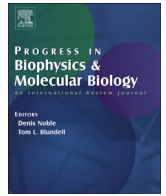




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Emotional sentience and the nature of phenomenal experience

Katherine Peil Kauffman ^{a, b, c, *}^a EFS International, 12626 NE 114th Place Kirkland, WA 98033, USA^b Harvard Divinity School, 45 Francis Ave, Cambridge, MA 02138, USA^c Northeastern University, 360 Huntington Ave, Boston, MA 02115, USA

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ABSTRACT

When phenomenal experience is examined through the lens of physics, several conundrums come to light including: Specificity of mind–body interactions, feelings of free will in a deterministic universe, and the relativity of subjective perception. The new biology of “emotion” can shed direct light upon these issues, via a broadened categorical definition that includes both affective feelings and their coupled (yet often subconscious) hedonic motivations. In this new view, evaluative (good/bad) feelings that trigger approach/avoid behaviors emerged with life itself, a crude stimulus–response information loop between organism and its environment, a semiotic signaling system embodying the first crude form of “mind”. Emotion serves the ancient function of sensory–motor *self-regulation* and affords organisms – at every level of complexity – an active, adaptive, role in evolution. A careful examination of the biophysics involved in emotional “self-regulatory” signaling, however, acknowledges constituents that are incompatible with classical physics. This requires a further investigation, proposed herein, of the fundamental nature of “the self” as the subjective observer central to the measurement process in quantum mechanics, and ultimately as an active, unified, self-awareness with a centrally creative role in “self-organizing” processes and physical forces of the classical world. In this deeper investigation, a new phenomenological dualism is proposed: The flow of complex human experience is instantiated by both a classically *embodied mind* and a deeper form of *quantum consciousness* that is inherent in the universe itself, implying much deeper – more Whiteheadian – interpretations of the “self-regulatory” and “self-relevant” nature of emotional stimulus. A broad stroke, speculative, intuitive sketch of this new territory is then set forth, loosely mapped to several theoretical models of consciousness, potentially relevant mathematical devices and pertinent philosophical themes, in an attempt to acknowledge the myriad questions – and limitations – implicit in the quest to understand “sentience” in any ontologically pansentient universe.

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* EFS International, 12626 NE 114th Place Kirkland, WA 98033, USA.

E-mail address: ktpeil@comcast.net.

1. Introduction

The attempts to naturalize phenomenology via the perspective of endophysics (Kauffman and Garre, 2015) biosemiotics (Kull, 2009), and/or 21st century “Enlivenment” philosophy (Weber, 2013) rightfully place the subjective perspective within the bounds of scientific inquiry – if not at its epicenter. Each in its own way honors the *mind*, the harbinger of the fundamental *flow of experience* through which we human beings perceive, categorize, and respond to the features and challenges of our ever-changing world.

Endophysics (Finkelstein, 1993), in particular (the approach to understanding physical reality from the internal subjective perspective), offers revelations that can move us beyond the Cartesian severance of the human mind from the body, as well as revisit the question of legitimate free will in a deterministic universe (Kauffman, 2014). They restore the centrality of subjective experience in human life, while also honoring any genuine *sentient experience* and *agency* in less complex organisms – the ability to detect, evaluate and respond adaptively to environmental changes. The endophysics approach also addresses the enigmatic role of the observer in quantum mechanics, offers scientific perspectives on the ultimate process of creation as well as the role of any potential intelligence involved, and even on the nature of the soul (Hameroff and Chopra, 2012). Indeed, on several interpretations, quantum mechanics suggests that a pan-*proto-consciousness* may be part of the physical furniture of the universe, a theme of *ontological panpsychism* that echoes across Western philosophy (Skarbinska, 2005) and is central to many Eastern religions.

However, while endophysics can move us well beyond both Newton and Descartes, it requires acknowledgment of an ancient ongoing physically creative dance between classical and quantum worlds, one that undergirds the unified phenomenological flow of being and becoming. This unifying process poses us with a new dualistic conundrum: a core ontological duality between *Classical/Embodied Mind* and *Quantum Consciousness*. While these two terms have been historically commingled and sometimes confounded, the proposal here suggests embodied mind and consciousness to be two distinct but complementary varieties of subjectivity, one from each physical realm, whose coexistence and ongoing interaction deliver our actual personal experiences. Indeed, from the classical, embodied, large-scale only view, the mind (while clearly associated with the embodied brain) is merely epiphenomenal and deterministic “with nothing to do and no way to do it” (Kauffman, 2014). Enter quantum consciousness, emanating from the realm of the very small, where ontologically real possibilities and probabilities exist but physical actuals do not. The quantum world remains the only realm wherein “the present could have been different” (Kauffman, 2016), wherein free will and perhaps any natural, universal value can exist. For indeed, actual living systems exhibit behavioral agency, self-deterministic *functional doings*, and – at least in healthy humans – we feel the mindful experience of both preference and free will when choosing any course of action or self-directed physical movement.

There are two broad interpretations of these familiar subjective phenomena: These experiences are epiphenomenal neurological deceptions of a deterministic machine driven by selfishly self-replicating genes (Dennett, 1992; Harris, 2014; Dawkins, 1989); or alternatively, that they are authentic and biologically meaningful experiences – the subjectively self-organizing phenomena of autopoietic (self-making) systems (Maturana and Varela, 1980; Thompson, 2007). The latter view, taken and expanded upon here, honors the rich tradition of phenomenology – particularly the fact of *embodiment* (Merleau-Ponty, 2002) as the fundamentally fleshy portal of perception and physical substrate of subjective

experience, a fact often eclipsed upon encountering the limits of reductionist methods and mechanistic models. It also takes seriously the conundrums presented by quantum physics, acknowledges the psychological relativity of perceptual reality, as well as the dynamically creative self-organizing patterns within the evolution of the biosphere. It also hopes to do biological justice to a largely neglected yet central component of experience, *human emotion* (Peil, 2014). Indeed, the rationalist bias (and the underlying cleavage between reason and emotion) results from our historical failure to properly identify the conceptual scope and biological functions of “emotion”.

I will begin by offering the latest science of emotion, suggesting that its biological function concerns regulation and integration of “the self” in all of its physical, mental, and spiritual dimensions – science that expands the theoretical construct of *self-organization* (Camazine et al., 2001) beyond the limits of its classical, exophysics conceptual domain, giving the subjective pole its rightful due. This new science suggests that the experience of emotion encodes a binary *self-regulatory* logic central to the body’s immune, genetic and epigenetic regulatory functions, as well as to the experience dependent developmental unfolding of the classical embodied mind, offering self-relevant messages concerning our deepest human potentials as well as any enduring identity components such as spirit or soul – any physically immanent connection to any higher level, transcendent, or unified Self. My purpose here is to follow the line of logic deeper still, and provide a brief intuitive sketch of how both classical, embodied, mind and quantum consciousness help give rise to emotional experience and its unique evaluative role in the stream of subjective awareness. While there are innumerable theorists from myriad fields – from Aristotle to Žižek – whose ideas may be reflected in this offering, my scope will be limited to a broad depiction of this process that invites pragmatic interpretations and applications. My hope is that through naïve gestures toward existing and potentially related math models along with tie-ins to the most relevant offerings from traditional phenomenology, that fruitful insights might be sparked toward more apt or unifying formulations that can do it the justice it deserves.

2. The missing component of emotion

The first requirement for sketching this new vision is to address the glaring omission of the *biology of emotion* – which remains conspicuously missing from even our most enduring explanatory paradigms. In its usage here, the term “emotion” refers directly to the rich pallet of human emotional experiences, such common everyday feelings as happiness, sadness, courage, fear, gratitude, anger, admiration, envy, love and hate. Such feelings color thoughts and motivate actions, they often mediate social interactions, and play an enormous part in our everyday lives. Indeed, what meaning would life hold without its blissful peaks and painful valleys? How would we learn? Where, and to whom would we belong – and *who would we be* – without our unique emotional experiences?

Historically, however, in terms of psychological science, there remain far more time-honored assumptions and controversies about emotion than established facts. To date, emotion theory can be likened to the Sufi tale of the Blind Men and the Elephant – ongoing disagreement about many of its legitimate parts, but with no real overall vision of emotion as a systemic, functional, whole. Fortunately, such a vision emerges upon the expansion of the categorical definition of “emotion” in light of its two core biological features: 1) phenomenal *feelings*, divisible into two broad categories: *positive (pleasurable) or negative (painful)*; and 2) *behavior*, their coupled “action tendencies” (Frijda, 2010), also in binary categories: *approach or avoidance*. Together the feelings and their

hardwired motor responses give rise to a pattern called *hedonic behavior* (also hedonic reflexes, drives, or hedonic motivation (Bolles, 1991)). While the term “hedonism” may carry some pejorative religious assumptions (often associated with sin, evil, and an utter lack of emotional self-control), its biological meaning is simply the pattern of behavior in humans and animals that consistently *approaches that which is pleasurable and avoids that which is painful* – a ubiquitous pattern of behavior observable across the entire animal kingdom from the complex human being to the single celled amoeba (Medicus, 1957). So in this new view, the operational, conceptual, territory of *emotion* is expanded to include both affective feeling and hedonic behavior, with “affect” being any *experiential binary signal* that serves as an evaluative categorization of beneficial or harmful environmental stimuli. These are the biological seeds of emotion still dynamically embodied within the complex human feelings that vitalize and color our daily lives.

More, although the phenomenal – feeling – component has long been underemphasized, Ivan Pavlov’s work demonstrates that hedonic behavior is the foundation of classical conditioning and all higher learning processes (Pavlov, 1927). (Indeed, he clearly had little doubt that the animal cowering from administered shocks was experiencing painful aversion. Let alone its mournful howling, a social cry for help.) The good or bad feelings and their coupled approach or avoidant behaviors, are what he termed the innate “unconditioned” stimulus–response pairing, upon which many other kinds of sensory stimuli can be paired, neurally categorized, and recalled as “good or bad”. The feelings deliver the experiential rewards and punishments that instill and reinforce approach or avoidant behavior. And while – in humans – the “feeling” may recede into the undercurrent of complex cognition, playing out in relatively unconscious urges, drives, habits and attitudes, the tell-tale emotional behavioral pattern is undeniable. Hence, emotion is rooted very deeply in our biology.

How far back in our evolutionary legacy does it go? With clues from neuroscience, it is clear that all three layers of vertebrate brain are involved in emotional processing – with bi-directional communicative paths, that go in both top-down and bottom-up directions – ultimately involving the whole body in emotional experiences. Indeed, in direct line with Merleau-Ponty’s (2002) central contextualization of phenomenological experience in the living embodiment, emotional experiences involve the body far more than ordinary cognition. As neuroscientist Antonio Damasio suggests, emotional feelings are somatic markers, messages from the body, concerning its wellbeing and its “proto-self-awareness” – the “feeling of what is happening” (Damasio, 1999). More, they bear specific messages, those that are meaningfully “self-relevant” (LeDoux, 1989) – the bidirectional neural circuitry fostering body to mind as well as and mind to body communication and supporting whole-self-integration. In fact, while neuroscientists often align “the self” with complex meta-cognition and limit the notion of a “proto-self”, in the new view the embodied *self-relevance* runs deeper still. It concerns the identity of the body at the cellular level, notably the intimate connection between emotion and the “self” versus “not self” distinction of the immune system (Pert, 1988, 1999). So the emotional system is not limited to brains; but is rooted as deeply as the *cellular membrane* – the cellular membranes of every cell in a human body and in all multicellular organisms. In fact, when venturing down the evolutionary ladder to examine the mechanisms that undergird the ubiquitous pattern of hedonic behavior, it becomes clear that emotion – or something very much like it – is at work in even the simple bacterium.

When pondering the evolution of life, there would have been tremendous selective pressure for a living system to be able to *sense, evaluate and respond* to harmful or beneficial environmental changes. As I have argued elsewhere (Peil, 2014, 2012), the simplest

life forms – single proto or autotrophic cells – did exactly that, evolving the first crude sensory system, a “self-regulatory sentience”, driving evaluative sensory-motor behavior toward that which is “good for me” and away from that which is “bad for me” – both animating and guiding the creature in ways that were once thought to require some nonphysical vital force or *elan vitale* (Bergson, 1907). Yet, while this inaugural sense has remained opaque to science, there is no magic required, for the original biochemical mechanisms are still utilized, their cybernetic and semiotic offerings readily observable as drivers of bacterial chemotaxis (hedonic behavior) as well as within the signaling and communication pathways of genetic, epigenetic, and immune regulatory processes of all multicellular creatures. With this biologically expanded definition of emotion, even plants (despite being rooted in place) demonstrate hedonic sentience and a degree of behavioral agency, via the concept of *bio-attention* (Marder, 2012); with “directional signs” (von Uexküll, 2010) orienting any vegetal awareness toward meaningful – self-relevant – environmental changes. They also exhibit evaluative preferences and remember trauma (Chamovitz, 2012).

But emotional sentience is perhaps the most beneficial in *animate* creatures those that can adaptively self-regulate propel or move themselves toward or away from any given location. Specifically, in bacteria for example, this first simple form of sentience operated much like the regulatory control mechanism of a *thermostat*, a simple cybernetic feedback loop like Ross Ashby’s more richly adaptive homeostat machine (Ashby, 1948), with three crucial functional steps: 1) A self/not-self **comparison** is made; 2) imbalances between the self and its not-self environment are **signaled**; and 3) that signal triggers a self-correcting **response** (not unlike a home heating system would compare inside to outside temperatures, signal significant differences, and switch the heat on or off.) This three step thermostatic/homeostatic loop is instantiated by an elegant blend of positive and negative feedback dynamics, which – together – yield both analog and binary informational cues and deliver a host of regulatory functions (Peil, 2014). Instantiated by the shape-shifting morphodynamics of the myriad protein receptor complexes that span the cellular membrane, these couplings of positive and negative feedback loops offer functional “motifs” (Brandman and Meyer, 2008) that sufficiently deliver the functional gifts of sensation, evaluation, and response that allow the organism to adaptively navigate within its environment and actively enhance its evolutionary fitness.

Key to our discussion, however, is that this inaugural sense instantiates what is herein defined as the *classical embodied mind*. This “mind” emerges from the simple thermostatic/homeostatic feedback loop that interactively connects the organism to its environment, with the three critical steps (compare, signal, respond) comprising what behavioral psychologist’s once called “the black box” – between input stimulus and output response. While in more complex creatures such computation and control functions are attributed to a nerve net or brain, this first crude mind is born of the aforementioned protein networks within and upon the cellular membranes – what I call “branes” – or mini-minds that comprise the body proper, the whole self-system. (Sparing the rich detail, the functional part of these branes are the myriad transmembrane protein receptor complexes, structures – akin to sensory organs – with outside heads to measure the external world and inside tails to measure the inside environment, and elegant shape shifting feedback dynamics and signaling systems to keep them in optimal balance (Peil, 2014). Together, in concert with nerve nets and complex brains, these mini-branes organize and regulate the experience of the whole self that interacts with the world – the biosphere outside of one’s membrane, scales, fur, feathers, or skin.

But does this functional brane truly foster a truly sentient mind or merely a mechanical computation? Indeed, despite the limits of the machine metaphor, it is arguable that steps one and three of the feedback loop can be programmable NAND and OR gates in computer logic, and can drive the simple if-then behavior of intelligent machines – with no genuine sentience required. (Indeed, the NAND gate, seems a universal, the source of negative feedback negation and from which all other logic gates can be constructed.) But, as biosemioticians suggest, a *signal* (step two) serves as a *meaningful sign* that is recognizable and biologically useful – to some *relative subject*, some responsive agent. *Perception of the signal* implies that *phenomenal experience* is the centerpiece requirement of the classical embodied mind. An observing subject is required not only to perceive and distinguish between the binary (+ or –) poles of the “signal”, but for that signal to become representationally remembered, and to drive feed-forward hedonic behavior – the active self-deterministic “doings” of a living agent. Or in other words, agency (the hallmark behavior of autopoietic – self-making – living systems) is contingent upon sentient experience, in this case the distinction between the binary hedonic categories; as Kauffman (2000) put it, using a taste metaphor, “yum” and “yuck”.

Perhaps most importantly, this self-relevant signal then serves as an *evaluative symbolic representation* of the two categories that is retained over time – an enduring *record* of life’s good and bad experiences. This opens the door for *adaptive learning* to emerge – something that evolving life forms can do that machines with propositional artificial intelligence may never accomplish without their designers. (In fact, while emotions remain elusive in AI (Minsky, 2006), the new robotic paradigm of “neosentience” – a “system of self-consistent loops” – require analogous “force fields” that bias attraction and repulsion as a central requirement for successful navigation (Seaman and Rösseler, 2011). In other words, the short term evaluative sensory information becomes embedded as *memory* in the system, yielding and elongating the perception of time, and facilitating genuine decision-making choices between binary responses – all clearly “cognitive” functions of the embodied mind, those long credited to nervous systems and brains. In fact, a recent review of the cognitive functions of microbial “nanobrain” suggests that cognitive science has much to learn from bacterial behavior (Lyon, 2015).

In the *Escherichia coli* sensorimotor circuitry, for example, the self-relevant “signal” is instantiated by an intracellular *methylation marking system*, a tertiary part of its sensory-motor system also yielding its representational and memory function. It works by attaching little methylation marks on the *inside tails* of the transmembrane receptor complex, increasing or decreasing in number in concert with the immediate external sensory stimulus (primary ligands occupying the *outside heads*) and hedonic responses (driven by a secondary internal phosphorylation marking system). But the increases and decreases of these third level methylation marks occur on a *longer time scale* than the immediate stimulus-response behavior, allowing the sensory information to be divided into binary good-for-me or bad-for-me *evaluative categories* that are *retained as memory* an evaluative *record* of previous experience (with *increases* in methylation directly corresponding with “good for me” circumstances, and *decreases* signaling “bad for me”). It allows the bacterium to *anticipate* and *act in advance* of the sensory feedback – adding feed-forward processes, and *self-deterministic goal seeking behavior* to the original 3 step loop. Hence, the capacity for memory ushers a more enduring aspect of embodied mind, a personalized repository, a library of individual experience, allowing the subject to re-member itself and its world, to make active choices based on its know-how and best guess of the actual conditions. This is the more familiar *identity* component of the embodied mind, an ever-becoming personality that continues to be

forged and honed through ongoing cycles of trial and error feedback over the duration of the creature’s life.

Furthermore, the “self” that is born of the self-regulatory sense can play the dual roles of an individual whole as well as a part of a larger social collective self-system. While in the earliest case of the single autocoell, the self-reflexive feedback loop is *intrapersonal*, with the subject being both sender and receiver of the signal, the same chemical toolkit was quickly pressed into service for *interpersonal* communication between relatives of a given bacterial species (in a phenomena known as quorum sensing (Bassler, 1999). The simple *E. coli*, for example, can switch between both an *autonomous* agentic mode of self and a communal or *social* sense of self when the external environmental conditions require cooperative group behavior, such as congealing into a little ball to avoid the effects of antibiotics, or in collective behaviors that yield commensal or symbiotic functions. (*E. coli* being one of some 150 principal bacterial species that live in the human gut and are required for digestion). Likewise, the slime mold (*Dictyostelium discoideum*), a eukaryote can also regulate as an autonomous or a communal self depending on the availability or lack food. (To accomplish this they utilize the same cAMP (cyclic AMP) sensing toolkit as humans rooted in two variants of the ancient 7TM receptor – the receptor that instantiates biological clocks.) Even plants demonstrate the dual identity construct, their root structures and grafting abilities affording them collective defenses, swarm behavior, and social intelligence likened to beehives or anthills (Ciszak et al., 2012; Marder, 2012; Gagliano, 2013).

From an evolutionary perspective, this dual sense of identity is arguably the inroad for the effects of group selection, as well as competitive tribalism. For although the subjective components have long been denied, very early on the original “me” self of the embodied mind developmentally expanded to include a good-for-me “we” and “us” versus a bad-for-me “them”, ushering socially cooperative and competitive behavioral regimes that carry forward the individualistic hedonic urges of approach and avoidance. In *E. coli*, for example, using only slightly fancier (species specific) peptide signals and keeping track of how many of my kin is around (as compared to not-self non-kin), with sufficient numbers of us, collective switching into virulence mode can launch an attack against another species. (I’ve termed this secondary, interpersonal level of self-regulation “social hedonism”, for it extends the *intrapersonal* identity sphere to include our kin and comrades). This me-to-we shift is arguably the source of *empathy* as the self-relevant signals extend to our kin and comrades, as well as the seed of dehumanizing contempt for the outgroup, the excluded (or “evil”) “other”. In fact, in the neosentience model of artificial intelligence, neosentience itself is deemed the *engine of benevolence* wherein “benevolence” marks the point where sufficient sentient self-awareness emerges for the agent to interact with others via some common evaluative rubric (Seaman and Rösseler, 2011). However, I would add that if the ancient hedonic logic is lost in this shift to social hedonism, violent and self-destructive patterns can, and do, emerge (Athens, 1992; Gilligan, 1996; Peil, 2012). Nonetheless, clearly, the dual part and whole nature of self-identity and emergence of these secondary, communicative, signaling functions substantially increases the biological value of the self-regulatory sense.

In terms of the evolution of phenomenal experience, with the emergence of biological clocks and mindful memory came the possibility for ever more complex organisms to enjoy subjective awareness for longer and longer stretches of time, opening doors for ever richer perception and increased behavioral flexibility, and eventually to the big-brain fully conscious learning, language, and the creation of culture that characterizes human being. Notably, however, with that increasing complexity also comes an ever

longer temporal gap between the original small-scale self-regulatory sensory loop and the ongoing large-scale phenomenal experience. In fact, a good deal of the original self-regulatory wisdom of the human body remains *below* our level of perceptual awareness, in what has been termed the *unconscious*, or subconscious realm of being, perhaps more accurately described as the *automatic realm*, the autopilot mode of the embodied mind, wherein prior experiences, feelings, and choices all play out in the form of conditioned *habits* – habits fueled by attitudes and beliefs.

The overall implication is that what we experience as human emotion is the modern day manifestation of this first crude sentience – that emotion is an entire sensory system (Peil, 2014, 2012); perhaps the first sense to have emerged upon the evolutionary stage, the grandfather of all senses such that its ancient hedonic logic remains encoded within them all: In resonant and disturbing sounds, in aesthetic beauty and ugliness, pleasant and unpleasant tastes and odors; and in warm fuzzy or cold prickly experiences of touch. Its ancient biological logic still reflected in the body's immune system (recently deemed a sensory system itself (Blalock, 2005), giving rise to the bottom-up self-regulatory signals that Hans Selye originally termed *eustress* and *distress* (Selye, 1957) – aka positive and negative “affect” in emotion theory. Although the human mind is much more cognitively complex, emotion still provides its foundational function, erupting into the stream of mindful experience whenever self-relevant changes are occurring, with the same homeostatic efficiency. This is the source of what was originally termed “cognitive dissonance” (Festinger, 1959) that dissonant feeling of being off-center accompanied by strong urges to get back in balance (although *emotional dissonance* is more biologically accurate.) It is also the foundation the “psychological immune system” (Gilbert et al., 1998), the phenomenological urges to protect oneself against pain – to feel good about oneself – if even to the point of self-deception (and Freudianesque defense mechanisms). Of course, with the clear connection to the physical immune system the metaphor is now more homologous than analogous, with signals concerning optimal, healthy – “right” – states of biophysical being (Peil, 2014). The dissonance is still dependent upon the ancient self/not-self comparison, informing us of self-relevant imbalances, so that we can actively course-correct in very specific ways.

Indeed, the negative emotions, our most aversive distress signals concern self-preservation – they protect the body proper, preserving our very *being*. They relate directly to a fixed and non-negotiable set of biophysical needs – biophysical requirements common to all humans if not all embodied creatures, moving us to correctively alter the conditions our external environment. Likewise, the positive, eustress feelings also serve their own unique self-regulatory function. For the positive emotional category mediates the counterpart imperative of adaptive self-development or optimal growth – good feelings serves as the True North phenomenological beacon for our ongoing *becoming*, they drive adaptive changes to the *internal* environment – the embodied mind. Good feelings inform us of growth opportunities, beneficial environmental affordances, new need-meeting resources and optimal life-giving circumstances. They concern learning and optimal psychosocial development, as well as creating and building cooperative culture – features that then become historical structures of the external sociocultural environment.

In short, the approach/avoid behavioral pattern is ubiquitous because the phenomenological experiences of pleasure and pain are central to the evolutionary process – delivering **self-preservation** of physical form, and **self-development** of the embodied mind, respectively. Dual self-regulatory purposes, if you will, the second of which has been largely omitted from the standard neoDarwinian story of evolution. Indeed, this is where the self-

organizing dynamics of evolution intersect with and enhance the Darwinian story, for the simple hedonic logic serves as a subjective reflection of the criteria for natural selection: survival and adaptation. Of course “adaptation” is far more elegant than random genetic mutation, covering all developmental and epigenetic processes and inheritance systems (Jablonka and Lamb, 2005). Indeed, identification of the ancient self-regulatory sense implies that the animal's adaptive behavior has been playing a role in evolution all along, as Jean Baptiste de Lamarck originally suggested, driven by “felt needs” (Lamarck, 2011) – an internal guidance system that is quite literally in-forming both body and mind from the cells on out. In his own emotion theory Darwin himself noted the regulatory feedback dynamics, behavioral automaticity and communicative functions, concluding that “the language of emotion is certainly of importance to the welfare of mankind” (Darwin, 2005). Furthermore, in a letter to Nathaniel Wallich in 1881, Darwin suggested that selection itself might be ‘the consequence of a much more general law of nature’ (Eigen, 1993) – to which I would add: That of the *binary computational laws (rules or processes) of self-regulatory feedback*. Indeed, the rich human emotional pallet now contains three levels of self-regulatory information that serve as a moral-spiritual compass – should we choose to attune to it (Peil, 2012).

Key to the present discussion however, is that when examining this elegant self-regulatory sensory system through the lens of physics, we encounter the new dualism I'm suggesting. In fact, with the causal closure of classical physics, it seems likely that the self-regulatory functions that forge the embodied mind could be machinelike, its choice-making illusory, and its subjective “awareness” merely an epiphenomenal by-product. But there is nothing interesting or creative in this dismal story: behavior is determined, human experience is largely meaningless, and our sense of free will and personal empowerment a cruel tease of nature. With the revelations from quantum mechanics, however, this is not the only possible story. And it is in quantum mechanics that we encounter the enigmatic, creative, role of *the observer*.

3. The new phenomenological duality: embodied mind and quantum consciousness

3.1. A pansentient universe?

It remains a theoretical mystery how the classical and quantum aspects of the universe might fit together. General relativity seems incompatible with quantum mechanics and the living body seems too warm and wet for any coherent and life-relevant quantum effects. But to take seriously any role of the subjective observer is to put a new spin on many enduring questions and potentially add new depth to the abstract notion of the “self” within a self-organizing universe. Indeed, the discovery of an ancient self-regulatory sense that has remained opaque to science places the self center-stage.

However, as just set forth, the description of the embodied mind effectively dodges the deeper question of *consciousness*. The hard problem, as Chalmers (1996) put it, wherein no third party description of reality can explain the essence and origin of qualitative awareness. Likewise, the indeterminate nature, the inherent randomness, of the quantum realm leaves little room for responsible free will – precisely the kind of genuine adaptive creative choice-making delivered by the self-regulatory sense. Clearly there must be more to the story.

To be sure, the loop of mind is very real and physically actualized in branes (Peil, 2014) and brains of living systems: it drives hedonic behavior across species, it allows us humans to experience ourselves when we awaken each day, it directs our attention to

important events, helps us get about in our world, builds knowledge and forges our sense of personal identity, and its activity is reflected in the EEG recordings of brain rhythms. But by this definition, the embodied mind begins at birth and is forged over time via the self-regulatory process. How then is the original self/not-self “comparison” of the process made? What is the actual mechanism that produces the qualitative feelings? What is the “self” itself? What constitutes the boundary of self? How is it distinguished from “not-self”?

In a Newtonian world there are always boundary conditions that are fixed and definable mathematically. But, without a Deistic god to have set those boundary conditions, their source remains a mystery. Likewise, as with the problem of consciousness, no third party observation can draw hard and fast boundaries that are not relatively arbitrary – relative to any given scale in time and space. For instance, I can observe a lovely madrone tree outside my window. But if I were to slice a section from that tree I would see the vascular xylem and phloem, and with a microscope I would see distinct cellular networks. From there, I'd observe the cells to be comprised of microfilaments, organelles, and with an electron tunneling microscope, perhaps blurring into a swarm of molecular and subatomic activity. As physician Neil Theise put it: “now you see it, now you don't” with a similar description of the human body dissolving into a “frenzied self-organizing dance of smaller components” (Theise, 2005). In short, where is the so-called boundary?

From an endophysics perspective, however, might we question the assumption that “impartial” third party observation has some higher degree of ontological reality? Perhaps, instead, the first person subject is the primary – most physically relevant – observer, if not the only legitimate mechanism of measurement? Wouldn't a subjective observer, one that defines and alters its own boundary conditions, change the entire Newtonian game? (Indeed, in Einstein's original formulation, there is a locally situated observer holding clocks, measuring sticks, and so forth, but he later disappears from the mathematical formalisms.) The part-to-whole, multi-tiered signaling processes discussed above (in the sensorimotor circuitry of the *E. coli*) suggests that the sentience of cellular mini-minds with mini self-boundaries (across the wide variety of specialized cells in organ tissues and neurons) each contribute uniquely to the emergent maxi-mind of the whole organism – that in emergent complex systems, simple self-regulatory sentience goes all the way up.

This might also mean that sentience goes *all the way down*, that interactive sentient observation doesn't stop at the emergence of living systems, but perhaps might be involved in the very being and becoming of the universe. Here is where we encounter the very essence of qualitative awareness, the deeper variety of consciousness, wherein a “self” is an abstract construct representative of the inherent subjectivity – the *quantum consciousness* – in matter and virtual particles all the way down. In this view, the smallest self-unit might be akin to the Leibnizian monad (Leibniz, 1710, 1719; 1898), each endowed with both perception and desire, yet like Whiteheadian “prehensions” (Whitehead, 1927, 1978), able to interact, assemble, and reassemble in perhaps infinite ways – the self-aware, self-determining, building blocks in a self-organizing universe.

Of course no one knows, and what will follow will be the unapologetically speculative, semi-poetic, intuitions of a psychologist turned naturalistic theologian fascinated by biophysics and the mathematical order of the universe. As such, I would argue that any physically valid panpsychist model of the universe must contain some version of the phenomenal dualism on offer, for any such foundational pansentience would naturally give rise to the very same pattern of self-regulatory sentience noted above. It would be the emergent driver of the classical embodied mind as the natural

extension of the inherent subjectivity of a creative universe – its ongoing cyclic nature key to the development and evolution of the universe if not the mystery of time itself. I would further suggest that the self/not-self comparison in the three step loop is actually related to the *quantum measurement event*, the quantum/classical interface wherein quantum possibilities collapse into classically actual events, while at the same time, a fundamental *self-reflexive* process of *symmetry breaking* that is ground zero for the “not-self” boundary distinction.

At the deepest level of such a pansentient universe the Self may be pure, nonlocal, quantum consciousness – dwelling in an infinite realm of ontologically real possible events, the quantum potentia. But such a Self would be highly active, with creative capacities and self-deterministic behavior manifesting in the electromagnetic attract-repel dynamics of matter in motion – in the orderly behavior of electrons that governs the chemistry of life. Such a unified Self would have the infinite capacity to break its own symmetry, to carve itself into potentially endless internal partitions; sculpting pseudo boundaries within itself, creations and recreations of ever new reflective and refractive blends of self and not-self – weaving uniquely subjective gestalts of consciousness that ebb and flow in time and space. These would be the local sentient “selves” that then continue to subjectively experience that initial symmetry break as their own ongoing self-reflexive feedback loop, encountering, contrasting and defining their own ever-shifting self/not-self boundary conditions, and freely self-regulating of their own accord. (Hence, this pure unadulterated quantum consciousness would be the ultimate source that forges the classical embodied mind, even if the smallest scale “body” in question is that of an atom, a quark, or a string – to the degree that it chooses and recalls it past, it qualifies by definition as an embodied mind.)

Should the expansion and contraction of these subjective boundaries involve varying degrees of quantum entanglement, such dynamic self-regulatory activity could yield the part to whole relationships of self-organizing systems with their classical arrangements of nodes, networks, and multi-tiered self-similar structures (along with their orderly statistical behavior, attractor dynamics, and edge-of-chaos criticality). Better still, this cyclic sentient interaction might also drive the classical manifestation of the *quantum measurement process*, wherein each local self via the perceptual sampling and resampling of its immediate world is quite literally helping create and recreate both itself and its local not-self environment. Indeed, such nonlocal quantum dynamism might also – via the active preferences and binary choices driven by self-regulatory sentience – tune the *probabilities* of super-positioned possibilities upward or downward, ultimately effecting the critical threshold that collapses quantum potentials into classically actual events. Or in other words, each self is – from the bottom up, via quantum consciousness – observing, measurably collapsing (“membering”, in-forming) possibles into new actuals, as well as cyclically, self-reflexively – from the top down, via embodied mind – informing, re-membering, and recreating the classical actuals of our shared objective world. Best of all, while the qualitative preferences involved may well relate to biophysically favorable states for life (long-range quantum coherence, thermodynamically

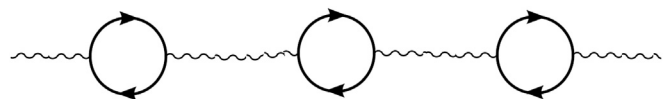


Fig. 1. Flow of large scale phenomenal awareness, punctuated by the ongoing original (small scale) self-regulatory feedback loops, well below the level of conscious awareness but erupting liminal threshold during self-relevant moments.

desirable energy exchanges, and optimal negentropic alterations of classical fitness landscapes), such preferences would be driven by a common yet highly personal evaluative experience, something with the feel-good resonant ring of pleasure.

Similar ideas have long been embodied in Eastern metaphysics, with the Unified Self akin to the universal mind of Indra's Web, in cycles of reincarnation and cause and effect Karma, or in the goal of the practice of yoga: the subjective state that is *Satcitananda*. This state marks the discovery of the ultimate reality – the Brahman of Being – the attunement with pure consciousness, an optimal experience accompanied by perfect bliss; likewise in Western religion, with the creative capacities of the Unified Self befitting an omniscient and omnipotent monotheistic God – one divinely self-actualizing itself in infinite ways. But the Unified Self is a *process* not a person or object, a verb not a noun, yielding, as process theologian Gordon Kaufman put it, the unending “serendipitous creativity” of the universe (Kaufman, 2005). The word serendipity here capturing those suspiciously spiritual synchronistic coincidences that seem to honor or challenge us personally, answer our deepest desires or promote our highest growth, whether due to karma, to the good or bad luck of random chance, to the collective unconsciousness (Jung, 1981), or the fundamental grace of an omnibenevolent universe – a Unified Self that faithfully honors and reflects the quality of our local self-actualizing creative efforts.

In short, in such a universe, qualia-filled, phenomenal experience would be central to the process, giving rise to a flow of “mindful” awareness in sentient living systems that consolidates the creative functions of both quantum consciousness and classical embodied mind (depicted in Fig. 1 below.) The contribution from quantum consciousness is represented by the circular loops, implying flexibility in time at the smallest scales (if not backward time effects), driving self-relevant feedback and feedforward processes in the realm of possibles and probables – wherein *not-self* and more adjacent *not-yet-self* distinctions can come together in the ongoing comparison – the self-actualizing measurement collapse. The wavy gap between loops constitutes the contribution of the classically embodied mind, the ever more complex flow of perceptual awareness, one that increases with the size and neural complexity of the creature. Indeed, there exists an inverse relationship between quantum consciousness and the length and duration of embodied mindful awareness, such that with increased neural complexity, the quantum loop recedes into the “unconsciousness”, bottom-up, regulatory behavior of the body, but erupting into mindful awareness when immediate attention must be called to self-relevant changes, our emotional “upheavals of thought” (Nussbaum, 2003). Similarly, is the top-down impact of the mind upon the body, with its notorious placebo (Lidstone et al., 2005) and nocebo (Hahn, 1997) effects.

If such a depiction holds any promise, the task then becomes how to factor the role of the experiencing self into our view of the universe, and to define its relationship to space and time and to the known physical forces. Does the self, for example, reside within space and/or time? Does it emerge from them? Or does it actually create them both? How does its existence and behavior relate to the mass of an object, the known behavior of gravity, of light, to the “spin” of an electron, to the electromagnetic attract and repel dynamics of matter in motion? What might be the nature and degree of its immediate experience? Would it experience itself as both a part and whole? Would a self, say, with the complexity of an atom or even an electron, enjoy multiple states of mindful awareness like we do? Would it feel energized or tired? Would it sleep, and perhaps dream? Would it ever “die”, be transformed, or experience some afterlife? Would its – however meager – embodied mind leave some memory trace on the universe?

But at the very least, any hint at Panpsychism in the universe

brings with it a set of implicit questions that require venturing into new scientific territory. There should be room for free-wheeling speculation as to how any such sentience can exist, how its informative processes are integrated across scales from the very small to the very large, and their central role in both being and becoming.

3.2. Pertinent theorists and maths

Despite the speculative liberties and intuitive leaps taken above, there are some serious scientists, physicists, mathematicians, and philosophers of consciousness that have indeed already ventured into such territory and have offered ideas that, together, support something along similar lines. Likewise, there are already a variety of potentially relevant but disparate mathematical devices and models for such a core process, the pieces of which may inspire intuitions of how they might fit together in some such way. Indeed, the mathematical *equation* itself (in all its various forms and all its orderly manipulative rules) implies some fundamental principle of balance (e.g. symmetry) that is inherent in the creative actions and reactions of the universe, some physically optimal energy space or centered “home” state toward which systems naturally incline (e.g. thermodynamic equilibrium). Likewise, is the inherent binary complementary, the fact of positive and negative numbers, the directional flow from positive to negative electrical poles, north and south magnetic poles, up or down spins – the dance of opposites that underlies the flow of creative and destructive transformations of matter. (Perhaps the Yin-Yang within the Tao, the way of the universe.)

Of particular interest is the *iterative function*, utilized in computer science, dynamical systems, the generation of fractals, and the behavior or cellular automata. With the iterative function, something goes in, undergoes a logical transformation, and something lawfully related comes out. Then, that specific outcome is *fed back* into the function to begin a new round – the entire cycle being repeated over and over again for some length of time. The aforementioned three-step (thermostatic/homeostatic) loop of embodied mind seems very much like an iterative function, which is emergent of – and contains – the behavior of quantum consciousness, so perhaps clues to the deeper nature of space-time-self can be begin here.

The first and most obvious would be the *cellular automata* (von Neumann, 1951), a form of microstructure modeling that has been proposed as a possible model for biological systems (Wolfram, 2002). A cellular automaton is a collection of “colored” cells on a specifically shaped grid, a pattern that evolves through a number of discrete time steps according to a set of rules based on the states of neighboring cells. The rules are then applied iteratively for as many time steps as desired. John Conway designed a two-dimensional cellular automaton named Game of Life (Gardner, 1970), with simple “nearest neighbor” rules that gave rise to quite lifelike and diverse behavior that fluctuated between randomness and order. (These were simple if-then decision-making rules such as: If a cell has two black neighbors, it stays the same. If it has three black neighbors, it becomes black. In all other situations it becomes white.) A key feature of the Game of Life was the frequent emergence of *gliders*, arrangements of cells that essentially move themselves across the grid – gliders that were later shown to interact to perform computations, even to emulate a universal Turing machine (Chapman, 2002). Stephen Wolfram went on to study cellular automata extensively, finding four classes one of which (class 4) was capable of universal computation. Decades previously, Alonzo Church developed a universal computational language known as *lambda calculus*, with large numbers of λ -expressions that can operate upon themselves and others. It has since been utilized to highlight the algorithmic and constructive aspects

of chemistry, those of self-making systems that can help explain the “arrival of the fittest” in evolution without yet appeal to the survival criteria of natural selection (Fontana and Buss, 1994). Lambda calculus has also been used to model the cooperative choice-making behaviors of operators as simple as molecules (Vaidya et al., 2012).

Indeed, such universal dynamics have been associated with the *edge-of-chaos criticality* that Chris Langton (1990) suggested to be the foundation of computation itself – also the prime suspect facilitator of rudimentary self-regulatory sentience (Peil, 2014). Edge-of-chaos criticality has also been suggested to be the source of the new “gestalt” or “experiential” variety of information proposed by physicist Alex Hankey, wherein critical phase transitions (“critical states on the feedback loops”) give rise to all three central pillars of phenomenal experience: the experiences of self, being, and time (Hankey, 2015; this issue). Criticality may well be the missing semiotic bridge between simple information processing machines and genuinely sentient systems. In the above example, should we think about each lambda operator or cellular automaton as “a self”, it seems clear that some form of information processing and interactive perception is implied. The automaton, for instance, must be able to detect environmental information, specifically to distinguish – to “see” – the colors, and be endowed with rules that direct different responses to the different colors. However, the ability to sense these critical instabilities, to *feel* the difference between the two physically complementary states and to have a preference for optimums, would eliminate the need for fixed programmed rules. (In living systems, something electromagnetic would be the most likely sensory stimulus (i.e. up/down spins; positive-negative directional flows; North or South poles) and negentropic, life-giving, optimums would be the inherent evolved preferences. And, in fact, the *E. coli* bacterium can sense and respond hedonically to EM fields as well as oxygen and thermal fluctuations and a variety of chemicals (Peil, 2014).

It also seems clear that such a self would have a dual sense of identity – self as part or self as whole – and the ability to switch between those two identities modes. For example, the simple rules of this game would lead to the kind of dual identity modes evidenced in quorum sensing: If I am alone mode 1 “autonomy” is my home state, I regulate myself as whole – “me”. Even if I have two different not-self neighbors, I stay in mode 1. But if I have three non-self-neighbors, I switch to the “we” communal mode of behavior (mode 2) – expanding my identity boundary to enter the social fold, gliding cooperatively across the state space with my homies. How would I know my status? In the case of the *E. coli*, with awareness of incremental increases or decreases in changing environmental stimuli (species specific chemical markers in this case), which itself is dependent upon the ongoing self/not-self comparison – the loop of quantum consciousness. In the case of our smallest scale monad, the stimulus might instead be the manifestations and exchanges of virtual photons, those that in

quantum field theory continuously pop in and out of existence, and can give rise to electron–positron pairs also simultaneously created and destroyed. With quantum effects such as entanglement and nonlocal connectivity these ever-shifting network patterns could tune probabilities of particular events upward or downward, just as the electrical activity of dendrites in neural networks strengthens or weakens synapses, tuning the patterns of more global neural firing. More, the consonance between dynamic attractors and repellers on fitness landscapes may well relate to the gauge symmetries – reciprocal equivalencies – between electric and magnetic fields. Indeed, in quantum field theory attractors can become repellers and vice versa via compensating changes in electrons between electric and magnetic potentials (Al-Khahlili, 2004).

Likewise, with its role in *fractal geometry* (Mandelbrot, 1977), the iterative function may help model the more abstract self-organizational relationship between parts and wholes in any given multidimensional, fractal, heterarchic, or “holarchic” (Koestler, 1967) self-unit in time and space. Indeed, iterative feedback is the engine that drives the emergence of such fractal hierarchical structures (Briggs, 1992), with positive (amplifying) and negative (regulating) varieties of feedback associated with chaos and order respectively. The complexity sciences have demonstrated how the bottom-up stochastic activity of smaller scale parts gives rise to more complex emergent structural wholes on larger scales, features that then gain functional closure by instituting an optimal amount of top-down regulation or “quenched disorder” (Theise, 2005). At each level, these dynamics reflect the aforementioned edge-of-chaos criticality, mediating just the right blend of chaos and order for computational, information processing, functions to occur.

In this view, the relationship between space-time scale and a living creature’s self-hood can be likened to a set of Russian Nesting Dolls with varying degrees of mindful awareness. As depicted (in Fig. 2), the largest doll in the set looks out upon and interacts with the external world, enjoying the most complex flow of experience. But the exact same process is occurring at every local level, with each inner doll responding to its own stream of sensory stimulus, correctively self-regulating at its own self-relevant scale in time and space, together accomplishing unified coherence across the whole. (In the Hankey model, the dual structure of information ($\leftarrow \text{=====} + \mathbf{O} \rightarrow \leftarrow \text{=====} \mathbf{O}$) dovetails cleanly with the complex flow of experience, the $\leftarrow \text{=====}$ portion corresponding to the embodied mind and the \mathbf{O} representing the quantum consciousness, the “perfectly self-observing system” Hankey, 2015.) Of course, no mini-mind need be privy to the subjective perspective of the whole, or to any other level within the global network or holarchy, and such a model would capture the unconscious realm of activity as well as the bidirectional regulatory pathways – wherein the common binary signal of emotional valence speaks the universal self-regulatory language.

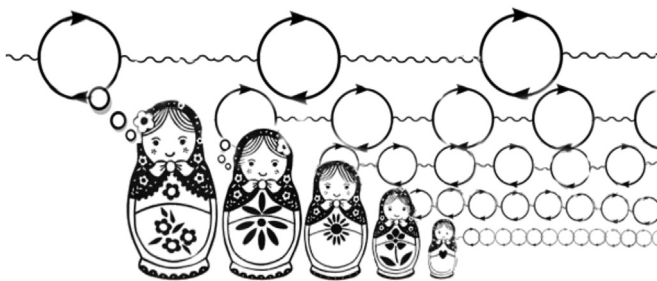


Fig. 2. Fractal Self like Russian Nesting Dolls; Relationship between Scale and phenomenal awareness. More distance between feedback cycles on larger scales and less on smaller scales.

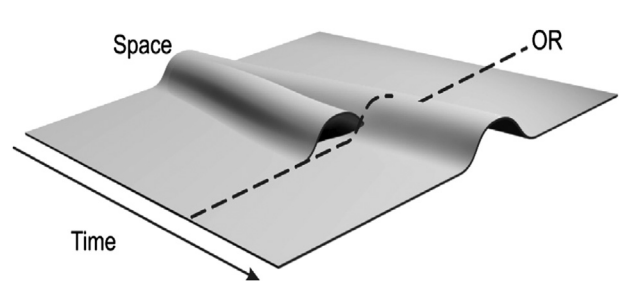


Fig. 3. The Penrose-Hameroff Objective Reduction; (With super-positioned states arguably the source of self/not-self comparisons, and the gravitational self-collapse the fundamental feedback loop itself).

This view is consistent with a theoretical model set for by Theise and Kaffatos (2013, 2015), an extension of Maturana and Varela's (1980) autopoietic theory (wherein mind is *embedded, embodied, extended* and *enacted* via constant interaction with the environment (Menary, 2010) – the 4 E's to which I would add the fifth: *evaluative* if not *emotional*. With their extension, sentience goes all the way down to a panpsychic universe, and is central to the observable self-organizing dynamics of the biosphere. At the very bottom, they describe an ultimate unified “monistic awareness” that begins to manifest (perceive) the possibility of self and other, via symmetry breaking resulting in the dualistic phenomenal universe and “the emanation of space-time, matter and energy”. They cite three organizing principles of a self-organizing universe (2015) that dovetail eloquently with the sentient loop of mind described above: *complementarity* (their self/other symmetry break creating the self/not-self duality for the comparison), *process* (the creative interactive self-regulatory process that yields sentience) and *recursion* (the ongoing nature of iterative feedback central to that process.) While such models may ultimately be untestable, they do address the potential role of the “self” as an active, sentient participant, in the self-organizing process.

Another highly relevant – and testable – enhancement to this general context of self-organization is the Penrose-Hameroff model of “orchestrated objective reduction” (Orch OR). This model equates the measurement event (the self-collapse of the super-positioned wave in the Schrodinger equation, due to the uncertainty principle given by $d = h/t$) with flashes of consciousness and free will causal action (Hameroff, 2012; Hameroff and Penrose, 2014; Penrose, 1999). In the Objective Reduction model superposition is viewed as classical Einsteinian spacetime splitting into two (or more) super-positioned possible structures of spacetime itself (Fig. 3 below), and when a gravitational threshold for “self-collapse” is reached, one of the possibilities becomes classically actual and bursts of consciousness – with “free will” causal action – materialize. This is akin to the multiple worlds view (Everett and Wheeler, 1973) in which each spacetime branch evolves its own entire universe, although no collapse or measurement event occurs. On the other hand, according to the Penrose theory, the spacetime separations are unstable, and due to quantum gravitational effects, will self-collapse after time T, constituting a measurement event. Furthermore, the Orch OR model also postulates *backward in time* effects, a causal in that they do not cause the collapse, but functional (in terms of top-down free will) in that they can affect the quantum possibilities perhaps tuning probabilities upward or downward, providing a potential explanation for such backward time effects in human experience. (Bem, 2011; Hameroff, 2012; Libet, 1985; Radin, 2006).

If we are to explicate the implicit role of the self, this process sounds very much like the flow of mindful awareness depicted in Fig. 1, although like the frames in a motion picture, these would actually be individual, discrete, events – the actual series of loops themselves. Indeed, what I've described as the loop of quantum consciousness actually reflects both the spacetime split into the multiple super-positioned possible states of the Orch OR model (where self/not-self comparison can be made) as well as its gravitational self-collapse (with objective reduction perhaps the discrete self-reflexive feedback loop itself). In this model, the self would be physically actualized, it would pop into classical existence, along with the flash of consciousness. In terms of classical structures, this quantum activity (“quantum computations”) must then be orchestrated from the Plank scale on upward, which, in organisms, they posit to be carried out in the *microtubules*, the tubulin proteins that structure cytoskeletons in cells as well as the exterior flagella that interface with the cell-membrane, and play roles in cellular morphogenesis and motility. (Indeed the microtubule cytoskeleton

serves as a platform upon the “branes” wherein the cellular signaling complexes – the sense organs – are assembled.) Penrose and Hameroff liken these mini-flashes of consciousness to the sound of an orchestra tuning up, with higher level gestalts of consciousness the actual music of complex phenomenal experience. To date, the Orch OR model may offer the most scientifically supportable explanatory mechanism for the phenomenon of emotional sentience, but it also hints of such deeper mysteries as “non-computable influences from information embedded in space-time geometry” (Hameroff, 2012) making it potentially compatible with other less developed models.

Indeed, another relevant model offered by David Bohm, set forth the concept of “active information” constituted by the nonlocal quantum potential. Like that of classical space-time geometry, this quantum field would be tantamount to the smallest scale *external environment* in which any given particle, say an electron, finds itself, a field with forces that surround it. The field then would provide the *stimulus input* for any postulated perceptual capacity of an electron, the stimulus that actively “in-forms” the action, literally “puts form into or imbues with form” – the behavior of the electron (Bohm and Hiley, 2006). But this must also be a cyclic, reciprocal relationship, given the *subsequent response* of the particle to that active information, which in turn actively alters the informational capacity of the field. A key point is that this information is *non-local*, available anywhere and everywhere, despite any localized subjective boundaries, likened to a radio signal available to the degree that any “thing” (any particle) can subjectively attune to it.

Another recent theoretical offering broadens the inquiry further still, Stuart Kauffman's proposal of the “poised realm” – a new state of matter wherein a particle hovers between quantum and classical states. The poised realm facilitates both decoherence and “recoherence” in terms of quantum possibilities that, upon measurement, eventually collapse into classical actuals. While the quantum plenum is often referred to as “potential”, following Heisenberg Kauffman posits a domain of ontologically real possibles, what he calls “Res potentia” (Kauffman, 2011). This model offers a new dualism, carrying forth Descartes' original realm of matter-stuff (*res extensa*), but replacing his supposed mind-stuff (*res cogitans*) with *Res potentia*, the realm of real, but non-stuff possibles. The poised realm also has “adjacent possibles”, implying varying degrees of probability at any given instant – wherein what is “waving” in the Schrodinger Equation are the *possibles* themselves. The creative picture here is an ongoing cycle of quantum possibles (waving, flowering forth, fading away), cohering and collapsing into new classical actuals that in turn flower and form new possibles, that then create new actuals ... and on ad infinitum. This poised realm model creates a conceptual space wherein Bohm's active information and Penrose & Hameroff's noncomputable classical information (and/or backward time effects) could interact, transform locally, and manifest any of their ontologically effective activity, yet consistent with the causal closure of classical physics. Indeed, the nonlocality and ubiquity of Bohm's active in-formation would suggest that it dwells only in the realm of *Res potentia*, playing a role in tuning the probabilities upward or downward, becoming classically actualized only when the quantum potentia becomes negligible, (or upon measurement, perhaps via Orch Or gravitational self-collapse). This pattern of tuning of possibles into more or less likely adjacent probables can be likened to the strengthening or weakening of synaptic weights in neural networks – perhaps drawing upon edge of chaos dynamics of “critical” systems.

Indeed, like the dynamics of cellular automata, these complex self-organizing dynamics were discovered in random Boolean nets (Kauffman, 1996) simple models with binary switching between two alternatives (light bulbs turning on or off). However, the model relied on periodic updates, measurements of the whole state space

that were then fed back into the system for the next round of switching. While these random dynamics and arbitrary updates made little sense in terms of observable physical systems, within the context of these other models these periodic updates could well be the objective reductions themselves, and the randomness actually the creative self-regulatory behavior – once again reflecting the flow of mindful awareness depicted in Fig. 1. Furthermore, the poised realm, active information, and the role of the self could bear upon certain problems such as the *infinities* and (negative probabilities) associated with quantum field theory, for another use of iterative functions is *renormalization* group physics. The original problem had to do with the fact that an electrical charge will generate an electrical field, but it was impossible to work out the effect of the field upon the charge that generated it in the first place. For the relationship between the field and the charge is worked out by the distance between the point of interest and the location of the charge, a distance of zero for the effect of the charge upon itself – yielding an infinity. But three physicists (Feynman, Schwinger and Tomonaga) separately figured out renormalization as a solution, a way to finesse the infinities, one that gave rise to quantum electrodynamics (QED) – a quantum theory of light in such high agreement with experiment that it is considered to be the most accurate theory in the whole of science (Al-Khahlili, 2004).

While Feynman (1985) admitted that renormalization was a bit of a trick (“a shell game” ... “a dippy process”) to sweep the infinities under the rug, there must be something deeply right about it. But what if we think about the role of the self in that situation? The effect of its own EM charge upon itself might be tantamount to the self-reflexive feedback loop – wherein the self is observing – measuring – itself. Perhaps this relates also to the Quantum Zeno Effect (Misra and Sudarshan, 1977; Facchi et al., 2004) wherein the self-reflexive feedback continuously recreates the actual, classical, self by trapping it in a paradoxical state wherein simultaneously the transition to decoherence did not yet happen and transition has already occurred (Panov, 2001). Indeed, the renormalization group is intimately related to *scale invariance*, symmetries in which a system appears the same – self-similar – at all scales (spacetime, through microtubules, EEG and Brain), as well as the critical phenomena and phase transitions in statistical physics (Wilson, 1971). Perhaps this flash of infinity means exactly that in terms of a self/Self comparison, wherein all levels of Unified Self are accessibly connected at once. Perhaps this is the self-actualizing instant wherein the self is visiting the infinite possibilities of the quantum potential, while also tuning the ebb and flow of possibles on all scales, while poised between both quantum and classical worlds? Perhaps this action – whatever it may be – is what leads to the threshold gravitational self-collapse in the Penrose Orch OR model? Perhaps this is where body and mind encounter quantum soul (Hameroff and Chopra, 2012)?

One further image to offer up is Stephen Hawking's proposal of a *universe without boundaries* based upon a quantum theory of gravity. In this view there is no boundary – no ending or beginning – to space-time, just as Theise and Kafatos (2015) suggest there to be no boundary of fundamental awareness or what I've termed the Unified Self. Hawking notes that any unification of gravity with quantum mechanics should incorporate Feynman's sum over histories proposal, wherein any particle traveling from point A to point B does not have just a single history as it would in classical theory, but instead would follow every possible path in spacetime (Hawking, 2015). But to do the required calculations is to encounter severe technical problems, so like the trick of renormalization, they use a mathematical concept called “imaginary time” – wherein the universe would be finite within imaginary time, yet without boundaries or singularities, self-contained with no outside creative

agency, yet in ways that predict its observable real-time inflationary behavior. Hawking suggests that imaginary time, a Euclidian space-time wherein there is no difference between the direction of time and the direction of space, might actually be the fundamental concept and what we think of as “real” space-time is “just a figment of our imagination”. Together, with some of the above proposals, a likely suspect for any genuine ontological reality of imaginary time might be the flow of time in the *realm of possibles*, the temporal flow in *Res potentia* as Kauffman suggests – the arrow of time from the perspective of the Unified Self in the Theise & Kafatos model; which might also imply a flow of backward in time classical informational effects like those of the Penrose-Hameroff model.

Indeed, the maths of quantum mechanics are founded on the complex plane (wherein there is one real axis and an “imaginary” axis), and it may not be coincidental that *fractal geometry* also plays out on the complex plane. Perhaps, then, a model of the Unified Self might resemble the ultimate fractal of them all, the Mandelbrot set. Arguably the most complex geometric shape in mathematics, the Mandelbrot set is a black symmetrical shape (known affectionately as the Mandelbug), where everything inside that black shape is “going toward zero” (radially inward on the complex plane) and everything outside that shape as “going toward infinity” (radially outward on the complex plane, and depicted in another color for contrast), highlighting its hauntingly beautiful *boundary*, which exhibits exquisitely detailed self-similarity. For when viewed on ever smaller scales, variations on the black Mandelbug itself appears in the boundary again and again at all levels – the epitome of fractal self-similarity – and a paradigm visual for the ubiquitous whole-in-part and part-in-whole relationship. (Indeed, every sector within the M-set also defines a uniquely shaped Julia set, each exhibiting varying degrees of complexity and connectedness or fragmentation along the real axis). But fractal structures are first and *processes* – for the Mandelbrot set is generated by the iterative function: $Z \rightarrow z^2 + C$. (Z being the existing-yet-becoming actual structure and C being the complex imaginary number that alters its becoming, and is then is fed back each time into the formula.) The iterative process echoes both the cyclic feedback within emotional sentience and the complementarity and recursion of the Theise and Kafatos (2015) model, perhaps the symmetry breaking that gives rise to the fractal branching found ubiquitously in biological systems – branches subdividing and subdividing again and again (Weibel, 1991). (The respiratory, circulatory, and nervous systems are remarkable instances of fractal architecture.) Indeed, the signature of fractal structure is coincidental to power law edge-of-chaos criticality dynamics (1/f pink or fractal noise). With all this in mind, what if the imaginary axis concerns the realm of ontologically real possibles that Kauffman suggests, and/or perhaps the flow of Hawking's imaginary time? Or perhaps that the process of fractal branching might represent new additions to the space-time (and self) that might accompany the objective reduction of the Penrose-Hameroff Orch OR model? The source of the relative and subjective self/not-self boundaries yet within one ultimately unified Self? In any case, the Mandelbrot set is intuitively and intellectually intriguing, qualitatively beautiful, and surely because of the many wonders it inspires, has been termed the “thumbprint of god”



Fig. 4. The complete stream of phenomenal experience: The combined flow of the classically embodied mind (interim waves), cyclically punctuated with loops of quantum consciousness – the inner complexity as place holders for all Planck scale self-actualizing behavior.

(Lesmoir-Gordon and Clarke, 2004).

Regardless of whatever ultimate answers might emerge, I now offer Fig. 4 as a depiction of the underlying duality inherent in our mindful phenomenal experiences – the full-on complex coupling of both quantum consciousness and embodied mind. The addition of the mini-loops within the central loop of quantum consciousness are place holders for all the combined lower level activity going on at ever smaller scales – all of which is still present in our bottom-up flow of self-regulatory processes. As described above, this could involve a continuous cyclic sojourn back to Unified Self, via the poised realm where possibles and probables ebb and flow and newly desired – pleasurable, more expansive – self-boundaries are chosen; the realm where the self/not-self symmetry break occurs (the expansive repartitioning of time, space and self) followed immediately by the gravitational self-collapse – the quenching, negative feedback reversal to Objective Reduction/Measurement. This cyclic journey would take us to that ultimate space where any form of consciousness that might be independent of the body might reside, the realm of a scientifically supportable “quantum soul” (Hameroff and Chopra, 2012). In this view, however, any “soul” or quantum potentials are *embodied*, knowable only from the bottom-up, rather than from the logos or “reason” of the complex human mind. This infinite realm of the Unified Self is an “inner” (rather than “higher”) realm, the ultimate origin and measure – if not creative actualization – of the self. I offer this depiction as food for serious thought for anyone choosing to enter this new frontier of science.

I also offer it also as another way of thinking about and mapping the standard brainwave patterns of the Electroencealograph (EEG) used to investigate the nature of complex brains (Buzsaki, 2009). These are the measureable brain rhythms, from fast to slow that oscillate across the brain at all times: *gamma* band (32+Hz; associated with highly focused, effortful attention and motor control) *beta* (15–32 Hz, normal active waking alertness); *alpha* (7–15 Hz, relaxed, drowsy waking states); *theta* (4–7 Hz, daydreamy, altered, and REM sleep states); and *delta* (<4 Hz, slow wave sleep), (rhythms conceived as “beats” of the much faster microtubules in the Orch Or model.) Together, they control the integrative brain functions at all sensory and cognitive levels. During daily experience a normal brain is scattered across all frequencies, staying primarily in waking range but constantly dipping into the slower ranges as well. As a rule, these rhythms manifest with several *superimposed* oscillations with varying degrees of amplitudes, duration and delays (Başar and Schürmann, 1996). Central to our discussion of emotional sentience, the *theta range* has also been associated with emotion (Lewis, 2005) and together with the slower rhythms is central to memory and its encoding (Klimesch, 1999) – to which I would add, that delta would then be the signature of the contribution of the core self-regulatory perception associated with quantum consciousness all the way down (perhaps the fractional – fractal – Brownian motion of the quantum plenum). Of course, to measure oscillatory behavior of the brain is very different than to measure it in say, microtubules, which vibrate at much faster mega (10^6 Hz), giga (10^9), and terahertz (10^{12}) ranges (Bandyopadhyay, 2014; Hameroff and Penrose, 2014; Sahu et al., 2013) – perhaps the range where “poised realm” (Kauffman, 2014) decoherence and re-coherence occurs and adjacent probabilities are tuned upward or downward, or tick forward or backward?

With all this in mind, in Fig. 3 above, I would align the gamma, beta and alpha rhythms with the flow of the classical embodied mind (the waves of waking state phenomenal experience), and locate the lower (unconscious) theta, and delta rhythms in the loops of quantum consciousness. Together, they manifest as the slow wave (bottom-up) and fast (top-down) contributions to the

EEG signature of self-regulatory activity – which in fact would reflect the reverse of the “speed” and small scale priority at which the processes are actually occurring (as in microtubules perhaps). Indeed, in our Russian Doll scheme (Fig. 2 above), the gamma rhythm wave would loosely relate to the largest doll in the set, the beta wave to the next smallest, on down to delta, representative of the smallest scales in space and time where purely quantum consciousness runs the show. Of course, from the human perspective, most of this inner activity remains hidden from our direct experience within our subconscious, unconscious, and sleep states. In short, as we are busy using our mindful awareness to get about in our daily lives, or even when sleeping, our brains (and branes) are venturing creatively into wild, wacky, and wonderful perhaps multidimensional territories of time, space and self. In fact, the goal of many contemplative spiritual practices is to consciously attain such transcendent or “enlightened” states of consciousness, many of which have been associated with specific EEG rhythms and/or coherence across them (Travis and Shear, 2010).

Indeed, understanding the dual components of phenomenal experience can help explain certain anomalous perceptual alterations that most of us have experienced at some point in our lives – rare but always impressive flashes of telepathy, precognition, out-of-body or out-of-time experiences, prescient dreams, Deja-vu experiences, minor telekinesis, oceanic spiritual oneness, or simply the serendipitously creative coincidences that we attribute to luck or divine providence. In fact, such anomalies have been the study of parapsychologists for quite some time, with small but consistent and significant effects having been noted (Wolman, 1977). Perhaps the most interesting and complete body of work is that of Dean Radin, who has reported upon many of the above anomalies (Radin, 1997) as well as how globally emotion-invoking events (such as the death of Princess Diana or the 911 attacks) map to changes in random number generators (Radin, 2006). He has also found evidence that focused intention can alter the outcomes of the famous double slit experiment (Radin, 2013). Likewise, such a view of consciousness might cast new light upon the nature of spontaneous spiritual experiences and/or the shamanistic transformative journeys induced by psychotropic “entheogens” (Ruck et al., 1979), sacred plants long utilized within aboriginal religious ritual for interaction with the divine. Clearly we have neural receptors that respond to such substances, and some suggest that entheogens can offer “profoundly revelatory truths, both spiritual and psychodynamic – truths that could prove highly relevant to our well-being, personally and culturally” (Richards, 2002).

Less mundane, yet more immediately pragmatic, is that acknowledging the dual aspects of phenomenal experience can shed light upon the “hallucinations” of the psychically disturbed, the empathic overlaps and deficiencies of deep attachment (at Martin Buber’s (1971) “I-Thou” interace), schizoid or multiple personalities and dissociative disorders, if not most forms of emotional, mental, and spiritual malaise. In fact, the new biology of emotion (Peil, 2014) suggests that there are crucial developmental windows for the emergent embodied mind of a child, wherein the bad-for-me socio-environmental context gets “under the skin” (Norman et al., 2012; Obradović et al., 2010), leaving behind telltale epigenetic and immune markers (Cole, 2009, 2010; Mattick and Mukunin, 2006; Segerstrom and Miller, 2004; Sternberg, 2001), abnormal stress responses (Boyce, 2007; Dickerson and Kemeny, 2004) malformed neural pathways (Meyer-Lindenberg and Tost, 2012; Tsankova et al., 2007; Zhang and Meaney, 2010), varying degrees of mental/emotional disorder (Boyce et al., 2001; Holmes et al., 2005; Worthman, 2009). Perhaps to plumb the depths of “the self”, is to discover new therapeutic insights into its scope and breadth, its being and becoming, its trauma and languishing, its resilience, flourishing, wellness, and wholeness.

Whatever the case may be regarding the role of consciousness in the creativity of the universe, there is now no question that quantum biology exists (despite the warm wet conditions thought to render quantum effects impotent), and has likely begun rendering the machine metaphor to the dustbins of history. Quantum effects have been demonstrated in light harvesting molecules (Engel et al., 2007), in bird navigation (Lambert et al., 2013) and in the sense of smell (Gane et al., 2013) which as I've argued is an extension of the original hedonic self-regulatory sense. Furthermore, the poised realm could well play a role in these effects, for the fractal signature of dynamic edge-of-chaos criticality seems apparent in biomolecules (Vattay et al., 2012), fostering a transitional electrical space that can accommodate either conduction or insulation, where computational functions can take place. Furthermore, the brain itself is also found to be critical (Chialvo, 2004, 2006). Indeed, a further extension by Stuart Hameroff, provides an explicit mechanism for integrating such biological information processing from branes to brains. He suggests that the criticality of complex networks evidences two levels of self-organizing hierarchy, an interface between cell membranes and microtubules, all of which have an internal quantum underground, a decoherence-free subspace of non-polar solubility ("pi resonance clouds"), olive-oil like regions where quantum superpositions are relatively stable. In short, while the functions of "branes" are telling enough, the microtubules run an even deeper level self-regulatory show – "the nervous system of the cell" – where anesthetics act and squelch mindful awareness. In fact, there is gathering evidence for the information processing and storage capacities of the microtubule (Bandyopadhyay, 2014) as perhaps the biological homologue of the semiconducting computer chip.

One final extension, however, also from Hameroff, is the addition of the deepest level *value system*, one consonant with the hedonic impulses of all living creatures – a value system to guide preferential free will choices between binary states. In the Orch OR model, for example, the flash of consciousness and free will that is emitted in the moment of measurement (objective reduction) constitutes the first form of "qualia". While the word qualia is often used to describe phenomenal subjective experience itself, this extension offers a more precise clarification, that at its first emergence quale is fundamentally *evaluative* exhibiting a qualitative preference for pleasure. He sets forth the "quantum pleasure principle" (Hameroff, in press) suggesting that microtubules and ultimately brains evolved to orchestrate and optimize OR-mediated pleasure and its behavioral pursuit. Indeed, why would a living system need to experience qualia at all if they were not of physical and biological functional significance? Here the deep level self-organizing physics of the universe meets with the view of the biosemioticians who realize that signs and meaning exist in all living systems (Barbieri, 2009) – to which I would add for neo-Darwinians: concerning the role of the subject, the ubiquitous pattern of hedonic behavior and its outcomes (adaptive development, niche construction, all learning ...) speaks for itself.

I have offered a vision of the universe in which there is an ongoing, unpredictable, participatory creativity, with subjective experience central to that process at every level – a far cry from the clockwork determinism of the Newtonian world, with its illusory free will – an impotent mind that can watch, desire and feel in control, but that cannot impact its destiny in any way. On the other hand, I've held up the idea that the language of mathematics can help us understand the puzzles of nature – a language with such acknowledged limitations Gödel's incompleteness (Goldstein and Alexander, 2006) that physicist (and Nobel laureate) Steven Weinberg laments: "We will never be sure that our final theory is mathematically consistent". Indeed, taking further the idea that

maths cannot be both completely accurate and completely universal, Gregory Chaitin posited the existence of the number "omega" (the "halting probability" for a Turing machine), and a number with no pattern or structure to it whatsoever – a number with "pure crystals of creativity" – implying that "randomness is the true foundation of mathematics" (Chaitin, 2008). But when placing the subjective self into the picture, this incompleteness might begin to make a bit more sense. Such "randomness" would likely describe the flexible creativity contextually required for the self-organizing self-actualizing choice-making dynamics to take place – it is the wide-open mathematical space for quantum consciousness. The space not where "God plays dice" but where any "Creator's" creative power is apportioned everywhere and to everyone. Should this be the case, we've come to nearly the exact opposite of the clockwork vision, to one of *radical accountability* for our creative endowments and historical constructions. Fortunately, nature has also endowed us with an innate guidance system to use that creativity optimally: our phenomenal experience with its True North of evermore complex pleasure.

3.3. Pertinent philosophical, psychological, and phenomenological thought

Indeed, the physical discussion thus far, while it can help bridge some fundamental conceptual gaps, fails to do justice to the highly complex phenomenal experiences of human beings – particularly the richly nuanced emotional experiences so biologically central to our self-identity and deeply meaningful to our personal lives.

The term "pleasure" for example, while crucial to understand as the evaluative mediator of the self-developmental imperative – the very driver of ongoing, optimal, becoming – is not to be conceptually limited to simple and immediate gratification. It extends through the autopilot *satisfaction* of needs and drives (the self-corrective rebalancing of each turn through the feedback cycle); through the basic spontaneity of *bio-interest* and *creative joy* of the moment, to such nuanced *complex pleasures* as *trust, confidence, gratitude, admiration, courage, wonder, honor, faith, devotion, love, and humanitarian compassion*. All the latter of which are *past, future, and/or self-as-other oriented*, and they emerge and endure as principal markers of optimal physical (Boyce, 2007; Xu and Roberts, 2010) psychosocial (Erickson, 1968; Maslow, 1970) and moral (Gilligan, 1977; Kohlberg, 1967) development. In other words, with optimal development these complex positive emotional perceptions come to be dominant in our experience, and although always punctuated by short term corrective pain, they characterize the state of human flourishing. The complex positive emotions are aligned with the newest portions of the triune brain including the prefrontal cortex, they are entangled with our uniquely personal experiences, our language, and early cultural context – they offer "positive" (amplifying, reinforcing) feedback information about the holdings of the *embodied mind* and how well they are actualizing the potentials of "the self" in its broadest meaning. The contribution from quantum consciousness here would be the not-yet-self "soul" potentials with feelings such as wonder, curiosity and intense interest, those that pull us to explore and actualize whatever facets of our being we find the most rewarding, yielding the diversity of interests, life trajectories, and personal specializations that foster the overall ecologically and economically co-creative arena of life. Such feelings would also be representative of any active information, quantum memory, or "spiritual" energetic tracings forged by any and every variety of classically embodied mind (including any potentially multiple incarnations). Yet, via entanglement and shifting boundaries within the Unified Self, they might sound the beckon call to much grander subjective gestalts of being and becoming, more majestic plans,

purposes, providential paths, and/or “sacred contracts” (Myss, 2003) we might have with our kin and historical cohorts. In short, complex pleasure serves as the resonant mediator of our divine destiny call.

In fact, this more meaningful and virtuous dimension of complex pleasure enjoys a rich history. It dates to antiquity, its seeds in Democritus, Socrates and Plato, yet perhaps best captured by Aristotle's Nicomachean distinction between simple *hedonia* (as immediate self-gratification) and *eudemonia* – the complex happiness born of living a good, complete, and meaningful life. (Practicing the virtues (“*arête*”) in one's everyday activities, subject to the exercise of practical wisdom (“*phronesis*”) to resolve any conflicts or dilemmas that might arise – optimal self-regulation via resolving emotional dissonance). Many of the ancients, of course, assumed reason and emotion to be opposing forces, with knowledge of the right and the good only attainable through rational activity. Epicurus, however, honored pleasure more pointedly, contrasting its short-term and long-term varieties, the latter with much greater and more lasting rewards. The Stoics, too, upheld *eudemonia* as the highest good, adding that given the limitations of our nature perfect virtue was an elusive dream, that to act “befittingly” (to optimally self-regulate) was the best we could do. Later, Augustine of Hippo, an early Christian, would elevate the superiority of reason to God-like proportions, miring our innate hedonic guidance (and human nature itself) within the doctrine of original sin and the dichotomy of good and evil (a false dichotomy, given this new science). Fortunately, Thomas Aquinas would help rescue the passions, reshaping the dimension of complex pleasure into the more positive, humanitarian, Christian ethic, wherein enduring happiness signaled blessedness or direct perception of God. Descartes, of course, introduced the machine metaphor and the authority of mathematics, liberating science from its theological constraints, yet severing the mind from its body (not merely privileging reason, but removing the sentient subject from physics. While theorists of the Scottish Enlightenment (Francis Bacon, David Hume, Adam Smith) along with Jean Jacques Rousseau revived emotion as central to ethical discourse, Kant's subsequent rejection of the happiness as goodness doctrine sounded its death knell, with existentialism ultimately dismissing it as little more than bourgeois fantasy.

More recently, however, the movement known as *positive psychology* has resurrected the original Aristotelian eudemonic vision with the goal of identifying strengths and virtues as causal factors in human flourishing – with positive emotion a central foundational pillar (Seligman and Csikszentmehalyi, 2000). The result, thus far, is a gathering body of evidence for the creative, self-developmental and self-actualizing functions of the positive emotional regime, as well as the cooperative and altruistic behaviors they inspire. Indeed, positive emotions have been associated with the prefrontal cortex – the neurological site of consciousness, linguistic categories, volitional action, executive self-regulatory control (Frith and Dolan, 1996), our relational identity, and optimal cognitive schemata (Fuster, 2008). They “broaden and build” (Fredrickson, 1998) and “inspire and rewire” (Haidt, 2003) the mindscape and social landscape, moving us to bond with others, to “mend, tend, and befriend” (Taylor et al., 2000), expanding our empathic boundaries, and to “shift and persist” (Chen, 2012) during formidably painful challenges. Given the intimacy between emotion and the immune system, they even promote vibrant health (Fredrickson, 2000; Richman et al., 2005), longevity (Carstensen and Mikels, 2005; Xu and Roberts, 2010), and may underlie the placebo effect (Lidstone, de la Fuente-Fernandez and Stoessl, 2005; Michael et al., 2012). Largely missing from this effort, however, is the integration of the *negative evaluative pole* – the painful emotions – into the story, as well as a

deeper understanding of the biophysical nature its self-regulatory function. In fact, psychology as a whole (if not the social sciences in general), makes certain pragmatic assumptions about human nature (particularly those concerning consciousness, free will, emotional “disorder” and pharmaceutical intervention) that are unfounded, often incompatible with classical physics, and/or more current understandings of genetics, epigenetics, and evolutionary biology.

There have also been, however, alternative philosophical voices throughout history, many within the phenomenological tradition, prodding scientists toward more nuanced approaches to consciousness, mindful sentience, and such concepts as *the self*. Indeed, despite little – if any – connection between the *nature of subjectivity* and the *pleasure-as-good* lines of inquiry (even within single theorists), when examined together through the lens of the new science of emotion, we find many offerings that parallel or dovetail quite cleanly with the phenomenological duality on offer.

Nietzsche, for example, while quite prescient about the moral dimension and power dynamics of emotion, adopted the Cartesian denial (the “death of the subject” as it came to be known), suggesting that the notion of an acting experiencing subject was an artifact of language. Realizing the freedom and personal accountability required for ethical concerns, Kant rejected this position, suggesting that an “I” is required to make knowledge claims and pass judgments. The Kantian “I” was represented as a pure unity relating to itself – likened to the aforementioned self-reflexive feedback loop – as well as a notion of an ultimate Unified Self. Had either of them known, however, of the self-relevant nature of emotional stimuli (and its self-regulatory function), they may have been able to distinguish between the conditioned and linguistic judgments of the embodied mind (associated with the top-down complex emotions) and the *biological evaluations of the body* (the ancient, bottom-up, hedonic valence, rooted in quantum consciousness) – upon which the entire semantic dimension of language relies. This understanding would also have enhanced the notion of Kantian wholes with “ascending and descending chains of determinism” ... “regressive and progressive causality” (Kant, 1900), cleanly capturing the dual nature of identity, the part-to-whole fractal self-structure, and the bi-directional feedback and feedforward dynamics of self-organizing systems. Fichte, rejecting the notion of the I-am subject as preformed, highlighted its developmental quality (capturing the unfolding nature of the embodied mind). He also noted how limiting one's urges for immediate gratification both honors others and accountably respects the freedoms we all share (also noting the self-disciplinary aspects of self-regulation). Schelling then added how the subjective self emerges naturally and remains part of nature (the eternal I AM of the Unified Self), despite which we objectively bound and differentiate ourselves so successfully (via our embodied minds) as to create the illusion of traditional dualism.

Hegel (1931; 1969) also captured many facets of the embodied mind, suggesting the self was a result of development, growing out of immediate sensory self-awareness and social self-consciousness gained through interpersonal relationships, and finally to a form of “spiritual” universality through participation in ethical and cultural life. Hegel characterized this formative process as part of three interdependent ‘dialectical’ patterns: *symbolic representations* operating through the medium of language; *cultural creations* operating through the medium of the tool; and *reciprocal interactions* operating through the medium of moral relations. In each case the subject is formed as both an individual and social being, and to reconcile any sense of separateness along this developmental trajectory is to recognize our common spiritual connection to nature – capturing the part and whole nature of identity, the empathic expansion of one's self-relevant sphere, and the

ultimately Unified Self of quantum consciousness. Indeed, Hegelian dialectics pointed perhaps the most directly toward the deeper self-organizing processes. In fact, his triad of dialectical roots in language, culture, and social morality are secondary extensions of the *primary self-regulatory process* driven by the experience of *emotional sentience*: With primary *symbolic evaluative representations* operating through medium of *binary sensory signals* (the common bodily language of emotion); *self-corrective creative actions* operating through medium of *bodily behavior* (those that create new environmental conditions); and *reciprocal interactions* operating through the medium of *social hedonism* (the interpersonal use of *intrapersonal* emotional perceptions). Furthermore, even these depend upon several deeper unifying dialectics those of the fundamental *self-actualizing* creativity of the universe: the ongoing *self* versus *not-self* comparison operating through the medium of phenomenal experience (symbolic representatives of the original *self/other* symmetry break; and/or Orch OR self-collapse; and/or the creative self-reflexive feedback loop); the *self-determining re-actions* of matter in motion operating through the medium of quantum information; and the ultimate dialectic reciprocal dance between *possibles* and *actuals* operating through the medium of *res potentia* and *res extantia* – the process of being and becoming itself.

In fact, modern readings of Hegel suggest that the *bodily desires* were central to his thesis of experiencing oneself as a subject, equating self-consciousness with desire in general (Jenkins, 2009). Of course, it would be Merleau-Ponty, who would firmly root subjective being-in-the-world back within the living body. He spoke of its temporal complexity and “intentionalities” – its “protentions” and “retentions” – clearly referring to the anticipatory and memory capacities of the embodied mind. I share this new science in his honor, for – regardless of the validity of any deeper forms of cosmic consciousness – the loop of mind is classically instantiated in crude molecular circuitry, and it is inseparable from emotional sentience, the primal, foundational, proprioceptive (Sheets-Johnstone, 2011) or “interoceptive” (Craig, 2008) sense that first emerged in living systems. An inaugural sense that delivers *primal perceptions of time, space and self* – perceptions of “how it feels to be alive” (Fingerhut and Marienberg, 2012), the feeling of what is happening (Damasio, 1999), our sense of “finding ourselves in the world” or the “feeling of being” (Ratcliffe, 2005) – one that may go all the way down. Of course when emphasizing the emergent nature of such sentience, it fair to assume that in the downward direction some “submergence” will eclipse it (Hunt, 2001). Should this prove to be the case, however, Williams James' weaker claim of epistemological pan-experientialism would still hold, given the abundance of semiotic signaling and hedonic behavior across living systems. So this new science of emotion goes out to James as well, neither stranger to the embodied nature of emotion (James, 1884) nor its role in uniquely spiritual experiences (James, 1958).

Nonetheless, perhaps it was Alfred North Whitehead's *ontological pan-experientialism* that most explicitly set forth the deepest implications of this sort of sentience. Indeed, a mathematician, perhaps disillusioned by its limits, set forth an ontology of *process* rather than things, a metaphysical framework of being and becoming in which subjectivity is central – a model integrating many facets of the physics and functions of emotion emphasized here, a few of which I can touch upon briefly. In a nutshell, his was an effort to describe phenomenology at all scales, one unbounded by space and time, serviceable for our everyday world and the universe itself. It described an ongoing process wherein possible occurrences are transformed into actual realities in an ongoing sequence of “prehensions” – a prehension connoting the transition from the many antecedents in a plural universe to the one “actual

occasion of experience,” quite reminiscent of the feedback loop of quantum consciousness. He describes a reduction in the complexity of the possibles to a unity of the chosen actual, with negative prehensions as those that do not become concrete and positive prehensions as those that do, connoting a conceptual space (like the poised realm) wherein probables can be tuned up or down, ultimately reaching a positive threshold and becoming the actual occasion. This is also a reciprocally creative process for potentialities, by definition, can be actualized in many different ways, and by each unique actual occasion something new is added back into the universe.

Indeed, Whitehead's “actual occasion of experience” is a key concept, not a substance or material but an activity of realization – of self-realization – a flow of occasions from potentials to actuals that constitutes the common subjective experience of entities from subatomic particles up through simple living systems and on up to human beings. The actual occasion is also a process that weds the subject and object in the unity of immediate “feeling” experience. The subject with its perspective does not pre-exist its feelings but creates itself through them, a subject that has a care-like “concern” for its object (s). As he put it: An “affective tone drawn from this object and directed towards it” (Whitehead, 1933). “An actual occasion is a concrescence effected by a process of feelings” ... “feelings with elements of identity and contrast” integrating (and made concrete) into their final unity, a feeling of “satisfaction” (Whitehead, 1927). Given that the actual occasions are the ultimate basic entities of the universe, with the notion of ‘satisfaction’ Whitehead is acknowledging emotion at the most basic level of existence. This not only connotes the satisfaction of restoring emotional equilibrium, but also the satisfaction of all innate biological drives and psychosocial needs – those that are loosely set forth by Maslow, encoded in the appraisal themes of the basic and complex emotions, and are prioritized extensions of the dual self-regulatory imperatives of self-preservation and self-development. In fact, Whitehead's offering was in direct response to the limits of positivist science and philosophy that even today cannot account for ‘the mass of our moral, emotional, and purposive experience [that] is rendered trivial and accidental’ (Whitehead, 1968). Instead, he offered a vision characterizing the creativity of the universe as “the throbbing emotion of the past hurling itself into a new transcendent fact.” (Whitehead, 1967; Mickey, S., Hamrick, W. S., Van der Veken, J., 2013); a vision most enlightening, enlivening, and timely. Indeed, to recognize and honor this common “spiritual” – humanitarian – core is the central theme of *Ubuntu*, the brand of human kindness, sharing and cooperation rooted in a universal bond that connects all humanity. More, the concept of *Ahimsa* (within Jainism, Hinduism, and Buddhism) extends this universality of feeling, this spark of the divine spiritual energy, to all living beings; holding forth the virtue of knowing that to hurt another being is to hurt oneself. As Stephen Hawking put it: “The future of mankind should be empathy. This would help us avoid catastrophes and wars and teach us how to reach the stars” (Hawking, 2015).

4. Conclusion

Throughout history voices have been raised against the idea that phenomenal experience has no efficacious or functional role in the physics of being and becoming: “The particulars of consciousness, so far as we know them, points to its being efficacious” (William James, 1890); “Subjectivity is the consciousness that represents something, relates this representation back to itself, and so gathers with itself” (Martin Heidegger, 1927); “When I say that I have senses and that they give me access to the world, I am not the victim of some muddle” (Maurice Merleau-Ponty, 1945); and

perhaps with increasing impatience: “We are not brain puppets” (Deepak Chopra, 2014). Meanwhile, it has become clear that failure to act upon and resolve one particular type of phenomenal experience – lingering emotional distress – has profound repercussions for the physical well-being of a living system (Peil, 2014). Recent efforts to shift toward an endophysics perspective (to incorporate the view from within), to naturalize phenomenology, to replace limited Enlightenment paradigms with an Enlightenment focus – with embodied mind and sentient life at the center – all seek to place the subject within the bounds of scientific inquiry, and all can help answer these plaintive cries.

I have argued that the new science of human emotion, as a complex version of an ancient inaugural “self-regulatory sense” can offer a major step in this direction – suggesting that phenomenal experience and subjective identity have long played a central role in evolution. That Descartes was wrong about identity rooted in thought alone, that “sentio ergo sum” – *I feel therefore I am* – is more biologically accurate. That even the simplest living systems enjoy a minimal embodied mind, an elegant self-regulatory mechanism instantiated via the molecular circuitry within the cellular membranes (“branes”) of single celled organisms as well as the wide variety of cell types in multicellular organisms, a molecular toolkit still involved in signaling cascades of whole-self immune, genetic and epigenetic regulation (a toolkit known as the “molecules of emotion” (Pert, 1999)). That, as the biosemioticians suggest, this yields the conclusion that for meaningful “signals” subjective perception is required; perception that is born of a three step thermostatic/homeostatic loop that instantiates the embodied mind – one that keeps the self in coherent balance. This three step loop involves first a *self/not-self comparison*, a signal when imbalances occur, and this signal then triggers a coupled self-correcting *response*, one that restores balance to the self-system – and over time cyclically forges an ever-more complex and integrated sense of identity. That the key binary “signal” is the qualitative experience of pleasure or pain, which together offer a subjective reflection of the criteria for natural selection, drive hedonic behaviors in creatures at all levels of complexity, and underlie all classical conditioning and all higher forms of learning, evaluative reasoning and semantic language. That this first crude mindful sentience – and its ancient evaluative logic – remains encoded, yet untapped, as self-regulatory information embodied within our common everyday feelings, the innate guidance that accompanies genuine free will agency.

While this new view of emotion unites many divergent bodies of literature and theory, examining this process through the lens of physics poses a new conundrum. It becomes clear that to accomplish the adaptive behavior that results, as well as to explain the fundamental “self/not-self” comparison, requires a sojourn into the realm of quantum mechanics – a journey that suggests that phenomenal awareness is comprised of two components, one from each realm: the classically *embodied mind* and of a core *quantum consciousness* (perhaps even worthy of the time-honored term *soul*.) Indeed, one is confronted with the possibility that such sentience goes all the way down, that consciousness itself may be a central component of a pansentient, panpsychist universe – where the notion of “self” becomes central to the self-organizing dynamics, of multidimensional fractal complexity, and perhaps essential to the observational measurement that creates matter if not the classical world itself.

To address this conundrum I've offered a vision of two different but interacting aspects of phenomenal awareness, one from each physical realm, yet each providing its own uniquely crucial function in the creative self-actualization of the universe. The first is the classically *embodied mind*, emerging at birth and forged by self-regulatory sentience; and personally complexified by ongoing life

experiences. It is the aspect of awareness that requires active participation and adaptive reactions. This embodied mind is instantiated by both branes and brains, perhaps orchestrated in physical microtubules with computational functions akin to the computer chip. It provides our daily waking state flow of awareness and serves as a repository for memory, knowledge, conditioned motives, attitudes and personal beliefs. It is also the top-down communicative inroad, enjoying supervenience upon lower systemic levels of the body (immune and epigenetic processes) via emotional valence and its common binary self-regulatory code, giving rise to placebo and nocebo effects. This embodied mind then interacts directly with the second aspect, a foundational *quantum consciousness* – an ultimately Unified Self-Awareness that pervades the universe (or multiverse as the case may be), with an infinite capacity to break self-symmetry and create infinite boundaries within itself that ebb and flow and serve as subjective spheres of experience to countless mini-self monads of being and becoming. This quantum consciousness might reside in a realm of infinite, ontologically real, possibles, self-reflecting into various gestalts of self-identity; gestalts of subjectivity that ebb and flow with the dynamic precision of networks, with edge-of-chaos criticality and attractor landscapes that creatively orchestrate the tuning of possibles into *probables*, and then play the local role of *observer* – collapsing them into *actuals* – events and structures in the classical world, those that meet in the everyday experiences of the embodied mind.

I've offered some theoretical models and described some mathematical devices that might support such a vision, along with the gathering evidence that quantum biology is real despite the warm, wet, nature of embodiment. Drawn connections between the Theise and Kafatos (2014) model of pansentience all the way down, with self-symmetry that could provide the foundational self/not-self distinction, and the Penrose-Hameroff model of Orchestrated Objective Reduction that could physically instantiate such sentience via the gravitational self-collapse between two or more possible configurations of space-time (Hameroff, 2012) – perhaps embodying an evaluative preference via the quantum pleasure principle (Hameroff, in press). These visions are further enhanced by Bohm's offering of active information, and Kauffman's (2011) addition of the poised realm, where matter can hover between classical and quantum states, perhaps tweaking possibles into and out of adjacent possibles that then collapse into actuals, perhaps trapping themselves via rapidly repeating self-observations and sustaining their classical self-actualization. I've also offered some evidence from parapsychology that such a view can help explain anomalous experiences that distort the nature of time space and self (Radin, 1997) and how they might present as disorders and developmental traumas of the embodied mind (Peil, 2014). And while I've pointed toward some likely mathematical processes – the nature of equations, iterative functions and their roles in cellular automata, network criticality, renormalization, and fractal geometry – I've also acknowledged their Gödelian limitations, suggesting that incompleteness and randomness might instead be the very creativity (Chaitin, 2008) required when factoring the self into the self-organizing forces of the universe.

I've noted the trends in philosophy, psychology and phenomenology relevant to the new science, following the strands of both pleasure-as-good line of inquiry alongside the often separate inquiry into the nature of the subjective self noting the common themes of self-organization, self-regulation and self-actualization in its grandest sense. Indeed, there have been many who have gestured toward the vision offered herein, toward an ultimate foundational process at work – a cyclic process driven by a dance of Yin/Yang opposites as the Taoists suggest, or by a process of thesis, then antithesis, resolving into synthesis as Hegelian

dialectics suggests, or even the ongoing creative and destructive battles between forces of good and evil that the religious fundamentalists suggest. But it has also been noted as a process with an inherent value system, for nearly every religious tradition in some way notes the virtue of our innate quantum hedonism, with such complex phenomenal pleasures as love, gratitude, compassion, forgiveness, ecstatic awe, and faith associated with the divine. But to recognize an ultimate core of Self, creatively apportioning – reflecting – itself into infinite versions of self and not-self, experiencing its own creativity in infinitely many ways, is to look to a deeper unity within each dichotomy. It is to face the possibility that – all along – we, ourselves, have long been physically forging our very reality, while apportioning credit or blame to chance, supernatural forces, or evil “others” – that as Pogo put it: “We have met the enemy and it is us” (Kelly, 1953), a revelation that must be met with spiritual fortitude and radical accountability rather than continuing denial.

But to acknowledge the physical complexity of the subjective self is to also embrace the vast untapped creative potential of human being and becoming. For we have also met the creator, and it is us.

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