

Toward a model of consciousness: philosophical problems and questions guiding a way forward

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Abstract

In spite of millennia of introspection, research and debate, there is still no compelling evidence for any single model of consciousness (Dehaene & Changeux 2011). Nor is there agreement on how to *define* consciousness, what constitutes a rigorous model of consciousness, and what research methods are most appropriate or productive when investigating consciousness. Current science relies on biological models of brain function as *metaphors for describing what consciousness does* and cannot confirm postulated causal relationships between discrete functional brain states and specific characteristics or subjective “states” of consciousness. The absence of a strong conceptual framework for *thinking about* consciousness, together with intrinsic limitations of contemporary research methods and technologies, have resulted in numerous un-testable hypotheses concerning the general *nature* of consciousness and a paralyzing lack of consensus on research priorities and methods, despite the fact that “mind” and “brain” have supplanted genetics as the next great scientific challenge for the international community -see the Human Brain Project in the EU and the BRAIN Initiative in the US (<http://www.nih.gov/science/brain>).

With the above circumstances in view the principal goal of this paper is to clearly describe and concisely review philosophical problems and questions that are important to consider when developing models and research methods pertaining to consciousness. Topics covered include the roles and limitations of paradigms in science and other epistemologies, the relevance of different levels of analysis for investigating natural phenomena including the special case of consciousness, and different understandings of causality. The integral relationship between the nature of consciousness and the ‘background’ structure of space-time is discussed. A concise review of strengths and limitations of popular models of consciousness shows that current scientific models are based on naïve materialist assumptions that cannot *potentially* explain all functional characteristics or *states* of consciousness. The concepts of ‘body-brain’ and ‘embodiment’ are explored with respect to consciousness. I argue that a *complete* systems model of consciousness cannot be attained in the context of current science using existing research methods and

technologies - however *limited* models of consciousness are possible. The evidence for so-called ‘non-ordinary’ characteristics or subjective states of consciousness including claims of psychic functioning is briefly reviewed and conceptual problems pertaining to deriving models of Psi are discussed. The paper concludes with questions aimed at reconciling contemporary models of consciousness with models that purport to explain so-called ‘non-ordinary’ states of consciousness, including claims of psychic functioning.

Approaching consciousness—first philosophical steps

Any rigorous discussion of consciousness must entail philosophical analysis to ensure that premises and arguments are both explicit and stated in clear language. When premises or arguments are not explicit or are phrased in vague jargon there is little hope for philosophically and scientifically rigorous dialogue slowing progress toward an adequate theory of consciousness. In order to derive an adequate and coherent model of consciousness capable of explaining ‘ordinary,’ ‘pathological,’ and so-called ‘non-ordinary’ objective characteristics and subjective states (i.e. qualia), premises and arguments must be consistent and transparent throughout the work.

There is disagreement on a single ‘best’ consensus definition of ‘consciousness’; thus disparate models of consciousness start from different premises, employ arguments with different logical forms, and have different conceptual and research goals. Depending on starting premises, disparate models lead to very different inferences with respect to satisfactorily “defining” consciousness. For example, the premise that consciousness is a specialized property of life and is possible only in relationship to certain kinds of complex living systems leads to very different kinds of models than the premise that consciousness exists *in its own right* as a ‘primary’ kind of phenomenon in the universe. It follows that attempts to define consciousness cannot be other than competing descriptions of premises about the kind of thing consciousness is or *can be*, what it is *like* to have such-and-such an experience, or what consciousness *does*, and how consciousness *is related (or not) to* life, matter and energy. Attempts to “define” consciousness are thus equivalent to statements about beliefs that certain premises are more valid than others—and not statements of fact. Proposed definitions of consciousness are often framed as descriptions of subjective states related to ‘what it is like’ to have ‘such and such’ an experience. Few definitions make claims about discrete mechanisms of action or attempt to distinguish between subjective experiences that are susceptible to empirical investigation and those that are not. In other words, the majority of ‘definitions’ of consciousness rely principally on conjecture about unsubstantiated mechanisms and constitute *a priori* metaphysical assumptions because they are not falsifiable using *available* empirical means. The problem of “defining” consciousness is related to the more general problem of establishing a typology of different models of consciousness with a view toward clearly stating the underlying premises of disparate perspectives and remarking on their respective strengths and limitations. In view of the above it is unlikely that a single consensus *definition* or ‘shared understanding’ of consciousness will be forthcoming in the foreseeable future (Gierer 2008). In spite of seemingly intractable philosophical problems encountered when attempting to define consciousness in general, it may be productive to explicitly state the premises underlying models that purport to describe or explain particular observable characteristics or subjective states of consciousness. I believe that investigating

particular or ‘*limited*’ characteristics or subjective states associated with consciousness in an open-minded multidisciplinary framework will invite systematic discussion and debate on various models and suggest important future research questions.

Different ways of knowing—general considerations and implications for future science

Science and alternative ‘ways of knowing’ rest on divergent assumptions about the nature of phenomenal reality. These differences reflect the incommensurability of paradigms embedded in contemporary science and alternative world views described by Kuhn in his seminal work *Structure of Scientific Revolutions* (Kuhn 1970). Science currently regards mainstream theories in physics, chemistry and biology as providing an adequate explanatory framework for consciousness, including ‘ordinary,’ ‘pathological,’ and so-called ‘non-ordinary’ experiences such as claims of psychic functioning. However, contemporary science is only one of many theoretical domains in which consciousness may be rigorously investigated, yielding valuable insights. Other *ways of knowing* (i.e., epistemologies) that offer valid schemata for conceptualizing relationships between body-brain-environment and consciousness include quantum physics, complexity theory and emerging concepts in the life sciences, medicine and spirituality.

Many ways of knowing do not endorse or rely on contemporary scientific models of space-time, matter, causality, energy and information, and claim that alternative epistemological lenses may yield more accurate and *more complete* understandings of consciousness than available in contemporary scientific discourse. For example, introspective analysis of the “quality” or “meaning” of unique highly subjective experiences may yield insights about the phenomenological nature of conscious experiences that are as valid as findings from advanced functional brain imaging research. Furthermore, alternative ways of knowing may examine conscious states or experiences resulting from dynamically interacting factors in the complex body-brain-environment system which may *not be reducible to* current scientific theories and the language of linear causality. Complexity theory and other emerging theories in physics and the life sciences that examine phenomena from the perspective of non-linear dynamics may ultimately provide more accurate and more complete explanatory models of life in general including the special case of living systems that exhibit the capacity for consciousness (Seth et al 2006; Bullmore & Sporns 2009). Diverging perspectives of contemporary science and alternative epistemologies suggest the need for conceptual bridges between disparate paradigms. A dialog based on such trans-paradigm ‘bridges’ may help resolve misunderstandings related to the ambiguities of language while also clarifying the nature of conceptual gaps between disparate ways of knowing about consciousness.

Evolving paradigms and implications for consciousness research

A paradigm is a conceptual framework or “way of knowing” that biases and *filters* how phenomena are observed and interpreted. Materialism is presently the dominant philosophical perspective of Western civilization and the received dogma embedded in the theories and methods of current science. Materialism is thus the (often implicit) perspective that underlies the conceptual framework of physics, biology, neuroscience and, by extension, consciousness research. All paradigms are in a continuous state of flux because emerging research findings and novel models transform ways of knowing about the world

on an on-going basis. In reciprocal fashion, the evolution of paradigms invites novel ideas about the nature of phenomena. Hundreds of years of conceptual evolution of the orthodox materialist paradigm have led to numerous models of consciousness whose propositions are congruent with the tenets of materialism including for example, different versions of functionalism (Van Gulick 2011). Recent decades have seen serious challenges to the conventional materialist paradigm by advances in the basic sciences including quantum mechanics, high energy physics, complexity theory and other domains. A new paradigm contributes to the explanatory power of science when it provides a more complete and more accurate picture of causes of phenomena or descriptions of relationships between phenomena. The evolution of paradigms will gradually transform contemporary science resulting in novel explanatory models of reality in general that will in turn lead to radical new models of life and consciousness. Accordingly, the findings of any particular research methodology used to examine objective 'characteristics' or subjective 'qualia' of consciousness do not *explain* consciousness so much as they reflect the limitations of the paradigm in which a question is asked. Emerging models *not yet* endorsed by science may provide important future research directions for examining the nature of consciousness per se, and help clarify complex relationships between particular characteristics or subjective experiences associated with consciousness and the dynamic system of body-brain-environment.

Every model is adduced within the context of a particular paradigm and from the unique perspective of its author. Humans are embedded in a rich social, cultural and intellectual tapestry that shapes the way they perceive, reason and act. Therefore all models, including models pertaining to the nature of consciousness, are by definition biased and limited in that they necessarily reflect the specialized and limited knowledge, perspectives and beliefs embedded in the cultural-ideological milieu of the author. The rigor and relevance of a particular model reflect the capacity of its author to objectify or 'step outside of' the lived social, cultural and intellectual context in which the creative work is done together with his or her skill at accurately identifying biases and constraints imposed by the milieu. This is equivalent to stating that the quality of any model reflects the capacity of its author to be cognizant of his or her social and ideological milieu and the limitations of method in a way that is self-reflective, self-critical and value-neutral.

The 'way of knowing' within which a particular phenomenon is approached prefigures the premises, model and method used to examine it, resulting in an inevitable self-reinforcing circularity between epistemology, method and findings. Making explicit both the epistemology and premises on which a particular paradigm is based will clarify assumptions about the nature of phenomena being investigated and suggest useful methods of investigation. A myriad 'ways of knowing about' are used to investigate a wide range of natural phenomena. Disparate ways of knowing employ various methodologies to investigate phenomena - however all methodologies can be reduced to two general conceptual approaches: *empirical* methodologies that provide objective information about properties of phenomena including, principally, scientific method; and *non-empirical* methodologies that use subjective approaches to characterize the nature of experiences related to phenomena including intuitive 'knowing,' and a range of other *non-rational* approaches including spiritual and transpersonal approaches. While claims of 'intuitive' or 'non-rational' knowing do not rely on empirical verification of phenomena, such claims may be regarded as 'stronger' when supported by 'objective' findings.

Scientific method is currently the dominant empirical methodology, however intuition is a widely used non-empirical methodology for 'knowing about' phenomena in disparate cultural contexts and spiritual

traditions. Asking questions about kinds of phenomena that *can have existence* (ontology) or about disparate *ways of knowing about* phenomena (epistemology) entails comparing advantages and limitations of disparate epistemological and ontological assumptions with respect to shared beliefs about their relative utility in adducing explanatory models. *Thus it is important when investigating phenomena from the perspective of any particular paradigm (e.g., science, linguistics, A.I., theoretical physics, theology, philosophy, mysticism, etc) to clearly articulate the paradigm and methods used to investigate phenomena and adduce explanatory models. Widely endorsed scientific models are generally based on expert consensus on their merits with respect to their ability to adequately explain phenomena being investigated. The endpoint of any investigation is pre-figured and limited by the paradigm in which the question being asked is conceptualized because the paradigm determines the kind and quality of information that can potentially be obtained through inquiry.* The models and methods that comprise contemporary science play a dominant role in financially more developed countries because the enormous social and economic benefits accrued from research ensure continuation of entrenched ideological and financial interests that directly benefit from scientific advances in developed world regions. In this way the dominance of scientific materialism as a paradigm and set of methods and the hegemony of world centers of geopolitical and financial power reciprocally reinforce one another on an on-going basis.

General models of reality rest on core premises about phenomena:

- that exist in ways described in the model
- that do not exist but for which existence is *metaphysically possible*
- that are related to particular phenomena being examined (including the special case of consciousness)

As already noted, the paradigm within which a theorist or researcher thinks and writes biases and constrains his or her perspective, choice of research problems and methods used to investigate phenomena, and thus pre-figures *legitimate* interpretations of findings pertaining to *causes* or *meanings* of phenomena regarded as *possible* or *plausible*. Along these lines, it is widely accepted as dogma in current science that *legitimate* explanations of observable characteristics or *functions* of consciousness or reports of subjective experiences are those which follow from and are consistent with core premises of a general model of consciousness widely acknowledged as valid by an academic community of ‘expert’ researchers. Keeping in mind that agreement on *valid* interpretations of objective characteristics or subjective experiences associated with consciousness may vary widely between disparate paradigms, it follows that the particular paradigm within which a researcher investigates or *thinks about* consciousness influences *what* he or she may ultimately ‘discover’ through research and by extension, biases interpretations of the significance of findings. Along the same lines, the method selected for interpreting the significance of findings pertaining to a particular characteristic or function associated with consciousness or assigning ‘meaning’ to reports of subjective conscious experiences informs and *biases* understandings of phenomena related to consciousness regarded as *valid* interpretations. Following the argument, the capacity of any model to adequately characterize phenomena associated with a particular observable characteristic or subjective ‘quale’ of consciousness are related to the *explanatory power* of the research methodology derived within the context of that model which in turn (above) reflects core premises of the paradigm in which the model is embedded. In sum the particular paradigm that *pre-figures* the way a researcher “sees” and interprets phenomena related to consciousness significantly

influences and constrains ‘findings’ that may be obtained using a particular research method and determines shared beliefs about valid ways to interpret the *quality or relevance* of findings and thus to *assign significance* to findings. Finally, different models of consciousness often rest on disparate (often implicit) models of causality which reflect divergent assumptions about the nature of causality in paradigms from which they are derived. A general model of consciousness and the paradigm within which a particular observable characteristic or subjective ‘quale’ of consciousness is understood or approached through experimental research are thus logically related and reciprocally reinforcing concepts.

Three levels of philosophical analysis

Regardless of particular kinds of phenomena being investigated, philosophical analysis takes place at 3 ‘levels’ with respect to verification of existence in general, verification of kinds of relationships between entities or processes that exist or *potentially exist*, and examination of the roles of fundamental entities or processes (i.e., whose existence has previously been established) in the particular phenomena being investigated in the context of a specified paradigm and a particular model. The first ‘level’ of analysis entails establishing a method for determining categories of phenomena that exist or *potentially exist*. Determinations of existence cannot be achieved using scientific method or other objective methods because premises about fundamental existence are by definition metaphysical propositions that cannot be verified but which reflect widely shared beliefs about the nature of existence and kinds of phenomena that *can exist*. Existence of any particular entity or process on *its own side* (ie, without reference to other phenomena or an ‘outside’ system) is not objectively verifiable however (some) properties of phenomena can be described in terms of human perception. The second ‘level’ involves analysis of fundamental or ‘ground’ phenomena including for example, space-time, matter and energy, in which particular phenomena under investigation are situated. This level of analysis often begins with examination of a general ‘theory of reality’ that may not be explicit in a model being investigated but which provides the ‘ground’ in which the phenomena under investigation are situated. The claim that certain general or ‘ground’ phenomena exist and make up the ‘world’ in which phenomena being investigated exist or for which existence is *metaphysically possible*, precedes and pre-figures claims of existence of particular phenomena that can be characterized only in relationship to the ‘ground’ or the ‘world’ in which they have existence. Most claims of existence of particular phenomena reflect widely shared beliefs about the truth of metaphysical propositions describing kinds of phenomena that exist or *can exist*. Such claims are highly problematic because the issue of non-verifiability remains as in the first level of analysis. The third ‘level’ of analysis of phenomena is different from the first two in that objective empirical *tests*—at least in some instances—can be used to determine properties of entities or processes that constitute necessary or sufficient conditions for the existence of particular phenomena including, for example, objective characteristics and subjective qualia associated with consciousness. Some claims about phenomena examined at the ‘third level’ of analysis are verifiable as either ‘true’ or ‘false.’ However, even in cases when findings support claims made in a hypothesis, confirmation of *existence* or of the nature of particular phenomena remains elusive because all claims about phenomena ultimately rest on non-verifiable metaphysical propositions.

It follows from the above argument that even in cases where existence of phenomena can be empirically verified, the ontological status of phenomena ultimately rests on antecedent metaphysical propositions

that are, by definition, non-verifiable. Such non-verifiable metaphysical propositions about the nature of phenomenal reality on which all scientific theories are based are “pre-scientific” assumptions in that they are by definition antecedent to the work of science (Boss 1994). In view of the intrinsic limitations of analysis with respect to verifying claims of existence it is germane to ask whether alternative ‘ways of knowing’ can be applied to analysis of phenomena yielding more *complete* or more *adequate* models complementing the explanatory power of science. Further, might such alternative epistemologies yield models that are more ‘elegant’ or more ‘useful’ compared to contemporary scientific models?

Models of natural phenomena—philosophical starting points

At the outset it is important to explicitly state premises that *pre-figure*, constrain or bias concepts used to build a model. As already noted, ‘pre-scientific’ premises are metaphysical propositions in that they do not rest on antecedent premises, and thus can neither be independently verified as true nor refuted as false. ‘Pre-scientific’ premises constitute the unstated core of all scientific thought and therefore, all scientific models. With the above in mind a prudent approach to building a model pertaining to natural phenomena in general may entail delineating core premises describing the dynamic attributes of the system at the broadest level possible, and assembling a coherent model on the basis of these core premises. My starting premise is that space-time is *a priori* necessary for existence of all ‘things’ and “processes,” by extension all natural phenomena ‘exist’ (ie, ‘are situated’) in a background of space-time. By convention, ‘things’ are discrete entities or complex aggregates of discrete entities situated in space-time, while processes are dynamic relationships between discrete things situated in space-time. My second premise is that the ‘thingness’ of any entity (by extension, the dynamic properties of relationships between any two or more ‘entities,’ ie, a ‘process’)—whether it is construed as an assemblage of particles, points in space-time, or a system of interacting particles or fields—is influenced by the properties of local space-time in which the particular entity or process exists or *can potentially exist*, and the properties of interactions between the entity or process and the local n-dimensional space-time in which it exists or *can potentially exist*. The ontological status of an entity or process (ie, the temporal extension of an entity or a relationship between any two or more entities) is thus premised on the ontological status of a ‘primitive’ space-time in which it is situated as well as the properties of relationships between the entity or process and other entities or processes in which the entity or process being evaluated is ‘enfolded’ forming a unique space-time manifold. My third premise is that reciprocal relationships exist between things or processes and space-time such that any entity or process is both characterized by properties of local space-time and, in reciprocal fashion, pre-figures or *determines* the properties of local space-time in which it is situated.

Is a *complete* model of consciousness possible?

Efforts to derive an *complete* model of consciousness capable of both *accurately* and *adequately* describing and explaining the broad range of characteristics, functions and subjective experiences associated with consciousness should ideally invite open-minded debate and inquiry from multiple perspectives including the formalisms of science, religion, spirituality and other epistemologies. The problem of reconciling disparate models of consciousness derived using diverse epistemologies is closely

related to the more general problem of trans-paradigm validation. Along these lines an important goal of interdisciplinary dialog on consciousness is to derive a ***general model that accommodates multi-level analysis of body-brain-environment examining the broad range of phenomena including quantum-level events, biological processes related to ‘ordinary states,’ ‘pathological’ states (e.g., mental illness) and so-called ‘non-ordinary’ states such as transpersonal experiences and claims of psychic functioning. A methodology that allows multi-level analysis may help elucidate important relationships between entities or processes in the body-brain-environment system including quantum processes, molecular mechanisms, single neurons, neuronal circuits, the whole brain, and interactions that take place at disparate levels in body-brain-environment that bear on consciousness. A complete model of consciousness should be able to rigorously characterize QM-level properties of body-brain-environment and reconcile these properties with physical or neurophysiological properties of the system at the levels of single neurons, complex neural circuits and networks of circuits.***

The problem of adducing a *complete* explanatory model of consciousness that addresses the above criteria, and is congruent with current science, entails selecting a methodology for comparing disparate objective characteristics or subjective experiences of consciousness using language that is acceptable to *and accessible* by both science and alternative epistemologies. The method used in theory building will *a priori* bias the logical structure of any future model of consciousness that is adduced from first philosophical or scientific principles, constrain its propositions, and frame its relevance (or lack thereof) to the task of developing testable hypotheses for evaluating mechanisms underlying ‘ordinary,’ ‘pathological,’ and so-called ‘non-ordinary’ conscious states or experiences. A *complete* model should ideally start from premises that are congruent with (at least some) premises of established scientific models of consciousness, as well as premises of general scientific models of space-time, matter, energy and information. This is true because the conceptual ‘ground’ of a complete model of consciousness is implicit in a model of cosmology which describes the nature of reality, places constraints on kinds of entities and processes that exist or *can potentially exist*, and delimits factors that may affect the evolution and functioning of complex living systems in which consciousness takes place or *can potentially* take place. Following the argument a broad conceptual ‘ground’ afforded by cosmology should provide the (explicit) framework in which any future systems model of consciousness is derived.

Scientific models of consciousness are grounded in unexamined materialist assumptions

Contemporary scientific models of consciousness reflect naïve *reductionist* assumptions about the nature of phenomena. For example, the assumption that conditions necessary and sufficient for consciousness can be empirically identified and correctly interpreted within the context of current science is equivalent to the belief that the nature of consciousness is reducible to *classically described* properties of matter and energy and contemporary models in neuroscience and psychology. Although many alternative explanatory models have been proposed, such ideas have had little or no influence on the direction of scientific inquiry. The result is that many theorists accept *a priori* what amount to naïve assumptions about the nature of phenomenal reality based on outdated or incomplete ideas in physics, neuroscience and psychology as constituting adequate explanatory models of consciousness. The philosophical biases that pre-figure current science suggest that *naïve* reductionist models may continue to be regarded as *adequate* explanations of consciousness barring a radical re-visioning of the core philosophical foundations of science. The reductionist framework imposed by current science on methods used to investigate consciousness presently excludes consideration of quantum-level processes or other postulated

non-classical phenomena because such phenomena are not verifiable using available technologies. Thus the current dogma limits contemporary scientific understandings of consciousness to naïve materialist assumptions while delaying progress toward models based on emerging research findings from physics and the life sciences that could potentially lead to novel understandings of mechanisms underlying both ‘normal’ and so-called ‘non-ordinary’ characteristics, functions and subjective states of consciousness.

Materialist theories of consciousness are at the foundations of Western philosophical and scientific thinking. Reductionist models of consciousness equate consciousness with brain function and include identity theories and functionalism. Reductionist theories are *monist* in that they posit the existence of only one kind of thing, namely fundamental kinds of physical entities. Contemporary reductionist models are, by definition, physicalist in that they reduce all observable characteristics and subjective states of consciousness to *currently knowable* physical and biological phenomena. Functionalism and identity theories are physicalist models that posit an equivalence between particular mental events and identifiable physical brain processes. According to reductionist physicalist models, words describing mental events are merely descriptions or “names” of processes, and there is no separate kind of corresponding mental “thing” that has existence independently of or ‘outside of’ the known physical world (Livaditis 2007). Authors cite evidence from psychological or neurophysiological research when arguing for different physicalist models of consciousness. Some evidence has been advanced in support of different versions of identity theory or functionalism however neither model has been strongly substantiated by research.

Models of consciousness that do not rely on current science often rest on dualist theories that posit the existence of two fundamentally irreducible kinds of phenomena—the mental (or spiritual) and the physical—which interact in complex ways. Starting with Descartes *non-physicalist dualist* models are inherently at odds with scientific *physicalist* models and are generally dismissed by science as *a priori* invalid. Because of the scientific bias against assumptions of a non-physicalist dualist nature of consciousness such models are seldom subjected to rigorous scientific inquiry. A challenging issue that must be addressed in any dualist model of consciousness is *agency* which refers to problems inherent in explaining interactions between the two fundamentally different kinds of *things* posited by dualism, namely *physical* and *non-physical* phenomena and further, explaining how postulated interactions manifest as *characteristics* or *qualia* of consciousness. Contemporary scientific *monist* physicalist models of consciousness avoid the problem of agency by positing the existence of *only* physical brain processes and their correspondence to empirically verifiable mental states. Exhibit 1 describes core propositions, strengths and limitations of the major contemporary models of consciousness.

Exhibit 1: Contemporary mainstream theories of consciousness

Theory	Core propositions	Strengths	Limitations
<i>Type-type identity theory</i>	<p>“Mind” is identical with brain (physicalism) therefore mental phenomena are physical phenomena, and all aspects of brain function are purely physical</p> <p>Each “type” of mental state is identical with a specific “type” of brain state</p>	<p>The <i>mind-body problem</i> is eliminated as only physical states (body) are posited to exist</p> <p>Corresponds to Western psychiatric theories of mental illness and treatment resting on genetics and molecular biology which assume type-type equivalence between brain states and mental phenomena</p> <p>Current functional brain imaging technologies are finding apparent correspondences between specific (‘ordinary’ and pathological) brain “states” and specific mental phenomena</p>	<p>Requires verifiable correlations between specific mental states and specific brain states. This level of evidence is not possible using current research methods and contemporary technologies</p> <p>Accumulating research evidence (e.g., neural plasticity in post-stroke patients) supports view that mental states associated with discrete brain circuits</p> <p>intentionality cannot be explained using a purely physicalist account of consciousness</p>
<i>Token-token identity theory</i>	<p>Every token or particular instance of a given type of mental state is identical with a token or particular instance of a given type of physical brain state</p>	<p>The <i>mind-body problem</i> is eliminated (as above)</p> <p>Neural plasticity in early development and post-CVA patients supports “multiple realized” mental states corresponding to</p>	<p>Contemporary technologies do not have capacity to demonstrate unvarying systematic equivalence between specific mental states and specific physical-spatial brain locations or processes. Therefore token-token</p>

		<p>many possible brain states</p> <p><u>Assumes that mental states are “multiply realized”</u> thus repairs major weakness of type-type identity theory</p>	<p><u>theories are inherently unverifiable</u></p> <p><u>Does not avoid problem of “dualism of properties”</u> as mental <i>states</i> must have corresponding <i>mental</i> properties</p> <p><u>Not all brain states are identical with mental states</u> (eg: autonomic functions), and therefore many brain states are likely unrelated to consciousness</p>
<i>Metaphysical functionalism</i>	<p>Mind or consciousness is a function in which specific mental states <u>can be adequately specified in formal terms</u> as inputs, outputs and relations to other mental states</p>	<p><u>Avoids the problem of agency in dualism</u></p> <p><u>Avoids problem inherent in type-type identity theories of verifying correspondences between mental states and brain states</u></p>	<p><u>Does not attempt to reconcile posited brain functions with known neurophysiological processes</u>, and is therefore not empirical falsifiable</p>
<i>Psycho-functionalism</i>	<p>Materialist view that <u>mental functions are contained in many possible kinds of processes in both complex living systems</u> (eg neurophysiological functions) and machines (eg cybernetic devices).</p> <p>Computational functionalism is a specific type of psycho-functionalism</p>	<p>Avoids problems of dualism</p> <p><u>Avoids apparent paradox of behavior “causality”</u> in that behaviors consist of “being in” a specified mental state (eg: pain)</p> <p>Similar to token-token identity theory in that mental states may be multiply realized</p> <p><u>Mental states are not</u></p>	<p><u>Does not account for intentionality or subjectivity</u> of many mental states like beliefs, attitudes and desires (this is the problem of “absent qualia”)</p>

	<p>which states that <u>the mind is like a complex Turing machine</u> in which functional elements are inter-related in complex hierarchical arrangements</p> <p><u>Mental states are reduced to complex input-output functions</u> of physical structures or states</p> <p>The dynamic core hypothesis (Tononi 1998) is a functionalist model which equates disparate conscious experiences with complex interactions among distributed groups of neurons</p>	<p><u>restricted to human consciousness</u></p>	
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Why current science cannot provide a *complete* explanation of life and consciousness

A widely held view in contemporary scientific discourse is that scientific method is capable of providing adequate explanations of all phenomena. This perspective, called “scientism,” rests on an unverifiable metaphysical assumption that all *real* phenomena are explainable in relationship to models and methods used in current science. This viewpoint amounts to metaphysical conjecture because it is *a priori* impossible to verify that all phenomena are explainable in the context of current scientific theories. Unstated *scientific* assumptions essentially limit the role of science to confirming that proposed novel models are congruent with established contemporary models, which serves to reinforce unquestioned dogma and direct inquiry away from insights and research findings that challenge the dominant paradigm. *Scientistic* beliefs have resulted in the dismissal of calls for rigorous *scientific* investigation of phenomena that may be related to consciousness on the assumption that theories and methods outside of current science can not further elucidate the nature of consciousness.

In addition to limitations of current scientific models of consciousness resulting from scientism posing as science, models of consciousness are limited by the *unknowability* of all possible phenomena. The

paradigm of current science does not—because it *cannot*—provide an adequate explanatory model of *all possible* complex non-living or living systems. This is true because what can be known about the set of propositions that describe *all possible* systems, including descriptions of conditions that are necessary and sufficient for the existence or *potential existence* of complex living systems, is by definition, unknowable and thus incomplete. It follows that current scientific models of life are *necessarily* incomplete because the set of all living systems constitutes an ‘open’ and ‘unknowable’ thus incompletely defined group of phenomena, i.e., the complete range of living systems that exist or may *potentially exist* throughout space-time is and will always remain unknown because *un-knowable*.

In models based on the assumption that consciousness is related to specialized functions of certain kinds of complex living systems, consciousness cannot be adequately explained by current science because *complete* explanations of all particular observable characteristics, functions or subjective states of consciousness cannot be achieved through induction. This is true because inductive analysis of the properties of a series of specific instantiations of systems that exhibit or *have the capacity* to exhibit consciousness cannot conceivably determine the complete set of factors that constitute necessary and sufficient conditions for all characteristics, functions or subjective states of consciousness because (above) the set of all possible systems that have or *potentially have* the capacity to exhibit or experience consciousness is *unknowable*. Therefore, at best, any model of consciousness can describe observable characteristics of particular functions of consciousness (e.g., vision, hearing, etc) or descriptions of ‘what it is like’ for humans to experience such and such a ‘state’ of consciousness. By the same token it is not possible to adduce a complete *general* model of consciousness that explains or is capable of explaining all possible conscious characteristics, functions, ‘states’ or ‘experiences’ because it is *not metaphysically conceivable* to establish through observation, introspection or induction a *complete* series of all particular instantiations of conscious ‘states’ or ‘qualia’ that exist or *may potentially exist*.

Three assumptions limit the capacity of current science to accurately characterize consciousness and to derive a *complete* model, namely one capable of explaining all observable characteristics and subjective states of consciousness. These *limiting* assumptions are often implicit in the scientific discourse on consciousness:

- Phenomena that affect complex systems are observable (and thus *knowable*) using current scientific methods and technologies, and can therefore be empirically verified
- Systems in general and complex living systems such as body-brain behave in predictable *linear* ways described by classical physics and chemistry.
- Complex living systems exist and operate in 4-dimensional space-time and their properties can be completely described by Newtonian physics.

Assumptions of “linearity” and predictability in complex biological systems are naïve and do not take into consideration recent research findings on both ‘ordinary,’ pathological and ‘non-ordinary’ aspects of conscious experience. While some properties of complex living systems can be characterized in terms of discrete processes from classical physics and chemistry, even the simplest life forms cannot be *completely* characterized without invoking non-linear dynamics. The assumption that linear cause-effect relationships exist between particular conscious states or experiences and discrete biological processes is not only unverifiable using current research methods and technologies but cannot even potentially explain complex

relationships that characterize consciousness in living systems. Simplistic reductionist assumptions about the nature of life itself and, by extension, consciousness are carry-overs from classical Newtonian physics that cannot potentially explain the dynamics of body-brain.

In view of the intrinsic limitations of the explanatory power of *contemporary* scientific models of consciousness it is nevertheless possible to adduce more ‘limited’ models that may adequately characterize the properties of select characteristics, functions or subjective states of consciousness in relationship to factors or processes that comprise the boundary conditions of systems that exhibit particular characteristics of consciousness in some cases. With this caveat in mind it is germane to remark that particular instantiations of certain objective characteristics or subjective states may not be reducible to a definable set of postulated ‘elemental’ or ‘core’ characteristics or functions of consciousness at a biological, physical, energetic or informational level, nor can *current* science identify or verify all possible constraints or limiting conditions associated with all ‘discrete’ observable characteristics or reports of subjective states of consciousness. Achieving a complete general systems model capable of explaining the range of observable characteristics and subjective states associated with consciousness will require nothing less than a radical re-visioning of science and established scientific theories at the level of their core premises and research methodologies.

Assumptions about *causality* in consciousness are paradigm-dependent

Theories of reality rest on disparate epistemological and metaphysical assumptions which, in turn, translate into different understandings of causality. Current science assumes that biological processes in general and the special case of consciousness in complex living systems can be adequately described in the terms of physical and biological processes linked by *discrete linear relationships*. Along the same lines current science asserts that ‘reality’ consists of categories of phenomena that are observable, susceptible to empirical investigation using existing research methodologies and technologies, and therefore *knowable* within the conceptual framework of science. According to this perspective, established ideas from the ‘basic sciences’ including physics, chemistry and biology, would be expected to eventually explain all causal mechanisms that exist or *can potentially exist* in nature. If this is the case there is no need to invoke non-classical models or radically different pathways of causality to explain any phenomena or the relationships between them. Contemporary scientific models of consciousness rest on similar naïve assumptions of classical *linear* causality. However, many alternative models of consciousness do *not* assume linear causality - including, for example, models based on complexity theory or quantum mechanics. Models of consciousness based on quantum mechanics or other non-classical paradigms are premised on *non-local* or *a-causal* relationships between phenomena (Vannini 2008). For example, quantum mechanics posits that photons or other sub-atomic particles can exist as entangled states related in exact and predictable ways, but that characteristics of entangled sub-atomic particles—or phenomena related to them—*cannot be formally described* using simple deterministic models of causality. Therefore, although entanglement between photons has been experimentally verified, classical Newtonian concepts of space, time and causality cannot adequately explain or predict properties of sub-atomic particles. Considerable debate is taking place over the relevance of quantum mechanics to models of consciousness (Baars & Edelman 2012). From the point of view of quantum mechanics all that can be claimed is that two particles that are separated in space sometimes remain *probabilistically*

correlated or *'entangled'* over vast distances. The same dilemma that constrains the explanatory power of current science with respect to the role of quantum-level events in consciousness may hinder on-going research efforts to elucidate mechanisms associated with claims of 'energy' healing, telepathy, clairvoyance, psychokinesis and other so-called 'non-ordinary' phenomena associated with human consciousness. For example above-chance correspondences have been reported between certain states of consciousness including sustained 'intention' or attention, prayer, or meditation, and intended physical effects in living systems - however to date scientific investigations have failed to elucidate a mechanism for such events. Along these lines, it is not clear whether energetic changes at the level of sub-atomic particles or energy fields when entanglement is confirmed to take place are related to biological processes associated with the effects of human intention on living systems. In spite of the absence of a testable model of quantum level events in consciousness, reports of beneficial outcomes following 'healing intention' and above-chance changes in both non-living and living systems following 'directed intention' may provide useful concepts for investigating phenomena associated with human consciousness (Jonas 2003)

Current science subscribes to materialism, the philosophical perspective that so-called 'ordinary' states of consciousness including perception, cognition and emotions are reducible to knowable and verifiable physiological processes at the level of neurotransmitters and brain circuits. According to the conventional model both pathological states such as neurological or psychiatric disorders, and 'non-ordinary' states such as transpersonal experiences and claims of psychic functioning are *caused by* dysregulations of 'normal' physiological processes that underlie 'ordinary' functions or states of consciousness. Proponents of the orthodox view argue that an adequate explanatory model of 'ordinary,' pathological and so-called 'non-ordinary' functions and experiences associated with consciousness will emerge from on-going advances in the current scientific paradigm without the need to introduce or invent new ways of 'thinking about' the phenomenal world in general or the special case of consciousness. This is essentially the perspective of functionalism, the current dominant scientific model of consciousness. Functionalism assumes that particular characteristics or subjective experiences are manifestations of corresponding *functional states* at the level of neurotransmitters or neural circuits. An (often) implicit assumption of functionalism is that physiological processes that underlie and *correspond to* particular functions or subjective states of consciousness can be adequately characterized in the context of current science using available research methods and technologies, permitting valid inferences about the nature of consciousness.

Biological, energetic and informational processes that shape living systems function in both discrete linear ways and complex non-linear ways. Simple discrete linear processes and complex non-linear processes are linked to one another in dynamic web-like hierarchies that change in relationship to both internal and external factors. *Along these lines body-brain can be viewed as a dynamic system that exists as a hierarchy of interdependent biological, informational and energetic processes in space-time. Models of consciousness must take into account the nature of complex living systems in which consciousness takes place or can potentially take place* (Tononi 1998). Most models start from the premise that body-brain exists as a dynamic system that functions in relationship to complex living systems and their environments. Disparate "levels" of structure-function in body-brain may be causally related to different categories of 'ordinary,' pathological or 'non-ordinary' conscious experience. According to the model experiences interpreted as 'pathological' or 'non-ordinary' states may reflect particular states or transitions in a dynamic hierarchy of inter-related biological, energetic and informational processes that

comprise body-brain. Particular processes and kinds of underlying biological, energetic or informational processes that characterize them may be reflected in the relative severity or ‘intensity’ of subjective experiences of so-called ‘ordinary,’ ‘pathological,’ and ‘non-ordinary’ conscious experiences.

Models that do not make the assumption that consciousness can be *accurately* or *completely* characterized in terms of discrete causal relationships in living systems invoke non-deterministic ideas about the nature of causality, including Jungian synchronicity, quantum field theory, morphogenetic field theory, PSI models, and others, to explain objective properties or subjective states of consciousness. The debate over determinism (i.e., the role of causality versus a-causality) in nature in general, and consciousness in particular, is fundamentally important to practical methodological problems involved in consciousness research, because disparate perspectives on causality translate into divergent methodologies for investigating postulated ‘causes’ of particular functional attributes or subjective experiences with respect to body-brain-environment. The debate over causality is reflected in the debate over research designs used to investigate the claims of disparate models of consciousness.

The nature of “body-brain” and its relationship to consciousness

The nature of “body-brain” in space-time is related to the nature of “embodiment” of structures or processes that *comprise* body-brain, and by extension the nature of interactions between embodied structures and processes and phenomena that exist “outside of” body-brain. Understanding the phenomenological nature of “body-brain” entails analysis of how body-brain is situated in space-time, which is limited by the capacity of science to accurately and completely characterize body-brain using contemporary research methodologies and technologies. Disparate models of reality are based on different premises about the nature of “body-brain” and space-time therefore addressing problems related to the nature of “body-brain” in space-time requires examining metaphysical and epistemological problems pertaining to verifying existence and characterizing properties of phenomena that disparate models posit. Different metaphysical *starting points* and epistemological perspectives embedded in disparate models of reality *a priori* bias and *place constraints on* models of “body-brain” construed as legitimate within a particular model of reality. Analysis of the nature of “self,” “mind,” and “consciousness” is related to the more general problem of understanding the nature of “body-brain” but also takes into account questions pertaining to identity and functional attributes of these terms. Philosophical and methodological issues pertaining to problems of “body-brain-environment” and “embodiment” are closely related to practical problems in designing research methodologies that determine how phenomena are investigated, and shape inferences about the nature of consciousness. In other words, the core premises of any particular model of consciousness determine methodological approaches that are regarded as legitimate for characterizing the nature of consciousness with respect to “body-brain-environment.”

Novel models of life in general including the special case of living systems capable of exhibiting consciousness take into account research findings in many domains of knowledge including complex systems theory, quantum mechanics, and other emerging perspectives that depart from current science. Recent advances in quantum biology are yielding important insights into the role of QM-level processes in the animal and plant kingdoms in general (Bunting 2013). However, most of this work remains highly theoretical and the majority of *scientific* studies on consciousness investigate postulated mechanisms of action that are strictly biological in nature. The assumption that only empirically verifiable phenomena

influence non-living or living systems is a widely shared belief based on an underlying *pre-scientific* metaphysical assumption about the ‘kind of thing’ consciousness is, which has not only *not* been empirically verified but which may not be verifiable in the context of current scientific thinking. This metaphysical assumption has led to the dogma that legitimate models of body-brain must be grounded in already established biological mechanisms. In contrast to the orthodox view, some recently proposed models posit that “ordinary,” “pathological (i.e., as in mental illness)” and “non-ordinary (e.g., transpersonal experiences and Psi)” functions or subjective states of consciousness are manifestations of complex structure-function relationships between the body-brain-environment system and incompletely characterized forms of “energy” or information. Emerging research findings suggest that a ‘subtle’ domain or “field” may comprise the *ground* in which the body-brain exists and functions outside of constraints widely held to be fundamental boundary conditions as described in classical Newtonian space-time.

Models that purport to explain how “body-brain” is situated in space-time are based on metaphysical assumptions about the nature of reality and “ways of knowing” (i.e., epistemologies) that are either *implicit* or *explicit* in disparate models of consciousness. Therefore assumptions about the nature of reality and agreement on valid ways of *knowing about* reality translate into schemata for identifying and characterizing attributes of body-brain that exist or *can potentially* exist. Important questions when approaching the problem of how “body-brain” is situated in space-time include:

- What *primary* entities or processes (if any) constitute “body-brain?” (i.e., what primary phenomena constitute necessary and sufficient conditions for the existence of ‘body-brain?’)
- What primary *external* phenomena ‘interact’ or ‘interface’ with body-brain comprising the body-brain-environment ‘system’ (i.e., the system in which body-brain is situated in space-time)? Stated differently, what constitutes the ‘environment’ in which body-brain is situated? Further, what research methods and technologies can most accurately and completely characterize the nature of the brain-body-environment system?
- Can inferences be made about specific properties of the body-brain-environment system that may help clarify necessary or sufficient conditions for consciousness, or necessary and sufficient boundary conditions in which consciousness *can potentially* take place in relationship to systems situated in space-time? *Stated differently, in view of what is known about the nature of the physical universe and how body-brain is situated in space-time, is it possible to make inferences about properties of the body-brain-environment system using current science?* Further, can this general approach be expected to lead to a more *complete* model of consciousness?
- *Can current scientific models of consciousness yield falsifiable claims about the nature of the body-brain-environment system in which consciousness exists or can potentially exist?* If so, what kinds of *testable* claims can be made? If not, what changes in current models would be expected to yield falsifiable hypotheses about the nature of consciousness?
- Can claims of correspondences between particular characteristics of body-brain-environment and particular observable characteristics or subjective states of consciousness be *empirically verified* using available research methodologies and technologies?

- In view of what is known or *knowable* (ie according to current science) about relationships between body-brain-environment and consciousness, are certain research methodologies more likely to yield accurate or more complete descriptions of particular objective characteristics or subjective *states* of consciousness? Along these lines, can current research methodologies be optimized to more adequately address problems related to consciousness?

The above general discussion bears on the problem of characterizing conscious experiences interpreted as ‘non-ordinary’ states including claims of Psi. Exhibit 2 lists models of “body-brain” that have been put forward in contemporary scientific dialog on consciousness including the author’s proposed model that incorporates assumptions of current science together with assumptions from emerging paradigms in physics.

Exhibit 2: Different models of “body-brain” imply different properties of consciousness

Issues in consciousness research	Current Science	Author’s proposed model
The nature of ‘body-brain’	<p>‘Body-brain’ is comprised of molecules, cells and tissues</p> <p>‘Body-brain’ can be accurately and completely described in terms of anatomy, physiology and interactions with the environment</p> <p>Structures and processes that characterize complex living systems exist in 4-dimensional space-time, are observable and empirically verifiable, and can be accurately and completely described in terms of linear dynamics</p>	<p>‘Body-brain’ <i>cannot</i> be adequately described using current science and can be more accurately and completely characterized as a dynamic pattern of interacting matter, energy and information</p> <p>Functional characteristics of ‘body-brain’ are influenced by complex interactions between molecules, cells and tissues at multiple levels in a complex web-like hierarchy</p> <p>Both linear and non-linear interactions take place within ‘body-brain’ and between ‘body-brain’ and ‘environment’</p> <p>Interactions between ‘body-brain’ and environment take place in 4-dimensional space-time, and in some cases possibly also in higher order n-dimensional space-times</p>

‘Ordinary’ states of consciousness	<p>Structures and processes in living systems can be adequately described in terms of linear dynamics using conventional scientific models</p> <p>‘Ordinary’ states of consciousness can be accurately and completely described in terms of established scientific models and investigated using contemporary empirical methods</p>	<p>There is no real distinction between “structure” and “process” in living systems. These terms reflect different semantic ‘frames’ for describing complex inter-relationships at different hierarchic ‘locations’ in ‘body-brain’</p> <p>‘Ordinary’ states of consciousness cannot be accurately or completely described using established scientific models and methods because they ultimately rest on poorly understood non-linear phenomena that are not susceptible to available research methods</p>
Pathological states of consciousness	<p>Pathological states of consciousness (eg mental illness) can be accurately and completely described using already established scientific models describing brain function</p>	<p>More complete understandings of pathological ‘states’ of consciousness can be achieved using non-linear dynamics than linear dynamics of discrete states</p>
‘Non-ordinary’ states	<p>‘Non-ordinary’ states of consciousness including transpersonal experiences and claims of psychic functioning can be explained using established models in neuroscience, psychology and anthropology</p>	<p>Certain ‘non-ordinary’ states of consciousness including verified cases of Psi <i>cannot</i> be explained by current science and may be consistent with the predictions of quantum mechanics or other non-classical models in physics</p>

Toward a model of Psi—review of evidence, framing the problem and questions

Evidence supporting claims of psychic functioning comes from many research domains. Several controlled studies show that prayer and other forms of directed intention influence biological systems on the scale of cellular activity and physiology (Radin 2004; Jonas 2003; Astin 2000). The first scientific report of an apparent non-local connection between sensory isolated individuals was published in 1965 (Duane 1965). EEG recordings of identical twins in separate rooms showed that when a light was flashed in the eyes of one twin, increased alpha activity occurred in the brain of the other twin. This effect, described as “extrasensory induction,” was replicated many years afterwards by several small open trials on empathically linked individuals. Visually evoked potentials (VEP) in one individual were correlated with above-chance brain activation in the other individual sitting inside an electromagnetically shielded room (Grinberg-Zylberbaum 1987; 1994). These early findings were subsequently confirmed by a controlled study involving 60 pairs of individuals (Standish, et al. 2001). Other studies suggest apparent non-local effects of intention or prayer on the basis of above-chance correlations in electro-dermal activity between sensory-isolated subjects (Schlitz 1997). Considerable controversy surrounded the publication of findings of a small controlled study suggesting that visual evoked potentials in one individual correlate with above-chance activation on fMRI in the visual association cortex of an empathically linked person who is physically and electromagnetically isolated (Standish, et al. 2003). This finding has been replicated in a case study using a similar VEP paradigm and conventional EEG recording methods (Wackermann 2003). Findings of a small non-blinded pilot study suggest that healing intention in one individual corresponds to consistent changes in activity on fMRI in brain regions involved with attention in an individual who is empathically “linked” however these findings have not been replicated in subsequent pilot studies or large controlled trials (Achterberg 2005).

Evidence of ‘non-local’ perception may reflect a special kind of quantum entanglement and be consistent with predictions of how QM-level phenomena operate in complex living systems (Tressoldi 2011). An apparent case of macroscopic quantum entanglement has been reported between cultured nerve cells that are electromagnetically isolated (Pizzi 2004). Independent replication of this finding may offer important clues of the involvement of quantum non-locality or other postulated non-classical mechanisms associated with prayer and other forms of healing intention (DHI).

Both current science and emerging non-classical paradigms have been invoked in efforts to explain apparent relationships between prayer and other forms of distant healing intention and changes in brain function measured using EEG or fMRI. Extremely low-frequency electromagnetic waves may explain some observed cases of apparent information transfer between two or more isolated individuals even when EMF shielding is used (Miller 2013; Sidorov 2012). Reports of apparent correlations between changes in brain activity and prayer or other forms of directed intention may be consistent with macroscopic quantum entanglement effects postulated by Thaheld (Thaheld 2000; 2005). It has been suggested that healing intention is an essential factor in both biomedicine and non-Western healing traditions (Zahourek 2004).

As is true when approaching the problem of consciousness in general, deriving an explanatory model of so-called ‘non-ordinary’ states of consciousness including claims of psychic functioning can be approached from disparate world-views or epistemologies. From the perspectives of cognitive psychology

and neuroscience models purporting to explain Psi are often described as corollaries to established neurobiological models of sensation, perception and attention. Models that postulate necessary and sufficient neurobiological or psychological causes, conditions or processes underlying Psi are sometimes offered as extensions of mainstream cognitive neuropsychological models pertaining to how raw sensory data are ‘filtered’ using implicit (unconscious) or explicit (conscious) cognitive routines. For example the concept of “non-conscious perception” (ie “subliminal perception”) is conventionally understood as a process by which an organism is ‘aware’ of environmental stimuli that are *below* the ‘normal’ sensory threshold. According to this model the organism can perceive in the absence of ‘awareness’ ie, a percept is formed in response to a stimulus however the organism is not conscious of the percept. Other models posit a capacity for awareness of ‘subtle’ stimuli that are *not* perceived, in other words there is awareness in the absence of perception. Cognitive psychology models hold that ‘normal sensory functioning’ subsumes non-conscious, “sub-liminal” or “sub-threshold” perception in addition to so-called ‘ordinary’ perception. However conventional scientific models rely on established theories in psychology and neuroscience to explain the range of perceptual states and do not invoke “subtle” energy or poorly described neural mechanisms to explain claims of so-called ‘non-ordinary’ states.

In contrast to contemporary scientific models of perception Psi models postulate the existence of novel *kinds* of energy or information that are generally excluded or *a priori* dismissed in contemporary scientific dialog, as well as neural functions that permit perception and accurate interpretation of subtle environmental signals. Important questions that must be addressed in any future model of consciousness that attempts to reconcile explanations of ‘ordinary’ perception with co-called ‘non-ordinary’ states including claims of Psi include:

- Are disparate neural structures and processes involved in ‘ordinary’ vs ‘non-ordinary’ perception?
- Are ‘ordinary’ vs ‘non-ordinary’ conscious states associated with different energetic or informational mechanisms? If it turns out that ‘non-ordinary’ states involve fundamentally different mechanisms can existing research methods and technologies be employed to investigate them? If it turns out that ‘ordinary’ and ‘non-ordinary’ states involve similar mechanisms, what neural or other mechanisms play a role when classically described forms of energy or information are associated with ‘non-ordinary’ states of consciousness including claims of psychic functioning?
- Is energy or information at the level of simple QM events or quantum fields related to Psi in *non-trivial* ways that can be investigated using contemporary research methodologies and technologies? In other words, are quantum-level events including sub-atomic particles or their fields *centrally* and *critically* involved in mechanisms underlying so-called ‘non-ordinary’ states of consciousness including claims of psychic functioning? Further, are models that postulate quantum-level energetic or informational processes in human brain functioning and—by extension perception—falsifiable using contemporary scientific research methods and technologies? If so what methods or technologies would more likely yield findings? If not, what advances in existing research methods or technologies may permit scientific investigation of the role of postulated QM phenomena in consciousness?

Closing remarks

In spite of rapid advances in neuroscience basic questions about consciousness remain unanswered. There is still no consensus on *how to define* consciousness, what a model of consciousness should encompass, or optimal research strategies for investigating different aspects of consciousness (Boly et al 2013). Research progress will accelerate and important advances in understanding will take place when science *becomes open* to asking questions about so-called ‘non-ordinary’ states of consciousness including transpersonal experiences and claims of psychic functioning. Philosophical inquiry into the nature of consciousness is not merely an academic pursuit but the work of collective imagination, self-reflection and reasoning that theorists and researchers *must engage in* to tackle the complex problems associated with consciousness, because philosophical inquiry will clarify important unanswered questions and suggest novel research methods designed to address those questions. Future models of consciousness will not rely *exclusively* on empirical verification of strictly biological processes and will take into account both classically described biological processes (eg, neurophysiological and immunological functioning) and *non-classical* physical phenomena, including the postulated role of macroscopic coherent quantum fields and quantum non-locality (Vannini 2008). Beginning from this more inclusive conceptual framework future research programs will explore the range of biological and physical phenomena yielding novel insights into ‘ordinary,’ ‘pathological’ and ‘non-ordinary’ functions and states of consciousness.

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