

MENTAL REPRESENTATIONS

Understanding Reality: The Importance of Mental Representations

William G. Huitt

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The topic of how human beings organize and use information to interact with the world around them has been studied for thousands of years. Researchers use the term mental representations or mental models to address this topic in current literature. This paper presents an overview of the most commonly used terms—worldview, paradigm, framework, model, schema, and script—and summarizes recent contributions on this topic. Implications for making the creation of these mental representations more explicit and modifiable are also discussed.

Human beings have an innate ability and desire to understand the world in which they live (Frankl, 1985; Wong, 2012). As they interact and organize their experiences with the world, they do so through the construction and use of mental representations (Markham, 1999) or mental models (Johnson-Laird, 1983). These are cognitive representations of the real or imagined world as it supposedly exists; they are a map rather than an exact replica of the territory they represent (Koltko-Rivera, 2004). Because they are merely constructed representations they are not necessarily accurate nor do they include all of the critical features of reality. However, they are very useful in that they serve to highlight important features of experience and facilitate the use of one's intelligence to adapt to, modify, or select environments in which one is embedded (Sternberg, 2003). Without them, experience would be perceived as a chaotic set of stimuli, making it very difficult, if not impossible, to interact with the world.

These mental representations are created at a variety of levels, from general ideas about the nature of reality to specific steps about how to accomplish tasks such as getting ready to go to work, ordering food at a restaurant, or interacting with others in a social situation. Quite often these mental representations are implicit, having been developed within a specific sociocultural context (McClelland, 1995). A variety of terms associated with mental representations—worldviews, paradigms, frameworks, models, schema, and scripts—will be discussed in the following sections.

Worldview

The term worldview is often used as the most encompassing mental representation (DeWitt, 2010) and has been defined as “the set of beliefs about fundamental aspects of Reality that ground and influence all one's perceiving, thinking, knowing, and doing (Funk, 2001). This mental construct includes thoughts related to such issues as “human nature, the meaning and nature of life, and the composition of the universe itself...” (Koltko-Rivera, 2004, p. 3). Indeed, Sire (2010) stated that a well-constructed worldview should address seven questions:

1. What is prime reality – the really real?
2. What is the nature of external reality – the world around us?
3. What is a human being?
4. What happens to a person at death?

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5. Why is it possible to know anything at all?
6. How do we know what is right and wrong?
7. What is the meaning of human history?

While it is certainly possible to systematically develop a worldview that explicitly addresses these questions, it is more common that a person's worldview is constructed implicitly within a specific sociocultural experience (Webb, 2009; Wilkens & Sanford, 2009). In fact, Webb (2009) went so far as to state that

No one comes to adult consciousness without first having passed through a cultural gestation, and no one begins to think by constructing a worldview on his or her own. Every human being is endowed with one from the start by the mere fact of having been born into a milieu where language is spoken and stories are told (p. 5).

As it is likely the case that one's worldview is only partially formed and hidden from conscious thought, those who want to make it more explicit can systematically address Sire's (2010) seven questions. A first step might be to complete an instrument developed by Ai, Kastenmüller, Tice, Wink, Dillon, and Frey (2014) that focuses on one worldview question—what happens to a person after death—as a means of identifying an individual's connection with one of three major cultural orientations: (1) a secular/materialistic worldview which holds no conception of an afterlife; (2) a cosmic-spiritual worldview which proposes that a spiritual soul exists in an abstract, ill-defined space; and (3) a God-centered view which advocates that a spiritual soul inhabits a well-defined "Heaven" under the control of a Creator. It should be noted that this latter view most often includes the concept that both the material and spiritual components of the universe or cosmos are under the control of a Creator.

Using the seven cultural/religious perspectives they explored, Ai et al. (2014) stated that followers of Confucianism and Daoism (Taoism) would likely hold a secular/materialistic worldview, those following Hinduism and Buddhism would likely hold a cosmic-spiritual worldview, and those following one of the Abrahamic religions of Judaism, Christianity, Islam, and Bahá'í would likely hold a God-centered worldview. It seems reasonable that an individual with an atheistic orientation would likely be associated with the secular/materialistic worldview, even though that orientation was not included in the construction of the instrument.

Although the secular/materialistic, cosmic-spiritual, and God-centered worldviews can be identified, there is extensive diversity within each of these categories. For example, Barrett, Kurian, and Johnson (2001) discussed how some countries, such as Australia, Canada, the United States, and South Korea have a wide variety of religions with which people identify; this multi-religious sociocultural experience can impact how people think about each of Sire's (2010) questions. On the other hand, one might expect less variety in countries such as Egypt, with a population of 90% Sunni Muslim, or Iran, with over 90% Shia Muslim (Central Intelligence Agency, 2013). Additionally, in countries with a higher standard of living, a higher percentage of people identify as secular/materialistic and/or cosmic-spiritual (McCleary & Barro, 2006). However, in countries with a higher level of education, more people report converting to a different religion rather than changing their God-centered worldview (Barro, Hwang, & McCleary, 2010). Therefore, worldviews must be interpreted within a specific sociocultural milieu (Hofstede, 2001) and even within a specific generation (Strauss & Howe, 1997). Nevertheless, these broad categories can be useful in delineating important similarities and differences about how people think, value, and behave.

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The modern and post-modern examination of the relationship between science and religion (eg, Clayton, 2012; Polkinghorne, 2011) has implications for a discussion of worldviews. Kluge (2001) suggested that a review of the four causes identified by Aristotle can contribute to this component of the concept of worldviews. He defined these four causes as

- a. Material – substance from which something is derived; made out of (bowl from clay).
- b. Formal – form from which something is derived; sample to be an exemplar (dress from pattern).
- c. Efficient – producer or initiator of change; produces (carpenter makes table).
- d. Final – the end result for which something will be used; purpose, teleos (driving a nail is the cause of a hammer)

Kluge stated that within this differentiation among causal explanations

lays the foundation for the unification of science and religion in a single, coherent scheme. Science restricts itself to the study of the material and efficient causes of all phenomena whereas religion studies formal and final causes. In this sense, they complement, that is, complete, each other and, thereby, help us make complete sense of the phenomenal world (p. 31).

The investigation of worldview is made somewhat more complex as the current formulation of the secular/materialistic worldview that dominates scientific investigation is undergoing revision because of recent discoveries in the relationships among brain, mind, and behavior in living organisms (Nagel, 2012). Nagel's reasoning is that science has yet to explain the existence of conscious minds and when it does that will most likely change the current version of the secular/material worldview. Another challenge to the current secular/materialistic paradigm comes from researchers who study near-death experiences (Moody, 2001; Long & Perry, 2011). While the evidence is anecdotal, the sheer volume of the data and the congruence of findings across researchers and cultures suggests the need for serious consideration of some of the basic tenets of at least a cosmic-spiritual worldview. It may be that in the near future, science provides the pathway to an integration of what now appear to be quite separate worldviews.

The possibility of using science and religion as two fundamental, complementary sources of information presents additional opportunities for scholarly interaction. For example, while each started from a different religious tradition, Bertrand (2007), Gosling (2011), Guessoum (2010), Harrison (2010), and Phelps (2009) all advocated a rapprochement between science and religion. Additionally, Peterson and Seligman (2004) took religious teachings into account when they developed their descriptions of personal strengths. The boundaries among sources of information used to generate worldviews as well as the worldviews themselves are being constantly deliberated and deserve additional consideration.

Maxwell (2016) proposed an emerging worldview, that he labeled as integrative, that combines the modern or mental/rational orientation that forms the foundation for a secular/materialistic worldview with earlier worldviews described as archaic, magical, and mythical (using the nomenclature developed by Gebser). He proposed that this emerging worldview identifies the partial truths from each of the previous worldviews that can be demonstrated as correct using both the methods of philosophy and science. More importantly Maxwell suggested there is a teleological aspect of the cosmos that is pulling all of its components to greater novelty and consciousness. This integrates the qualitative dimensions of

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form and final causation with the quantitative material and efficient causation that is the foundation of modern science and technology. Maxwell concluded that the basic principle of physics of entropic disorder must be synthesized with a syntropic teleological principle of an impulse towards novelty, consciousness, and order. Finally, he proposed that the great world's religions anticipated this integrative worldview in their scriptures.

As one's worldview is the most comprehensive mental representation and as it impacts all other representations, it is worthy of study. This brief overview suggests there are many aspects that need further consideration and that everyone needs to put effort into identifying one's own worldview as many aspects are likely unconscious for most people.

Paradigms

Cutting across these major worldviews are different paradigms that offer more precise statements about how reality works (Baker, 1992; Huitt, 2011a); that is, paradigms can be thought of as "a subset of a shared worldview" (DeWitt, 2010, p. 352). Kuhn (1970) described the importance of paradigms for scientific investigation as they define:

1. What phenomena are to be investigated?
2. What are the parameters of the questions that can be asked?
3. How should the questions be structured and organized?
4. What types of data should be collected?
5. What methods should be used to collect data?
6. How will the data be organized and interpreted?
7. What legitimate theories can be developed from the data and interpretations?

Four paradigms currently used in science include a mechanistic/reductionistic paradigm based on Newtonian physics; an existential/phenomenological paradigm based on the philosophers Kierkegaard, Heidegger, and Husserl; an organismic/wholistic paradigm based on Darwinian biology and systems theory; and a process paradigm based on the philosopher Alfred North Whitehead (Crowell, 2015; Smith, 2013; Ulanowicz, 2009). These categories are quite similar to the world hypotheses presented by Pepper (1942, 1967). See Table 1 for an overview of basic principles associated with each paradigm.

In general, the mechanistic/reductionistic paradigm assumes interchangeability and a linear relationship among parts, and a deterministic relationship among parts that is consistent at multiple levels. The existential/phenomenological paradigm focuses on the qualitative and subjective perceptions of an individual's concrete experiences. The organismic/wholistic paradigm focuses on the dynamic changes of a whole system or organism as it interacts with its environment. A basic assumption is that the whole emerges from the interaction of parts at a lower level and cannot be reduced to the parts on which it is based. The process paradigm assumes that the dynamic relationships among parts are more important than the temporary stable structures that might define the whole at any given point in time.

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Table 1. Identification of Worldview Paradigms

Paradigm	Worldview		
	Secular/Materialistic	Cosmic-Spiritual	God-centered
Mechanistic	<p>A focus on parts and the functioning of a machine-like organization.</p> <p>If parts and mechanisms are known, prediction and control are possible.</p> <p>It is important to study cause/effect factors one at a time.</p> <p>Physics and chemistry are the foundational sciences for investigating how the world works</p> <p>Empirical observations should be the basis for making decisions</p>	<p>Interaction of material and spiritual operate in deterministic manner.</p> <p>If parts and mechanisms of material and spiritual are known, prediction and control are possible.</p> <p>A spiritual practice will have a positive impact on one's life.</p> <p>Regular mediation will be beneficial to uplifting one's spirit.</p> <p>One's spiritual practice is the most significant impact on one's happiness.</p>	<p>God's actions determine reality; reality is deterministic emanations from God.</p> <p>If God's laws are known, prediction is possible.</p> <p>Asking God for assistance is always beneficial.</p> <p>Following God's laws is the best way to live a good life.</p> <p>Whatever happens in the universe is determined through God's will.</p>
Existential/ Phenomenological	<p>Phenomenological explanations are critical</p> <p>Subjective experience is reality</p> <p>Human needs and understanding are the foundation for investigating reality</p> <p>Asking people about their lived experiences provides the best information about how the world works.</p>	<p>Human beings are spiritual beings engaged in a material experience.</p> <p>There are many different paths to spiritual development.</p> <p>It is important to select a spiritual practice that feels comfortable.</p> <p>Spirituality is uniquely experienced by each individual.</p>	<p>Human prayers are answered.</p> <p>Human beings have the potential to understand God's methods.</p> <p>God directly interacts with human beings.</p>

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	Context makes it difficult, if not impossible, to generalize scientific findings.	There is ample scientific evidence to support human spiritual existence.	
Organismic/ Systems	<p>Biology and living systems are the foundational sciences for understanding reality.</p> <p>Parts cannot be understood completely in isolation from the whole.</p> <p>Investigating organism/ecology interaction is critical for understanding development.</p> <p>Emergence and self-organization are critical principles to understand reality.</p>	<p>Connect to spiritual reality.</p> <p>The process of spiritual development can be explained.</p> <p>There are both unique and universal aspects of human spiritual development.</p> <p>Spiritual potential is actualized in much the same way as biological potential.</p> <p>Human spiritual development is a naturally occurring process.</p>	<p>God created the context within which material and spiritual evolution occurs.</p> <p>Everything in the universe is connected and emanates from God.</p> <p>God has created the potential for the establishment of observed patterns of material and spiritual aspects of reality.</p> <p>God establishes laws; human beings have choice as to whether to follow.</p>
Process	<p>Reality is comprised of coordinated collections of occurrences, all of which are relational in nature.</p> <p>Processes are arranged holarchically.</p> <p>Becoming (coordinated change in processes over time) and being (processes occurring at one time) are equally relevant.</p>	<p>Everything (physical and non-physical) is connected to everything else in vast web or network.</p> <p>There is an essential unity between the concrete, physical aspect of reality and the abstract, non-physical aspect of reality.</p> <p>The material and spiritual are connected via processes.</p>	<p>God is sum of all past actual events and future possible events.</p> <p>God actively draws nature towards greater organization and complexity.</p> <p>Panentheism – An impersonal God is in all events and relationships which, in turn, comprise God.</p>

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Each of these paradigms can be seen in guiding research and theory development in the behavioral and social sciences. For example, the mechanistic/reductionistic paradigm is seen in psychology in the research of Skinner (1953), in sociology in the work of Coleman (1969, 1988), in anthropology in the work of Malinowski (2014), and in economics in the work of Samuelson and Nordhaus (2009). While this paradigm is considered the dominant scientific paradigm today (Ulanowicz, 2009), significant work has been done within other paradigms as well. The existential/phenomenological paradigm is well represented—in psychology, Rogers (2003) is an excellent exemplar as are Schutz (1967) in sociology, and Sartre (1993) in anthropology. The organismic/systems paradigm is seen in psychology through the work of Piaget (1952, 2000); other representatives include Bowen (1994) in sociology, Bateson (1987) in anthropology, and Daly and Farley (2011) in economics. While the process paradigm has yet to gain much acceptance in the sciences (see Hibberd, 2014, as an excellent example), there is a large body of work related to process theology (Mesle, 1993).

Combining concepts derived from the worldview and paradigm orientations provides the opportunity for more detailed analyses (see Table 1). It is hypothesized that each of the paradigms is seen in each of the worldviews. However, as most people have not developed their thoughts on worldviews and paradigms through explicit analysis, it is likely that research will find that actual categories are not as clearly differentiated as this analysis might project (Bencivenga, 2012; Kosko, 1993).

Framework

While a worldview provides an overall picture of reality and a paradigm provides some detail about how the worldview should be investigated, a theoretical or conceptual framework provides a more focused presentation of the factors to be studied, the relationship among factors, and the importance or strength among those factors (Maxwell, 2013). Though the terms theoretical framework and conceptual framework are often used interchangeably, they are overlapping, but different, terms. A theoretical framework is connected to one specific theory that provides an explanation of the relationship among factors that one is investigating. Any research or anecdotes are selected for review because they fit within a particular theory. As such, it will be connected to one of the paradigms described above. Skinner's (1953) operant conditioning theory, Freud's psychoanalytic theory (Gay, 1989), Roger's (2003) humanistic theory, and Piaget's (1952, 2000) cognitive development theory are exemplars that have provided a variety of theoretical frameworks. On the other hand, a conceptual framework is more based on personal experience and research support and the construction of important factors and their relationships will likely cross theoretical (and therefore, paradigm) boundaries. The World Health Organization's (2010) framework for action on the social determinants of health and McCurry and Hunter Revell's (2015) partner's in family caregiving framework are two exemplars of conceptual frameworks.

As an example of how worldview, paradigm, and framework might interact, two people may adopt a secular/materialistic worldview and mechanistic paradigm and even a behavioral theory of human behavior, but have different conceptual understandings of exactly what factors to observe and why (Graham, 2005). Or two people may adopt a cosmic-spiritual worldview and existential paradigm, and have similar conceptual understandings even though these are derived from different theories (Webster, 2004). The Brilliant Star framework is an example of how a

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theoretical and conceptual approach might be combined (See Figure 1; Huitt, 2011b). It was developed from an organismic/systems theoretical paradigm approach (Huitt, 2009) while the specific domains or categories included in the framework were identified from research. Diener and his colleagues (Diener, 2012; Diener, & Diener, 2008; Diener, Suh, Lucas, & Smith, 1999) as well as Seligman and his colleagues (Peterson, & Seligman, 2004; Seligman, 2011; Seligman, Railton, Baumeister, & Sripada, 2013) review much of the same literature but organize the concepts differently because they start from different theoretical perspectives. Diener and his colleagues developed measures of positive and negative emotions, positive thinking, and psychological wellbeing while Seligman and his colleagues focus on five factors (PERMA: Positive emotions, Engagement, Relationships, Meaning, and Achievement). Much work remains in the development of frameworks for each of the worldview/paradigms shown in Table 1.

Model

A model is an even more specific mental construction. The Merriam-Webster Online Dictionary (2012) defined a model as

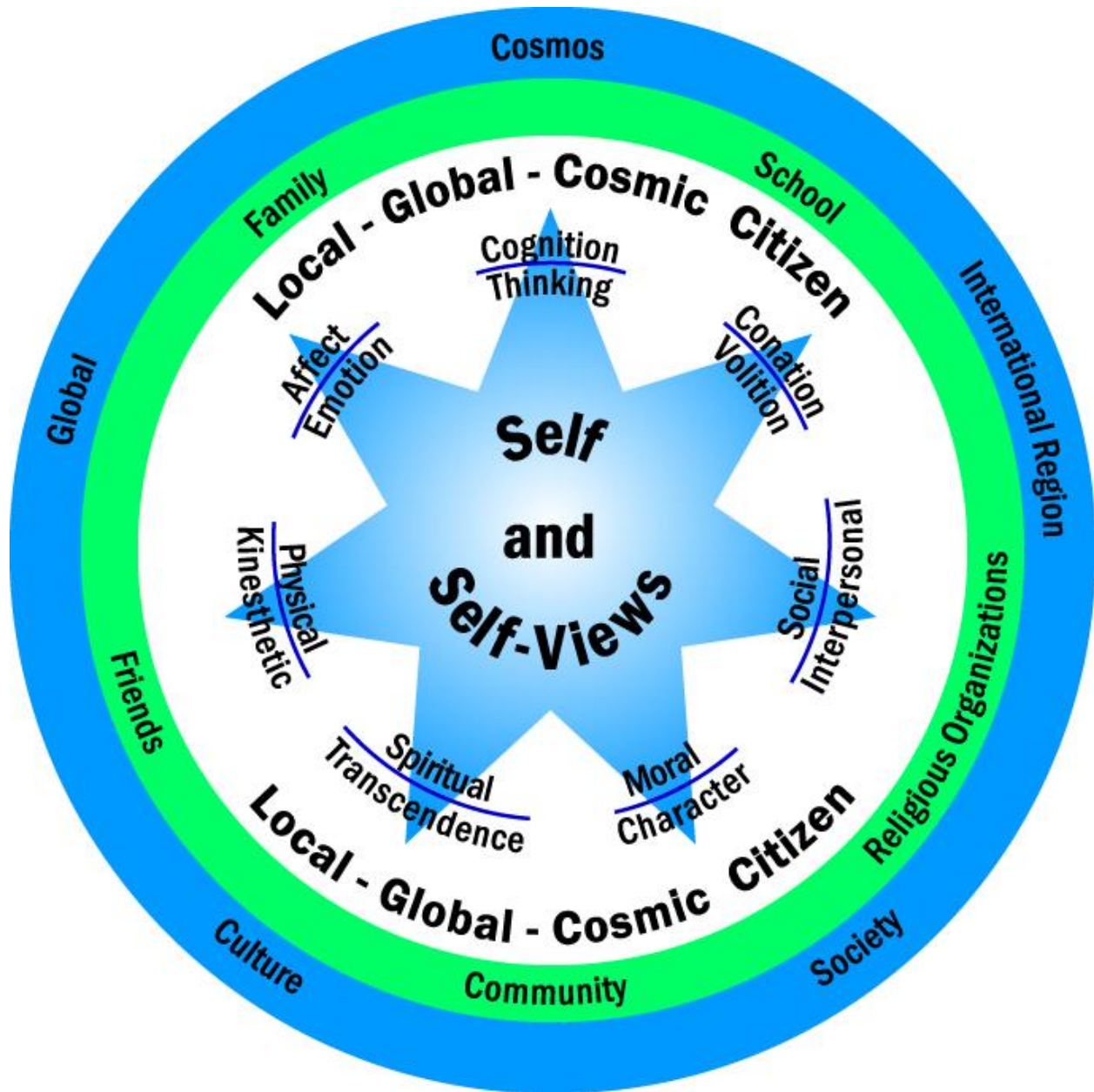
usually small copy of something; a particular type or version of a product (such as a car or computer); a set of ideas and numbers that describe the past, present, or future state of something (such as an economy or a business).

Within the behavioral and social sciences, whereas a framework describes the concepts and principles that would be included in a depiction of reality, a model provides a more explicit statement about factors or variables to be included, methods of measuring those, and precise statements about the relationships among those variables. A model is specific enough to allow for the development of simulations so that the performance of the model can be analyzed.

Models are especially important in the study of complex adaptive systems (which includes any systems involving human beings) because the realities involving humans are so complex that they are difficult to study in real time (Miller & Page, 2007). Running simulations (for which a model is required) has become a viable alternative to the traditional statistical investigations of systems (Hegyí & Garamszegi, 2011). This is especially important as many of the traditional statistical procedures used in the behavioral and social sciences are built on assumptions from a mechanistic paradigm that are limited when it comes to studying phenomena from an organismic/systems paradigm (Ulanowicz, 2009, Yackinous, 2015).

A wide variety of examples of the use of models are available in the behavioral and social sciences. For example, Savery and Duffy (1996) developed a model of instruction focused on problem-based learning that was derived from a constructivist paradigm which, in turn, was developed from Piagetian and Vygotskian theories of learning and development. Bures and Tucnik (2014) used systems theory in their development of agent-based economic models. Garamszegi (2011) described how information theory was the foundation for multiple explorations of behavioral ecology models. In each of these instances (and many more could be cited), the development of theory within a worldview and paradigm led to the development of a framework within which models could be developed and explored as to their efficacy in making predictions of future performance. These were then investigated using actual or simulated behavior.

Figure 1. The Brilliant Star Framework



Schema and Scripts

The terms schema and scripts are mental constructions that people use daily as they think about themselves and their interactions with the world around them. Use of the term schema (plural, schemata) has a long history, dating to Kant (1993) in the late eighteenth century. It has been part of the terminology in the study of memory and information processing for at least eight decades (Bartlett, 1995) and has received considerable attention in the investigation of reading (Bransford, 1979, 1985) and the development of network and connectionist theories of memory (Rumelhart as cited in Lutz & Huitt, 2003). From this perspective, a schema is a generalized,

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somewhat abstract, organization of knowledge that provides a structure for receiving and organizing new information. For example, in the process of reading, the text is understood in the context of the schema one brings to the reading process. If one reads about cold or snow, but has lived in the tropics all one's life, those terms do not have the same meaning as someone who has grown up in an area where cold and snow are annual occurrences. Or if one has lived exclusively in a rural environment, comprehending stories about living in an urban environment is a difficult process. An important principle of schema theory is that the schema must be activated in order to be utilized properly; therefore the process of activation is as important as the process of construction (Bransford, 1985).

Piaget (2000) used the term schema (and, alternately, scheme) somewhat differently. From his perspective as a genetic epistemologist who studied children's thinking extensively, a schema is an organized pattern of thought that allows an individual to interact with, and adapt to, the demands of the environment. More specifically, whereas investigators using information processing theory consider a schema is as a set of propositions (Corcoran, 2012), for Piaget (1952) a schema is "a cohesive, repeatable action sequence possessing component actions that are tightly interconnected and governed by a core meaning" (p. 240). For Piaget, the ability to meet the requirements of the environment using these cognitive structures is central to cognitive development. Whenever that does not occur (ie, when disequilibrium or imbalance occurs), the individual will first change the stimuli extracted from the environment (called assimilation) or, if that does not work, change the cognitive structures (labeled accommodation) (Lutz & Huitt, 2004). This activity of adapting to the environment adds a dimension not found in a traditional information processing approach.

The last mental representation to be discussed, scripts, are similar to schemas; in fact, script theory was derived from schema theory by Tompkins (1979, 1987) as part of his theory on affect and emotions. A script is a simpler version of a schema with the additional condition that repetitive events are expected or steps are followed within a specific context called a scene or vignette (Abelson, 1981; Schank & Abelson, 1977). The specific expectations or action patterns of a script are activated when triggered by thoughts and emotions generated in specific contexts. As an indication of how widespread is research on the use of scripts, just a few of the topics include emotion regulation (McRae, Misra, Prasad, Pereira, & Gross, 2012), monetary wealth (Klontz, Saay, Sullivan, & Canale, 2015), personal transformation (Erskine, 2010), projections of machoism (Ihanus, 2014), social anxiety (Lau, Wang, Fung, & Namikoshi, 2014), and weight loss (Hartmann-Boyce, Jebb, Fletcher, & Aveyard, 2015).

An important component of a script is that it allows one to automate certain behaviors by simply following a narrative of how a story should unfold. To the extent that the script makes it more efficient to achieve a goal, it is considered as positive. However, to the extent that it thwarts goal achievement, especially a feeling of happiness or wellbeing, it is considered as negative. The challenge in the latter case is that once a script is activated, it is very difficult to alter because it is often implicitly developed and, therefore, unconscious (Schank & Abelson, 1977; Tomkins, 1979, 1987).

Altering Mental Representations

Even though, historically, sociocultural worldviews and paradigms can take decades, even centuries to change (DeWitt, 2010; Van Belle, 2013), it is possible for change to happen much more quickly. As the brain demonstrates a remarkable amount of plasticity (Schwartz &

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Begley, 2002), individuals can modify mental representations once they are developed. However, it generally requires more energy and effort than constructing correct representations of reality during childhood and adolescence (Gardner, 2004). Once developed, mental representations take on a life of their own and resist alteration. An excellent example is Einstein's refusal to adopt quantum theory even though he was one of its originators (Bohr, 1949). Einstein could never accept the probabilistic version of the universe that is foundational to quantum theory.

DeWitt (2010) suggested that mental representations change when they are no longer held to be true in the sense that the facts, concepts, and principles on which they are based are not coherent (ie, there are unresolvable conflicts in the relationships among the parts) or they do not correspond to reality as it is believed to exist. In his theory of cognitive dissonance, Festinger (1957, 1962) showed that when there is conflict among thoughts or between thoughts and behavior, friction occurs and the individual is motivated to take action to reduce that conflict. This is especially true when the thoughts or behavior involve personal experience (Salti, El Karoui, Maillet, & Naccache, 2014). Because mental representations, more often than not, are developed out of personal experience embedded within a specific society or culture, they are implicit and unconscious. Nevertheless, they have a powerful impact on how people live their lives, reflect on past events, and plan for the future. This suggests that an important component of the transformation of mental representations is to make implicit representations more explicit so that conflicts can be identified.

Schlitz, Vieten, and Amorok (2008) proposed that changing one's view of reality as described by a worldview and/or paradigm is most readily accomplished through a process of transformation in consciousness or perception of reality, including one's own reality. More specifically, "It includes self-awareness, your relationships to your environment, the people in your life, and your worldview or model of reality" (Schlitz et al., p. 16). This change in consciousness can be quick through a transformative experience or occur more slowly through diligent, mindful practice. For example, many individuals having a near-death experience report an immediate alteration in how they view bodily death which alters their perceptions of reality (Moody, 2001; Long & Perry, 2011). Alternatively, individuals who engage in mindfulness exercises experience heightened self-awareness and corresponding positive changes in self-regulated behavior and wellbeing that occur gradually over time (Brown & Ryan, 2003).

With respect to frameworks, theoretical frameworks can be very difficult to change unless underlying theory changes. As is the case with worldviews and paradigms, a well-established theory can take decades or more to change. However, conceptual frameworks are more readily changed as they are explicit conceptualizations based on understandings derived from empirical analysis and personal experience. For example, a comparison of the frameworks for identifying important knowledge, attitudes, and skills needed for success in the twenty-first century (eg, Partnership for 21st Century Skills, 2009; Wagner, 2012) could provide opportunities for modification as different viewpoints are analyzed and as new data becomes available that might change important factors and their relationships.

Models are also more readily changed when used in simulations; empirical validation is required to continue to use a model. An excellent example is work done by RTI International as they use a variety of models to simulate the relationships among economic factors and environmental policies (<http://www.rti.org/page.cfm?objectid=DDC06637-7973-4B0F-AC46B3C69E09ADA9>). They regularly publish their findings and seek peer review of their models. The models are constantly changed based on experience and feedback.

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In general, schema are constructed based on one's experiences in specific situations. This highlights the importance of the relationship among environment, behavior, and mental representations (a basic principle of Bandura's (1986) social cognitive theory). The reciprocal influence of these three factors has been studied extensively over the past several decades in such areas as personality (Bandura, 1999), learning and teaching (Zimmerman, 1989), leadership (Ibarra, 2015), and cultural differences (Bandura, 2002). A basic principle is that change in mental representations best occurs through reflections on personal experience in a variety of contexts, but all three elements must be present if mental representations are to be transformed.

Finally, while changing scripts (patterns of thought and behavior in specific contexts) is difficult, recent work in the area of prospection supported the recognition that scripts can be modified. That is, positive scripts can be strengthened and negative scripts can be weakened so as to allow one to better achieve goals and higher levels of wellbeing (Seligman, Railton, Baumeister, & Sripada, 2013). A key concept for script transformation is that when mentally activating a future script, it must feel real, providing validation for the concept of triune consciousness—the idea that thoughts, feelings, and intentions are naturally integrated in conscious thought (Tallon, 1997). This idea of bringing unconscious mental representations into consciousness in order to change them is an area requiring further exploration (Christian, Miles, Hoi Kei Fung, Best, & Macrae, 2013).

In summary, mental representations can be modified and transformed. Many of the methods and techniques for doing so can be categorized as a form of metacognition (ie, strategic knowledge, knowledge of cognitive tasks, and self-knowledge; Krathwohl, 2002). Some key principles for explicitly modifying mental representations include having a wide variety of experiences while engaging in a wide variety of contexts and then reflecting on those in a way that implicit mental representations are made explicit. It is also beneficial to change one's language and manner of speaking as one engages in different environments. Coordinating and sustaining these components is no easy task, but the possibility for doing so should provide hope as human beings learn to cope with an environment that is rapidly changing.

Summary and Conclusion

This brief overview of different types and levels of mental representations cannot do justice to this burgeoning field of cognitive psychology. Entire books have been written on the topic, with no single text able to cover the whole field. However, it is important that people begin to think about how the mind works as it is widely recognized that the world is rapidly changing, moving in ways never before experienced by humanity (Brynjolfsson, & McAfee, 2011; Diamandis, & Kotler, 2012, 2015), and this is producing significant discomfort (Rushkoff, 2014). Add to this the fact that America (and likely the entire developed world) is in the middle of a winter season of economic downturn (Strauss & Howe, 1997), and the need for accurate mental representations to guide individual decisions and social policy has never been greater.

Just considering these two, somewhat conflicting, sociocultural challenges supports the importance for having a correct view of reality. On the one hand, there are major changes that are accelerating exponentially as a result of forces such as globalization, increased digitalization, population growth, and climate change while at the same time there is an economic downturn influenced by demographic changes (Dent, 2014) and the increase in global debt relative to economic activity (Duncan, 2012). It is easy to become paralyzed when confronted with these complexities and simply rely on incremental adaption. However, rapid sociocultural and

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technological change requires that time is spent on stating and analyzing mental representations to insure they correctly map to reality.

As Piaget (1952, 2000) demonstrated, people are more likely to change their perceptions of reality and use already developed schemata to adapt to the world (assimilation) than create new, more accurate, schemata (accommodation) that can be used to adapt to the demands of this new environment. Wagner (2012) proposed that developing innovators who can create new approaches to all aspects of modern life is an extremely high priority. I propose that engaging in systematic analysis of created mental representations can begin the process of achieving that objective. A good place to start is to systematically teach the skills associated with meta-cognition (Bartsch & Estes, 1996). Making the implicit representations explicit and providing the opportunity to modify those will provide learners with the skills necessary to be systematically creative.

It is not easy to develop a coherent worldview and paradigm that corresponds to reality, but it is necessary if one wants to be something different than a dead fish floating down the stream of the twenty-first century. As Wallerstein (2000) pointed out, humanity is in a sociocultural transition that will result in a completely different manner of living for children and youth living today. Increasing the likelihood that individuals and their offspring can build a more positive living experience should be reason enough to put time and effort into examining and modifying one's mental representations. Not doing so means that humanity will simply continue to use mental representations that have yet to produce high levels of life satisfaction and wellbeing for all of humanity and increase, rather than decrease, anxiety and low levels of happiness and wellbeing.

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