Chapter 1
Social Learning from the Inside Out:
The Creation and Sharing of Knowledge from the Mind/Brain Perspective

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ABSTRACT

This chapter explores from the viewpoint of the mind/brain the factors and conditions which influence the social creation and sharing of knowledge. A foundation is developed by providing clear definitions of information, knowledge and learning, including levels of knowledge and the process through which the mind/brain creates new knowledge. Then neuroscience findings are used to discuss social interaction, including environmental impacts on the creation and sharing of knowledge. Factors such as arousal and stress level, social attunement, holding environment, intersubjective space, level of trust, social bonding, and an enriched external environment are posited to enhance the creation and sharing of knowledge. Finally, the individual learning and knowledge activity is extrapolated to the societal level through a short introduction to collaborative entanglement (learning to create and apply knowledge as communities), and the use of metaphor and story. Summary highlights of neuroscience findings are also provided.

INTRODUCTION

We are social creatures. While this concept has been around for centuries, Cozolino believes that we are just waking up to this fact from a biological perspective. As he describes,

> *As a species, we are just waking up to the complexity of our own brains, to say nothing of how brains are linked together. We are just beginning to understand that we have evolved as social creatures and that all of our biologies are interwoven. (Cozolino, 2006, p. 3)*

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While humans have studied the brain since ancient Greece and perhaps before that, neuroscience is a very young field. Although an association of professional scientists known as The Society for Neuroscience was formed in 1970 (Bear, Connors, & Paradiso, 2001), it wasn't until the development of measurement and excitation technology (George, 2007; Ward, 2006) in the early 1990s that the field began to flourish. Examples of these technologies include functional magnetic resonance imaging (fMRI), the electroencephalograph (EEG), and transcranial magnetic stimulation (TMS); (George, 2007; Kurzweil, 2005; Ward, 2006). fMRI is used for neuroimaging to produce precise measurements of brain structure activity (Hyman, 2007). EEG is another noninvasive technique that measures the average electrical activity of large populations of neurons (Nicolelis and Chapin, 2007). TMS uses head-mounted wire coils that send very short but strong magnetic pulses directly into specific brain regions that induce low-level electric currents into the brain's neural circuits, and appears to be able to "turn on and off particular parts of the human brain" (George, 2007, p. 21).

Simultaneously, because of increasing computational power, the field of neuroanatomy has become a central aspect of neuroscience. Neuroanatomy is the branch of anatomy that deals with the nervous system. The first comprehensive volume in this field, edited by Giorgio Ascoli, head of the Krasnow Institute for Advanced Study at George Mason University and published in 2002, defines this field as, "… the use of computer models, simulations, and visualizations to gain a deeper understanding of the complexity of nervous system structures" (p. v).

Collectively, these advancements are steadily providing new information on how the mind/brain works. The term "mind/brain" connotes the combination of the physiological brain and the mind, that is, the patterns of neuron connections, the strengths of those connections, and the signals they send to other neurons that exist in the brain. The neuroscience findings that have emerged since the 1990's form the foundation of this paper. With learning and knowledge at the core of our exploration, we will (1) develop a common understanding of baseline definitions; (2) discuss the creation and sharing of knowledge from the viewpoint of the mind/brain; (3) discuss social interaction and the mind/brain, including environmental impacts on the creation and sharing of knowledge; and (4) extrapolate the individual learning and knowledge activity to the societal level through a short introduction to collaborative entanglement (learning to create knowledge as communities), and then the use of metaphor and story.

DEVELOPING A COMMON UNDERSTANDING

Embracing Stonier's description of information as a basic property of the Universe—as fundamental as matter and energy (Stonier, 1990; Stonier, 1997)—we take the amount of information to be a measure of the degree of organization expressed by any non-random pattern or set of patterns. The order of a system is a reflection of the information content of the system. Data (a form of information) would then be simple patterns, and while data and information would both be patterns, they would have no meaning until some organism recognized and interpreted the patterns (Bennet and Bennet, 2006a, 2008c). Thus knowledge exists in the human brain in the form of stored or expressed neuronal patterns that may be activated and reflected upon through conscious or unconscious thought. This is a high-level description of the creation of knowledge that is consistent with the neuronal operation of the brain and is applicable in varying degrees to all living organisms. From this process neuronal patterns are created that may represent understanding, meaning and the capacity to anticipate (to various degrees) the results of potential actions. Thus it is not just information that characterizes knowledge, but the relationships or associations (in space and time) among that information. Through this process of associating (or complexing), the mind is continuously growing, restructuring the physiology of the brain, creating increased organization (information), and by doing so, changing.

Taking a functional approach, our definition of knowledge then becomes: *knowledge is the capacity (potential or actual) to take effective action in varied and uncertain situations* (Bennet and Bennet, 2004). Knowledge consists of comprehension, understanding, meaning, insight, intuition, creativity, judgment, and the ability to anticipate the outcome of our actions. Recognizing that knowledge is the result of associative patterning in the brain and consistent with our understanding of information and that the relationships among information define knowledge, we choose to consider knowledge as comprised of two parts: Knowledge (Informing) and Knowledge (Proceeding). This also builds on the distinction made by Ryle (1949) between "knowing that" and "knowing how".

Knowledge (Informing), or Kn_I, is the *information (or content)* part of knowledge. While this information part of knowledge is still generically information (organized patterns), it is special because of its structure and relationships with other information. Kn_I consists of information that represents insights, meaning, understanding, expectations, theories and principles that support or lead to effective action. When viewed separately this is information that *may* lead to effective action. However, it is considered knowledge when it is used as *part of the knowledge process*.

Knowledge (Proceeding), Kn_P, represents the *process* and *action* part of knowledge. Kn_P is the process of selecting, associating and applying the relevant information (Kn_I) from which specific actions can be identified and implemented, that is, actions that result in some level of effective outcome. There is considerable precedence for considering knowledge as a process versus an outcome. As Kolb (1983) forwards in his theory of experiential learning, knowledge retrieval, creation and application requires engaging knowledge as a process, not a product. The process our minds use to find, create and semantically mix the information needed to take effective action is often unconscious and difficult to communicate to someone else. The more complex a situation, the more difficult to find a solution, and the larger the role played by tacit knowledge in our unconscious mind (Goldberg, 2005; Bennet and Bennet, 2008b).

Knowledge can also be considered in terms of surface, shallow and deep levels. Surface knowledge is predominantly but not exclusively information. Answering the question of what, when, where and who, it is primarily explicit, and represents visible choices that require minimum understanding. Further, little action is typically required; it is more of an awareness of *what is* on the part of the receiver.

Surface knowledge in the form of information can be stored in books and computers, and the mind/brain. Much of our everyday life such as light conversations, descriptions and even self-reflection could be considered surface thinking and learning that creates surface knowledge. Perhaps too much of what is taught in schools is focused on awareness and memorization (surface knowledge) with inadequate focus on understanding or meaning. For example, the National Research Council has expressed concern that the U.S. education system teaches students science using a mile wide and inch deep approach (National Research Council, 2000; Oakes and Lipton, 1999). The emphasis is on surface learning, that is, learning that "relies primarily on short term memorization—cramming facts, data, concepts and information to pass quizzes and exams… deep learning asks that we create and re-create our own personal understanding" (Chickering et al., 2005, pp. 132-133). Further, surface knowledge is frequently difficult to remember and easy to forget because it has little meaning to improve recall, and few connections to other stored memories (Sousa, 2006).

Shallow knowledge is when you have information plus some understanding, meaning and sense-making. To understand is to make some level of meaning, with meaning typically relating to an individual or organization and implying some level of action. To make meaning requires context; meaning is something the individual creates from the received information and their own internal information, a process of creating Kn_P. Shallow knowledge requires a level of understanding and meaning such that the knowledge maker can identify cohesion and integration of the information in a manner that makes sense. This meaning can be created via logic, analysis, observation, reflection, and even—to some extent—prediction. In an organizational setting shallow knowledge emerges (and grows) through social interactions as employees move through the processes and practices of the organization. For example, organizations that embrace the use of teams and communities facilitate the mobilization of knowledge and the creation of new ideas as individuals interact in those groups.

With deep knowledge one has developed and integrated many if not all of the following seven components: understanding, meaning, insight, creativity, intuition, judgment, and the ability to anticipate the outcome of one's actions. Deep knowledge represents the ability to shift your frame of reference as the context and situation shift. Since Kn_P must be created in order to know when and how to take effective action, the unconscious plays a large role in this area. The source of deep Kn_P lies in your creativity, intuition, forecasting experience, pattern recognition, and use of theories (also important in shallow knowledge situations). Deep knowledge is the realm of the expert. The expert's unconscious has learned to detect patterns and evaluate their importance in anticipating the behavior of situations that are too complex for the conscious mind to understand. During the lengthy period of practice needed to develop deep knowledge—a "lived" experience—the expert has often developed an internal theory that guides her Kn_P. Gathered through what is called *effortful practice* through a process of chunking, much of this knowledge resides within the unconscious and surfaces only when the individual takes an action or makes a decision based on "feel" or "intuition."

Learning is the process of creating knowledge (the capacity to take effective action). From an evolutionary perspective, those individuals who could observe, experience and take the best actions—whether it was to take flight, attack, or hide—had the best chance of survival. This capability to understand and see the meaning of a situation, and then figure out what to do and do it, we call knowledge. As the mind/brain evolved over thousands of years, it created the capacity to learn and act on what it learned. The advent of brain imaging allows us to watch the neurophysiology of learning unfold. "Not only can we trace the pathways of the brain involved in various learning tasks, but we can also infer which learning environments are most likely to be effective (Johnson and Taylor, 2006, p. 1).

While there are many ways to learn—self-reflection, observing others, our own instincts, etc.—as the value of knowledge sharing has been proven, the art of social communication and interactions has become an essential aspect of our organizations and communities. This shift has prompted an exponential growth in learning from each other, without the penalty of other individual's mistakes.

CREATING AND SHARING KNOWLEDGE IN THE MIND/BRAIN

The brain stores information in the form of patterns of neurons, their connections (synapses), small electrical pulses, and the strength between those connections. These patterns represent thoughts, images, beliefs, theories, emotions, and so on. A single thought could be represented in the brain by a network of a million neurons, with each neuron connecting to anywhere from 1 to 10,000 other neurons (Ratey, 2001). Although the patterns themselves are nonphysical, their existence as represented by neuronal cells and their connections *are* physical, that is, composed of atoms, molecules and cells. If we consider the mind as the totality of neuronal patterns, then we can consider the mind and the brain to be connected in the sense that the patterns (mind) cannot exist without the brain (atoms, molecules, and neuronal cells), yet the brain would have no mind if it had no neuronal patterns. We have previously used a metaphor to understand this relationship: The mind is to the brain as waves of the ocean are to the water in the ocean (Bennet and Bennet, 2008c). Even this is simplified because surrounding the neurons are other cells and continuous flows of blood, hormones, and other chemicals which have complex interactions within the brain (Pert, 1997; Church, 2006). The power of the metaphor derives from the relationship between the neuronal network patterns used to represent the external (and internal) world of concepts, thoughts, objects, and relationships and the physical neurons and other material in the brain.

To get some idea of the density and intricacies of the brain, consider the following: "A piece of brain tissue the size of a grain of sand contains a hundred thousand neurons and one billion synapses, all talking to one another" (Amen, 2005, p. 20). As another example, consider the following description of how the brain creates patterns of the mind. Antonio Damasio uses the term "movie" as a metaphor for the diverse sensory images and signals that create a show and flow we call mind. In the following quote Damasio also brings out a few of the large number of semi-independent systems in the brain that work together to make patterns that make sense of our external environment.

Further remarkable progress involving aspects of the movie-in-the-brain has led to increased insights related to mechanisms for learning and memory. In rapid succession, research has revealed that the brain uses discrete systems for different types of learning. The basal ganglia and cerebellum are critical for the acquisition of skills—for example, learning to ride a bicycle or play a musical instrument. The hippocampus is integral to the learning of facts pertaining to such entities as people, places or events. And once facts are learned, the long-term memory of those facts relies on multi-component brain systems, whose key parts are located in the vast brain expanses known as cerebral cortices. (Damasio, 2007, pps. 63-64)

We learn by changing incoming physical signals (images, sounds, smells, sensations of the body) into patterns (of the mind and within the brain) that we identify with specific external concepts, objects, or relationships. These incoming neuronal patterns have internal associations with other internal patterns that represent (to varying degrees of fidelity) the corresponding associations in the external world. Thus we re-present external reality through the creation and association of internal patterns of neuron firings and connections. Stonier (1997) refers to this process as semantic mixing or complexing.

Incoming external information (new information) is mixed, or associated, with internal information, creating new neuronal patterns that may represent understanding, meaning, and/or the anticipation of the consequences of actions, in other words, knowledge (Stonier, 1997). The term *associative patterning* describes this continuous process of learning by creating new patterns of the mind and stored in the brain (Bennet and Bennet, 2006a, 2008c). From the viewpoint of the mind/brain, any knowledge that is being "re-used" is actually being "re-created" and, in an area of continuing interest, most likely complexed over and over again as incoming information is associated with internal information (Stonier, 1997). During reflection, the mind/brain is thinking about the incoming concepts, ideas, objects, and their relationships by associating them with various internal neuron patterns.

If Knowledge (Informing) is different, there is a good chance that Knowledge (Proceeding) will be different. Recall that Knowledge (Proceeding) is the *process* of pulling up and sequencing associated Knowledge (Informing) and semantically complexing it with incoming information to make it comprehensible. In essence, every time we apply knowledge (Informing and Proceeding) it is to some extent new knowledge because the human mind—unlike an information management system—*unconsciously tailors what is emerging as knowledge to the situation at hand* (Edelman & Tononi, 2000). See Bennet and Bennet (2008a) for an in-depth treatment of knowledge reuse.

A significant aspect of the mind/brain is its capability to continually make sense of its environment and anticipate what's coming next. As Buzsaki (2006) states,

brains are foretelling devices and their predictive powers emerge from the various rhythms they perpetually generate ... The specific physiological functions of brain rhythms vary from the obvious to the utterly impenetrable. (p. vii).

In other words, our behavior is closely related to our capacity to form accurate predictions. This perspective is reinforced by the neuroscientist Rudolfo Llinas (2001) who considered predicting the outcome of future events as the most important and common of all global brain functions. The sense of movement of the body provides a simple demonstration of the need—and power—of anticipating the future. Imagine walking down a staircase and accidentally missing a step, recognizing the surprise one has when beginning to fall (Hawkins, 2004). Since for thousands of years survival has depended upon humans being capable of anticipating their environment and taking the right actions to survive, perhaps it should be no surprise that that capability has come through the evolution of the brain. As Damasio explains,

survival in a complex environment, that is, efficient management of life regulation, depends on taking the right action, and that, in turn, can be greatly improved by purposeful preview and manipulation of images in mind and optimal planning. Consciousness allowed the connection of the two disparate aspects of the process—inner life regulation and image making. (Damaso, 1999, p. 24)

One way the brain anticipates the future is through the process of storing sequences of patterns. Since we never see the same world twice, the brain (as distinct from a computer) *does not store exact replicas* of past events or memories. Rather, it stores invariant representations. These forms represent the basic source of recognition and understanding of the broader patterns (Hawkins, 2004).

Marchese (1998) points out, when you see a picture, only about 20% of what you are seeing is brought into your brain; the other 80% of that image comes from information, ideas, and feelings *already in your brain*. The point is that the mind/brain doesn't store memories like a computer, that is, storing everything that comes in. It stores the *core* of the picture, what was referred to above as an invariant (Hawkins, 2004).

For example, if you see your friend from the side or back you can usually recognize who they are since your mind has stored a core basic memory that includes major features of that person (Begley, 2007; Hawkins, 2004). When you see your friend, your mind is filling in the blanks and you recognize the incoming image as your friend. There is also robustness in the way the brain *stores* core memories. Assume that it takes a million neurons to create a specific pattern (the core part of incoming information), the brain may set aside 1.4 million neurons with their connections as space for that pattern, providing a looseness to account for future associative changes, or dying cells (Hawkins, 2004). Thus for this particular pattern you could lose tens of thousands of brain cells related to the pattern and still have significant aspects of the core memory available for future retrieval via re-creation.

Further complicating the situation, at the same time you catch sight of your friend and are smiling, getting ready to call out and wave, you may be swatting gnats away from your eyes, shivering from a soft breeze, registering the dark clouds moving in from the west, feeling hunger pains in your stomach, and sensing a soreness in your little toe from tight shoes, and so on. The brain is multidimensional, simultaneously processing visual, aural, olfactory, and kinesthetic sensory inputs and, as discussed above, combining them with mental thoughts and emotional feelings to create an internal perception and feeling of external awareness (Bennet, 2006).

According to Hawkins (2004), "the problem of understanding how your cortex forms invariant representations remains one of the biggest mysteries in all of science" (p. 78). It is so much so that "no one, not even using the most powerful computers in the world, are able to solve it. And it isn't for a lack of trying" (p.78). As the Nobel Laurate Eric Kandel explains,

By storing memories in invariant forms, individuals are able to apply memories to situations that are similar but not identical to previous experiences. Cognitive psychologists would describe this as developing an internal representation of the external world, a cognitive map that generates a meaningful image or interpretation of our experience. (Kandel, 2006, p. 298)

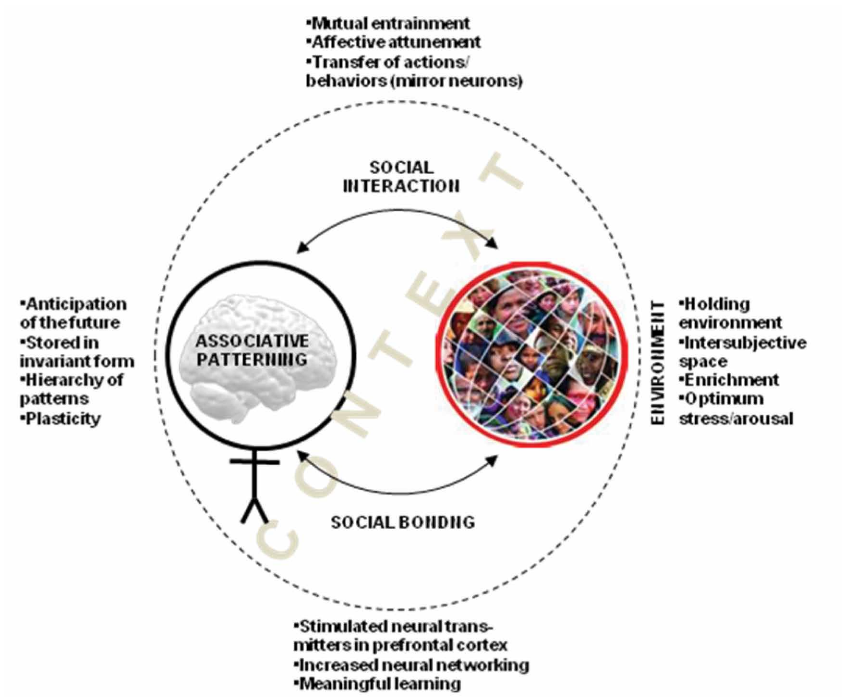
As discussed above, the brain is simultaneously identifying and storing core patterns (invariant forms) from incoming information; in other words, there is a hierarchy of information (Bennet and Bennet, 2006b) where hierarchy represents "an order of some complexity, in which the elements are distributed along the gradient of importance" (Kuntz, 1968, p. 162). A hierarchy of knowledge is analogous to the physical design of the neocortex, "a sheet of cells the size of a dinner napkin as thick as six business cards, where the connections between various regions give the whole thing a hierarchical structure" (Hawkins, 2004, p. 109).

In a hierarchy the dominant structural element may be a central point such as in a circular structure, or have an axial symmetry. Wherever the central point (dominant structure) is located, each part is determined by where it is located in relation to that central point. While it is true that in a radial version of hierarchy the entire pattern may depend directly on the open center, most hierarchies consist of groups of subordinate hierarchies who in turn have groups of subordinate hierarchies, with each group having its own particular relation to the dominant center point (Kuntz, 1968). The higher-level pattern stored in the brain could be described as a pattern of patterns with possibly both hierarchical and associative relationships to other patterns. See Bennet and Bennet (2006b) for an in-depth treatment of hierarchy as a learning platform.

Considering the brain as a semi-independent subcomponent of the body that contains a hierarchy of patterns associated with other patterns, the higher level (core) patterns would retain their associations (in terms of meaning, understanding, and anticipation of the future) even as the lower level patterns (internal information that is situation dependent) are re-created in response to new incoming information. A recent study of chess players showed that experts examined the chessboard patterns (not the pieces) over and over again, looking at nuances, generally "playing with" and studying these *patterns*. Ross (2006) noted that their ability to chunk patterns for ease of memory and retrieval was a significant part of their success.

The above discussion brings home the fact that the mind/brain develops robustness and deep understanding derived from its capacity to use past learning and memories to complete incoming information and instead of storing all the details, it stores only meaningful information.

Figure 1. Social creation of knowledge



This provides the ability to create and store higher level patterns while simultaneously semantically complexing incoming information with internal memories, adapting those memories to the situation at hand. Through these processes the brain supports survival and sustainability in a complex and unpredictable world. How do these mental processes affect social learning and information exchanges? Figure 1 is a graphical overview of several key factors of associative patterning and their relationship to the social creation of knowledge discussed in the following section.

SOCIAL INTERACTION AND THE MIND/BRAIN

When two people meet there may be a large amount of information (and only information) exchanged between them. Visibly, when they first see each other, light waves (or photons) travel between them, communicating patterns of movement, colors, pictures such as facial expressions, and sound waves as they speak or walk. Each person automatically creates in their own mind images, thoughts, feelings and an overall "sense" regarding the entire situation, including the surrounding environment. Much of this information is automatically processed by our unconscious, sometimes influencing our behavior and feelings before we become conscious of them.

All of this is primarily information (ordered patterns) or, at best, what could be called surface knowledge. It is not shallow or deep knowledge as described above. These latter knowledges can only be created by each person within their own mind/brain by thinking about the information coming in through the senses. Since we each have unique autobiographies, different belief systems and personal goals, to create knowledge (that is, understanding, meaning, insight, etc.) we must mix the incoming information with our own internal thought patterns as discussed above. This mixing process is most effective if there is a dialogue or affirmative inquiry process between two people.

Amen (2005) says that physical exercise, mental exercise and social bonding are the best sources of stimulation of the brain. Social neuroscience is the aspect of neuroscience dealing with the brain mechanisms of social interaction. Studies in social neuroscience have affirmed that over the course of evolution physical mechanisms have developed in our brains to enable us to learn through social interactions. Johnson says that "these physical mechanisms have evolved to enable us to get the knowledge we need in order to keep emotionally and physically safe" (Johnson, 2006, p. 65). She also suggests that these mechanisms enable us to:

1. Engage in affective attunement or empathic interaction and language,
2. Consider the intentions of the other,
3. Try to understand what another mind is thinking, and
4. *Think about how we want to interact.* (Johnson, 2006, p. 65)

People are in continuous, two-way interaction with those around them, and the brain is continuously changing in response. As Cozolino and Sprokay explain,

It is becoming more evident that through emotional facial expressions, physical contact, and eye gaze—even through pupil dilation and blushing—people are in constant, if often unconscious, two-way communication with those around them. It is in the matrix of this contact that brains are sculpted, balanced and made healthy. (Cozolino and Sprokay, 2006, p. 13)

Through these interactions, the genes are operating options "that are tested as an environment provides input that results in behavior" (Bownds, 1999, p. 169). Which supporting neuronal pathways become permanent depend on the usefulness of the behavior in enhancing survival and reproduction (Bownds, 1999). During this process, social preferences are also being developed. Tallis (2002) says that people's day-to-day social preferences are most likely influenced by unconscious learning. As he describes,

Human beings are constantly forming positive or negative opinions of others, and often after minimal social contact. If challenged, opinions can be justified, but such justifications frequently take the form of post-hoc rationalization. Some, of course, are laughably transparent. (Tallis, 2002, p. 129)

The literature suggests that there are specific changes within the brain that occur through enriched environments, that is, when the surrounding contains many interesting and thought-provoking ideas, pictures, books, statues, etc. Specifically, thicker cortices are created, there are larger cell bodies, and dendritic branching in the brain is more extensive. These are physiological changes in response to the environment, the feelings, and the learning of the participants. These changes have been directly connected to higher levels of intelligence and performance (Begley, 2007; Byrnes, 2001; Jensen, 1998). Byrnes sees the results of research on the effects of enriched environments on brain structure as both credible and well-established (Byrnes, 2001).

For example, Skoyles and Sagan presented the results of research on adolescent monkeys that suggested prefrontal cortices (considered the executive part of the human brain) respond better than other parts of the brain to an enriched learning environment. After a month of exposure to enriched environments the monkey's "prefrontal cortices had increased their activity by some 35 percent, while those of animals not exposed to an enriched environment had slightly decreased their activity" (Skoyles & Sagan, 2002, p. 76). These researchers go on to say that, "As the most neurally plastic species, we can choose to put ourselves in stimulus-rich environments that will increase our intelligence" (Skoyles & Sagan, 2002, p. 76).

Social forces clearly affect every aspect of our lives. As Rose (2005) describes,

The ways in which we conduct our observations and experiments on the world outside, the basis for what we regard as proof, the theoretical frameworks within which we embed these observations, experiments and proofs, have been shaped by the history of our subject, by the power and limits of available technology, and by the social forces that have formed and continue to form that history. (Rose, 2005, p. 9)

Physical mechanisms have developed in our brain to enable us to learn through social interactions. Stern (2004) says that these physical mechanisms have evolved to enable us to get the knowledge we need to keep emotionally and physically safe. These mechanisms would enable us to, "(1) engage in affective attunement or empathic interaction and language, (2) consider the intentions of the other, (3) try to understand what another mind is thinking, and (4) think about how we want to interact" (Johnson, 2006, p. 65). The physical mechanisms for this capability come from mirror neurons and also from adaptive oscillators.

Mirror neurons aid in stimulating other peoples states of mind. As Stern (2004) proposes, "This 'participation' in another's mental life creates a sense of feeling/sharing with/understanding the person's intentions and feelings" (p. 79). As Blakemore and Frith describe the phenomenon call mirror neurons,

Simply observing someone moving activates similar brain areas to those activated by producing movements oneself. The brain's motor regions become active by the mere observation of movements even if the observer remains completely still. (Blakemore and Frith, 2005, pp. 160-161)

Further, Dobbs explains,

These neurons are scattered throughout key parts of the brain—the premotor cortex and centers for language, empathy and pain—and fire not only as we perform a certain action, but also when we watch someone else perform that action. (Dobbs, 2007, p. 22)

Zull (2002) suggests that mirror neurons are a form of cognitive mimicry that transfers actions, behaviors and most likely other cultural norms. Thus when we *see* something being enacted, our mind creates the same patterns that we would use to enact that "something" ourselves. While mirror neurons are a subject of current research, it would appear that they represent a neuroscientific mechanism for the transfer of tacit knowledge between individuals, or throughout a culture. Siegel suggests that mirror neurons are the way in which our social brain processes and precedes the intentional or goal-directed action of others. Thus mirror neurons link our perception to the priming of the motor systems that engage the same action. In other words, "what we see, we become ready to do, to mirror other's actions and our own behaviors" (Siegel, 2007, p. 347).

Another mechanism that aids in the synchronism of two individuals is the adaptive oscillators that are part of our physiology. These oscillators are created by stable feedback loops of neurons. They may bring an individual's rate of neural firing into sync with another individual. This is when two people relate well to each other and learn to anticipate each other's actions (Stern, 2004). Buzsaki calls this phenomenon mutual entrainment, meaning a measure of stability that oscillators have when they lock in with each other (Buzsaki, 2006).

The effects of social forces, of course, are often not in conscious awareness. The role of the conscious is to connect it all together. LeDoux (1996) says that the present social situation and physical environment are part of what is connected. Following extensive research, LeDoux (1996) concluded that, *People normally do all sorts of things for reasons they are not consciously aware of (because the behavior is produced by brain systems that operate unconsciously) and that one of the main jobs of consciousness is to keep our life tied together into a coherent story, a self-concept. It does this by generating explanations of behavior on the basis of our self-image, memories of the past, expectations of the future, the present social situation and the physical environment in which the behavior is produced. (LeDoux, 1996, p. 33).*

Stonier agrees that when people are engaging in heavy duty thinking "it is not generally in terms of unlabelled images, sounds, smells, tastes or tactile experiences" (Stonier, 1997, p. 151). Stonier posits that thinking is actually talking to oneself, and that,

This ability to talk to oneself is so basic a part of our human internal information environment that it tends to shape all our thought processes. It is this fact that allows us to be so influenced by our social and cultural surroundings. (Stonier, 1997, p. 151)

Building on our earlier discussion, knowledge (understanding, meaning, insight, etc.) can be thought of as theories, beliefs, practices and experiences coupled with a whole neighborhood of associated concepts, facts, and processes that together create the understanding, meaning and insight (to take effective action) we consider knowledge. If the individual receiving information from a knowledgeable person cannot recreate the invariant forms and neighborhood, or modulate his own invariant forms and neighborhood, then little or no learning will occur. Knowledge will not be shared, that is, the receiver has not recreated the sender's knowledge, nor is she likely to create her own comparable knowledge.

Further, knowledge is dependent on context. In fact, it represents an understanding of situations *in context*, insights into the relationships within a system, and the ability to identify leverage points and weaknesses to recognize the meaning in a specific situation and to anticipate future implications of actions taken *to* resolve problems. Shared understanding is taken to mean the movement of knowledge from one person to the other, recognizing that what passes in the air when two people are having a conversation is information in the form of changes in air pressure. These patterns of change may be understood by the perceiver (if they know the language and its nuances), but the changes in air pressure do not represent understanding, meaning or the capacity to anticipate the consequences of actions. The perceiver must be able to take these patterns (information) and—interpreting them through context—re-create the knowledge that the source intended. In other words, under perfect circumstances, the content and context (information) originating at the source resonate with the perceiver such that the intended knowledge can be re-created by the perceiver.

The innate ability to evoke meaning through understanding—to evaluate, judge and decide—is what distinguishes the human mind from other life forms. This ability enables people to discriminate and discern—to see similarities and differences, form patterns from particulars, and create and store knowledge purposefully. In this human process to create meaning and understanding from external stimuli, *context shapes content*. Eight primary avenues of context patterns that may directly impact the content of a message focus on the content, setting or situation, silent attention/presence, non-voiced communications patterns, the system, personal context, unconscious processes and the overarching pattern context. An explication of these eight avenues is included below.

Context 1 focuses on the *content* itself: the specific nouns and verbs selected, the adjectives and adverbs used in the primary expression, and the structure of the sentence that support this expression. The semantics of the content is crucial but still may not be sufficient for shallow knowledge sharing and will never be adequate for sharing deep knowledge.

Context 2 is the *setting or situation* surrounding the content of information; that is, the words and structure of the words, phrases and sentences expressed before and after the primary expression that provide further explication of the intent of content. Contexts 1 and 2 are informational in nature and directly tied to the use and rules of language.

Context 3 is that which is not expressed, not available, what we call *silent attention/presence.* Attention represents awareness and focus. Presence represents immediate proximity in terms of time or space.

Context 4 includes the non-verbal, *non-voiced communications patterns* that inevitably exist in conjunction with the content, whether face-to-face interaction, hand written exchanges, or computer supported information. This is what could be termed associated information signals. In the convention used in nonverbal communication literature, this would be encoding (expression) from the source, and decoding (interpretation) of the perceiver. These are, of course, interdependent.

Context 5 is focused on the *system* within which interaction takes place, the mutually-shared, common information and patterns with meaning *within the system*. The context of the system would include an understanding, either consciously or unconsciously, of the boundaries, elements, relationships and forces within the system.

Context 6 is the *personal context* which includes beliefs, values, experiences and feelings that emerge into conscious awareness. Personal context would also include positions that individual's take that are locked into the conscious mind, unconscious patterns that are made conscious by the emerging content of the message (what might be termed implicit knowledge), and the core values and beliefs that rise to awareness by virtue of "feelings." Contexts 6 and 7 work together, with context 6 being those aspects that surface in an individual's thoughts and feelings and context 7 being those processes occurring of which an individual is unaware, i.e., occurring in the unconscious.

Context 7 is the impact of *unconscious processes.* These can be thought of in terms of (1) the unconscious response to external stimuli (environment); (2) experiences and feelings (memories) not in conscious awareness; and (3) empathetic processes that can mirror behavior. As you will recall from our previous discussion, the selection, interpretation and meaning of incoming patterns are very much a function of pre-existing patterns in the brain (Bennet and Bennet, 2006).

Context 8 is the *overarching pattern context*, higher levels of patterns of significance that emerge in the mind. These include: (1) the unconscious—and sometimes conscious—connecting of contexts 1 through 7 to develop a pattern of understanding or behavior; and (2) the development and recognition of patterns of patterns among different interactions (over time). The connecting of multiple contexts would include comparing, manipulating and combining patterns. As noted above, the development and recognition of higher-level patterns among multiple and different interactions occurs over time. While this generally forms in the conscious mind as a feeling or sense of knowing (intuition), it may also be accompanied by a mental remembering of an emotional response from previous interactions.

These contexts are present and influential to various degrees depending on the specific social situation. Their influence on knowledge sharing may be through the participant's unconscious, but they are there. The higher the number of related (relevant) patterns (the greater the context), the greater the resonance between the source and receiver and the increased sharing of understanding. See Bennet and Bennet (2007b, 2008a) for an in-depth treatment on context. Cozolino (2002) says that along with language, significant social relationships stimulate learning and knowledge creation and shape the brain. He offers that the two powerful processes of social interaction and affective attunement, when involving a trusted other, contribute to "both the evolution and sculpting of the brain ... [since they] stimulate the brain to grow, organize and integrate" (Cozolino, 2002, p. 213).

Following a study of unconscious communications which supported the fact that people are in constant interaction with those around them (often unconsciously), Cozolino and Sprokay say that one possible implication of this finding of specific interest is the fact that "the attention of a caring, aware mentor may support the plasticity that leads to better, more meaningful learning" (Cozolino and Sprokay, 2006, p. 13). Plasticity refers to the fact that new ideas change the patterns in the mind which changes the physiology of the brain. Also, changes in the physical brain can change the patterns of neurons and thereby thoughts of the mind. As we live, learn and change through experience, our mind/brain also changes both physically and pattern-wise. Thus the mind/brain is said to have a great deal of "plasticity." Similarly, referring to recent discoveries in cognitive neuroscience and social cognitive neuroscience, Johnson (2006) says that educators and mentors of adults recognize "the neurological effects and importance of creating a trusting relationship, a holding environment, and an intersubjective space" (p. 68) where such things as reflection and abstract thinking can occur.

Social bonding reduces individual fears, creates trust, and makes the mind/brain much more open to incoming information and creates a desire to understand (and thereby re-create) the knowledge of the sender. In Sousa (2006) social bonding carries with it a positive, trusting relationship that allows the learner to take risks and not be concerned with mistakes made during learning. It also encourages an open mind and willingness to listen and learn from a trusted other.

Fear has been identified as an impediment to learning and knowledge sharing throughout the field of adult learning (Brookfield, 1987; Daloz, 1986, 1999; Mezirow and Associates, 1991; Perry, 1970/1988). The limbic system, the primitive part of the human brain, and in particular its amygdala, is the origin of survival and fear responses.

The literature is extensive on the need for a safe and empathic relationship to facilitate learning and knowledge sharing. Cozolino says that for complex levels of self-awareness, that is those that involve higher brain functions and potential changes in neural networks, learning cannot be accomplished when an individual feels anxious and defensive (Cozolino, 2002). Specifically, he says that a safe and empathic relationship can establish an emotional and neurobiological context that is conducive to neural reorganization. "It serves as a buffer and scaffolding within which [an adult] can better tolerate the stress required for neural reorganization" (Cozolino, 2002, p. 291). Taylor explains that,

Adults who would create (or recreate) neural networks associated with development of a more complex epistemology need emotional support for the discomfort that will also certainly be part of that process. (Taylor, 2006, p. 82).

From a neuroscience perspective, trust in a relationship enhances the sharing of knowledge, especially regarding shallow and deep knowledge. When a secure, bonding relationship in which trust has been established occurs, the learner's neurotransmitters in the prefrontal cortex (dopamine, serotonin, and norepinephrine) are stimulated and lead to increased neuronal networking and meaningful learning (Cozolino, 2002). Schore describes this as "a cascade of biochemical processes, stimulating and enhancing the growth and connectivity of neural networks throughout the brain" (Schore, 1994, as cited in Cozolino, 2002, p. 191). Thus a caring, affirming relationship promotes neural growth and knowledge creation. Such physiological changes can quickly influence the attitude and expectations of people involved in social knowledge sharing and learning.

Without such trust and bonding, a listener tends to defend his or her own pre-established beliefs, theories, frames of reference, and self-image. Under normal situations, we tend to defend our beliefs and how we see the world. This defense may accept some incoming information, reject other, and change some. When these distortions occur, the incoming information can no longer represent the knowledge of the sender and therefore it is not shared. New knowledge that challenges or contradicts what we already know also tends to threaten our concept of Self, and thereby creates defensive reactions that minimize or negate learning. Our mind concentrates on "defending itself" and does not have time for listening or taking the other person's view and understanding.

On the other hand, if a trusting, nurturing relationship exists between two people, a safe environment can be created that eliminates or minimizes potential threats to the learner. Daloz (1986) refers to such a situation as a holding environment (in Johnson, 2006, p. 64). When such a relationship is created, the receiver can build a new sense of Self while building the sender's knowledge out of the information that moves from the sender to the receiver. Such knowledge may not be identical to the sender's knowledge because the mind/ brain of each participant is different. However, when the knowledge sharing is successful, the knowledge in each person may be equally capable of taking effective action even though their understanding, meaning and insight may differ n some ways.

Andreasen cites mentoring as one of the elements that helps create a cultural environment to nurture creativity. From a broader perspective, the five circumstances that create what she calls a "cradle of creativity" include an atmosphere of intellectual freedom and excitement; a critical mass of creative minds; free and fair competition, mentors, and patrons, and at least some economic prosperity. As she concludes, "If we seek to find social and cultural environmental factors that help to create the creative brain, these must be considered to be important ones" (Andreasen, 2005, p. 131).

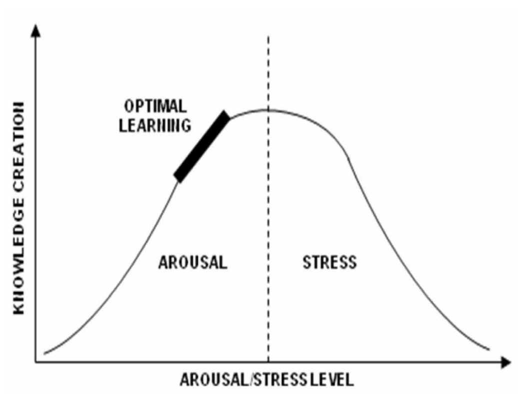
Cozolino (2002) says that the efficacy of the mentoring relationship—a balance of support and challenge—is supported by the literature on brain function. "We appear to experience optimal development and integration in a context of a balance of nurturance and optimal stress" (p. 62). Considering stress, Akil et al. state,

The stress system is an active monitoring system that constantly compares current events to past experience, interprets the relevance (salience) of the events to the survival of the organisms ability to cope. (Akil et al., 1999, p. 1146)

If the emotional content of incoming information from a conversation is one of strong fear or uncertainty to the individual, stress is created and can significantly limit any learning involved. However, if there is too little arousal/stress involved then there may be no desire for listening. Thus, for each individual there exists at any given time some optimal level of arousal/stress (Zull, 2002). Note that low levels of stress are often referred to as arousal.

Plotting knowledge creation rate on the vertical axis and arousal/stress level along the horizontal axis, we get an inverted U. See Figure 2. The optimum arousal level shown just to the left of the center of the inverted U challenges the listener but does not make them fearful of failure or embarrassment (Akil et al., 1999). This optimal level learning and knowledge creation is context sensitive and content dependent and is also influenced by the individual's history. The learner's personal beliefs and feelings about the content of the materials can also play a role in determining his or her stress level. To optimize learning in a given situation, individuals need to understand their own arousal/stress level that challenges them to create knowledge from what they hear, but does not reduce this capacity because of fear. It is possible for individuals to control their

Figure 2. Representation of the relationship between knowledge creation and arousal/stress



perception of stress by recognizing its existence and understanding that stress is created *inside* the body and can therefore be understood and managed (Begley, 2007).

The notion of affective attunement is connected to Dewey's observations that an educator needs to "have that sympathetic understanding of individuals as individuals which gives him an idea of what is actually going on in the minds of those who are learning" (Dewey, [1938] 1997, p. 39). As Johnson (2006) explains, "According to social cognitive neuroscience, the brain actually needs to seek out an affectively attuned other if it is to learn. Affective attunement alleviates fear," (p. 65) a significant impediment to learning. These mechanisms support learning situations by enhancing understanding, meaning, truth and how things work, and anticipating the results of actions.

One example of affective attunement that stimulates the orbitofrontal cortex is eye contact because "specific cells are particularly responsive to facial expression and eye gaze" (Schore, 1994, p. 67). As Johnson explains, literally "looking into the eyes of the affectively attuned other is another significant form of social interaction that can assist in promoting development" (Johnson, 2006, p. 67). This reflects the earlier discussion on the importance and natures of context. Similarly, Frith and Wolpert (2003) forward that an infant and caregiver enter into an intersubjective space. This space may be created around the infant and caregiver through the process of emotional resonance or affective attunement (Johnson, 2006).

COLLABORATIVE ENTANGLEMENT (LEARNING TO CREATE KNOWLEDGE AS COMMUNITIES)

Biological systems are remarkably smarter in their support of the body than we are in sustaining our work places and communities. Fortunately, we can and are learning from ourselves in this sense, and whether we reflect on this learning in the form of a reality or as an analogy is insignificant as long as we keep learning and creating knowledge (Bennet and Bennet, 2008).

In a social setting new thoughts and behaviors proposed through research or personal reflection (based on earlier learning) emerge and then build on other's thoughts and behaviors and then become mixed with yet another set of thoughts and behaviors from the community, and so on. We call this mixing, entwining and creation of unpredictable associations the process of *entanglement*. In other words, the knowledge creation process in a group or community works very much as does the human mind/brain.

In communities, collaborative entanglement consistently develops and supports approaches and processes that combine the sources of knowledge and the beneficiaries of that knowledge to interactively move toward a common direction such as meeting an identified community need. In addition to decision-making, collaborative entanglement includes the execution and actions that build value for all stakeholders, engaging social responsibility and providing a platform for knowledge mobilization. The collaborative entanglement model is highly participative, with permeable and porous boundaries (being continuously reshaped) between the knowledge creator—an individual, team, or community—and knowledge beneficiary. An example is a university research program in the social sciences involving action learning (of a team, group or community), where the research itself becomes part of the process of implementing research results (Bennet and Bennet, 2007). Lee and Garvin contend that to be effective, knowledge exchange depends on multi-directional, participatory communication among all participants (Lee and Garvin, 2003). *The collaborative entanglement model moves beyond knowledge exchange to the creation of shared understanding resulting in collaborative advantage and value creation* (Bennet and Bennet, 2007b, 2008a).

Collaborative entanglement as a social phenomenon can be analogous to the natural activities of the brain, with the brain representing the researcher (in our example) and the stakeholder community representing the knowledge beneficiary. All the living and learning of the host human is recorded in the brain, stored among some hundred billion neurons that are continuously moving between firing and idling, creating and re-creating patterns. Information is coming into the individual through the senses which, assuming for the sake of our analogy, resonates with internal patterns that have strong synaptic connections. When resonance occurs, the incoming information is consistent with the individual's frame of reference and belief systems. As this incoming information is complexed (the associative patterning process) it may connect with (and to some degree may bring into conscious awareness) deep knowledge. The unconscious continues this process (24/7), with new knowledge stored in the unconscious and perhaps emerging at the conscious level.

In the collaborative entanglement model, individuals and groups are continuously interacting as new information becomes available through their sensors; for example, if (1) they recognize a problem or issue and/or solution, (2) they see new indicators that bode well or poorly for the community, or (3) new events occur that affect an on-going project or community effort. From these interactions—often connected to strong emotional feelings which increase the importance and strength of their meaning—new knowledge emerges. When individuals or groups are engaged in this interactive, emergent process with other stakeholders, the new knowledge that emerges is *informed* by their learned expertise. As new knowledge is applied and this iterative loop of collective learning continues, a large amount of tacit knowledge (embodied, affective and intuitive) is created beyond that which visibly affects the community (Bennet and Bennet, 2008a). This new tacit knowledge then forms the grounding (best thinking) for future incoming information that will be associated with these patterns. In other words, the process of collaborative entanglement among individuals not only helps provide a specific solution to a current issue, but seeds the ground for continuous community self improvement, collaboration, and sustainability.

AN EXTRAPOLATION

With the new century emerged new ideas on every front, one of which was expansion of the global brain concept. The term originally emerged in print in 1983 with the publication of Peter Russell's book by that name. Grounding his work on historic observations of new levels of organization occurring based on the tight-but-flexible coupling of 10 billion units in a system, Russell described an interconnected network of humans as becoming a Global Brain (Russell, 1982). In 1995 Gottfried Mayer-Kress and Cathleen Barczys proposed that "a globally and tightly connected network of computer workstations such as the Internet can lead to the emergence of a globally self-organized structure that could be called the Global Brain" (Mayer-Kress and Barczys, 1995, p.1). In 2000 Howard Bloom's treatment described the network of life on Earth as a complex adaptive system. He shows how animals and plants have evolved together as components of a worldwide learning machine, with humans playing conscious and unconscious roles, with development of the World Wide Web as part of this learning. And so forth.

We choose to explore the concept of Global Brain from the viewpoint of the mind/brain—perhaps moving towards the higher level of evolution introduced by Pierre Teilhard de Chardin's *noosphere*, a network of thoughts ushering in a new level of consciousness. Recognizing that the mind/brain supports survival and sustainability in a complex and unpredictable world, we now consider, somewhat metaphorically, the potential of learning from the totality of ourselves to further explore the emergence of social knowledge, that is, extrapolating our model of the individual mind/brain to a societal level. Perhaps the simplest way to achieve this extrapolation is through story form.

As SETH streamed into unknown territory, he was further excited by the feelings of familiarity and resonance emerging within. SETH represented Self-Evolved Thinking Humans, a pattern of men and women crossing cultural, ethnic, religious and gender boundaries in pursuit of ultimate knowledge. SETH's capacity to anticipate was high, honed by the association of a wide range of experiences and a highly tuned emotional guidance system. Still, with all her historic success in anticipating and dealing with the future in her area of expertise, this landscape was different … was that a tinge of fear in her side tagging along for the ride?

SETH was responding to a strong message received from this distant realm, a message associated with survival, no doubt one of those learnings worthy of a new category of The Nobel Prize, a grand new way of thinking and being. He now stood on the high ground above that distant realm, a hundred thousand homes stretched out as far as he could see, lights twinkling through the windows and pulsing along the billion connecting three-dimensional highways, roads and paths that made the community One. Some spots were brighter than others: flitting patterns from a movie theatre playing reruns; flashing sparks from a loudly-buzzing generator; colorful streams from an observatory at the far edge of the city sporting a large, upward-focused telescope. And near the center of this hub of activity, to the left, where connecting paths intertwined with incessant beams of entangled reds and blues and yellows, the brightest light moved in and out of the central library. SETH understood the power of record-keeping at its best, a living, vibrant field of growing and expanding patterns evolving from instant to instant.

SETH moved toward that light, carefully navigating the busyness of the intersections, pulled this way and that by the excitement, but committed to staying the course. He had come to learn from the Master, to discover that single thought that guided all the others. He paused to reflect on this singular yearning for the discovery of something more that had emerged since his first feeling of the message.

Then he arrived at his destination, startled by the peace within the hub of excitement, but gently perceiving the silence and fullness that comes with knowing. What might be described as an inner council of sorts welcomed him, each member of the council a different aspect of the One. Eager to discover answers to his questions, he moved quickly through the formalities of introductions, conveying greetings from mutual distant relatives, sharing the urgency of his mission, and expressing gratitude for a warm reception.

"The environment is rapidly changing," the leader began, "and though you journeyed quickly following the first flash, much new information is coming in from our sensors and emerging from our internal sources that is shifting our direction. Let us see how you fit, what you contribute …"

"And what ***we*** *can learn from you," SETH interrupted.*

"Yes," the leader confirmed, "that is also a possibility."

"Possibility?" SETH questioned. "But this sounded like the answer we have been seeking;

finally, absolute knowledge. It resonates with our beliefs, with our preferred frames of reference, with our values …"

"Ah," responded the leader, "but beliefs and frames of reference and values also change. They are tools for us to act effectively in an uncertain and changing environment."

SETH was puzzled, confused even. "No. Our community is also one hundred thousand strong, although many of those connections are outliers, at a distance, only a few reside in the center of town. Still, we have held onto those early values embedded during the beginning of time, and have picked up incoming information throughout our history that has reinforced those values, and we have sent continuous messages beyond our boundaries to guide those who are on misdirected paths …"

"So that was you," the leader sighed. "Those historic values were holding all of us back for awhile." There was a short pause, accented by rhythms of soft bursts of light. The leader continued, "And yet you are here. You were able to sense something new and different with the potential of evolving our connections and firings to another level."

"Yes … it was magical," responded SETH. "There was an explosion right in the center of town—at our Central Library—that coincided with the explosion here, visible and felt even across such great distances. So strong that it pulled me here. Where did it come from? What exactly is it? Give me the words, the pattern, the context, to understand and learn and connect and share."

The leader smiled and silently moved away from SETH even as another form approached and continued the interaction. "YOU are part of the answer to your questions! It is at the core of who you are, and now you are more, for you are more strongly connected to us, and, in turn, to all those with whom we interact. We welcome your contribution."

SETH was beginning to tire of these circular responses. "But I'm here to discover the grand new way of doing and being, the answer!"

A third form was now moving toward SETH, hand out-stretched, eyes sparkling with amusement. "There is no such thing; and simultaneously all you know is part of such a thing!"

"We are part of such a thing that does not exist!?" SETH blurted out.

The third informer gently motioned to the shelves and shelves of books and movies surrounding them in a hazy glow. "We store here only a small amount of what we observe, what we reflect, what we discover, and it is always reforming and reconnecting in new ways to create the wonderful flash which brought you here." She gestured a full circle, gliding around with the gesture. "Perhaps you had forgotten? This is the process of birth and regeneration, the way of knowledge, the capacity to take effective action, a human gift to navigate the rapids of change, uncertainty and complexity."

"I don't understand," SETH sorrowed. "How can I anticipate those rapids?"

"You started that journey already" came the slow response. "You are here with us, interacting, each of us learning from the other. Our thoughts are no longer distant to you. The third informer paused, pulsing with soft light that reached toward SETH."

My friend, our future is neither predetermined nor knowable. It rests with the dynamics, uncertainty and complexity of an almost infinite number of quasi-independent biological thinking subsystems that are continuously and deeply interconnected, with each trying to comprehend the whole but acting to the benefit of the individual. There is no "answer" or ultimate action, there is learning, thinking and recognizing (and acting) the role of each biological subsystem which, in turn, affects the learning, thinking and acting of the whole in completely unpredictable ways. Patterns in a never-ending journey in which SETH was fully participating.As SETH turned her energy towards home, she reflected on re-connecting *with her trusted network, sharing new patterns, expanding their thoughts through exchange and dialogue, and re-creating themselves (continuously) to co-evolve with a changing universe ...*

FINAL THOUGHTS

Experiential learning is not just a function of the incoming information. It becomes clear that the nature of the social interaction plays an important role in determining knowledge creation and sharing. The overall environment, a trusted other, and the conscious and unconscious state of the learner all have a role in the final efficiency and effectiveness of learning that occurs. Further, the specific social interaction that influences the neural structure, and the perceived stress level of the individual, will affect the nature and amount of knowledge that is created and shared. By being aware of these factors, learners may be able to change the local physical environment, improve communication with others, or perhaps position and adjust their own internal feelings and perspectives to maximize learning.

Here are a few summary highlights of this paper in terms of recent neuroscience findings:

There is an optimum level of stress for learning (the inverted "U"). This level is somewhere between a positive attitude and a strong motivation to learn (arousal), and some level of fear of learning or the learning situation.

Physical mechanisms have developed in our brain to enable us to learn through social interactions. These mechanisms support affective attunement, help us consider the intentions of others and what others are thinking, and help us think about how we want to interact (Johnson, 2006).

The brain actually needs to seek out an affectively attuned other for learning. As Johnson explains, effective attunement reduces fear, and creates a positive environment and motivation to learn (Johnson, 2006).

Physical and mental exercise and social bonding are significant sources of stimulation of the brain. Studies in social neuroscience have affirmed that over the course of evolution physical mechanisms have developed in our brains to enable us to learn through social interactions (Amen, 2005).

Language and social relationships build and shape the brain. This significantly impacts the sensing aspect of concrete experience and the concepts, ideas, and logic of abstract conceptualization. Good social relationships enhance learning through a reduction of stress, a shared language, and the use and understanding of concepts, metaphors, anecdotes, and stories.

Adults developing complex neural patterns need emotional support to offset discomfort of this process. Taylor (2006) suggests that this support is needed by individuals developing complex knowledge. Such emotional support will enhance the feelings of an individual during concrete experience, and also aid in the creation and understanding of concepts and ideas during abstract conceptualization.

Effective attunement contributes to the evolution and sculpting of the brain. Effective attunement involves a mentor, coach, or another significant individual who is trusted and capable of resonance with the learner. When this happens, a dialogue with such an individual can greatly help the learner in understanding, developing meaning, anticipating the future with respect to actions, and receiving sensory feedback. As these new patterns are created in the mind, they in turn impact and change the structure of the brain.

An enriched environment increases the formation and survival of new neurons. Such an enriched environment can influence both the nature of the experience of the learner and his or her learning efficacy. As Begley (2007) describes, "exposure to an enriched environment leads to a striking increase in new neurons, along with a substantial improvement in behavioral performance" (p. 58).

Collaborative entanglement represents the continuous interaction, movement of information, and sharing and learning of knowledge resulting in a community movement toward a higher level of awareness, understanding and meaning. Such a process builds both explicit and implicit knowledge and creates a learning, trust and bonding that may energize and accelerate community progress.

While we have addressed information, knowledge, learning and the factors and conditions which influence the social creation and/or sharing of knowledge, it must not be forgotten that every individual learns (creates their own knowledge) from a baseline of past experiences, theories, biases, motivations and perceptions of their Self.[1] It is concepts and their associated internal patterns that can be mixed with incoming information. Thus we can only create new knowledge from our personal autobiography, and the information coming to us in the future will be complexed with what we are learning today. Then again, our personal autobiography is rich with social interactions, social bonding experiences, and reflection—a richness to which we contribute every day of our lives.

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ENDNOTE

See Bennet and Bennet (2009) for a discussion of Self in a CUCA environment, that is, increasing Change, Uncertainty, Complexity, and Anxiety.