Opinion and Perspectives

The Place and Role of Consciousness in Human Psychoarchitecture

Robert W. Boyer

Abstract

The ontological place and causal role of consciousness is examined in evidence-based models of mind. The challenge is highlighted of placing disembodied functional cognitive models of conscious processes emphasizing downward causation into embodied neuropsychological structural models of unconscious processes emphasizing upward causation. Recent quantum theories that posit abstract information space and nonlocal mind are shown to be progressing toward the model of mind in ancient Vedic literature. The Vedic model provides the basis to resolve the challenge through an expanded ontology of subtler levels of nature underlying the physical.

Key Words: psychoarchitecture, information space, nonlocal mind, Vedic model of mind

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Introduction

The primary approach to gain knowledge in modern science is the outer, indirect, third-person objective approach. Applying this approach to inner subjective processes, a general model of mind or *human psychoarchitecture* has not been achieved even after 3000 years of western philosophy and science. A brief historical account of experimental research in psychology shows that certain conceptions have arisen repeatedly, however, which can be mapped together into a general functional model.

But attempts to place the functional model in brain structure suggest that an ontologically real causally efficacious conscious mind is logically inconsistent with physicalism. Recent quantum theories posit an abstract nonlocal information field or mental space underneath the physical. This fits the Sankhya model of mind in ancient Vedic literature and is shown to provide the basis to reconcile the challenge of integrating functional models into structural models. The ancient Vedic model applies the inner, direct, first-person approach to gain knowledge in Yoga, suggestive of systematic means for consciousness studies that have been overlooked in modern scientific epistemology. The steps of the paper are:

I. Summarize progress toward a disembodied functional model of mind.

II. Make explicit the challenge of embodying the functional model in physical brain structure.

III. Summarize progress in quantum theories toward nonlocal mind underlying the physical.

IV. Show how the theories are consistent with the ancient Vedic model of mind in Sankhya that can resolve the challenge.

I. The cognitive paradigm toward a general functional model of mind

For brief historical context, the task in the behaviorist paradigm prominent in the first half of the 20th Century was to build predictive theories of lawful relationships between observable macroscopic stimuli (S)

Corresponding author: Robert W. Boyer, Ph.D.
Address: Institute for Advanced Research, Box 4052, Malibu CA, 90024
Phone: 1-641-472-2566
e-mail: rw.boyer@yahoo.com
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and responses (R). In this paradigm *hypothetical constructs* and *intervening variables* to describe unobservable processes in-between stimuli and responses—such as attention, mind, and consciousness—were placed in a 'black box' and rejected as legitimate topics in scientific psychology. About the same historical period, and applying similar 'positivistic' perspectives, the initial orthodox (Copenhagen) interpretation of quantum theory in physics constructed a conceptual 'inviolable wall' beyond which it was assumed that there are no answers to questions about quantum reality because it doesn't exist. In this view only the physical really exists. As Bohr, the founder of quantum theory, asserted, "There is no quantum world.... [T]here is only an abstract quantum description (In Herbert, 1985, p.22)." Einstein's notion of *hidden variables* to assert his belief in the incompleteness of quantum theory is similar to hypothetical constructs and intervening variables hidden in the 'black box.'

Indirect third-person experimental research in psychology soon progressed beyond the behaviorist paradigm to the cognitive paradigm that posits unobservable 'black box' processes. As we will see, recent quantum theories also have progressed beyond the 'inviolable wall,' and even out the bottom of the 'black box.' These new theories address the age-old mind-body problem in a manner that allows the possibility of a real causally efficacious conscious mind.

Into the 'black box'

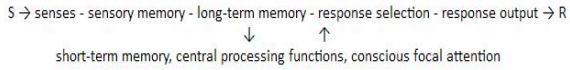
Scientific psychology progressed into the 'black box' via disembodied *functional* accounts of psychological processes. The shift to the cognitive paradigm came with evidence stimulus-response relationships depend on the unobservable *information value* of stimulus input. Research supported the inference that inside the 'black box' are complex information processing functions not observable from the outer third-person perspective, such as sensory discrimination, memory, innate drives, intelligent decision making, attention, and consciousness.

Stage analytic models

Initial cognitive models conceptualized a linear sequence of stages inside the 'black box' through which parallel inputs (S) narrow down to serial behavioral output (R). Broadbent's seminal 'filter theory' (1958) implied that consciousness is associated with the stages of perceptual input analysis and response selection. Research on activation of long-term memory, however, showed that perceptual analysis including semantic meaning is not as capacity-limited as initially theorized, and doesn't necessarily involve conscious attention (e.g. Leahey, 1979). Consciousness was then placed later in the sequence, associated with decision making and output selection. Evidence supported a two-process theory of unconscious automatic versus consciously controlled processes (Shiffrin & Schneider, 1977), akin to the recent metaphor of zombie or 'auto-pilot' versus 'conscious pilot' modes of processing (Hameroff, 2008).

Levels of depth of processing

Automatic processing further implied that consciousness doesn't necessarily have a functional role in *any* stage between stimulus input and behavioral output once a task is automatized. The linear 'horizontal' conception of early and late stages was elaborated to include a 'vertical' notion of shallow non-conscious and deep conscious processing related to attentional resources—called *depth of processing*. Once automatic processing develops, conscious attention is not required; conscious attention was associated only with deeper interior stages. A related concept of depth developed from studies of long-term semantic memory activation. Inputs receiving functionally deeper conscious attention in short-term working memory resulted in stronger and typically longer lasting memory traces when encoded in long-term memory; but retrieval from long-term memory can occur without conscious attention. In other words, the disembodied functional 'black box' was divided into two levels of an *inner dimension* of depth, expanding the linear stage model:



Similar two-process theories of deeper levels of mind developed using introspective approaches prior to behaviorism. Wundt (1907; 1912) delineated an apperceptive focal attentive process and an apprehensive

inattentive vague periphery, involving 'retrogradation' in which an initial conscious task faded out with practice into a reflexive habit. In the 'law of two levels' proposed by Titchener (1908, 1913), Wundt's student, focal conscious tasks 'degenerate' with habitual practice into acquired automatic reflexes with no affective components such as effort. The inner sense of performing the task continued in a *fringe* of conscious experience—no longer in focal attention or requiring effort but still conscious. A related model of fringe regions was proposed by James (1890).

The models implied fringe regions not only of shallower preattentive input processing but also conscious processes functionally even *deeper* than focal attention. The deeper fringe relates to an extended range of processes underlying focal attention, similar to contemporary notions of the *richness* or *thickness* of conscious experience (e.g. Siegel, 2008; Schwitzgebel, 2008). The deeper interior fringe includes undertones of feelings and a global sense of self or 'I' as agent of the response output. This is somewhat implied in contemporary *global workspace theory* (GWT), according to which consciousness functions as a generalized central workspace analogous to center stage of a theatre (Baars, 1997).

Objective emotions and subjective feelings

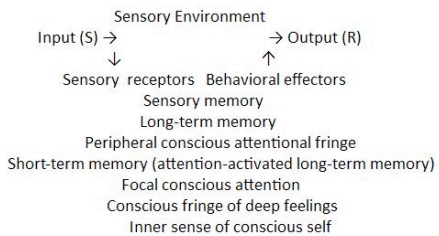
The notion of an interior conscious fringe functionally deeper than focal attention concerns an important debate in the psychological literature about the primacy of either cognition or affect. On one side of the debate were theorists who thought that emotions depend on the cognitive evaluation of an event in attributing meaning to a situation (e. g., Lazarus, 1984). On the other side were theorists who felt that cognitive evaluations depend on deeper, subtler undertones of affect that are more powerful contributors to the sense of self and intentional direction of behavior than cognitive thinking (e. g., Zajonc, 1980).

The term affect covers both emotions and feelings: to *emote* is to show, display, or express feelings. To delineate them, *emotions* are observable behavioral expressions in the body typically exhibited in body language, gestures, postures, facial expressions, voice tone, and verbal utterances; and *feelings* are unobservable conscious inner felt senses that are functionally deeper interior processes (e.g., Zajonc, 1980; Damasio, 1999). The inner dimension included levels of increasing depth from emotional behavior to interior cognitive thinking to deeper interior feelings.

The attribution of feelings as functionally 'deeper' than cognitive thinking extends the model of levels of depth. Conscious processing has a deeper conscious fringe of feelings, including a deep interior 'felt sense' of a holistic functional 'I' or self. In other words, the 'black box' was further divided into levels of the inner dimension from shallow to deeper functional levels, the deepest and most integrated level being a globally integrated or holistic conscious self.

The human information processing system as a conscious self or 'I' is proactive, guided by top-down feelings and thoughts in *downward causation* to achieve its own valued internal states and external conditions. But it is also reactive to unconscious sensory input processes in *upward causation*.

The simple model depicted below summarizes a massive body of research over the past 150 years that had not been mapped together into a functional model of mind. Importantly it is generally consistent with both *third-person* experimental findings and *first-person* phenomenal experience. Levels of depth of the inner dimension are depicted vertically, with earlier functionally more surface processes on top and later, more central and functionally deeper processes on the bottom. (Note that the terms 'top-down' and 'bottom-up' reverse the vertical dimension as depicted in this model).



II. The challenge of embodying the functional model in physical brain structure

The notion of 'deeper' in *functional* models refers to more extensive involvement of higher-order, holistic conscious processes. But a contrasting notion of 'deeper' is associated with structural models that embody mental functions in the brain/body system. These models generally follow Freud's (1949) psychobiological model of '*depth psychology*' that emphasizes unconscious processes underlying consciousness. In this widely accepted view the notion of 'deeper' relates to levels more fundamental than conscious processes, including the preconscious, deeper unconscious psychobiological, and even deeper biophysical processes. This embodied *structural* notion of depth is reductive—into lower-order unconscious biophysical processes that underlie holistic higher-order conscious processes and are the basis of the conscious part of the mind.

When functional models attempt to be embodied in physical brain structure, different meanings of depth become apparent. In functional models causal efficacy refers to higher-order conscious processes in a holistic self or 'I' that directs lower-order neurobiological processes in *downward causation;* and *upward causation* relates to sensory input processes that influence higher-order functions.

But when placed in brain structure, another meaning of upward causation is emphasized. Structurally, upward causation emphasizes lower-order unconscious biophysical processes upon which all higher-order functional processes are believed to depend entirely, according to the physicalist view of nature.

Selected prominent models will be summarized to highlight the challenge of placing disembodied functional models of a causally efficacious, holistic conscious self emphasizing downward causation into reductive models of lower-order, unconscious brain structures emphasizing upward causation.

Damasio's model of consciousness as a 'feeling of knowing' in a *complex neural network*

The model by Damasio (1999) is used to begin making explicit the challenge of embodying the functional model of mind in brain structure. Similar to cognitive models with respect to functions, this model contains increasingly higher-order levels—proto-self, core self, and autobiographical self— comprising an integrated life regulation system from lower-order components for metabolism, reflexive action, motivation, pleasure and pain to highest-order processes of 'high reason' and 'conscience.' The proto-self is a *first-order unconscious* internal mapping of the organism's state, implemented through interconnected neural pathways from brain stem to cerebral cortex. Consciousness is said to be generated from an integrated but transient neural pattern that fuses participating brain areas together into a higher *second-order conscious* mapping, which feeds back via downward causation to influence the first-order mapping. The system is driven by sensory input which activates the various levels of processing.

The second-order conscious mapping, associated with the core self, includes the superior colliculi or tectum, cingulate cortex, thalamus, and prefrontal cortices. Prefrontal cortices also come into play in even higher-order extended consciousness associated with continuity in long-term memory of the autobiographical self (Damasio, 1999). According to this model, consciousness is a momentary feeling of knowing that coheres into a higher-order extended stream of consciousness associated with the autobiographical self.

Whereas *functional* depth is toward higher-order holistic conscious processes with the power of downward causation, the notion of *structural* depth is toward lower-order, reductive, non-conscious biophysical processes that control higher-order functions in upward causation. Conscious mind is somewhere and somehow generated by the neural network of lower-order processes. It becomes more apparent in the next model that the different verbal conventions of 'depth' concern core issues of the ontological place and causal role of consciousness.

Edelman and Tononi's model of consciousness as reentrant connections in a *neural swarm*

Edelman and Tononi's (2000) model addresses consciousness by a more concrete notion of function and a more abstract notion of structure. Functionally it delineates lower-order primary consciousness and higher-order secondary consciousness, again similar to two-process models. But it also proposes how lower-order neural structures generate consciousness, via the principles of *reentry* and *selectivity*. Reentry refers to reciprocal interaction of functional neural groups; selectivity refers to evolutionary development of the brain through interaction with the environment in natural selection.

Complex, strong, and rapid reentrant neural interconnections across multiple groups in parallel are theorized to allow for the stable integration or coherence to create consciousness in a changing swarm of neurons called a *functional cluster* or *dynamic core* (Edelman & Tononi, 2000). This model is supported by computer simulations of large collections of neural units. No specific area is given the role of coordinating the different functional neural groups. Rather, the dynamic core *emerges* with sufficient differentiation of functional groups and integration of reentrant activation.

In the computer model the requirement of coherent holistic guidance in top-down control is added by a simulated "*value system*"(Edelman & Tononi, 2000; p. 46). In living organisms, however, the value system is said to develop in neural activity as explained in the notion of neuronal group selection termed "Neural Darwinism" (Edelman & Tononi, 2000; p. 83), which brings us to the second core principle in this theory, *selectivity*.

In this theory human information processing does not consist of coded programs based on logic and representational memory characteristic of artificial intelligence in computers programmed into the system from outside. The value system that shapes behavior emerges in the biological structure via developmental as well as experiential selection, slowly evolving into an integrated behavioral system of a holistic self with diverse functional capabilities including consciousness in the service of survival.

This and the previous model exemplify core issues of neurocognitive and evolutionary psychobiological approaches within the physicalist paradigm. With random mutation, some organisms happen to be more capable of surviving; and consciousness is said to emerge spontaneously in this way, naturally favored if it increases survival. But lower-order, *structurally* 'deeper' physical processes are believed not to have consciousness or survival functions. How and at what degree of neural complexity does consciousness and the instinct or intention to survive emerge?

Outside of neural cells in the brain are various tissues, arteries, veins, glial cells, skeletal encasement, skin and hair. Farther outside can be said to be the organism as a behaving unit, as well as the larger social context of family, community, nation, culture, and world system. No ontologically real super-ordinate holistic self or 'I' has been found in the physical as emerging from complex neural reentrant interaction or any feedback, non-linear, referential or self-referential physical interactions that could have volitional control of the brain. If the conscious self as a coherent behaving unit has causally efficacious intentions that actually effect change in the physical, it has to exist somewhere. Also, the conscious self as a coherent behaving unit seems fundamental to the concept of biological survival; and in living organisms the 'value' or 'preference' for survival seems necessary to begin with for natural selection to contribute to evolution of higher life forms. What would survival mean absent a holistic self—survival of molecules, atoms, or quanta?

On the other hand, perhaps there is a holistic self or 'I' not conscious of being a self, such as possibly in plants that also appear to exhibit survival behaviors, or that might have some small degree of proto-conscious self. The survival instinct and the conscious self or 'I' as *inherent* in neurons—not first emerging at some undefined level of neural complexity outside of neurons—is proposed in the next model that treats conscious mind even more reductively, placing it deeper in the physical structure.

Llinas' model of consciousness as the 'I' or 'command and control function' *inside* the neuron

Llinas' (2001) model tries to embed function even more tightly into structure. It provides an alternative to neural network complexity as the basic generator of consciousness. This model focuses on the ability to predict the results of actions and modify evolutionarily 'fixed action patterns (FAPs)' via higher-order, super-ordinate volitional control to respond more effectively to environmental changes in the service of survival—again consistent with two-process theories. In this model *functional* levels are described as levels of memory from shallow sensory memory to deeper phylogenetic, genetic, implicit, and explicit memory to the deepest level—the holistic 'I' or conscious self similar to Damasio's 'autobiographical self.' The levels comprise a centralized "command and control function" to predict appropriate action patterns and shut off or modify fixed patterns by conscious choices of the "I" (Llinas, 2001, p. 33). The 'I' is functionally the deepest, highest-order level with top-down control or downward causation of lower-order processes through feedforward and feedback mechanics.

In contrast to the previous models, however, this model posits that the value system that predicts the results of actions and directs behavior is *not* based on natural selection through environmental interaction. Each level of physiological genesis is *intrinsically* organized self-referentially. The model further emphasizes the critical role of conscious *qualia* as the essence between input and output, stimulus and response. Qualia are attributed the crucial work of sensation, integration, decision making, and prediction through which the conscious organism implements survival behavior. These functions are held to be *inside each neuron*, elaborated in more complex neural networks. The unobservable 'black box' of conscious mind is reduced from the macroscopic stimulus-response gap of observable behavior to the microscopic input-output gap in a self-referential system somewhere inside each neuron.

This model is more reductive than neural network complexity models in that it places some form of conscious mind *inside* neurons—but it does not reduce it below the neuron into more fundamental organic and inorganic physical processes. In attributing some degree of conscious mind to individual neurons, it is in the direction of *panpsychism*. How a proto-conscious self with some level of phenomenal experience associated with qualia is generated inside neurons is a mystery in the model.

The binding problem and the causal efficacy problem

The core issue being discussed here was captured in Whitehead's (1925; p. 194) insightful comment, "The whole of science revolves around this question of enduring organisms." The issue is how and where lower-order neurobiological processes bind into a higher-order *enduring self* for coherent survival behavior. This is associated with the *binding problem*. The binding problem can be taken structurally 'deeper' into elemental, atomic, and subatomic levels that are inert, non-conscious, non-living with no sense of self, survival, or ability to decide and perform action intentionally.

Lawful processes in nature do bind together pieces of inert matter into atoms, crystals, planets, and stars. But unlike these inert structures, in living organisms there is an *individualized* binding into a holistic self with the instinct and volitional intention to survive. How does the value or preference to survive get into inert random valueless physical systems in the first place? How do we get from the *entropy* of physics—fundamental randomness, no inherent order, no 'memory' whatsoever to connect and direct events—to the *negentropy* of an evolutionary progression to an *enduring* self? And more reductively, how can the closed causal chain that purportedly began long before minds existed unlink and insert a conscious mind with real volitional power to change the causal sequence?

When embodied in physical structure, higher-order conscious functions are sandwiched in-between shallow unconscious sensory processes and deep unconscious biophysical structures. Cognitive and neurocognitive models attempt to account for them by some form of *emergence* theory, according to which conscious mind is created spontaneously at an unidentified level of the

physical. In the functional view bits of information/energy/matter spontaneously bind into highly-ordered networks from which emerge a holistic conscious self when the parts become sufficiently complex. Thus robots presumably would evolve conscious selves automatically with sufficiently fine-grained interactive referential networks, regardless of their material composition. The ontological place for this emergent level isn't specified. In a reductive structural view, simple organisms apparently are inherently proto-conscious selves, and then higher-order conscious selves via complex neural networks. How a proto-conscious self got into individual neurons also isn't specified.

The physicalist view is taken to the extreme in the *functional identity hypothesis* that equates psychological function and physiological structure. In this view there is no object-subject gap. The physicalist view attempts to describe a causally closed clockwork physical universe (Hawking, 2001), in which neither an ontologically real place nor causally efficacious role for conscious mind have been found (Stapp, 2007)—outside or inside neurons.

In other words, emergence theories conceive of a whole created from a complex integration of parts, which somehow then gains control over the parts. But there is no real physical place for such an emergent conscious whole, and no possibility for its causal power. For those who take conscious mind to be entirely a product of the physical—to *supervene* on the physical—it ends up as epiphenomenal, or even non-existent as in eliminativist cognitive views.

III: Beyond the physical toward information space and nonlocal mind

In the search for the real place and causal role of consciousness, recent theories suggest that structurally deeper quantum processes must be involved. But then the issue arises of quantum randomness, which challenges the concept of causally efficacious mental intentions (Stapp, 2000; 2007). Quantum theories extending beyond the physical into ontologically real quantum information space and nonlocal mind are now discussed. Importantly these theories also are extending causality even below quantum randomness, which allows for the logical possibility of real mental intentions.

Hameroff and Penrose's model of consciousness as a *non-reductive* quantum process

The *Orch OR* model by Hameroff and Penrose (2000) combines neurobiology and quantum physics. The physics aspect concerns how consciousness is generated, associated with the collapse of the quantum wave function as a real phenomenon called *objective reduction* (OR). In orthodox quantum theory the collapse of the unbounded quantum wave function is said to occur spontaneously and *instantaneously* in the measurement process by a conscious observer—which curiously precludes any possible causal dynamics. In some recent interpretations, however, the collapse occurs objectively (in time and not requiring an observer) under conditions in which random influences in the environment dissipate or *decohere* the coherent superposition of the quantum wave function—and under special conditions as in this model.

This model favors cytoskeletal microtubules as the site for the ORs, *orchestrated* by microtubule proteins that 'tune' the quantum oscillations. Under special conditions in which a quantum system is well isolated from random environmental influences and remains coherent until a threshold is reached, it 'self-reduces' in a non-random fashion that "creates an instantaneous 'now' conscious event…(Hameroff & Penrose, 2000; p. 187)." The conscious event is non-random but also *non-computable*, meaning that the OR cannot be derived entirely from preceding states through any computation method. This is associated with Gödel's incompleteness theorem, the result of "…some presently unknown 'non-computational' mathematical/physical (i.e., 'Platonic realm') theory…(Hameroff & Penrose, 2000; p. 180)."

Discrete ORs, each a momentary 'now' conscious event, build up into a cascade that produces the forward flow or 'stream of consciousness.' This is likened to descriptions in Buddhist thought of consciousness as collections of mental events—each somehow appearing and

disappearing with no temporal duration—that produce the subjective impression of continuous time (Hameroff & Penrose, 2000). Hameroff (2008) further theorizes that gamma synchronized dendritic webs 'skate' across neural networks in a very abstract quantum mechanical process associated with the 'now' conscious events. These abstract 'now' conscious events, produced through objective reduction, are associated with the 'conscious pilot' function that overrides auto-pilot modes to cause behavioral changes in response to environmental demands and the organism's intentions.

This model almost extends beyond the classical physical level in the sense that it has a non-reductive, non-computable quantum feature. But the model seems not yet to address binding problems, including how quantum mechanical conscious 'now' events combine into a coherent stream, how the stream incorporates cognitive computational functions, and how it inserts into the causal chain a holistic conscious executive pilot or self that intentionally applies the conscious stream in global survival behavior. Also, it seems to be a quite localized notion of nonlocal quantum processes. And importantly, it only hints at an abstract place ('Platonic realm') for the conscious 'now' events, without describing what their actual place and causal role might be in nature. It refers to an abstract mathematical 'Platonic realm,' but seems not to take the leap to identify it as an ontologically real level underlying the physical.

Stapp's model of consciousness as *experiential reality* between classicality and Hilbert space

Recognizing that the core issue of at what ontological place a real, causally efficacious conscious self might exist needs to be addressed directly, Stapp's (2000, 2007) model probes deeper into the collapse from quantum potentia to classicality. It emphasizes that the 'cause' of the collapse is:

> "...not to be found in that physical part of the quantum ontology.... [F]rom the purely physical standpoint the collapse seems to come from nowhere, as an unpredictable and undetermined 'bolt from the blue.' Something is needed to...bring 'classicality' into the dynamics, and it needs a 'cause' for the collapse, and it needs a reality to complement the 'potentia'.... It must be something that exists, and the only thing that we know exists, besides the physical part of reality...is the experiential part... (Stapp, 2000; p. 213)."

The model begins to consider how the actualization event of wave function collapse actually involves subjective intentionality of a conscious individual 'I' at an ontologically real level of nature. In this model the quantum wave collapse that actualizes classicality involves an experience and thus an *actual experiencer* as an individual 'I' or conscious mind. The actualization event:

> "...contains the slowly changing fringe of the experience that constitutes the 'I', or 'psyche', which is felt as the experiencing subject and actualizer. The experiencing subject is *part of the thought*, not an outside observer of the thought: if the 'I' were not *part of the thought* then there could be in the thought no awareness of 'I' as the background relative to which the focus of the thought is the foreground (Stapp, 2000; p. 213)."

This model exemplifies progress toward serious consideration of how mind and matter are actually related—which can no longer be glossed over in physics or in cognitive science. It locates the background self or 'I' as part of thought processes in an experiential reality distinguishable from classical reality, both of which somehow derive from the substrate of all-possibilities mathematical Hilbert space (Stapp, 2000). It explicitly recognizes causally efficacious personal intention and choice in addressing explanations of the transition from the abstract quantum to the concrete classical level of nature. It counters the two factors of local determinism (unbroken physical causal chain) and quantum chance that obviate the causal efficacy of mind, noting that 'free choice' is made at the level of the whole organism—not the neuron and neural network levels as in the neurocognitive and psychobiological models described earlier:

> "One's fate is not controlled exclusively by mechanical local deterministic laws or by an avalanche of microscopically entering chance elements that would make a mockery of the idea of personal choice.... If the quantum events in the brain occurred at the level of the neurons then the choices would be blind, for the

> consequences of each individual choice would be screened from view by the inscrutable outcomes of billions of similar independent random choices.... The conditioning for this event is an expression of the values and goals of the whole organism, and the choice is implemented by a unified action of the whole organism... (Stapp, 2000; p. 210)."

This model proposes a real *experiential* level of nature where conscious choice is made that is less fundamental than the random possibilities of the quantum soup of Hilbert space and more fundamental than classical reality. It continues the trend of placing conscious mind in structurally 'deeper' levels, even deeper than the 'inviolable wall' and now underneath physical notions of the 'black box.' It associates consciousness with the fringe of thoughts in an expanded ontology of a real non-random *experiential* level that includes consciousness and some form of free will in a holistic individual self. This experiential level seems to float somewhere between the quantum potentia of Hilbert space and its physical carrier of the actualized classical level of the brain/body.

Thus three levels are proposed: the physical, the experiential, and Hilbert space. Real power to collapse the unbounded wave function from all-possibilities Hilbert space to classicality is attributed to the experiential level (Stapp, 2000; 2007). Importantly this implies that the causal chain cannot be closed in the physical if it includes real causally efficacious mental intentions.

Again, how the abilities to sense, remember, reason and the like actually bind together into a holistic 'I' to make conscious choices for globally coherent individual behavior isn't explained. But at least it does propose a real conscious 'I' with real intentional thoughts that is distinguishable from and not accounted for in the physical.

Deeper into the 'black box' to quantum information space, nonlocal mind, and beyond

Interpretations of quantum theory positing quantum wave collapse as an objective reduction imply that quantum and classical levels causally interact, which also implies that both are ontologically real. The reality of the quantum level also is implied in recent quantum gravity theories, now briefly discussed. Again, the thread that runs through this paper is the search for the real place and role of consciousness. In this search, contemporary evidence-based theories are taking us underneath the 'inviolable wall' of the closed causal physical nexus into a real, non-physical, nonlocal 'black box' of causally efficacious conscious mind—and soon beyond.

For example, the most prominent new area in physics of string theory proposes six or seven higher dimensions in which strings vibrate, in addition to the ordinary four dimensions. Although these higher dimensions are mathematical degrees of freedom used to explain string motion, they also are conceptualized as higher spatial dimensions (Greene, 1999; 2004; Randall, 2005). Mathematical geometric strings in compactified higher-dimensional space, and also branes in M-theory which integrates some string theories, are theorized to be the source of physical objects in ordinary space. This implies causal interactions between ordinary objects in physical space and geometric 'objects' in some more abstract mathematical concept of space, which again tacitly attributes ontological reality to both.

M-theory further hints at a new form of *nonconventional* space in a more encompassing, entangled, abstract level of nature. Loop quantum gravity theory, an alternative to string theory, further proposes that this new nonconventional level is a *pure geometry of quantized information space* that generates conventional space and relativistic spacetime (Smolin, 2001).

The 'neorealist' or Bohmian interpretation of quantum theory goes even 'deeper,' proposing a nonlocal field of mental space (Bohm, 1980; Bohm & Hiley, 1993). This theory is consistent with the notion of hidden variables mentioned earlier in connection with Einstein's belief in the incompleteness of orthodox quantum theory□perhaps influenced by discussions between Bohm and Einstein toward the end of Einstein's life (Talbot, 1991).

This interpretation of quantum theory posits a hidden, underlying, ontologically real nonlocal wave field□the *quantum potential* or *psi wave*□not in classical or other quantum theories (Bohm, 1980;

Goldstein, 1998). The subtle, non-physical, real nonlocal wave pilots the motion of real local particles. Importantly the general concepts of causal determinism and of objectivity independent of conscious observers are *recovered*, but are extended beyond Einstein local causality (light-speed) and orthodox quantum theories.

The subtler wave field is proposed to be the level of causally efficacious nonlocal mind, called the *implicate order*, a huge step to a more expanded ontology of nature beyond the physical realm or explicate order. In identifying a grosser, local, classical explicate order and a subtler, non-classical, nonlocal implicate order, however, both are held to be aspects of a *super-implicate order* or 'universal plenum.' This is related directly to non-dual Vedanta in the ancient Vedic tradition (Bohm, 1980; Bohm & Hiley, 1993), and it also is akin to the emerging theory of an ultimate unified field of nature.

These cutting-edge theories have gone underneath the physical 'inviolable wall,' out the bottom of the physical 'black box' and the underlying mental 'black box' as well, to a super-implicate order or unified field. Applying these quantum interpretations to human psychoarchitecture, when the structural notion of depth is taken 'deep' enough a real ontological place and a real causal role for conscious mind are posited. In this new expanded ontology, the old mind-body problem now concerns the contrast between conscious mind as a powerless epiphenomenon of the gross physical brain versus a subtle, underlying and permeating non-physical information space or causally efficacious nonlocal mind.

IV. Reconciling functional and structural models of mind

If the only real level of nature is the physical, the disembodied functional notion of depth ends up being just a conceptual convention. This view is supported by interpretations of evidence that consciousness dissipates when neural processes lose functional integrity, or in states such as sleep and coma. In this view conscious qualia, thoughts, feelings, and memories have no reality other than being the epiphenomenal inside of neural processes that don't have such an inside. Historically one of the strongest challenges to the physicalist view was that experientially and intuitively for many it just *doesn't ring true*. Many of us feel that our minds and consciousness really do exist, and that we make real intentional choices that have real causal effects in the real world. To deny this seems to deny what is *naturally* evident and eliminate much of what is held to be meaningful in life, such as personal responsibility and the *pursuit* of happiness—at least the *pursuit* of scientific knowledge.

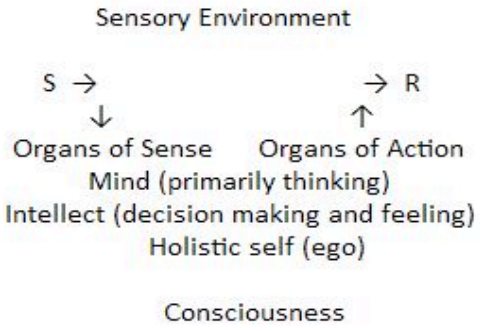
But now there is a stronger, evidence-based challenge: the rational theoretical and empirical evidence, appreciated by many physicists, suggests that physical matter is not the most fundamental level of nature. Rather than conscious mind as a powerless and inexplicable epiphenomenon of the gross physical brain, it can be understood as a subtle non-physical quantum information space or nonlocal mind. This allows the possibility that phenomenal experiences such as intentional thoughts, feelings, and memories *really exist* somewhere (Bernroider, 2008). A major contrast is emerging between theories of conscious mind as *epiphenomenal functional space* somewhere in the macroscopic brain and theories of *real non-physical, nonlocal mental space* underlying and permeating the physical, including the brain.

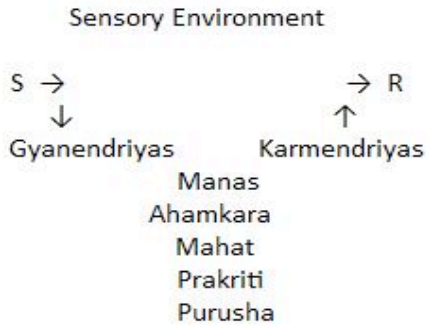
The Vedic model of mind in Sankhya

One additional model helpful to reconcile this major contrast will be discussed: the ancient Vedic model (referred to in Bohm's quantum theory interpretation noted earlier). Other ancient traditions have somewhat similar accounts, but also important differences that need to be adjudicated by research to discriminate which models most accurately reflect these subtle levels of psychoarchitecture. The Vedic model is used to exemplify them because it deals explicitly with ontological levels of nature (and also in part because it is the one with which the author is most familiar).

The *Sankhya* aspect of the Vedic literature—one of the *Darshanas* or perspectives of nature sometimes called the six systems of Indian philosophy—is relevant to contemporary research on the place and role of mind and consciousness. Sankhya

enumerates levels of nature said to cover the entire range from the emerging contemporary theory of the unified field through sequential symmetry breaking to the grossest levels of inert matter (Maharishi, 1967; Boyer, 2008; 2010). This enumeration includes levels of subjective mind. In simple form, the Sankhya model of mind can be depicted as in the chart below. (On the left side is the depiction using language similar to the models earlier in this paper; on the right side are corresponding Vedic terms from Sankhya.)





As shown here, the functional model of mind summarized earlier from historical, cognitive, and neuroscientific research is reasonably consistent with the Sankhya model. Of fundamental importance, however, is that in the Sankhya model consciousness underlies all sensory, cognitive, and affective processes of the individual self *both functionally and structurally*. The Sankhya model can be interpreted to suggest that all levels of mind and body are not conscious, but are underlain by consciousness itself (Boyer, 2008).

This furthers the point in functional models including the theatre analogy in GWT (Baars, 1997) that many information processing functions are conducted outside of consciousness. For example ordinary visual experiences are not presented with the complex electrochemical, feature detection, and gestalt processes involved in psychophysiological functioning—only the final picture is presented to phenomenal experience (e. g., Dennett, 2000; Edelman & Tononi, 2000). For another example, in ordinary experience we seem to have no ability to sense or observe the inner mechanics of memory encoding, storage, and retrieval. These examples suggest that information processing is conducted outside of consciousness, and only the outcomes of processing are presented to consciousness.

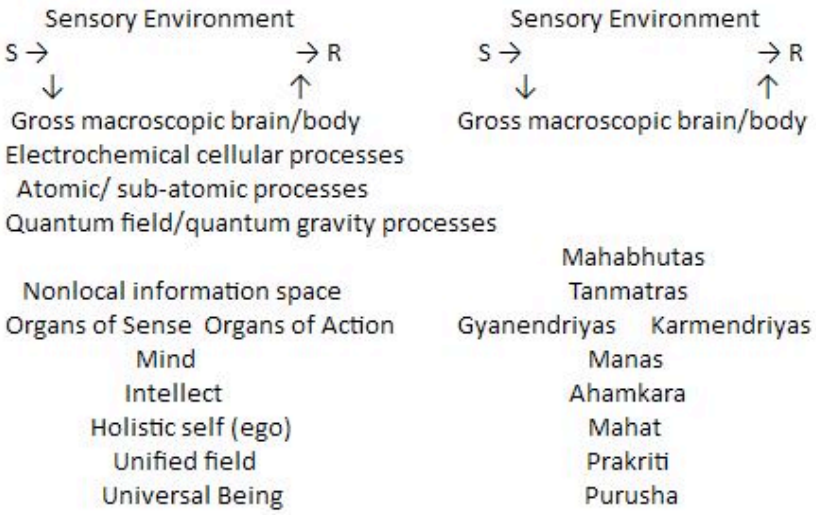
In this view interior stages associated with input (Stimulus), computation (Black Box), and output (Response) ordinarily do not have phenomenal experience as a concomitant property. There are no bits, pieces, glimpses, cascades, or streams of consciousness in any stage or level of processing in body or mind. Consciousness exists neither in nor as a reductive or non-reductive emergent property of the physical. This is consistent with eliminativist views mentioned earlier. But unlike eliminativist views, only consciousness is non-reductive, and both the physical and the mental reduce to it. In the Sankhya view phenomenal mind can be understood to be in the subtle nonlocal, non-physical level underlying and permeating the gross local, physical level, further underlain by consciousness itself.

In other words, in the perspective of Sankhya consciousness itself is not only deeper than the physical 'black box,' but also deeper than the underlying nonlocal mental 'black box.' It is the underlying transcendent basis of both the gross local brain/body and the subtle nonlocal mind, associated directly with the notion of an underlying unified field. (However, this Sankhya view fits into a larger developmental context of purported 'higher states of consciousness' not discussed here, including the Darshana of Vedanta which describes universal consciousness permeating all levels of nature.)

Applying the Sankhya perspective, we now return to the key issue of reconciling functional and structural meanings of depth. The following model is suggested as a reasonable speculative depiction of levels of mind and the place of consciousness in human psychoarchitecture. As an integrated functional-structural model, it covers structural levels not appearing in the earlier functional models. Consistent with those models, however, it depicts the inner dimension generally with the outer, shallower, more expressed or grosser levels on top and the inner, deeper, less expressed and more abstract or subtler levels toward the bottom. The expanded structural ontology in the Sankhya model of levels of nature which includes the levels of mind extends beyond conventional spacetime, consistent with the theorized nonlocal level posited in quantum and quantum gravity theories briefly described earlier.

The most fundamental levels are identified as the holistic *unified field* and *universal Being* because the modern scientific theory of the unified field is the closest conception to that level in Sankhya. The tremendous accomplishment in modern science of beginning to formulate mathematical models of the ultimate unity of nature has established the theoretical basis to link up with the ancient Vedic tradition. Until modern science arrived at a rational theoretical framework to consider mathematical formalisms of a single unified field, the correspondence with the ancient Vedic model generally was not appreciated. The most parsimonious explanation is that the two traditions of knowledge converge on the same unified field from their respective vantage points (Hagelin, 1987).

But importantly, in the Vedic model the wholeness or unity does not emerge from a collection of reductive parts; rather, the parts emerge from the whole—from the completely unified field. Many issues undoubtedly will arise with respect to this correspondence with unified field theory. The terms are included for completeness of the chart of the Sankhya model, but these theorized levels cannot be given adequate explanation in this short paper. Readers interested in them are referred to a recently published paper in *NeuroQuantology* (Boyer, 2009); as well as other more extensive treatments (Boyer, 2008; 2010).



This depiction shows how the Sankhya model reasonably fits into a speculative interpretation of an expanded ontology. It is proposed here as a resolution to the challenge of placing the disembodied functional model of mind into physical brain structure. It is consistent with the progression in quantum theories toward a subtle information space or nonlocal mind underlying the physical. The Vedic model posits three levels of nature: the ordinary gross local physical level of conventional spacetime, the subtle nonlocal mental level, and the unified field (universal Being). Three-level models introduced earlier by Stapp (2000) and Bohm (1980) are pointing in the direction of this trinity.

Direct first-person approach to mind and consciousness

But how can there be consistency between a contemporary scientific model of mind developing through extensive experimental research and an ancient model conceived long before experimental methodology had developed? Was it just a good old guess?

The objective approach applies ordinary sensory experience and reason—the epistemological basis of modern science. To protect against unreliable subjectivity in ordinary sensory experience and reason, the objective approach relies on consensual validation or public agreement. But it is important to recognize that consensus is based on the state of functioning of those who contribute to it. The entire enterprise of modern science is based primarily on sensory experience and logical reasoning shared by scientists in the ordinary waking state, and there is almost no recognition of this state-dependent limitation.

The ordinary waking state is a representational, reflective mode of knowing that is the phenomenological basis for the pretheoretical assumption of the independence of observed and observer fundamental to objective science. In this state the fragmented localized objective view of object-subject duality is imposed on the natural world by the observer's ordinary waking experience.

Contemporary proponent of the Vedic tradition Maharishi Mahesh Yogi (1963; 1967) states that systematic, direct first-person investigation is needed to resolve long-standing problems of consciousness such as discussed in this paper that are now on the forefront of scientific inquiry. Yoga is held to provide systematic means to examine directly and validate empirically the thesis that consciousness itself, unmixed with mental activity underlies both gross objective matter and subtle subjective mind. In this regard the direct first-person subjective approach can be contrasted with the third-person objective approach, and understood to be its necessary complement in the field of consciousness studies. Systematic methods to investigate levels of mind and consciousness in Yoga thus may present the strongest challenge to physicalism: empirical validation in direct first-person experience of ontologically real levels of nature that transcend the physical.

Conclusion

As summarized in this paper, the challenge of reconciling functional and structural models of mind directly concerns major new developments in modern science that posit an expanded ontology of levels of nature. Psychology and neuroscience have been progressing toward a general functional model of mind; and concurrently structural theories of an ontologically real underlying information space or field of nonlocal mind are developing in quantum physics.

The Sankhya model in ancient Vedic literature allows these models to be integrated in a manner that is not possible in the physicalist view of nature. For the first time in modern science a logically coherent framework is emerging that integrates physics and psychology to address the mind-body problem and the ontological place and causal role of consciousness. Incorporating systematic first-person methods from Yoga may facilitate direct investigation of these quite subtle issues in order to link matter, mind, and consciousness.

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