Zhuangzi in effect was illustrating the pitfalls of the mechanistic, reductionistic worldview, as if once all bits and pieces of the universe are localized or fixated, we will get the whole picture of the universe since the whole universe can be understood by the bits and pieces. Alas, accordingly to Zhuangzi, one would miss the essential of what makes the whole work and kill the dynamics. In hindsight, Yukawa's comments predict the birth of string theory in physics, which sees all manifestations of particles, not as materials, but as notes, as it were, (i.e., effects) of music played out on a proverbial string of a string instrument such as violin. How string theory follows the logic of dynamic whole is beyond the scope of this paper (and the author's expertise), but that the ancient Chinese philosophy still resonates with modern scientists such as Bohr or Yukawa suggests its potential to inspire creative thoughts that transcend mechanical reductionism.

Summary. The essence of indigenous Chinese epistemologies is its special attention to movements and changes and the ensuing uncertainties in physical, biological, and social systems. It rejects the mechanic view of the world as a machine-like or clockwork cosmos, which is fully determined in terms of its components and operating rules. In that manner, they insist that the key to understanding the dynamic world is not to figure out its starting point, basic elements, and general rules governing their operation, but to capture its dynamic properties and changes through flexible, adaptive cognitive control.

Implications for Nurturing Creativity

Before discussion of implications of indigenous culture as a source of creativity, a disclaimer is in order. I am not saying reductionism is categorically ill-informed or Newton and Einstein were wrong. Without reductionism, we would not have had space shuttles, nanotechnology, vaccines, or neurosurgery technique. The divide-and-conquer strategy in science is still an effective one in many situations. However, it is also clear that reductionistic approaches have not been very successful in dealing with problems that involve dynamic changes and complex self-organization of physical, biological, and social systems over time. The prevalence and dominance of reductionsim in all areas of science for the last two hundred years can be attributed to success of classical physics; as commonly perceived, God created the world, and Newton (and Einstein) found out the formula of God's creation. If it is so good for physics, it should be good for chemistry, biology, psychology, economics, sociology and political science. Alas, even God would be puzzled as to how the world has evolved since His creation into such a dazzling complexity!

Given the diversity and complexity of the physical, biological and social processes, alternative perspectives become increasingly important. Western thinking is predominantly mechanistic one. In psychology, for example, behaviorist and information processing theories have been dominating the field because they both provide mechanical models of behavior and cognition with a strong reductionist flavor (e.g., mind as an input-output data crunching machine, or operant conditioning as a mechanical law). In contrast, non-mechanical models, such as gestalt theory (Duncker 1945) or "fuzzy trace theory" (Brainerd and Reyna 1990; Reyna and Brainerd 1995), which pay special attention to the role of intuition and holistic processing, have struggled to be part of mainstream psychology at least in North America, despite the overwhelming evidence that everyday cognition as well as

scientific thinking relies on intuition (Miller 1996) and related processes such as metaphors (Lakoff and Johnson 1980) and analogy (Holyoak and Thagard 1995).

Root-Bernstein and Root-Bernstein (1999) found in their research on scientific creativity that eminent scientists use a variety of thinking tools to tackle problems they are facing. These "tools" range from the most intuitive (maintaining the integrity of the whole) to the most analytical (collapsing a system to its basic components). Most scientific endeavors are model-based rather than axiomatics-based, and thus have an intuitive basis at its core (root metaphors or an implicit or explicit epistemic stance; see Dennett 1987; Pepper 1942). The process of scientific discovery starts with intuition of the inner workings of a system, and proceeds with imagery, modeling, simulation, bootstrapping, testing-modifying, means-ends analysis, so on and so forth, until a relatively satisfying solution is reached. Without an intuitive basis, a theoretical model simply cannot be derived from deductive or inductive logic itself.

Furthermore, since many physical, biological and social processes are self-organizing with emergent properties and organizational principles (Prigogine and Stengers 1984), there are emergent new approaches that are non-reductionistic, non-axiomatic, non-deterministic, allowing for perturbation, randomness, and errors, adaptive to real-time changing conditions, non-linear causal relations, diversity, probabilities, and variations, and uncertainties (e.g., Barabási 2003; Strogatz 2003). Theories so developed should be judged by how well they represent dynamic changes and governing principles, conceptually as well as empirically, rather than how formal (i.e., mathematical) they look. For instance, the quantification of economic science per se does not make it more "scientific."

How useful are indigenous epistemologies in this modern context? To be sure, some indigenous concepts and theories in the ancient Chinese culture can be outdated, and some part of its metaphysics borders on superstition. Granted they might have been detrimental to modern scientific advances. With that said, however, the vision of the Chinese sages took a direction drastically different from that of the Greek sages, and still shows their deep insights and wisdom even after more than two thousand years (recall how prophetic Zhuangzi was with the fable of "Chaos"). Chinese medicine still teaches us how to treat human body as a living whole rather than its stripped-down version with only tangible tissues and chemicals dictating diagnosis. The game of Go still teaches us how to make rational decisions under enormous complexity or in the face of "surplus of choice." The Taoist teachings still teach us about the fundamental limitations of human cognitive apparatus (e.g., language) and how we make most of it. Their voices found echoes today among those who have come to recognize the shortfalls of technical rationality meant to rule the world by the "book", and realize the importance of personal reflection on and insights into one's practice in situ (Polanyi 1974; Schön 1983).

In the educational context, Peng and Nisbett (1999) found that Chinese college students are more receptive to dialectic logic, and American college students more inclined toward formal logic. Likewise, Masuda and Nisbett (2006) found consistent differences between Japanese and American students on picture processing: the Japanese are more likely to move back and forth between foreground and background, whereas Americans stayed more focused on the foreground objects, suggesting a more analytic stance. Given these differences, my suggestion is to get more cross-cultural experiences and develop cognitive flexibility, which has been shown to improve creativity (Leung et al. 2008). This way, students will see both the advantages and disadvantages of a particular epistemological orientation regarding a phenomenon. The complementarity principle Bohr used to resolve the particle-wave duality is relevant even to productive and creative thinking.

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Chapter 4
The Person in Creativity, Development and Culture from the Perspective of William Stern (1871–1938)

Ai-Girl Tan

Introduction

The Person in Early Studies

In the history of modern time, the two World Wars of the last century have deprived humanities and resulted in a great loss of compassionate creativity and wise practices. These man-made disasters disrupted scientists' efforts to continuously develop sound methodologies for a deep understanding of the person in the world. To a great extent the situations of the pre- and immediate post-war periods created chaos in life and disabled open sharing of new knowledge. After World War II (1939–1945), the circumstance in the United States of America (U.S.) permitted some researchers and scientists to conduct studies on identifying creative talents in sciences and engineering. The then president of the American Psychological Association (APA), Joy Guilford (1897–1987) led a task force in constructing assessments for identifying creative talents. The subsequent year, Guilford (1950) delivered the APA presidential address with a title of creativity. He articulated explicitly the timely revival of the study of human creativity which was a long, overdue, and neglected endeavor among psychologists and scientists.

In his address, J. Guilford conceptualized creativity with reference to characteristics of creative people. He suggested immediate attention to discovering creative potentiality in children and youth and to promoting development of creative personality. Creative personality, which he humbly termed in a "narrow" sense (Guilford 1950, p. 444), referred to the unique patterns of traits that are relatively enduring ways in which creative persons differ from the others. To Guilford, behavioral traits are traits that manifested in performance such as attitudes, interests,

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