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Chapter 7

SENSE OF SELF AND CONSCIOUSNESS: NATURE, ORIGINS, MECHANISMS AND IMPLICATIONS

William R. Klemm*
Neuroscience, Texas A&M University, US

ABSTRACT

This analysis addresses four issues: 1) the nature and origin of the Sense of Self (SoS), 2) the nature of the sequential development of SoS and consciousness, 3) how a conscious SoS can be created by the brain, and 4) the consequences of a SoS that is consciously perceived.

Herein, I present the case that the SoS is like a sixth sense functioning with the same neuroscience principles used by the other senses, yet distinct in that it individuates our other senses in complex and rich ways. SoS is actually created by the other senses. All six senses begin early non-conscious development in the womb as a result of embryonic cell division, migration, and differentiation of neurons. The sculpting of early circuitry is influenced by self-referential stimuli from the developing fetus and from mother-specific signals from the womb that inform those circuits that they have a body they can influence. At some point, a year or more after birth, enough neurons appear and circuitry differentiates to enable episodes of conscious awareness of self and non-self.

Consciousness occurs in the context of self and non-self awareness. I submit that the brain implicitly *learns* to become consciously aware of self and non-self. Such learning, to be consciously operative, requires a species to have enough neuronal circuitry to create the "carrying capacity" required for conscious representation of ordinary stimuli, a SoS, and cognitive interactions with environment.

The SoS, like all senses, is represented in brain by patterns of nerve impulses propagating in circuitry, which can be called circuit impulse patterns (CIPs) that could contain a combinatorial code of impulse activity, a possibility that is ripe for investigation. The concept is that circuits of interacting neurons can have specific properties of their own that are not evident in any one member neuron. Moreover, the phase and frequency relationships of the CIPs are likely representations of sensation of

* Email: WKLEMM@cvm.tamu.edu

both ordinary senses and the SoS and no doubt change dramatically as capacity for consciousness develops. This too is a research area whose time has come.

Consider that conscious mind could be a CIP Avatar that acts on behalf of the brain and body as a partner with subconscious mind to make the total brain and body functions more adaptive and effective. The CIPs representing the SoS are pre-requisite for a conscious brain to be also aware of things affecting the self and non-self. Thus, brain can be aware, by definition, that it is aware or "knows that it knows" about the self's interaction with a world of non-self.

Existing technology is sufficient to begin testing these ideas. We should be able to detect CIPs that are specific to the SoS and its conscious perception. Causality seems likely if changing the neural activity patterns changes conscious thought and if changing thought changes the CIP patterns.

Implications of conscious self-awareness extend across the whole spectrum of human thought and behavior. Examples are given for such things as value assessment, extension of self via tools, value judgment, self-directed learning, dreaming, and willed behavior, time perception, and notions about death and religion.

Nature of the Sense of Self

Central to each person's existence is their Sense of Self (SoS). We engage our environment in a context of self and non-self. Experiences happen to "me." It is "I" who have intentions to act in certain ways amidst a world of things that are not "me." Like all senses, the SoS can be received in the non-conscious or subconscious brain or perceived in a brain that is conscious. Being consciously aware of self is not essential for life, but it certainly magnifies the consequences of having such awareness. SoS has its roots in our biological evolution, arising in animals that had no capability for consciousness. As better brains evolved, so also did the capacity for conscious self-awareness. This is the miracle of nature that no biologist, psychologist, neuroscientist, or philosopher has adequately explained.

Herein, I present the case that the SoS is like a sixth sense functioning with the same neuroscience principles used by the other senses. All senses, including SoS can operate at non-conscious, subconscious, or conscious levels. However, SoS is distinct in that it is created by the other senses and integrates them in the context of self and non-self.

With a SoS, we can individuate traditional senses in terms of their properties. That is, each person may respond to those properties in different ways. What it feels like to hear jazz or Mozart is not the same for everybody, yet every ear receives the same sound vibrations. Additionally, the SoS not only subsumes the other senses, it is often used to guide the delivery of input from other senses. For example, we actively touch or look at things to explore and enhance how they relate to our own SoS.

Animals in various phyla exhibit signs of a non-conscious SoS. For example, even schooling fish maintain their position in the school. A fish that strays from the school can detect that it is an entity of some sort that is "out of step" and it reflexly re-joins the school, moving in unison with the group. To sustain position in the school, the sensory signals from retina and lateral-line detectors constantly adjust swimming in the context of the SoS and where a fish is in space. Similar behavior occurs in flying flocks of birds. Of course, such behavior indicates only a very primitive SoS. Only higher animals, maybe only humans, are *consciously* aware of their SoS.

The schooling of fish and bird flocks makes another fundamental point about the SoS. The neural circuitry of such animals is such that they not only detect when they are “out of step” but that sense directs reflex behavioral responses. The fundamental principle is illustrated by a non-conscious spinal reflex which is activated by sensory nerve terminals that detect a peripheral stimulation of the self and issue appropriate movement commands of that same self. Thus, we should regard a SoS as something very fundamental to nervous systems.

Just as a spinal reflex can be activated non-consciously by somatic stimulation, the brain has sensory and motor maps of its body in relation to the space outside the body. These maps tell the brain there is a self that is described by those maps. The brain, moreover, uses the maps to detect external non-self objects and events as they relate to self. The maps are created during early neuronal migration, and a non-conscious SoS is among the first things that develops in an embryo. We can say that sensations engage the maps to instantiate the mind, which once created, now has the power to do other things than just register sensation. Moreover, the brain even can re-organize its body map, as many experiments on brain plasticity have demonstrated (Johnson et al, 2002).

Even in the early embryonic stages each neuron has a built-in SoS. As each neuron appears, it immediately starts a migration to the places in the brain where it is supposed to be. Neurons “know” they exist, where they are, and where they belong. Initially, they “know” they don’t belong where they originate, and they migrate with chemical and mechanical steering. Of course, this “knowing” is non-conscious.

Two seemingly conflicting views of the conscious sense of SoS are presented by Prinz (2009). One is a naturalistic position, positing that the SoS is a naturally innate feature that is independent of experience. The other is that the nature of the SoS is constructed from experience. I will argue that it is both.

HOW DOES A SOS EMERGE AND EVOLVE?

Antonio Damasio (2010) asserts that consciousness causes the SoS. I contend that brain life begins with a non-conscious SoS and at some point, enough ontological development occurs to enable that SoS to be realized in consciousness.

Neurons are among the first cell types to appear in an embryo (reviewed by Spitzer, 2006). Even neuronal precursors (neuroblasts) release the neurotransmitters GABA and glutamate, and these in turn participate in generating electrical activity. Neurons release GABA or glutamate at these early stages and this in turn affects neuronal proliferation. Migration follows development of calcium channels and formation of NMDA receptors. Electrical activity of primitive neurons guides all three stages of brain development: proliferation, migration, and differentiation.

Spitzer explains these effects this way: “electrical activity seems likely to operate at a more fundamental level, integrated with gene expression signaling by electrical activity may refine signaling via gene expression, providing feedback loops to validate or fine-tune steps of development driven by genetic programs.” I would extend the statement to say that SoS becomes stored in the genome as an acquired characteristic.

As the neural tube begins encephalization, creating its “nonconscious mind” of spinal cord and brainstem, its rudimentary neuronal circuits fire impulses spontaneously. Some of this firing occurs in the peripheral sense organs, which are basically specialized neurons, especially in the skin of body surface, limb buds, and emerging facial structures. Circuits begin to form in response to fluid pressure in the womb, chemicals in the surrounding fluids, and sounds propagated through mother's bodily fluids. Spontaneous activity of spinal motor neurons creates squirming and kicking movements that provide proprioceptive feedback. Even the retina, which has no light to see, spontaneously sends waves of electrical signals into the primitive developing thalamus (Constantine-Paton et al., 1990; Katz and Shatz,1996; Wong et al. 1998).

Consider the yawning behavior that occurs at about the three-month stage of a fetus. Yawning is a self-referenced behavioral response to interoceptive stimuli. Walusinski (2006) explains the relevance to the ontogeny of SoS this way: "The body's schema is a main component of the self, and interoceptive process is essential to awareness of the body and arousal. Yawning can be seen as a proprioceptive performance awareness which inwardly provides a pre-reflective sense of one's body and a reappraisal of the body schema."

All of these various kinds of fetal stimulation inform the developing brain that it has a body that supplies it information and that can be made to move. In short, the developing brain learns at a very earlier stage that it exists, that it is a discernible self. This non-conscious SoS expands in tandem with the rapid division and migration of neurons form the cerebrum and cerebellum.

Vast numbers of neurons that fail to become recruited into this growing SoS circuitry will die and become the refuse of the emerging foetal brain. The remaining circuitry has not only been sculpted by embryonic development, but it now has a deeper SoS that becomes permanent as memories form of what the brain has learned about its body.

At this point, presumably in the last trimester, enough circuitry has been sculpted to accommodate the increasing amount of unique stimuli and thus begin the process of creating a SoS unique to that particular fetus. Such unique stimuli would include a mother-specific cocktail of chemicals in blood arising from environmental exposure, diet, metabolites, and timing of hormone changes. Fetal bodily movements must surely have some unique features, and certainly this is true of feedback from the developing uniqueness of structure of the body, particularly the face.

Eventually, enough circuitry has matured to enable this SoS to be perceived consciously. We can suspect that because electrographic signs of dreaming occur in human fetuses by 7 months of pregnancy (Schwab, 2009). If this dreaming is anything like the dreaming that occurs after birth, it should entail a rudimentary conscious SoS deployed within the dreams where self is an observer or even participant. Dream sleep may even be a crucial factor in developing conscious awareness of self.

We know that in all mammals, including humans (Petre-Quadens, 1974), the physiological signs of dreaming occur more often in the young. Young children exhibit a great deal of REM sleep, accounting for as much of 50% of sleep time, compared with about 20% in adults. While it is true that young children often fail to remember dream content, I believe this reflects more a failure to remember than a failure to have conscious dreams. We know that very young children can have their conscious self engaged in dreams, as revealed by their being awakened by nightmares.

Of course, the SoS is not fully developed until adulthood, because the brain itself is not fully developed until then. MRI studies show that although the callosum is basically formed by age 2-3, it does not fully mature until the teen years (Kim et al. 2007). Common experience teaches that the SoS seems to develop in parallel.

I propose that consciousness arose out of an antecedent SoS, which begins in the womb long before there is enough neocortical circuitry to sustain consciousness. The SoS, once accompanied by consciousness, detects not only itself, but distinguishes itself from non-self. It also locates itself in both space and time. Like all senses, the SoS learns this from experience. Just as nasal receptors learn to discriminate different odors as they are presented, the SoS continuously updates its registry of self-characteristics as it goes through life encounters. However, the SoS seems to differ from other senses in significant ways. For example, the SoS seems more internally consistent and temporally stable (Ayduck et al. 2009).

A conscious SoS comprises not only identity, but also assessment in the forms of personality, skills, preferences, values morals, self-worth, and the like. It is obviously malleable, ranging along a continuum of self-worth and acceptance to a variety pathological distortions. Both self-identity and self-assessment are learned. One example is the different ways boys and girls come to view themselves as they grow up to assume gender-specific personalities (Jacklin and Maccoby, 1978; Maccoby, 1990; Gabriel and Gardner, 1999).

Comparison with Traditional Senses

Ordinary senses have dedicated neural pathways and circuits. Though the pathways of the SoS are not so easily defined, the SoS operationally has far larger degrees of freedom of than ordinary senses for engaging with the world, because its circuitry has wider distribution throughout brain and its circuits are less dedicated to a specific operation.

Immanuel Kant's philosophical take on the traditional senses was that they prevent us from knowing the world as it really is. Kant correctly held that what we know about the world is captured by neuronal representations generated in the nervous system. These representations occur in their "on-line" deployment as nerve impulses and in the stored form as patterns of synaptic facilitations.

The currency of non-conscious mind has been well-documented to be the neuronal action potential, or more precisely, the patterns of impulses as they flow in their circuits of origin. The brain is a network of networks, and every small network contains a propagating flow of impulses in patterns that may be unique to each neuron in the circuit. Collectively, however, the processes of that circuit are best characterized as the combination of all the patterns within it. I call these "circuit impulse patterns" (CIPs) (Figure 1).

One thing all senses, including self sense, have in common is that they exist in latent form and in deployed or "on-line" form of propagating neuronal action potentials. The latent form for ordinary senses exists in the hard-wired circuit anatomy specific to a given sense organ. The SoS has a much more complex latent form. It exists most robustly in the micro-column circuit anatomy of the cerebral cortex and its reciprocal connections with brainstem and thalamic neurons. This system unleashes the latent form into "on-line" wakefulness during which cortical circuits generate oscillatory activity of various frequencies and phase coherences.

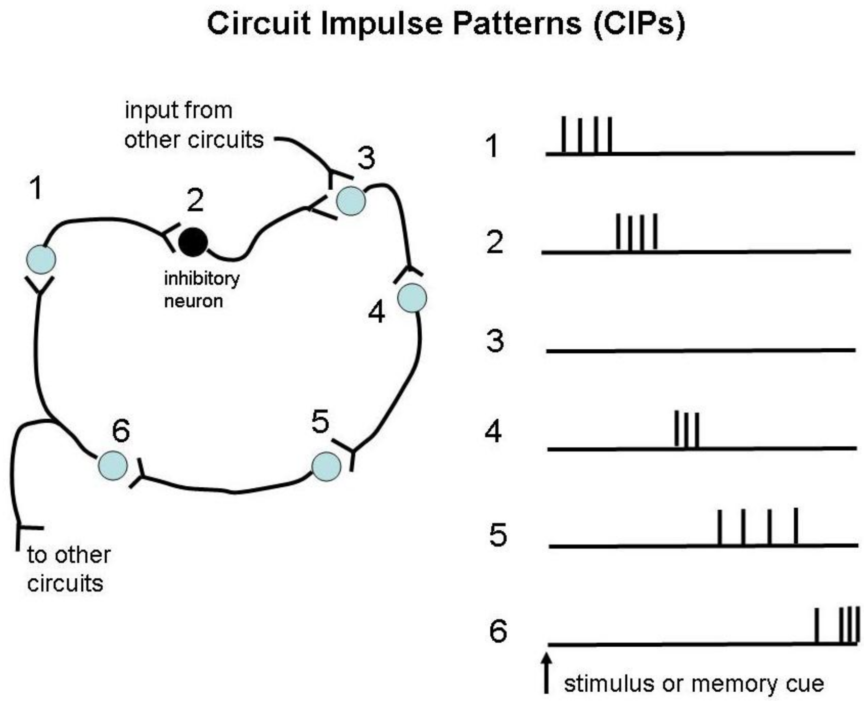

Figure 1. Illustration of the idea of CIPs. In this example small circuit, each neuron generates a certain pattern of spikes, which in turn influences a target neuron. For example, the inhibitory neuron #2 shuts down activity in #3, which nonetheless can reactivate when the inhibition wears off or when excitation comes from another circuit with which it interfaces. Collectively, all the neurons in the circuit create a combinatorial CIP for a finite segment of time. Because circuits like this feed back on themselves, they can generate the well-known oscillation of brain activity. The frequencies of oscillation are governed by the size of the circuit, time constant of synaptic delays, and the presence of any inhibitory neurons in the circuit. When embedded within a network of interfacing circuits, such a CIP may become part of a more global set of combinatorial CIPs that can be regarded as the mechanism for creating specific mental states. From Klemm, 2011b.

In the process, the brain gains conscious access to the stored memory of facilitated synapses that contain the long-term memory of the nature of self that has been evolving through daily experience since its days as a fetus (reviewed in Klemm, 2011a).

Unlike energy, however, deployed mind does not dissipate in the process of being released. Deployed mind can modify the impulse patterns representing the deployed SoS and gradually change the representations that are stored. The SoS that is stored is thus susceptible to change in response to the experiences of deployed mind, which inevitably occur in a context of self and non-self.

CONSCIOUSNESS SOS

Consciousness is the darling of modern philosophy. Yet, I am not sure that philosophy has the tools to take us very far in understanding consciousness. Philosophy's limitation, as I see it, is that it tends to be a global "black box" approach that skirts the basic neural functions that give rise to consciousness. Unlike philosophers, neuroscientists focus on the assumption that certain kinds of neural activity are unique and constitute the cause of consciousness. This leads experimenters to look for "neural correlates," particularly those that can actually create and sustain consciousness (Koch, 2004).

Understanding of consciousness would benefit, I think, from considering it as a self-aware SoS. I take issue with the philosophical assertion that conscious experience comes in two forms, one referenced to self and the other to externals (Tye, 2009). I assert that in conscious experience, everything is seamlessly referenced to a SoS. For example, the claim is made that when one sees the color of red, that experience somehow is independent of self. But it is still the "I" who perceives red. Of course, red has its own physical reality in its chemicals that reflect the red portion of the visual spectrum, but the *perception* of what red is like still occurs in the inner consciousness of the SoS. Also, though I don't think this has been looked for experimentally, when eyes focus on different shades of red, the neurons in visual cortex represent various shades with specific neural impulse patterns. The classic work of Hubel and Wiesel revealed that there are color-specific neurons in visual cortex and it seems entirely reasonable to suspect subtle changes in firing pattern specific to shade of color. Considered physiologically, we can avoid the endless arguments of philosophers over "what it means to experience" such things as red. Different colors and shades are represented in neuronal spike trains, and if those trains are processed within the global circuitry of consciousness, do we not have an explanation for what it means to experience red? When a capacity for consciousness emerges, it enables a "novel cognitive structure that stands above and outside the cognitive processes that are available to organisms with a *conscious* [my insert] sense of self" (McPhail, 1998). McPhail adds that conscious self has thoughts "about" sensory representations. However, he fails to emphasize that the thoughts are themselves representations using the same processes of neuroscience as all the senses, including SoS.

BODY MAPPING

Anatomical relations of nerve fibers to body parts create a SoS in which the body is mapped in the nervous system. Such "topographical mapping" is fundamental to the way in which body parts are sorted and represented in the nervous system. This applies to both sensation and to control over movements. While segregation of sensory and motor pathways in spinal cord, thalamus, and cerebral cortex has been known for many decades, we have recently learned that mapping apparently occurs even for such comparatively ill-defined senses as taste (Chen, 2011). Topographically mapped functions may operate non-consciously or consciously. A related but distinctly different concept is the matter of body image. Each person has a conscious perception of his or her body (fat, thin, beautiful, ugly, etc.). Both body mapping and body image contribute to the brain's construction of its SoS.

PERSONAL SPACE

Common experience teaches that the human SoS includes within the definition of self a certain amount of adjacent space, on the order of a meter or so, which is a zone that is belonging to or being part of the SoS. If people get too close to us in conversation, we feel uncomfortable and back away. The SoS has a concept of nearby space that belongs to it, as opposite to "not mine." This space and objects within it may be considered as part of "me." The size of personal space varies by individual and even cultures (Low and and Lawrence-Zúñiga, 2003).

Holmes and Spence (2004) have written an extensive review of "peri-personal space," mostly from an engineering-like perspective of how a brain tracks its position and calculates what it must due to manipulate objects within its peri-personal space. But to me, it seems equally appropriate to think of peri-personal space as being a virtual component of the SoS.

Origins of Self Space in Lower Animals

Personal space in primates may have its origin in the territorialism of lower animals. Many animal species have identifiable territories, which are a kind of self-space that may extend over large distances, such as the home range. Certain species may also have a smaller self space that is more personal. Domesticated dogs may have a collapsing self space that ranges from their owner's yard, to the home, to within a few feet of the animal's body. In dogs, for example, aggression may be triggered if a threatening animal gets too close.

The extent to which lower animals are consciously aware of the self space is highly debatable, but the clear existence of such space testifies to the fundamental nature of the SoS and its associated space.

Mirror Neurons

Mirror neurons were discovered in several areas of cerebral cortex of monkeys around 1990 in the laboratory of Giacomo Rizzolatti at the University of Parma, Italy. These neurons fire when the animal sees or hears an action performed by others and when the animal carries out the same action on its own.

Similar extensive monitoring of action potentials in human cortex has not been conducted, but neuropsychological testing indicates clearly that humans also have neurons that code peri-personal space in the context of "mine" and "not mine." Humans seem to have multiple mirror-neuron systems that specialize in carrying out and understanding not just the actions of others but their intentions, emotions, and social meaning of their behavior. This capability confers a capacity to consciously "read minds" (reviewed in Craighero, 2004).

Mirror-neuron function underlies the well-established "Theory of Mind," in which one person imputes conscious mental function to another that is similar to one's own. To do that, one must have not only a SoS, but a sense of other.

A key, seldom-discussed feature of mirror neurons is that they participate in the monitoring of the body in relation to nearby objects in personal space. To move through space, the body must integrate the neural representation of the body and the space around the body, which includes nearby personal space and more distant non-personal space (Holmes and Spence, 2004). These mirror neurons are multi-sensory, as well as coding in the context of self if the information comes from within one's personal space.

Mirror neurons might encode differently depending on whether the act takes place within the individual's personal space, where access is more likely, or if the act takes place at a distance and the observer is less likely to participate. This would test the "understanding" hypothesis, because understanding of the movements involved should be the same irrespective of separation distance.

Caggiano et al. (2009) recorded mirror neurons in monkeys when an object was within the monkey's personal space (within arm's reach) and when it was some 28 cm or more away. Pre-motor neurons were activated by both the execution of the required movement or by observing a human make the same movements. But 53% of the mirror neurons fired selectively, depending on where the object was located relative to the monkey's personal space. These space-sensitive neurons were about equally divided between those that were preferentially responsive when the object was in the monkey's personal space and those that responded when the experimenter manipulated the object some 28 cm or more from the monkey. Thus, it would seem that mirror neurons not only encode the understanding of the movements but a subset of them encodes the spatial context of the act.

The investigators concluded that these space-sensitive neurons are important for evaluating subsequent interacting behaviors. That is, the only way a monkey can interact when the object is outside is personal space is to plan movements to get closer to the object.

A subpopulation of these spatially selective mirror neurons encodes space via a metric representation, while other neurons do so in operational terms, altering their response properties in accordance with the possibility that the monkey will interact with the object. The authors suggest that a set of mirror neurons encodes observed motor acts, not just to understand them, but also to analyze them in a manner that contributes to answering the question "how might I interact with them?

I have an additional explanation that I think has profound implications. Space-sensitive neurons could be coding for the object's relevance to the monkey's SoS. Those mirror neurons that fire selectively when the object is within personal space, may be part of a larger circuit that contains a representation of a SoS. Close objects are viewed as a component of the SoS (e.g. "this object is *mine* and thus a part of me"). Mirror neurons that are selective for objects outside of personal space suggest that the object might belong to others ("not mine, at least not yet"). A vivid way to illustrate the difference is the difference between the possessiveness a tethered dog shows for a bone placed at its feet and a bone place beyond its reach.

MECHANISMS OF CONSCIOUSNESS

Modern research has made it abundantly clear that consciousness emerges from distributed processes within multiple regions of the cortex. This has been confirmed by brain imaging and by brainwave coherence during consciously performed tasks. If either the brainstem core or neocortex is non-functional, as during anesthesia or brain damage, there may be no conscious mind.

Some philosophers ask how "mind" can come out of a brain reality that has "no mind." Such as question misses the mark and creates a barrier to understanding. We need a definition of "mind" that is expressed as a tangible reality. "Mind" is a reality, not an abstraction.

I describe three "minds" in the brain as tangible realities. One is non-conscious mind, which basically exists in the form of spinal and brainstem reflexes and neurohormonal controls. Second is subconscious mind, which is all those other neural processes that are not directly accessible to conscious realization, and third, conscious mind, which is not only aware of environment but aware that it is aware. Conscious mind is aware of its SoS and of assorted interactions of self with the non-self environment.

I described earlier the evidence that a SoS begins development in the womb. The more gripping question is when a conscious sense of self emerges. E. M. McPhail (1998) contends that it begins in children around 1-1.5 years when they start to acquire language. I suggest it may begin much earlier, as suggested by observations of dream sleep in the fetus.

How Does Consciousness Emerge?

Over the last 100 years research has established that consciousness is a system property of brain that involves widespread expanses of neural tissue. Most critical to this system are the structures shown in Figure 2.

Of special importance are the spatial and temporal patterns of impulses in distributed and linked microcircuits and networks, especially those in the parallel clusters of neurons in the cerebral cortex known as cortical columns (reviewed in Klemm, 2011a,b)(Figure 3).

If an ordinary stimulus is detected by brain, it is represented in the form of nerve impulses that propagate in circuits and network. But when an ordinary stimulus occurs within the context of the pre-existing SoS, it is more than just a CIP representation of the sense. It may then be perceived self-consciously.

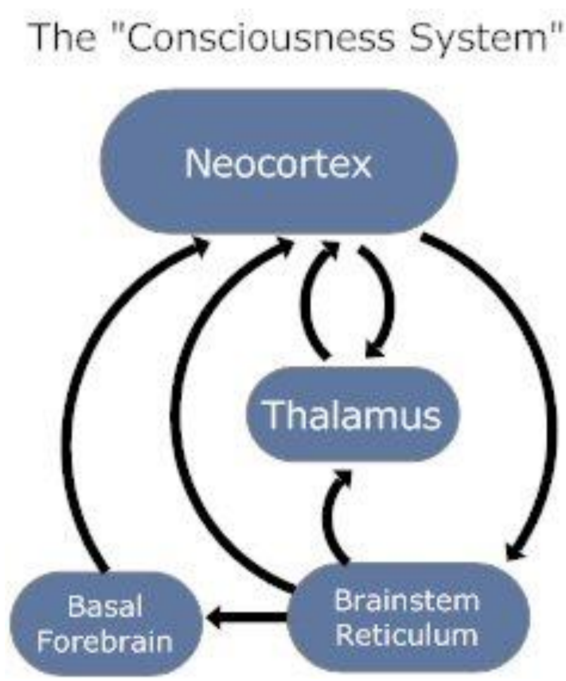

Figure 2. Author's concept of consciousness as a system function of specific areas of brain (from Klemm, 2011b).

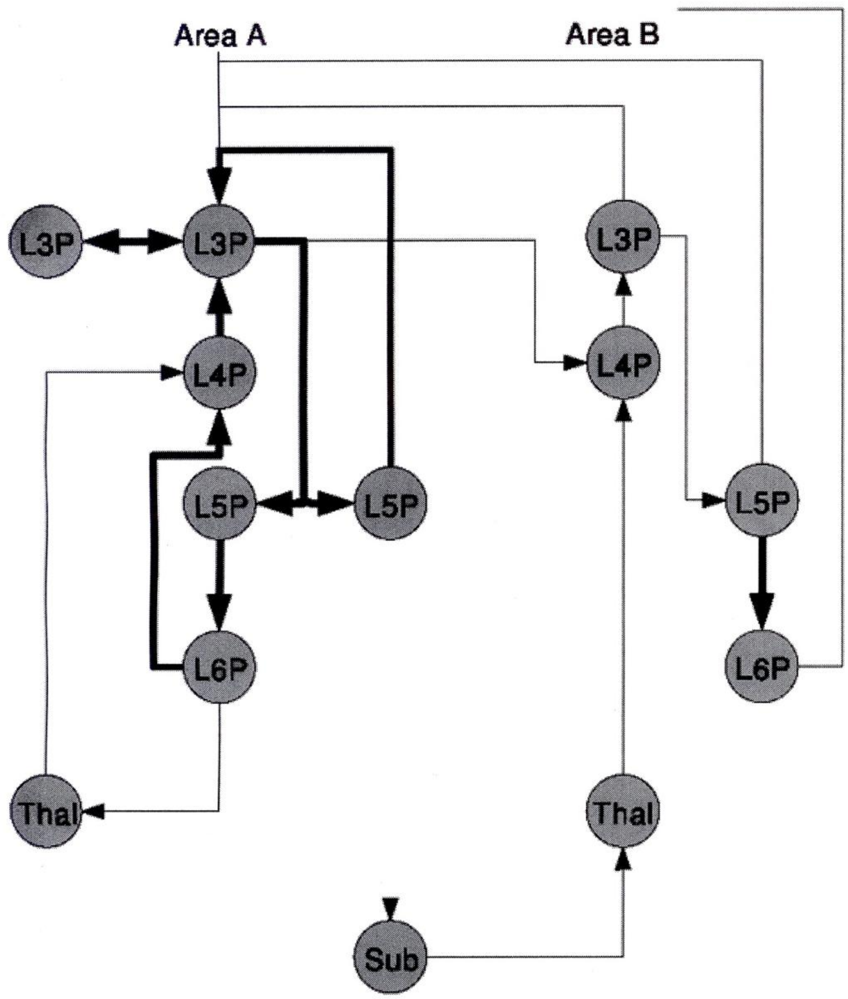

Figure 3. Simplified diagram of the excitatory neurons in any given cortical column (Area A of the human neocortex and the interconnections with other columns (Area B). The vertical layer location of neurons is indicated by L3, L4, etc. Shown are input sources from subthalamus (Sub) and thalamus (Thal). From Binzegger et al. 2005. The nodes of the graph are organized approximately spatially; vertical corresponds to the layers of cortex, and horizontal to its lateral extent. Arrows indicate the direction of excitatory action. *Thick edges* indicate the relations between excitatory neurons in a local patch of neocortex. *Thin edges* indicate excitatory connections to and from subcortical structures, and inter-areal connections. Each node is labeled for its cell type. For cortical cells, *Lx* refers to the layer in which its cell body is located; *P* indicates that it is an excitatory neuron. *Thal* = thalamus and *Sub* = other subcortical structures, such as the basal ganglia Not shown are the inhibitory neurons and the modulating brainstem inputs, such as noradrenergic neurons in the locus coeruleus, serotonergic neurons in the raphe nuclei, dopaminergic neurons in the ventral tegmental area, and the energizing cholinergic neurons in the nucleus basalis. Top of diagram is the outer surface of cortex, while bottom of diagram shows the deepest layers of cells.

Consciousness is not some ethereal “Ghost in the Machine,” (Ryle, 1949) but a genuine physical reality that exists in the form of CIPs flowing in uniquely timed ways in widely distributed circuits of the neocortex (Klemm, 2011a,b). I regard these patterns as not only reflecting consciousness but as representing an embodied SoS.

Just as certain CIPs are a representation of bodily sensations, the brain may also use a unique set of CIPs to generate a conscious SoS. When we humans are awake, we are usually conscious, except when operating on cognitive autopilot. I could say that our SoS is a virtual reality, located "in here." Reality also certainly exists "out there" as well. It is all represented in CIPs.

CIP representations of which humans are consciously aware occur in the context of a SoS. Thus, research on mechanisms of consciousness might benefit from a focus on how a conscious SoS is represented in the spike trains in brain.

Unlike the traditional senses that are registered by CIPs in relatively simple, pauci-synaptic projection pathways, the SoS is a system-level phenomenon that is generated by CIPs in widely distributed complex and interacting circuits. The problem for researchers then is to identify the CIPs that are unique to conscious experience. Also coherence shifts in timing relations among the circuits are likely to be of great relevance.

As with other kinds of CIPs, those representing the SoS can be learned from experience, stored in memory, modified by subsequent experiences, and expressed in the form of decisions, choices, and commands. Because the selfhood CIP patterns may only have to represent the self and not directly represent the inner and outer worlds of embodied brain, the self representation should have more degrees of freedom than subconscious mind and may therefore have some capacity for a free-will mind of its own.

A conscious SoS requires huge amounts of circuitry to exist. Not only must all parts of the body and personal space be represented as part of the self, but the system must also accommodate the traditional senses which the conscious SoS can detect. This is why we don't expect much in the way of higher levels of consciousness from most mammals.

It is also likely that subtle differences in cortical anatomy provide unique circuitry for enabling the conscious SoS. As just one example, apes and monkeys do not have layer 4A of area V1 of the visual cortex (Preuss and Coleman, 2002).

I reviewed several lines of evidence for this theory and suggested that new research should identify state-dependent combinatorially coded impulse patterns and their temporal coherence shifts in defined circuitry, such as neocortical microcolumns. An example of a simple way to detect combinatorial codes is shown in Figure 4.

Performing such a task in a defined circuit, such as in a cortical column, might be technologically too difficult. This task might be facilitated by identifying monitored CIP aliases (spontaneous and evoked field potentials) in terms of the micro-topography of field-potential oscillatory coherences among various regions and between different frequencies associated with specific conscious mentation. Other approaches can include identifying the changes in discrete conscious operations produced by focal transcranial magnetic stimulation (Klemm, 2011b).

A convenient state-dependent conscious operation can be induced by viewing ambiguous figures. Such stimuli present the eyes with a constant input, irrespective of the conscious percept. Moreover, the subconscious and conscious processes apparently co-exist at all times. Presumably, only a change in CIP and spatio-temporal relationships account for which percept is consciously perceived and which is not at any given moment. The percepts are mutually exclusive. Thus, I presume that the two alternative percepts are differentially represented, not only in terms of perceptual meaning, but also whether or not the stimulus registers consciously.

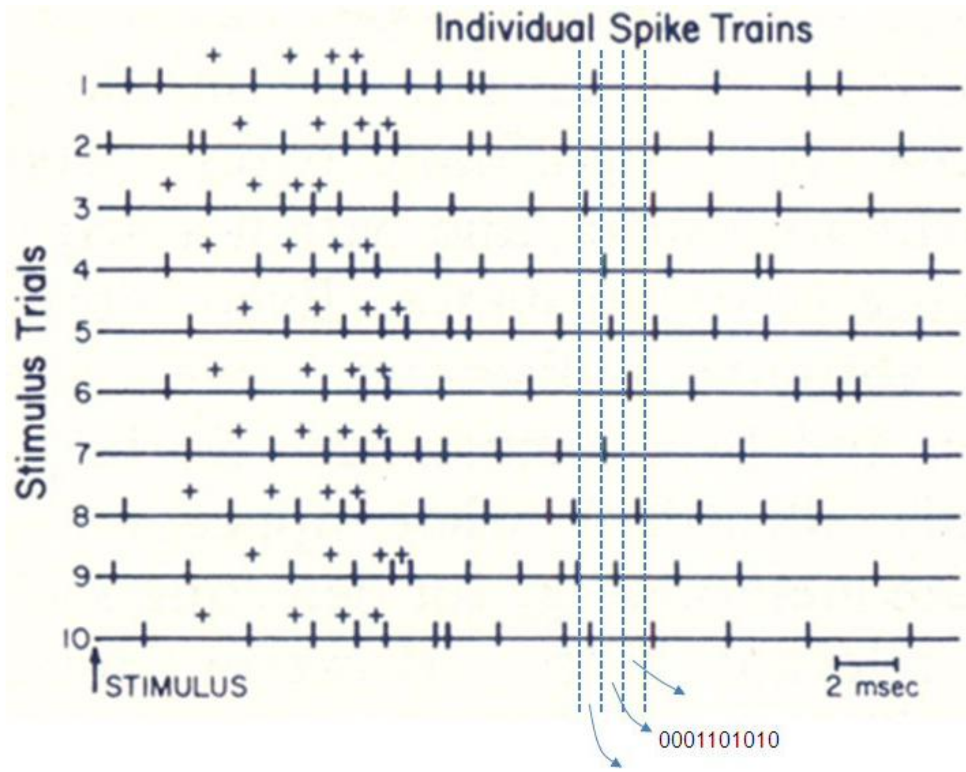

Figure 4. Illustration of one simple way to identify any existing combinatoric code of spike trains in a defined network. Moving a small time window across simultaneously recorded spike trains allows detection of which neurons produced spikes within that window, and the code could be read as a sequence of 0s and 1s. In this illustration of 10 simulated spike trains, each has the same conventionally calculated interval histogram. Yet each train contains a "byte" set of serially ordered intervals (expressed here as a ++++ pattern where each interval has a longer duration than the succeeding one). This ordering is not otherwise detectable. At any instant of time (vertical dashed lines) activity within the whole circuit of 10 neurons can be seen to be indexed as a combinatorial coding of impulses; these can even be expressed in quasi-digital form, with presence or absence of an impulse being indicated as a 1 or 0 respectively). From Klemm, 2011b.

My lab has reported that humans have a default percept for any given ambiguous figure. When subjects suddenly consciously realize the alternative image, there is conspicuous coherence of EEG signals among many brain areas at multiple frequencies. (Klemm et al. 2000). Important in this regard is the report of Degué et al. (2001) in which conscious awareness of visual illusions triggered by single pulses of transcranial magnetic stimulation of visual cortex depended on the ongoing phase of brain activity in relation to stimulus onset.

But how do certain spatio-temporal patterns of CIPs generate consciousness? This, as they say, is the crux of the "hard problem" of consciousness. From the foregoing ideas, one might conclude that it is a mature SoS that is a necessary, but perhaps not sufficient condition, for the emergence of consciousness. What makes the SoS sufficient for consciousness is for a species to have enough neuronal circuitry to create the "carrying capacity" for representing ordinary stimuli and associated thought, but also representing the SoS Avatar. Certainly, SoS is enriched by conscious experience. I would expect the CIPs and their timing relationships to change in tandem with maturational change.

ILLUSORY SENSATIONS

Humans can have conscious experiences affecting their SoS that are illusory. Michael Tye (1995) grapples with the enigma of such illusory sensations as pains, itches, and tickles that may occur but are not really where they seem to be. Phantom limb sensations in amputees are a common example of distorted SoS. Such sensations are perceived in the consciousness.

Tye finds this to be perplexing from a philosophical point of view. But viewed physiologically, I see little problem. The explanation may be nothing more than certain details of the self being erroneously represented by CIPs. But the basic sense of embodied self is still intact.Opposite situations occur wherein one fails to feel sensations in a body part when they should be there. This is a common problem in vascular stroke. But again, the explanation is that sensation is not properly represented because the neurons needed to mediate it are dead. The SoS is still present, though it can be severely diminished depending on the extent of brain damage. In normal people, whatever sensations and emotions one feels, there is a sense of ownership. One feels that such feelings belong "to me." So, whatever neural activity that represents conscious awareness does so in the context of a concurrent SoS.

HOW CIPS CAN DIRECT ACTIONS

CIPs not only are physical representations of sensations, thoughts, retrieved memories, and thoughts, but they typically have an output that either influences CIPs in other circuits or, if there are projections to motor neurons, directs bodily movement. This is always done in the context of the self, either non-consciously or consciously.

As an example, consider a spinal reflex action, the crossed extensor reflex. If you step on a big sharp rock, nerve impulses go up the leg to relay on a motor neuron that excites flexor muscles. Thus, the train of impulses directs lifting of the leg. At the same time, a train of impulses flows across the spinal cord to a motor neuron on the other side, which is connected so as to excite the extensor muscles of that leg. Thus, you do not fall down. This is a hard-wired circuit, but the self-referencing principle is the same for CIPs in any circuit. Now suppose you step on a small pebble. The train of impulses in this crossed extensor reflex is much diminished, and you may not even flex the leg, much less extend the opposite leg in response. Thus, we see that CIPs have directed which optional action to take. Let's not say a "decision" was made, because that implies a conscious direction that is not needed for spinal reflexes to operate. At higher levels of nervous system action, CIPs may also direct or withhold an action. Or, if movement is not directly involved, the CIPs can influence the processing going on in other circuits with which it has an interface. Again, this may be non-conscious and need not involve conscious intent, decision, or command.

But suppose these processes operate asa sense-of-self Avatar. Now the information content of CIPs is not hidden, but rather is made "consciously explicit" in the self-aware Avatar. Now, these processes can constitute an intent, choice, decision, or voluntary command. How can a network of CIPs generate an intent or make any kind of choice or decision? No doubt, the same synaptic summation principles found at simple levels like spinal reflexes apply here also. The difference would be that intents or choices are network operations, not dictated by any particular circuit. We should also consider that the CIPs that cause an action may be distinct from those that make us aware of our decision to cause the action.

SELF CONSCIOUSNESS

There are three kinds of awareness of self: 1) direct awareness, 2) indirect awareness wherein a proposition or state of affairs holds with respect to self, and 3) awareness of non-self entitities or states perceived in the context of self (Bermudez, 2009).

The consciousness is constructed in neuroantomy and neurochemistry, stored in latent form as long-term memory, and deployed each day via the neurophysiology of nerve impulses and synaptic neurotransmitters. Once initiated, consciousness enables the brain to become aware that it recognizes its sense of embodied self, existing as a body in space, surrounded by other "non-self" things.

As mentioned, many animals have a non-conscious SoS. Speculation about which species might have a conscious awareness of self has been oriented around mirror testing. Higher animals, like dogs, will inspect images in a mirror but soon realize that what they see is not another real dog (to a dog, another dog is something that smells like a dog). In general, animals looking in a mirror do not seem to make much mental connection with themselves.

Apparently only higher primates (Gallup, 1970), dolphins (Marten and Psarakos, 1995), elephants (Prior et al. 2008), and humans have a conscious SoS. This is inferred from their ability to recognize themselves in a mirror by perceiving tags or marks placed on their body. All species which pass the mark test will inspect their own body and test for correspondence of what they see in the mirror and their own body movements. If they see a mark on the image in the mirror which does not naturally occur in conspecifics, they inspect their own body in the correct location and try to remove it.

Notably, it is these species that have a greater than normal brain-to-body weight ratio. This alone suggests that consciousness requires extra neuronal mass in the neocortex. The secret may lie not so much in the architecture of individual cortical-column circuitry but in the total mass of such interconnected circuits. It is as if the mere adding of computational elements to a computer at some point creates capacity for doing entirely different things otherwise impossible.

One caveat to this conclusion is that European magpies reportedly pass the mirror test (Prior et al. 2008). Magpies, like all birds, don't even have a laminated cortex but instead have clustered forebrain entities. It is not known if the brain-to-body weight ratio is unusual. However, some groups of corvid birds, which includes magpies, do have unusually large brain-to-body weight ratios (Rehkämper et al. 1991).

Such animals clearly recognize themselves in the mirror. But it is not possible to know how conscious that awareness is. Self recognition in a mirror by no means indicates the human capacity for consciousness. Mirror recognition could simply reflect more an enhanced sense of intelligence in detecting the correspondence of mark-associated movements in the mirror with movements being directed in the brain of the viewing bird. A role for mirror neurons should be expected. Indeed, mirror neurons may be an important substrate for self detection in a mirror. This has not been tested.

Comparison with human children is of interest. In one study (Povinelli and Giambrone, 2000), children were observed while playing a game during which an experimenter secretly put a large sticker in their hair. When shown the videotape a few minutes later, children saw themselves with the sticker, but only children older than about three reached up to their own hair to remove the sticker, demonstrating that the self they saw in the video was the same self at the present moment.

Developmental psychologists conclude that self-recognition emerges in children at about age two. Many psychologists reject Gallup's notion that apes and young children have Theory-of-Mind capability. They do accept that mirror self recognition is a necessary first step in consciousness development. Theory of Mind is the notion that people can attribute mental states (beliefs, intents, knowledge, etc.) to oneself and to others, with the understanding that these states may differ among individuals and change with time or circumstance. While this is clearly derives from a conscious SoS, it is far more complex than simple self-recognition.

Most pertinent to the present discussion is the evidence against imputing self-recognition as necessary for consciousness. There is a disease in adult humans known as prosopagnosia, a disorder in which the patient has difficulty in recognizing faces, even one's own. Such people are clearly conscious. Looking in the mirror, for example, a prosopagnosia victim named John might shave around his mustache. The man in the mirror shaves around the mustache. But John does not make the connection. That is not John in the mirror. If he shaves off the mustache, he notices that the guy in the mirror did also, without recognizing that he, John, is the guy in the mirror.

Note that these patients have a SoS and they are conscious. It is the connection between the two that has been broken by the disease.

More common is the degradation of the conscious SoS that occurs in Alzheimer's disease. This among other things is a memory problem where the stored latent mind no longer has an adequate representation of the SoS. When conscious mind is deployed, as in awakening from sleep each morning, such patients may not know who they are or who or what are many of the non-self things they once knew. Alzheimer's patients exhibit such symptoms because many of their neurons have been killed. There is no longer enough circuitry to sustain simultaneously both a complete SoS and consciousness.

All of this points to certain fundamentals of self-identity. Our self awareness is in a constant state of flux. We transform who we think we are by how we think of ourselves. The enlightened brain nurtures this self image, using consciousness to monitor and adjust the brain's engagement with the world in the most adaptive ways. Further, how we think of ourselves continuously programs the brain, transforming who we really are, which in turn can change the way we think of ourselves and behave.

Consciousness gives us the capacity for introspection about ourselves. Personality growth depends on recognition of personal weakness in need of change. This was the main point of my *Blame Game* book (Klemm, 2008).

We can know when we feel defensive, or angry, or overly critical, or judgmental, or upset—and even when we try to make excuses. We can also recognize the situational causes or triggers of undesirable attitudes and behavior. Further we can realize that avoiding the situational causes or triggers will not always work, that real change must come from within. Conscious intent and planning will guide us in making those changes from within.

States of Mind Relationships to Self-Awareness

It is fashionable in some circles to think of mind as a quantum mechanics phenomenon (Hameroff, 2011). As a parallel to Bohr's physics principle of complementarity (a particle may be a wave or a particle, depending on context), we might think of human mind as subconscious or conscious, depending on context. Perception of alternative images in ambiguous figures is an example in that whichever image is perceived consciously is a function of the portions of the drawing one is momentarily attending to.

But unlike particles, subconscious and conscious minds may only seem to co-exist at the same real time. When consciously thinking about a problem, for example, certain ideas may just pop up, apparently from the subconscious. However, such simultaneity may be illusory. The brain apparently can only do one thing at a time. Multi-tasking is accomplished much in the manner of "multiplexing," an engineering term denoting doing one thing for an instant, then rapidly switching to another, and then another, and finally returning to the next step of the first task. As applied to human thinking, all this switching is distracting and interferes with information registration (Banai et al. 2010).

Scholars in this field tend to treat self-awareness as a consequence of being conscious. That is, we could not be self-aware without consciousness. This is sort of a circular argument.

Consider the opposite. Namely, maybe we are conscious *because* we have deep non-conscious and subconscious SoS. The advantage of this perspective is that it is less mystical and more amenable to the rigorous experiments we perform with more traditional senses (vision, hearing, taste, small, and somatosensory input).

Conscious SoS it evolves slowly as the brain adjusts in identity and self-awareness over the years with learning experience. How could we have conscious perceptions independent of a SoS? After all, it is the "I" that sees, hears, tastes, smells, and feels. Lower life forms, like an ant, for example, can only detect stimuli, not perceive them.

A difference between the conscious SoS and other senses is that the former is a "being," operating as a partially autonomous Avatar on behalf of its embodied brain. It is a being in the sense that it has a physical reality of propagating nerve impulses through real neural pathways. When not actively deployed, as during sleep for example, conscious mind is stored intact in synaptic microanatomy and in the biochemical systems of numerous neurotransmitters. It is why, as a child, I always awakened as me, instead of the Stan Musial baseball star I would have preferred to be.

This being, which I call an Avatar as a matter of convenience, has an existence of its own, though clearly it is not independent of the rest of the brain. This being is "I" and knows that it exists. This being knows that it knows about much of what happens to it. This is yet another way to define consciousness. One consequence is that the conscious brain recognizes that it is aware of this distinction. Moreover, if brain develops a need to change the nature of its SoS, it can do so. This being allows itself to recede into its non-deployed state when the brain has a need to sleep. Yet, the brain needs to deploy the Avatar frequently in order for the body to successfully contend with life's necessities. Thus, the brain releases the Avatar after we have had enough sleep and does so, I argue, via a series of abortive attempts at awakening during the night via the neurophysiological changes that create REM sleep and dreaming (Klemm, 2011c).

How does the Avatar "act on behalf" of its embodied brain? First, having more degrees of freedom in its action, the conscious Avatar has broader scope of activity, capable of engaging a wider range of options, some of which may be selected by what we normally call free will (see below). Secondly, the Avatar provides subconscious mind with another source of programming, which is especially useful when the subconscious mind needs to learn something it cannot know about ahead of time without explicit guidance, as for example in learning how to read sheet music or play a musical instrument. Conscious mind provides a new dimension for actively programming the subconscious. Third, the Avatar provides capability for explicit introspection. Most commonly, this takes the form of self-talk language. In short, conscious mind is the brain's way of intervening with itself.

Implications of Self Consciousness

Non-conscious SoS confers obvious advantages in automating complex behaviors. What purpose is served by having a conscious SoS? Clearly, it improves the quality of what one believes, thinks, and does. It also leads to highly developed social understanding and an attendant enlarged repertoire for social interactions.

Meaningfulness

Sensory stimuli give rise to "thoughts," both conscious and subconscious, that assess the stimulus meaning and determine what, if anything should be done. Meaning is formulated from the integration of the information content, the context, its salience, and its emotional valence, both real-time and stored in memory. All of this is accomplished in the context of SoS. Being consciously aware of self enhances the brain's ability to control body and behavior. The conscious capacity for generating intentions, decisions, beliefs, and teaching of the brain greatly expands functional capacity of the brain. The priority of each of these capacities varies with how conscious SoS values them. We can, and do, adjust the values in response to our learning experiences and the outcomes we predict.

Over the course of years our conscious sense of self develops a value *system* to filter how we will perceive input from the traditional five senses to our conscious perception. This reduces the brain's workload. We don't have to think deeply about everything, only that part that emerges from our value system prism. The downside, of course, is that sometimes the wrong things are filtered out from serious evaluation. Conscious mind provides a reality check that provides the opportunity to question the appropriateness of the sensory filter. The reality check is always made in the context of self and non-self.

Extension of Self

When SoS is consciously perceived, humans commonly create secondary SoSs. For example, we extend that sense into other parts of our environment, such as our personal heroes, our favorite sports team, our home, our belongings, our nation. These secondary selves are usually affirmations of our self that give us emotional comfort or relief.

Self is also extended through our tools, such as computers and assorted machines. What humans create, in art, language, science, literature, and the like are extensions of the self.

Nothing illustrates how self is extended more patently than Internet social media, such as Facebook and Linkedin. The explosive popularity of such interactions suggest that humans have a compulsive need to extend themselves socially. We egotistically think everybody wants and needs to know about what we are doing.

Another way to view this phenomenon is to consider the profound psychological responses when the SoS becomes isolated through lack of social interactions. Penal institutions universally regard solitary confinement as an extra degree of punishment for inmates. Why is it punishment? Why do people need social interaction? I submit it is because the conscious SoS needs affirmation and reinforcement from experiences with non-self humans. Personal identity and autonomy degrade with social isolation.

A brain that has been learning about its self ever since the early days in the womb most certainly is perturbed by later events that diminish that sense. When an isolated SoS is diminished, for example, the brain's mirror neurons have little to respond to. At a conscious level, there is no opportunity to engage in social identity testing. Psychological difficulties are likely to arise, such as social withdrawal, diminished sense of autonomy, apathy, lethargy, and clinical levels of depression, anxiety, distorted perceptions, irrationality, and lowered impulse control. Bizarre behavior, psychosis, suicidal behavior, and self-mutilation increase in likelihood. Partial compensating for these adverse effects derives from the quality and intensity of the certain available stimuli, such as the amount and quality of light, the size of rooms, the ability to perceive sounds in the surrounding environment, and the color and appearance of the environment (reviewed by Arrigo and Bullock, 2008; Metzner and Fellern, 2010). Such stimuli provide robust ways an embodied brain can test and re-assert its SoS.

FREE WILL

If we can accept that consciousness is like an Avatar that can direct thoughts, beliefs, feelings, and actions in the context of its SoS, we are poised to confront the issue of free-will. Are the intentions, choices, decisions, and commands emanating from conscious mind generated freely or driven by prior programming? I think the explanation lies in some combination of free action and programming.

The issue is addressed by many theorists in terms of quantum mechanics (QM), which is invoked as proof of determinism and absence of free will. First, there is no compelling evidence I know of that quantum mechanics operates beyond the atomic level of organization, certainly not at the level of human mind. To apply QM to consciousness, free will, and mental functions in general seems inappropriate. We simply don't understand how it is that we have the perception of conscious choice. Secondly, confusion abounds in the use of words like "determinism" and "free will."

Free-will debates are driven by the concept of determinism, a doctrine which states that for everything that happens there are conditions such that, given them, nothing else could happen. This is hardly a useful way to think about SoS or consciousness.

Philosophers like to approach these issues in terms of "determinism, indeterminism, and compatibilism." As robust as these debates are, I think they lead us away from considering underlying cause.

Willed action (freely or not freely determined) arises in the context of self and comes from neural circuit activity. So, of course, a willed action has a cause: it is driven by CIPs. But what light does that shed on the argument over free will?

The words we use in such debates have multiple and vague definitions. For example, free will can be likened to a multiple-choice test: yes...you can choose A, B, C or D...but you can ONLY choose from A, B, C or D. You can't choose L or V or W. So.is it really free-will if the choices are limited to the teacher's parameters? What we have here could not be a totally free-will situation.

Life in the real world is the same. We make such decisions based on the influences and constraints around us, many of which of out of our control. The freedom to will is limited both by the relative degree of freedom to choose and the opportunity to realize choices through action.

Then there is the matter that brains operate probabilistically. For any given choice situation, there is a set of probabilities that we will choose A or B or C. That does not mean that we *must* choose the highest probability option. And we often do not. When we make an improbable choice, was free will exerted?

In the context of CIPs, neurons not only represent the world but they also represent a family of probabilities. Brain networks operating on Bayesian principles determine those probabilities and combine them with estimates of outcomes. Bayes' rule tells how the brain should update its "data base" or frame of reference as it receives new information. Generation of any intent, choice, decision, or command is based on selection of alternative options based on probabilities. Eric Baum (2004) points out that the value of Bayesian mechanisms is that they allow our brain to estimate the likelihood of various outcomes and the desirability of those outcomes.

This might suggest that a brain operates without free will, basing its processing strictly on probabilities and choose to violate them. But just because a system *can* operate in a certain way does not mean it always does. One's SoS Avatar may be consciously aware of certain probabilities and make choices that do not correspond.

Freely determined actions would seem to arise if the brain integrates the options in conscious awareness and then decides on one option based on evaluation of the usefulness of the probable outcomes. Why isn't that "free will" if it is done consciously?

Another way to view this is to think about my buying a new car. At first, in the absence of information, the probability might be equal that I would select any one of four brands. But after reading data sheets and reviews, the probabilities change in favor of the one brand I end up buying. Sure, the choice was determined by the probability, but it was "I" that willed actions that led to changing the probabilities.

We can make unwise choices and decisions that are unsupported by data or reason. Are such choices and decisions freely chosen or biased by our stupidity, emotions, or whatever? But then, if we consciously recognize we are being stupid or emotional, we can choose to be more rational. Is that choice freely made or biased by past experience that programmed our brain to understand that things work better for us when we are informed and rational?

Many scholars argue that free-will is illusory, based on a series of experiments in which brain activity anticipates movement before it occurs and before the person realizes they have made a choice to make the movement.

We should distinguish between intentions and control over intended acts once they are instantiated (Libet et al., 2003). The distinction applies irrespective of whether either arise freely or deterministically. Libet, however, generally argued that free will is an illusion in that one cannot freely intend to act but can perhaps freely veto an intended act.

A series of experiments in several laboratories build upon the pioneering work of Libet and led to the same conclusion that free will is an illusion. However, as I established in my exhaustive critique, the notion of illusory free will is itself illusory (Klemm, 2010). The published experiments either did not test what was purported or the interpretations of results were flawed.

In the typical experiment, a subject is asked to voluntarily press a button at any time and notice the position of a clock marker when they think they first willed the movement. At the same time, brain activity is monitored over the part of the brain that controls the mechanics of the movement. The startling observation typically is that subjects show brain activity changes before they say they intended to make the movement. In other words the brain supposedly issued the command before the conscious mind had a chance to decide to move. All this happens in less than a second, but various scientists have interpreted this to mean that the subconscious mind made the decision to move and the conscious mind only realized the decision later.

My criticisms focus on three main points: 1) timing of when a free-will event occurred requires introspection, and other research shows that introspective estimates of event timing are not accurate, 2) simple finger movements may be performed without much conscious thought and certainly not representative of the conscious decisions and choices required in high-speed conversation or situations where the subconscious mind cannot know ahead of time what to do, and 3) the brain activity measures have been primitive and incomplete.

I identify 12 categories of what I regard as flawed thinking about free will. Some of the more obvious issues that many scientists have glossed over include:

- Conscious decisions or choices are not often instantaneous (certainly not on a scale of a fraction of a second).
- Conscious realization that a decision has been made is delayed from the actual decision, and these may be two distinct processes with their own time course.
- Decision making is not the only mental process going on in such tasks.

Some willed action, as when first learning to play a musical instrument or touch type seem freely willed because the subconscious mind cannot know ahead of time what to do.

Free-will experiments have relied too much on subjective awareness of actions and time estimation of accuracy. Extrapolating from such simple experiments to all mental life is not justified. Conflicting data and interpretations have been ignored.

The real issue is what causes brain circuits to select one set of choice-associated CIPs over alternatives. The brain selects among CIP options on the basis of such situational contingencies as what has been stored in the brain’s memory, likely outcomes, reward/punishment probabilities, and no doubt other factors. So, of course, all these factors constrain the brain’s choices, and in that sense there is no completely free will. But a brain is free to choose an alternative that is not even in its own embodied best SoS interest, which is commonly done.

Subconscious representations are constrained by the realities of the physical world, both inside and outside the body. The conscious Avatar has no such constraint, because its representations are not necessarily referenced to worldly events. True, the Avatar representations are often modified and biased by the output of subconscious programming, as evidence by mental “knee-jerk” responses.

If for any given willed action, the chosen effect violates the expected probability, the issue becomes whether that action was a random choice or one that emanated from the neural processing (i.e. free will). Why would we assume randomness from a brain operation that is being influenced non-randomly by situational contingency, memory, reinforcement probability, etc.? Statisticians assume randomness and independence as a matter of practical utility, not because that is the way the world really works. For Avatar function, no one choice or decision is inevitable. Why isn’t that free will?

I conclude that intents, choices, and decisions may well arise through either subconscious programming or from free-choice conscious mechanisms. In the unified mind of embodied brain, all major acts of will may involve cooperative engagement of both subconscious and conscious minds in the genesis of deterministic thinking or free will, or some combination of both. Both minds interact and inform each other to varying degrees of what each is doing. Each can guide and influence the actions of the other. In the case of conscious mind, the feedback to subconscious operations also serves a programming function. Providing such programming can even be a free-will intention.

“VOLUNTARY” ACTIONS

Maybe the free-will issue is not particularly relevant to the issue of how SoS directs the body to act in specified ways. It’s not even clear what “free” adds to ”voluntary” as opposed to involuntary behavior. Voluntary action is a thoroughly respectable description of certain behaviors, without any necessity for metaphysical overtones.

Humans respond and act or not act in the world. “Voluntary” simply means that a person willingly agrees or volunteers to think or do certain things. This choice may arise freely or not.

Actions that are considered voluntary arise from pre-existence of internal CIP states that encode, store, and guide the performance of the action. In other words, knowing and acting are separate phenomena. All this necessarily is accomplished in the context of a SoS.

In the real world, subconscious and conscious minds interact and share duties in producing voluntary action. Subconscious mind governs simple or well-learned tasks, like habits or ingrained prejudices, and may therefore not involve free will. But conscious mind deals with tasks that are complex or novel, like first learning to ride a bike or playing sheet music, and are therefore unlikely to occur without some major free-will component.

We do act like robots driven by our subconscious when we act out of habit, prejudice, or prior conditioning. But we should and can be responsible for what we make of our brains and for the choices in life we make. In a free-will world, people can choose to extricate themselves from many kinds of misfortune — not to mention make the right choices that can prevent misfortune.

What obstructs development of ideas about the origins of volition is the implicit assumption that conscious mind is fundamentally different from other brain processes. Many theorists contend that conscious mind can't do anything, "mind cannot cause matter," as they like to say. But mind *is* matter. Conscious mind is a CIP representation of the self and non-self, and those CIPs can do things, including thinking, choosing, and directing action in the context of its SoS.

If one thinks of this as an Avatar, the conscious mind Avatar not only can control the subconscious but it can also control itself. Conscious mind can choose what to read, what people to associate with, what is good for the individual, what attitudes to hold and adjust, what to believe, and what to do. True, because of pre-existing subconscious programming, some conscious choices are more deterministic than others. But because of conscious mind, everyone can at least become aware of the price being paid for bad attitudes, beliefs, and choices and has the option to change brain's programming accordingly.

It is clear that a brain Avatar could make such choices. What is less clear is whether those choices are freely willed. But the neural representation for the conscious SoS is probably quite different from the representations held in subconscious mind. Subconscious representations *are* constrained by the realities of the physical world, both inside and outside the body. The conscious avatar has much less of such constraint, because it's representations are not necessarily referenced to worldly events. True, the Avatar representations are often modified and biased by the output of subconscious programming, as evidence by mental "knee-jerk" responses.

Despite the logic above, and actual evidence for free will (reviewed by Mele, 2010), the idea of illusory free will seems to prevail. It reminds me of the idea documented recently by Roediger and McDermott (2011) that people tend to remember what their peer group remembers, even when it is wrong. Thus, the illusory free-will crowd remembers its myths and collectively fails to recall conflicting evidence.

Endless wrangling over the issue of free will becomes a distraction from the primary issue of this paper. Namely, conscious thinking is enabled because we have CIP representations of our SoS and these representations can act in the world via the equivalent of an Avatar. That Avatar can learn "who it is" and modify itself in light of what it has learned about what best serves the interests of its embodied self. The extent to which such modifications are freely chosen by the CIPs representing the Avatar is somewhat beside that point.

BEHAVIORAL FLEXIBILITY

The spinal cord and brain have defined pathways that produce stereotypical responses to stimuli. In the course of living, animals and humans expand the built-in behavioral repertoire through learning to create what are called "fixed action patterns (FAPs)," which are likewise stereotyped. We all have certain rather predictable behavioral responses to certain contingencies. But humans are much more flexible in their FAPs than other advanced mammals. For example, the courtship ritual of bulls is quite stereotyped (Rivard and Klemm, 1990). Not so for male human courtship.

Rudolpho Llinás (2001) regards FAPs as species-specific, elaborated reflexes that relieve the self from the cognitive load of attending to many necessary actions. Being able to do some things automatically facilitates doing more than one thing at a time. FAPs are a basic mechanism by which animals and humans predict the outcome of movements in the context of self in response to sensory input.

FAPs are modifiable by learning, even in lower animals where consciousness is unlikely. Animals learn how to modify their behavior in response to reinforcing contingencies. The clearest examples are in the shaping of behaviors by operant conditioning in circus and work animals. Such learning is always in the context of self, even when not consciously perceived. Animals learn what they like and dislike, i.e., what is positively or negatively reinforcing, and adjust FAPs accordingly. Animals, and humans, have a built-in brain reward system which itself is a kind of hedonistic FAP that promotes the seeking of positive reinforcement and avoidance of the negative.

The advantage of consciousness is that it expands the range of options and ways to modify or even over-ride any given FAP. Thus, behavior need not suffer the limits of stereotypy, but may be made more flexible and adaptive. Whether FAP modification or veto arises from free will is a somewhat moot point. The practical point is that voluntary action does occur.

Human language, of course, adds the immense advantage that we can teach others how to change their FAPS, so that whole groups may come to behave in ways that hopefully benefit the group. This is fundamental to development of human cultures.

The extent of conscious behavioral flexibility is governed by one's attitudes about self. That greatly influences the conscious choices one makes. People with low self-esteem do not aspire to much personal growth and achievement because they don't believe they deserve it or can achieve it. The opposite is true for those with high self-esteem.

The non-conscious SoS that begins in the womb is continuously shaped by conscious experience throughout life. Such experience, and how one consciously chooses to regard and respond, correspondingly builds or destroys self-esteem. That in turn determines one's ambitions, choices in life, and plans — and usually the degree of success.

Anticipation of Death

Humans have a special perception of time, oriented around the self as it passes through past, present, and future. We do not "live in the moment." Introspection leads to a perception of time as occurring in chunks to which a given self is allotted a small slice in the grand pie of eternity. Conscious SoS becomes aware of its finitude, forcing conscious thoughts early on about "What will I do with my allotted time?" to the inevitable questions of old age about "What have I done with my life?"

Perhaps nowhere is the SoS so intense as when the Avatar consciously realizes that the self will someday be terminated by death. This apparently is a unique attribute of the human SoS that allows us to stand outside of our SoS to contemplate our fate. All sorts of attitudes, beliefs, and behaviors are driven by this realization.

RELIGION

The dualism philosophy of mind holds that there are two basic entities in the world, material and non-material, with conscious mind in the latter category. This view is largely discredited by scientific evidence for a material basis for mind.

What few philosophers or scientists consider is the possibility that non-material things are really material phenomena that are not yet explicable by science. Yet, it is highly likely that "spiritual" dimensions are really just laws of physics, chemistry, and biology we do not yet understand. Current candidates include quantum mechanics, dark matter, dark energy, string theory, multiple dimensions, and parallel universes. Perhaps electromagnetic and gravitational fields are not the only kinds of "force fields" present in the universe.

Religion is created by conscious mind, and despite any sanctimonious claims to the contrary, religion is a creation of the SoS to address its concerns over the meaning of life and what will happen to the self upon death. This basic human need to construct religious belief has yielded widely differing views of creator gods or God. The divergence of belief arises because the SoS of each person is heavily influenced by the culture and learning environment in which it has been cast.

Fundamental to most religions is the existential question, "What will happen to *me* when I die?" Science can't answer that question and doesn't even have tools to study it. But let us start constructing alternative options from what science does know: the SoS is a virtual reality existing in the form of CIPs. We know that when we die, the neurons that generate those CIPs cease to function and rot.

What then happens to *me*? One possibility embraced by atheists is that "this is the end. I cease to exist." Science-based religious alternatives might include the possibility that our virtual SoS exists simultaneously in another form, perhaps mirrored in a form of entangled quantum state, dark matter, dark energy, parallel universe, or some sort of unknown force-field that does not perish when neurons die.

I close with a fitting thought about self from the Czechoslovakian political reformer, former Czech Republic President Vaclav Havel (1994). Regarding the essence of human being and the SoS we all experience, he said:

> The only real hope of people today is probably a renewal of our certainty that we are rooted in the earth and, at the same time, in the cosmos. This awareness endows us with the capacity for self-transcendence.
>
> Politicians at international forums may reiterate a thousand times that the basis of the new world order must be universal respects for human rights, but it will mean nothing as long as this imperative does not derive from the respect of the miracle of Being, the miracle of the universe, the miracle of nature, the miracle of our own existence.

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