Two papers

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Meanings Attributed to the Term 'Consciousness'

An Overview

Keywords: Classification, consciousness, definitions, meanings, structure, function, experience, materialism, physicalism, dualism, dual-aspect, neural-Darwinism, *yogins*, pure awareness, *samadhi*.

Abstract: *I here describe meanings (or aspects) attributed to the term consciousness, extracted from the literature and from recent online discussions. Forty such meanings were identified and categorized according to whether they were principally about function or about experience; some overlapped but others were apparently mutually exclusive — and this list is by no means exhaustive. Most can be regarded as expressions of authors' views about the basis of consciousness, or opinions about the significance of aspects of its contents. The prospects for reaching any single, agreed, theory independent definition of consciousness thus appear remote. However, much confusion could be avoided if authors were always to specify which aspects of consciousness they refer to when using the term. An example is outlined of how this can be done (using a 'PE–SE' framework).*

1. Introduction

The term consciousness 'means different things to different people' (Rao, 1998). Here, I shall offer outline descriptions and tabulations of

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Corrections in the proof of "Meanings attributed to the term 'consciousness': an overview" (Author: Vimal) are as follows. The locations are yellow-highlighted in the proof:

1. Page 2, paragraph 4: Please replace "Matter may be the *carrier* of …" with "There are three hypotheses: Matter may be the *carrier* of …".

2. Page 2, paragraph 4: Please insert the following after "… though possessing different epistemic aspects."

"A SE is an *expressed* first person experience that occurs/arises/emerges during interaction between feed-forward signals and feedback signals in a neural-net, which satisfies the *necessary* ingredients of consciousness (Vimal, 200x-e) such as wakefulness, re-entry, attention, working memory, stimulus at above threshold, and neural-net proto-experiences (PEs). In general, PEs are precursors of SEs. In the first hypothesis, PEs are precursors of SEs in the sense that PEs are superposed SEs in unexpressed form in the mental aspect of every entity, from which a specific SE is selected via matching and selection process. In the second and third hypotheses, PEs are precursors of SEs in the sense that SEs *somehow* arise/emerge from PEs, as elaborated in (Vimal, 200x-a, 200x-b, 200x-c, 200x-d)."

This is necessary to make clear the meaning of the terms SEs and PEs for the readers.

3. Throughout Proof, please replace "2008c" with "2009", "2008d" with "200x-d", and "2008e" with "200x-e".

Their locations are highlighted in yellow in the Proof; this is necessary due to my current development.

4. Page 5, line 3: Please replace "in Table 1" with "in his Table 1".

Otherwise readers will be confused with Table 1 of the Proof.

5. Page 6, lines 10-11: Please replace "Therefore, I have used the term 'Subjective experience (SEs) of objects/qualia' in" with " In general, qualia are properties of conscious experiences, properties/qualities of objects, or both (Vimal, 200x-c). Therefore, I have used the term 'qualia; subjective experiences (SEs) of objects' in".

6. Page 8, end of footnote 1: Please delete "My jcs-online post #6523, and #5957 on the proper formulation of the hard problem." This is a mistake, it must be deleted.

7. Page 9, Table 1 legend, lines 3-4: Please replace "JCS online yahoo discussion group as per footnote 1" with "online discussion groups as per footnote 2".

8. Page 13, Table 2 legend, lines 3-4: Please replace "JCS online yahoo discussion group as per footnote 1" with "online discussion groups as per footnote 2".

9. Page 13, Table 2, meaning#3 : Please replace "Subjective experience (SEs) of objects/qualia" with "qualia; subjective experiences (SEs) of objects".

10. Page 15, Acknowledgments: Please add the following at the end of Acknowledgments section: "The most recent and longer version of this article is available at http://www.geocities.com/rlpvimal/meanings-Vimal.pdf. The author is affiliated with Vision Research Institute, 428 Great Road, Suite 11, Acton, MA 01720 USA; Dristi Anusandhana Sansthana, A-60 Umed Park, Sola Road, Ahmedabad-61, Gujrat, India; Dristi Anusandhana Sansthana, c/o NiceTech Computer Education Institute, Pendra, Bilaspur, C.G. 495119, India; and Dristi Anusandhana Sansthana, Sai Niwas, East of Hanuman Mandir, Betiahata, Gorakhpur, U.P. 273001, India. " This is necessary otherwise my institutes will press charges/objections against me because they supported this research and they want to see their names published in the article for future funding and support. Thanks for understanding.

11. Page 18, ref. Vimal, R.L.P. (200x-a): Please replace "*NeuroQuantology*. Submitted for publication on 5 August 2008," with "*In review*,"

12. Page 18, ref. Vimal, R.L.P. (200x-b): Please replace "*NeuroQuantology*. Submitted for publication on 5 August 2008," with "*In review*,"

13. Page 18, ref. Vimal, R.L.P. (200x-c): Please replace "Quest for the Definition(s) of Consciousness" with "Quest for the Definition of Consciousness, Qualia, Mind, and Awareness".

14. Page 18, ref. Vimal, R.L.P. (2008c): Please replace "Vimal, R.L.P. (2008c), 'Selection of a Specific Subjective Experience: Matching of Superposed Subjective Experiences in Internal Neural-Nets with That in External Sensory Input'," with "Vimal, R. L. P. (2009), 'Selection of a specific subjective experience: conjugate matching and subjective experience',".

15. Page 19, ref. Vimal, R.L.P. (2008d): Please replace "Vimal, R.L.P. (2008d), 'Towards a Theory of Everything: Unification of Consciousness with Fundamental Forces in String Theory', *NeuroQuantology Journal*, submitted on 26 September 2008, " with "Vimal, R.L.P. (200x-d) , 'Towards a Theory of Everything: Unification of Consciousness with Fundamental Forces in String Theory', *In review*,".

16. Page 19, ref. Vimal, R.L.P. (2008e): Please replace "Vimal, R.L.P. (2008e), 'Visual Awareness: Integration of Psychophysical, Neurophysiological, and Consciousness Research for Red-Green Channel', In review, Journal of Integrative Neuroscience, re-submitted on 28 August 2008," with "Vimal, R. L. P. (200x-e), 'Necessary Ingredients of Awareness: Integration of Psychophysical, Neurophysiological, and Consciousness Research for the Red-Green Channel', *In review*, ".

various meanings and/or definitions, derived from published works and also from recent online discussions. The latter can perhaps be regarded as providing a useful indication of usages current among 'people out there' in the consciousness community.

Although the meanings (or aspects) identified differ, many appear to share common characteristics and can be grouped according to two criteria, namely, *function* and *experience*. In general, materialists [Types A–C: (Chalmers, 2003) — see later discussion] attribute various *functions* ('easy problems', such as detection, discrimination, recognition, cognition, etc.) to consciousness, whereas others (e.g. Chalmers' Types E–F) attribute to it *experiences* (i.e. aspects of the 'hard problem').

Thus, from a reductive/materialistic perspective, consciousness has been defined as (a) a multidimensional physical/neurobiological process that 'emerges from interactions of the brain, the body, and the environment', and (b) 'the result of dynamic interactions among widely distributed groups of neurons' (Edelman, 2003). According to non-reductive views (such as substance dualism, property dualism, panpsychism, and pan-informationism), on the other hand, consciousness is an irreducible fundamental mental entity, even when regarded as being an aspect of, or closely associated with, matter or material processes.

From a dual-aspect perspective, one can envisage a variety of possible relationships between objective aspects of matter, proto-experience (PE) and subjective experience (SE) — see (Vimal, 2008b) and also (Vimal, 2008a; 2008c). Matter may be the *carrier* of both PEs and SEs (Vimal, 2008b); or it may carry PEs only, with *emergence* of SEs in the course of neural evolution (Vimal, 200x-a; 200x-b; 2008d; 2008e); or the three may be ontologically inseparable (Vimal, 2008d) though possessing different epistemic aspects. This framework is a *non-reductive physicalism*, (where *physicalism* = materialism + *experience*) (Vimal, 200x-c).

It thus suggests one way of envisaging overlap between *function* and *experience*. Hence, I am not suggesting that the two categories must be mutually exclusive, but they are nevertheless useful guides. Armed with them, we can set out to explore the jungle of meanings, starting with a description of David Chalmers' views on the topic.

2. Selected meanings

1. David Chalmers' Categorization

According to (Chalmers, 2003), 'On my view, the most important views on the metaphysics of consciousness can be divided almost exhaustively into six classes, which I will label "type A" through "type F". Three of these (A through C) involve broadly reductive views, seeing consciousness as a physical process that involves no expansion of a physical ontology. The other three (D through F) involve broadly non-reductive views, on which consciousness involves something irreducible in nature, and requires expansion or reconception of a physical ontology. … The word "consciousness" is used in many different ways. It is sometimes used for the ability to discriminate stimuli, or to report information, or to monitor internal states, or to control behavior. We can think of these phenomena as posing the "easy problems" of consciousness. … The hard problem of consciousness is the problem of experience. Human beings have subjective experience: there is something it is like to be them. We can say that a being is conscious in this sense — or is phenomenally conscious, as it is sometimes put — when there is something it is like to be that being. A mental state is conscious when there is something it is like to be in that state. Conscious states include states of perceptual experience, bodily sensation, mental imagery, emotional experience, occurrent thought, and more. …

Type-A materialism (Dennett, 1991; Dretske, 1995; Harman, 1990) sometimes takes the form of eliminativism, holding that consciousness does not exist, and that there are no phenomenal truths. It sometimes takes the form of analytic functionalism or logical behaviorism, holding that consciousness exists, where the concept of "consciousness" is defined in wholly functional or behavioral terms (e.g., where to be conscious might be to have certain sorts of access to information, and/or certain sorts of dispositions to make verbal reports). For our purposes, the difference between these two views can be seen as terminological. Both agree that we are conscious in the sense of having the functional capacities of access, report, control, and the like; and they agree that we are not conscious in any further (non-functionally defined) sense. … the concept of consciousness [in Type-B materialism (Block & Stalnaker, 1999; Hill, 1997; Levine, 1983; Loar, 1997; Perry, 2001; Tye, 1995)] is distinct from any physical or functional concepts, but we may discover empirically that these refer to the same thing in nature. [According to (Levin, 2008), "Type-B materialism is the thesis that though phenomenal states are necessarily identical with

physical states, phenomenal concepts have no *a priori* connections to physical or functional concepts"]. … According to type-C materialism (Churchland, 2003; Crick & Koch, 2003; Edelman, 1993; 2003; Hamker, 2004; Koch, 2004; Nagel, 1974; Tononi, 2004; Van Gulick, 2001), there is a deep epistemic gap between the physical and phenomenal domains, but it is closable in principle. … [According to (Quine, 1951)] explaining the functions explain everything (Dennett may be an example). … [If materialism is false], it could be that consciousness is itself a fundamental feature of the world, like spacetime and mass. …

[In] Type-D dualism (Beck & Eccles, 1992; Foster, 1991; Hodgson, 2005; Popper & Eccles, 1977), … usually known as interactionism, physical states will cause phenomenal states, and phenomenal states cause physical states. … Type-E dualism holds that phenomenal properties are ontologically distinct from physical properties, and that the phenomenal has no effect on the physical. [Type-E dualists include (Campbell, 1970; Huxley, 1874; Jackson, 1982; Robinson, 1988)]. This is the view usually known as *epiphenomenalism* (hence type-E): physical states cause phenomenal states, but not vice versa [and consciousness is irreducible]. … Type-F monism [or panprotopsychism (Chalmers, 1996; Griffin, 1998; Lockwood, 1989; Russell, 1927; Stoljar, 2001; Strawson, 2000; Whitehead, 1978)] is the view that consciousness is constituted by the intrinsic properties of fundamental physical entities. … On this view, phenomenal or protophenomenal properties are located at the fundamental level of physical reality, and in a certain sense, underlie physical reality itself'.

To summarize the above, consciousness is (i) a physical process for materialists (reductive or emergence views: Types A–C) or (ii) an irreducible fundamental mental (non-material) entity (Types D–F views including dualisms, panpsychism, etc.). However, on the basis of the PE–SE framework (Vimal, 2008b) mentioned earlier, for example, it can be argued that some, though probably not all, meanings of (i) and (ii) overlap.

2. Examples of Materialistic Definitions (James, Edelman, Baars, Block and Searle)

According to Edelman (2003), 'Consciousness is not a thing but rather, as William James pointed out (James, 1977), a process that emerges from interactions of the brain, the body, and the environment. … it is a multidimensional process with a rich variety of properties. … [C]onsciousness is not a property of a single brain location or

neuronal type, but rather is the result of dynamic interactions among widely distributed groups of neurons'. Edelman (2003) also suggests, in Table 1, that conscious states have *general features* '1. Conscious states are unitary, integrated, and constructed by the brain. 2. They can be enormously diverse and differentiated. 3. They are temporally ordered, serial, and changeable. 4. They reflect binding of diverse modalities. 5. They have constructive properties including gestalt, closure, and phenomena of filling in', *informational features* '1. They show intentionality with wide-ranging contents. 2. They have widespread access and associativity. 3. They have center periphery, surround, and fringe aspects. 4. They are subject to attentional modulation, from focal to diffuse', and *subjective features* '1. They reflect subjective feelings, qualia, phenomenality, mood, pleasure, and unpleasure. 2. They are concerned with situatedness and placement in the world. 3. They give rise to feelings of familiarity or its lack'.

For Baars (Baars, 1988), on the other hand, consciousness is accomplished by a 'distributed society of specialists that is equipped with a working memory, called a global workspace, whose contents can be broadcast to the system as a whole'. In a subsequent comment on Ned Block's proposals, Baars remarked (Baars & Laureys, 2005), 'Block (2005) has long argued that there are two kinds of consciousness: "phenomenological consciousness" (what we experience) and "access consciousness" (roughly, the information we can access via conscious experiences). … There is no need for "access consciousness". All we need is consciously-mediated access to brain capacities, most of which are simply not conscious'.

Searle (2000) opined, 'Consciousness is entirely caused by neurobiological processes and is realized in brain structures. The essential trait of consciousness that we need to explain is unified qualitative subjectivity. Consciousness thus differs from other biological phenomena in that it has a subjective or first-person ontology, … Two common approaches to consciousness are those that adopt the building block model, according to which any conscious field is made of its various parts, and the unified field model, according to which we should try to explain the unified character of subjective states of consciousness'.

All these authors, while emphasizing different details, thus appear to regard consciousness as an outcome of complex neuro-biological processes.

3. Gordon Globus' View

Globus (1998) stated, 'the vague term "consciousness" is partially unpacked into "self", "cognition", "qualia" and "thrownness-in-the-world" […] problem. I shall partially do so here, confining my investigation to (1) the self or subject, denoted by "I", (2) cognition, (3) thrownness in the world, and (4) "qualia"'.

However, the term 'qualia' may have different meaning to different people. Therefore, its meaning should be clarified; for example, SEs or 'first person experiences' is one of the meanings attributed to the term 'qualia'. Therefore, I have used the term 'Subjective experience (SEs) of objects/qualia' in Table 2 (meaning #3).

4. Non-Representational Theories: Dynamic System Theory, Externalism and Fractal Catalytic Theory

According to (Freeman, 1999), 'The emergent pattern is not a representation of a stimulus. … It is a phase transition that is induced by a stimulus, followed by a construction of a pattern that is shaped by the synaptic modulation among cortical neurons from prior learning. … It is a dynamic action pattern that creates and carries the meaning of the stimulus for the subject'.

O'Reagan and Noe (2001) aver, 'seeing is a way of acting. It is a particular way of exploring the environment. Activity in internal representations does not generate the experience of seeing. The outside world serves as its own, external, representation. The experience of seeing occurs when the organism masters what we call the governing laws of sensorimotor contingency. … [E]xperience does not involve having an internal representation, but instead involves making use of certain capacities to interact with the environment'.

In Radical Externalism or Consciousness as Existence, consciousness is perceptual (say seeing this page), reflective (say, thinking of home) or affective (say wanting to be there or intending to get there); perceptual consciousness is outside the head, whereas reflective and affective consciousness may be inside the cranium (Honderich, 2006). Furthermore, 'with respect to consciousness, *there is no difference between appearance and reality*. With consciousness, what there seems to be is what there is. What there seems to be is all there is'(Honderich, 2006).

According to Velmans (2007), 'Dualists believe that experiences have neither location nor extension, while reductive and "non-reductive" physicalists (biological naturalists) believe that experiences are really in the brain, producing an apparent impasse in current

theories of mind. Enactive and reflexive models of perception try to resolve this impasse with a form of 'externalism' that challenges the assumption that experiences must either be nowhere or in the brain. However, they are externalist in very different ways. Insofar as they locate experiences anywhere, enactive models locate conscious phenomenology in the dynamic interaction of organisms with the external world, and in some versions, they reduce conscious phenomenology to such interactions, in the hope that this will resolve the hard problem of consciousness. The reflexive model accepts that experiences of the world result from dynamic organism-environment interactions, but argues that such interactions are preconscious. While the resulting phenomenal world is a consequence of such interactions, it cannot be reduced to them. The reflexive model is externalist in its claim that this external phenomenal world, which we normally think of as the "physical world", is literally outside the brain. Furthermore, there are no added conscious experiences of the external world inside the brain. … [I]n closing the gap between the phenomenal world and what we normally think of as the physical world, the reflexive model resolves one facet of the hard problem of consciousness. Conversely, while enactive models have useful things to say about percept formation and representation, they fail to address the hard problem of consciousness'.

In a paper by Carpenter, *et al.* (2009), they '… [provide] support for a non-representational theory of perception called the Fractal Catalytic theory, which proposes that perception is a catalytic type of process. … [E]xperience arises as an organism mediates (catalyzes) the transitions in its surround … consciousness may be fundamental'.

Non-representational theories therefore suggest that consciousness is mostly *function* because (i) emergent pattern is viewed as a stimulus-induced phase transition (Freeman, 1999), (ii) experience is a way of acting that involves sensorimotor interaction (O'Regan & Noë, 2001), (iii) perceptual consciousness is outside the head (Honderich, 2006), or (iv) experiences of the world result from dynamic organism-environment interactions (Velmans, 2007).[1] Alternatively, consciousness may be fundamental and 'experience arises as an organism

[1] Velmans commented that the discussion (iv) of representational theories versus non-representational implies 'that I argue for a non-representational view of consciousness. But in my own work I find it important to distinguish the conditions that support the arising of a given conscious experience from the conscious experience itself. Dynamic organism-environment interactions are clearly involved in the formation of percepts of the external world, however the latter may represent events in the world once they arise — see, for example, (Velmans, 1990) which also elaborates on the closure of the psychological with the physical (and which predates Honderich, 2006, by 16 years' (personal

mediates (catalyses) the transitions in its surround' (Carpenter *et al.*, 2009).

5. Meanings Attributed in JCS, MindBrain, and Nature Network Online Discussion Groups.

In 2008–2009, JCS-online and MindBrain-online discussion groups, and the *Nature Network forum 'Brain Physiology, Cognition and Consciousness'* held interesting discussions on the definition of consciousness[2] (see meanings listed in the tables below that have no year attributed to them).

6. Idealism and Modern Constructivism

In idealism, matter emerges from consciousness; for example, cosmic consciousness is the primary from which matter emerges (De & Pal, 2005; Hegel, 1971; Pal & De, 2004; Schäfer, 1997; 2006). For constructivists, according to (Müller, 2008), 'Matter is a structure that crystallizes within mind'.

7. Eastern Perspectives

According to (Rao, 1998), 'In the western scholarly tradition, (a) consciousness is generally equated with the mind; (b) intentionality is regarded as its defining characteristic; and (c) the goal is one of seeking rational understanding of what consciousness/mind is. In the eastern tradition, as represented by the Indian approach to the study of consciousness, (a) consciousness and mind are considered to be different; (b) consciousness as such is believed to be nonintentional while the mind is regarded as intentional; and (c) the goal is one of developing practical methods for transformation of the human condition via realization of consciousness as such.

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communication November, 2008). My jcs-online post #6523, and #5957 on the proper formulation of the hard problem.

[2] See http://tech.groups.yahoo.com/group/jcs-online/messages/nnnn : where nnnn is (i) 6240 and 6269 for Allsop, (ii) 6231, 6246 and 6247 for Deiss, (iii) 6221, 6230, and 6236 for Edwards, (iv) 6332 for Faichney, (v) 6228, 6243, and 6244 for McCard, (vi) 6246, 6267, 6645, and 6683 for Patlavskiy, 5957 and 6523 for his formulation of the hard problem, (vii) 6305 for Alfredo Pereira Jr., and (viii) 6244, 6249, and 6283 for Ricke. See http://groups.yahoo.com/group/MindBrain/nnnn, where nnnn is (i) 12877 for Patlavskiy's formulation of the Law of the Conservation of Consciousness, (ii) 14552 for Kelvin McQueen, (iii) 14553 for Robert Karl Stonjek, (iii) 14562 and 16505 for Serge Patlavskiy, and (iv) 14560 for Alfredo Pereira Jr.. See http://en.wikipedia.org/wiki/Consciousness for wikipedia. See also http://network.nature.com/groups/bpcc/forum/topics/t?page=p#, where t: 1585 with p: 71, 81, 84, 85, 93, 97, 99 and 101; t: 3943 with p: 1; these are not discussed because of the lack of space.

Table 1
Meanings attributed to the term *Consciousness* by various authors based on the criterion *function*. References without year are from JCS online yahoo discussion group as per footnote 1.

#	**Meanings Attributed to the Term 'Consciousness'**	**References**
	Materialistic Meanings (Types A–C)	
1	The ability to discriminate stimuli, to report information, to monitor internal states or to control behaviour: related to 'easy problems'	Chalmers, 2003
2	Consciousness as (multidimensional) physical/neurobiological processes	Baars, 1988; Edelman, 2003; James, 1977; Searle, 2000; Vimal, 2008; 2008e; Pereira Jr.
3	Consciousness is accomplished by a 'distributed society of specialists that is equipped with a working memory, called a global workspace, whose contents can be broadcast to the system as a whole'	Baars, 1988
4	Cognition including memory, attention, abstraction, inner speech, imagination, behaviour, intentionality, and language	Globus, 1998; Vimal, 2008a; 2008c
5	Processing of SE	Bruzzo & Vimal, 2007; Vimal, 2008a; 2008b
6	Thought processing, initiation of activities and/or other cognitive processing	Bruzzo & Vimal, 2007; Vimal, 2008a; 2008c
7	Consciousness is 'that which can be reported verbally (in humans) and that which is experienced subjectively'; however, consciousness is not necessarily dependent on the language constraint	Stonjek; Pereira Jr.
8	Thrownness in the world	Globus, 1998; Vimal, 2008c

9	Act of processing and conceptualization of information and the construction of the intellectual products in a form of inner speech and imagination, behaviour (including adaptive activity), language, etc.; consciousness as an ability of the complex system to reduce its entropy by transforming physical sensory signals into information	Patlavskiy; Patlavskiy, 1999
10	Self-organization	Vimal, 2008a; 2008c
11	Responsive to the environment: Humphrey's (2000) primitive, single-celled creature (floating in the ancient sea) detects red light and makes a characteristic *wriggle* of activity. The detection is its *function* because the animal is responsive to the environment (Vimal, 200x–b)	Humphrey, 2000; Vimal, 200x–b
12	'The awareness of a dynamic physical entity is its being informed by influences from other dynamic entities, including, perhaps, indirect influences from its own prior state. Phenomenal experience is what it is like to be thus informed'. Interpreter of sensory signals: 'interpretation and experiential sensing may be the same thing', panexperientialism	Edwards
13	Stream of intentional information	Faichney
14	Non-representational theories: Consciousness is mostly *function* such as emergent pattern is a stimulus-induced phase transition (Freeman, 1999), experience is a way of acting that involves sensorimotor interaction (O'Regan & Noë, 2001), perceptual consciousness is outside the head (radical externalism) (Honderich, 2006), or experiences of the world result from dynamic organism-environment interactions (Velmans, 2007)	Freeman, 1999; Honderich, 2006; O'Regan & Noë, 2001; Velmans, 2007
15	Reflective awareness, such as perception, thought, and volition; intentional entity in western perspective	Rao, 1998

16	Paradoxical awareness or awareness without being aware, such as subliminal perception, implicit memory, blindsight and hypnotic analgesia[3]	Rao, 1998
17	Consciousness is a way of being and of perceiving the various dimensions of reality; consciousness is a tool we use, not who we are; self-consciousness.	McCard
18	Consciousness is a process of interpreting sensed qualitative contrasts for their meaning as expectations we derive from them and storing those expectations in memory for future use.	Deiss
19	Memory and abstraction.	Ricke
20	Consciousness denotes being awake and *responsive to the environment*, in contrast to being asleep or in a coma.	Wikipedia

It is suggested that consciousness encompasses two different domains, the transcendental and the phenomenal, and that humans enjoy dual citizenship in them. … Consciousness in the sense of being aware refers to at least seven different things. First is reflective awareness, such as we find in the acts of perception, thought, and volition. Second is paradoxical awareness or awareness without being aware, which includes among other things subliminal perception, implicit memory, blindsight and hypnotic analgesia. Third is awareness of awareness, the awareness of being aware. Fourth is self-awareness, the awareness of personal identity, one's being distinct from the rest. Fifth is the awareness of unity and continuity in one's awareness, the so-called stream of awareness. Sixth is intuitive awareness, awareness

[3] Rao remarked, '… western paradigm … equates consciousness with subjective awareness, and does not apparently leave room for consciousness as something entirely different from and independent of the mind, a notion central to Indian tradition. I have no problem with considering blindsight as some sort of subconscious phenomena. … In the Indian tradition I have attempted to espouse, consciousness is the underlying principle of all awareness, including implicit awareness. It is not the same as subjective awareness, which is a category of awareness. It is a manifestation of consciousness but mediated and modulated by cortical processes. Function, structure, experience, etc. are inappropriate categories to understand consciousness-as-such even though they may prove helpful in understanding the manifestations of consciousness as in implicit memory or subliminal perception. I have no problem with your classification, even though I may have some reservations about the analysis of consciousness in terms of function and experience. I enjoyed reading your paper'. (Personal communication in September and October 2008).

that is apparently independent of and sensorially disconnected from the object of awareness such as intuitions, veridical hunches and extrasensory perception (Rao & Palmer, 1987). Finally, awareness as such or pure awareness which is not predicated of any object or process, a state often reported in mystical experiences and by yogins.

The above seven meanings of consciousness fall into two categories. The first category is what may be called 'object awareness', where awareness is always predicated of an object. The object may be physical or mental, real or imaginary. The second category is 'subject awareness' where awareness is awareness of itself or one of its aspects. It also includes the possibility of experiencing or realizing awareness as such, an awareness state with no object, whether of the awareness process or of the world of objects and thoughts'. Again according to Rao (2005), 'Perception is sensory awareness. Cognition is reflective awareness. Consciousness is awareness-as-such. In Indian psychology, as represented by *Samkhya-Yoga* and *Advaita Vedanta* systems, consciousness and mind are fundamentally different. Reality is the composite of being (*sat*), knowing (*cit*) and feeling (*ananda*). Consciousness is the knowledge side of the universe. It is the ground condition of all awareness. … In the western tradition the dominant perspective is one of rational understanding of what consciousness is. In the eastern tradition the approach is one of developing practical methods for transforming consciousness in specific ways for specific purposes. These differing approaches led to radically different emphases as to what is essential in discussing consciousness. A recognition of this fact is not only likely to help us appreciate the context and significance of each other's perspectives, but may also enable us to see the respects in which they are genuinely complementary'.

Meanings of consciousness extracted from the above relating to *function* are listed in Table 1 and those related to *experience* in Table 2, including awareness-as-such or pure awareness occurring in *samadhi* states, which has been replicated by many yogis since the RigVedic period 6000 years ago (Vimal & Pandey-Vimal, 2007).

Table 2
Meanings attributed to the term *Consciousness* by various authors based on the criterion *experience*. References without year are from JCS online yahoo discussion group as per footnote 1.

#	**Meanings Attributed to the Term 'Consciousness'**	**References**
	Non-materialistic but physicalist (= materialistic + experiential) meanings includes western/eastern perspectives: (Types D–F), idealism, and modern constructivism	
1	The problem of experience: '*hard problem*': Conscious states include states of perceptual experience, bodily sensation, mental imagery, emotional experience, occurrent thought and more (Chalmers, 2003)	Chalmers, 2003
2	Self (subjective or first person experience of subject) or self-awareness denoted by 'I'; the subject of cognitive activity	Bruzzo & Vimal, 2007; Globus, 1998; MacGregor & Vimal, 2008; Rao, 1998; Vimal, 2008a; 2008b; Wikipedia; Patlavskiy
3	Subjective experience (SEs) of objects/qualia	Edelman, 2003; Globus, 1998; Searle, 2000; Vimal, 2008a; 2008b; Edwards (qualia)
4	Proto-experiences (PEs)	Vimal, 200x–b; 2008a; 2008b
5	*Something that it is like* to be something (Nagel, 1974). It can be re-phrased as 'A state is a phenomenally conscious state, if and only if there is something it is like to have (or be in) that state. Moreover, an organism is phenomenally conscious, if and only if there is something it is like to be that organism' (McQueen)	Nagel, 1974; McQueen
6	SEs related to sensations, perceptions, moods, emotions, dreams and so on	Wikipedia; Bruzzo & Vimal, 2007; MacGregor & Vimal, 2008; Vimal, 2008a; 2008b
7	Access and phenomenal awareness; phenomenal experience	Block, 2005; Lamme, 2003; 2004; Vimal, 2008a
8	Thought	Wikipedia; Bruzzo & Vimal, 2007; Vimal, 2008a
9	Awareness of awareness	Rao, 1998

10	Intuitive awareness	Rao, 1998; Rao & Palmer, 1987
11	Free will	Bruzzo & Vimal, 2007; Vimal, 2008a
12	Phenomenal time and phenomenal space	Vimal, 2007; Vimal & Davia, 2008
13	Unified world of knowledge or awareness composed of phenomenal properties maintained by our brains; ineffable phenomenal qualities	Allsop
14	Whitehead's Actual Occasions	Whitehead, 1978; McCard
15	Non-representational theory: Consciousness may be fundamental and 'experience arises as an organism mediates (catalyzes) the transitions in its surround'	Carpenter *et al.*, 2009
16	Idealism: matter emerges from consciousness	De & Pal, 2005; Hegel, 1971; Pal & De, 2004; Rao, 1998; Schäfer, 1997; 2006
17	Modern constructivism: matter is a structure that crystallizes within mind	Müller, 2008
	Experiential meanings: Eastern perspective	
18	Non-intentional entity in eastern perspective	Rao, 1998
19	Awareness of unity and continuity in one's awareness or stream of awareness	Rao, 1998
20	Awareness-as-such or pure awareness of *yogins*, such as during the unification of SE of observer, SE of observed objects, and the processing of SEs at *samadhi* state	Rao, 1998; 2005

3. Conclusions

Given such a multiplicity of meanings, even within some particular paradigm such as materialism, it is hard to arrive at any single, widely acceptable, definition of consciousness (Vimal, 200x–c); attempts to do so often lead to confusion and circular discussion. And of course the lists offered here are by no means exhaustive — they simply represent meanings to be found in some of the most popular current literature and everyday usage.

According to (Crick & Koch, 1998), 'Everyone has a rough idea of what is meant by being conscious. For now, it is better to avoid a

precise definition of consciousness because of the dangers of premature definition. Until the problem is understood much better, any attempt at a formal definition is likely to be either misleading or overly restrictive, or both'. But confusion also often arises from misunderstandings of what people mean when using the term. Therefore, the best option may be to identify its various aspects and then define each aspect.

An example of how this can be done is provided by discussion of the dual-aspect PE–SE framework (Bruzzo & Vimal, 2007; MacGregor & Vimal, 2008; Vimal, 200x–a; 200x–b; 2008a; 2008b; 2008c; 2008d; 2008e; Vimal & Davia, 2008). The subjective experience (SE) and proto-experience (PE) aspects of consciousness were differentiated, described, and separately addressed. In the PE–SE framework, an entity has two aspects: material and experiential. The material aspect is composed of structures and *functions*, whereas the experiential aspect is composed of *experiences*. As shown in Tables 1 and 2, the *functions* and *experiences* together constitute the meanings attributed to the term *consciousness*. This approach arguably allowed relatively precise and understandable treatments of 'consciousness' in these papers; the method can, I suggest, be recommended to all.

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Quest for the Definition of Consciousness, Qualia, Mind, and Awareness

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Abstract

The *optimal* definition (that has the least number of problems) of consciousness is: '*consciousness is a mental aspect of a system or a process, which has two sub-aspects: conscious experience and conscious function*.' A *general* definition (that accommodates most views) is: '*consciousness is a mental aspect of a system or a process, which is a conscious experience, a conscious function, or both depending on the context*', where *experiences* can be conscious experiences and/or non-conscious experiences and *functions* can be conscious functions and/or non-conscious functions that include qualities of objects. The term *context* refers to metaphysical views, constraints, specific aims, and so on. Based on this investigation, (i) *qualia* are properties of *conscious experiences* and/or *qualities* of objects, (ii) *mind* includes *experiences, functions*, or both, and (iii) *awareness* includes *experiences, conscious functions,* and/or pre- and sub-conscious *functions*. These are *a posteriori* definitions because they are based on observations and the categorization.

Keywords: Structure; function; subjective experience; proto-experience; materialism; dual-aspect view; consciousness; qualia; mind; awareness

1. Introduction

In (Vimal, 2009b), the meanings (or aspects) attributed to the term *consciousness* were extracted from the literature and from online discussion groups: "Forty such meanings were identified and categorized according to whether they were principally about *function* or about *experience*; some overlapped but others were apparently mutually exclusive – and this list is by no means exhaustive. Most can be regarded as expressions of authors' views about the basis of *consciousness*, or opinions about the significance of aspects of its contents. The prospects for reaching any single, agreed, theory independent

definition of *consciousness* thus appear remote. However, much confusion could be avoided if authors were always to specify *which* aspects of consciousness they refer to when using the term." The recommendation to specify the meaning(s) of consciousness in each investigation is certainly needed to avoid confusion. However, the quest for the *optimal*[1] (that has least number of problems) and *general* (that can accommodate most views) definitions of consciousness is also desirable, which can guide us how to design *subjective* (first person) and *objective* (third person) experiments and how to investigate, at least theoretically, to link *structure*, *function* and *experience*.

There are many metaphysical views related to consciousness as categorized by (Chalmers, 2003) and discussed further in (Vimal, 2008b, 2009b). Each view has its own problems (listed in Section 2). I tried to investigate which view has the least number of problems. I found that the dual-aspect-dual-mode proto-experience/subjective experience (PE-SE) framework, so far, fits this litmus test (Bruzzo & Vimal, 2007; MacGregor & Vimal, 2008; Vimal, 200x-a, 200x-b, 200x-c, 200x-d, 2008a, 2008b, 2009a, 2009c; Vimal & Davia, 2008). It is the *optimal* framework, where every entity has dual-aspect (material and mental); it has the least number of problems: the only problem is that the dual-aspect is a *brute fact*, but it is justified because SEs are irreducible, fundamental and inherent. In Section 3, the PE-SE framework is concisely described. In Section 4, I search for the *optimal* definition of consciousness.[2] This definition is then extended to make it more *general*, which can encompass most views; this effort is represented by qualifying the definition with '*depending on the context*'.[3] This investigation is extended to define qualia, mind, and awareness. In Section 5, I summarize my quest for the definition of consciousness, qualia, mind, and awareness.

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[1] According to Nunn (personal communication), "My own feeling is that what one might call 'mentality' [this is the *function* and/or *experience* aspects of a system or a process] is the big deal, and 'consciousness' is just the icing on the cake (Nunn, 2007). Some of what you have written suggests you may share this feeling. In that case, my own (strictly personal) view is that the optimal definition of consciousness has to be Marvin Minsky's. He said that when someone says they are conscious, what they mean is that they remember a little bit about the state of their mind a few moments ago. It's the 'consciousness is reportable mental content' definition. It seems to me that this is largely a theoretical, pragmatic, an advance on purely circular definitions, and usefully points to associations between consciousness, and memory and attentional processes. Of course it leaves a huge amount unanswered, simply sweeping the problems under the carpet of 'mentality' (Nunn, 2007). I suggest this too is useful, since it's too early to give firm answers to any of them." Minsky's definition seems to be the *access* awareness component of the *experience* aspect of *consciousness,* which is one of the 20 aspects of *experience* (see Table 2 of (Vimal, 2009b)). This definition is memory and attention based reportable and pragmatic definition of awareness; if it is materialistic definition, then it has a number of problems and hence it is not *optimal* in the sense used in this article. Therefore, at the best, Minsky's definition may be *optimal* in a very limited sense.

[2] The term '*optimal*' indicates that the definition is based on the dual-aspect-dual-mode PE-SE framework that has the least number of problems. The term '*general*' indicates that the definition can accommodate most views.

[3] The term 'contex' refers to metaphysical views, the relevant constraints, research protocols, or the specific aims of the investigation.

2. Problems in various views on the metaphysics of consciousness

The relevant problems in some of views are described as follows.

2.1. Materialism/Emergentism

In materialism, a specific experience (such as *redness*) is *identical with* a specific state (such as redness-related state caused by long wavelength light) of a specific neural-network (such as red-green V4/V8/VO-neural-net). The major problem is the Levine's explanatory gap (Levine, 1983): the gap between experiences and scientific descriptions of those experiences (Vimal, 2008b). In other words, how can our experiences *emerge* (or arise) from non-experiential matter such as neural-networks of our brain or organism-environment interactions? In emergentism/materialism, qualia/subjective experiences (such as *redness*) are assumed to mysteriously emerge or reduce to (or *identical with*) relevant states of neural-nets, which is a *brute fact* (that's just the way it is).[4] In addition, materialism/emergentism has 3 more assumptions (Skrbina, 2009a): material is the ultimate reality, material reality is essentially objective and non-experiential.

2.2. Dualism

The problems of (substance) dualism are as follows:

(i) Association or mind-brain interaction problem: how does the non-material mind interact with the non-experiential brain? For example, how can we associate *redness* with red-green cells of 'V4/V8/VO' neural-net[5]? This is a problem of unexplained epistemic gap: how is the jump made from the mental *redness* to material 'V4/V8/VO' neural-net (and vice versa).

(ii) Problem of mental causation: how can a mental cause give rise to a behavioral effect without the violation of the conservation of energy and momentum?

(iii) **'Zombie' problem**: Dualism "allows us to subtract the mind from the brain while leaving the brain completely intact. This possibility implies an "epiphenomenalism" that claims that mind does not matter,

[4] According to Carruthers (personal communication), "very few materialists endorse a brute identity claim. Most are reductive representationalists of one sort or another."

[5] The color area 'V8/V4/VO' refers to visual area V8 of Tootell-group (Hadjikhani, Liu, Dale, Cavanagh, & Tootell, 1998; Tootell, Tsao, & Vanduffel, 2003), visual area V4 of Zeki-group (Bartels & Zeki, 2000), and VO of Wandell-group (Wandell, 1999); they are the same human color area (Tootell et al., 2003). VO is ventral-occipital cortex.

that it makes no difference what happens in the world, because it does not cause behavior. My zombie twin behaves just like me but it has no mind at all" (Eerikäinen, 2000).

(iv) 'Ghost' problem: It is "the converse of the zombie problem. If the mind is separate from the body, then not only can the brain exist without the mind but also the mind can exist without the brain. Thus, the so-called "disembodiment" becomes a real possibility" (Eerikäinen, 2000). Nunn argues that the evidence for the occurrence of apparently disembodied states is actually quite strong, for example, near-death experiences (NDEs). If this is true then this may not be a problem.

(v) Neurophysiological problem: Interactionism or dualism is not favorable to neurophysiological tests because it entails a many-one or many-many the ψ-φ (i.e., psycho-neurophysiological) relations or correspondences (Feigl, 1967).

2.3. Idealism

The problem of idealism is reverse to that of materialism/emergentism: how can non-experiential matter such as neural-networks of our brain emerge from non-material experiences/consciousness?

2.4. Panpsychism

(Skrbina, 2005)(p.255-265) discusses many sources for problems of panpsychism, covering some 25 problems in total – which reduce to six core problems. In addition, (Globus, 2009) raises the restricted panpsychism problem. Some of these problems might also be that of panprotopsychism (Chalmers, 2003), panexperientialism and panprotoexperientialism[6]. The relevant problems are as follows:

(1) Combination problem: This problem is "how low-level proto-experiential and other properties somehow together *constitute* our complex unified conscious experiences" (Seager, 1995), i.e., how a specific SE can *emerge* from the PEs of constituent elements in a related neural-net (Vimal, 200x-c, 200x-d). In other words, "sub-minds, such as those of atoms, cannot be conceived to combine or sum into complex, unified minds such as humans have. Hence panpsychism is not an adequate account of mind" (Skrbina, 2005)(p.265).

(2) No sign or not testable problem: The problem is "there is no evidence whatsoever of a nonphysical dimension to the elemental units of nature" (Seager, 1995) and there is no 'sign' of mentality in the basic features of the world. In other words, there are "no 'new facts' or empirical basis on which to evaluate the panpsychist claim. … This includes the assumption that non-verifiable theories are invalid in some fundamental sense" (Skrbina, 2005)(p.265). However,

[6] See http://en.wikipedia.org/wiki/Panpsychism

Nunn (personal communication) argues that it is simply not true. Quantum counterfactuals (e.g. the Elitzur-Vaidman bomb test) show clearly that what one might term *knowledge* is built into the foundations of physics.

A related problem, the **completeness problem,** is that the inert system should also show sometime causal power of proto-experiences, which is not the case; this leads to incompleteness of physical picture of world (Seager, 1995; Vimal, 200x-d). However, Nunn argues that if (Seager, 1995) is implying that the physical is causally closed, then it only thought to be true if *causal* is confined to efficient (spontaneous or chance) causation. It is not true otherwise as Henry Stapp and Hans Primas have shown with their *Heisenberg choice* arguments.

(3) Inconclusive analogy or not-mental problem: "The purported analogical basis between humans and other objects is groundless" (Skrbina, 2005) (p.265). The variant 'not-mental' problem (Seager, 1995) "objects to identifying the conjectured 'inner nature' of, say, an atom with something we can reasonably call mental" (Skrbina, 2005)(p.262-263). However, one could argue it out as in problem (2).

(4) Physical emergence problem: "Emergence is in fact possible because we see it in other realms of the physical world; mind is not ontologically unique; hence emergence of mind *is* conceivable" (Skrbina, 2005)(p.265). A related problem is **unconscious mentality problem,** which is "accepting the mentality of the elemental units of mind while denying that they are actually conscious experiences" (Seager, 1995). In other words, "how can consciousness emerge from unconsciousness?" (Skrbina, 2005)(p.262-263).

(5) Implausibility problem: "Panpsychism is so implausible and counter-intuitive that it cannot be true. Also known as the '*reductio ad absurdum*' objection" (Skrbina, 2005)(p.265).

(6) Eternal mystery problem: "Mind-body problem is unsolvable in principle, and hence panpsychism, which purports to offer a solution, must be false" (Skrbina, 2005)(p.265).

(7) Restricted panpsychism problem: "Quantum thermofield dynamics does in fact prescribe a lower boundary below which there can be no cooperative dynamics, and without cooperative dynamics there is nothing mind-like […] If qualia were tied to the coherence of cooperative dynamics, then the descent into panpsychism would halt at the coherence length [of about 50 microns]" (Globus, 2009).

The problems of the most views are addressed in the dual-aspect-dual-mode PE-SE framework (Vimal, 2008b, 2009c), which is concisely described below.

3. Dual-aspect-dual-mode PE-SE framework

This section is mostly adapted from (Vimal, 200x-d, 2008b, 2009c). There are three entities that need to be linked: *structure, function,* and *experience*. Various materialistic neuroscience models link *structure* with *function* well, but fail to link them with *experience* that leads to the explanatory gap (Section 2.1). The dual-aspect-dual-mode PE-SE framework is complementary to reductive/materialistic views, i.e., it does not reject neuroscience models; rather it complements them because it closely depends on them for linking *structure* with *function* and for *global broadcasting* (Baars, 1988). In non-reductive views, such as in this dual-aspect framework, a specific *experience* (such as mental aspect *redness*) *is linked to* (*or coincides with*) a specific state (such as redness-related state caused by long wavelength light) of a specific *structure* (such as material aspect red-green V4/V8/VO-neural-net) that has specific *functions* (such as detection, discrimination, and recognition of red color).

In (Vimal, 2008b), to address the above explanatory gap, it was hypothesized that strings or elementary particles (fermions and bosons) have two aspects: (i) material aspect such as mass, spin, charge, force, quanta, and space-time, and (ii) mental aspect. The mental aspects of strings, elementary particles, and inert matter are considered as the *carriers* of superimposed fundamental *experiences* in unexpressed form. The superposition of multiple possible experiences is based on the hypothesis 'the mental aspect of wave is wave-like and is a function of experiences', which is based on the assumption that matter (wave/particle) has double aspects (mental and material aspect). These possibilities are actualized when neural-networks are formed via *neural Darwinism*, and a specific subjective experience (SE) is selected by a *matching* process. For example, SE *redness* will never be selected and experienced without the formation of redness-related V4/V8/VO-neural-network. The 'brute fact' of dual-aspect is justified because SEs are fundamental, inherent, and irreducible.

In (Vimal, 200x-d), I describe three competing hypotheses of the 'dual-aspect-dual-mode PE-SE' or simply 'PE-SE' framework, where PEs are proto-experiences that are precursors of SEs (defined in the next paragraph). They are (i) *superposition* based hypothesis $\mathbf{H_1}$, (ii) *superposition-then-integration* based $\mathbf{H_2}$, and (iii) *integration* based hypothesis $\mathbf{H_3}$ where the superposition is not required. "In $\mathbf{H_1}$, the fundamental entities and inert matter are the *carriers* of superimposed fundamental subjective experiences (SEs)/proto-experiences (PEs). In $\mathbf{H_2}$, the fundamental entities and inert matter are the *carriers* of superimposed fundamental PEs (not SEs), which are *integrated* by *neural-Darwinism* (co-evolution, co-development, and sensorimotor co-tuning by the evolutionary process of adaptation and natural selection). There is a PE attached to every level of evolution (such as atomic-PE, molecular-PE, … genetic-PE, … bacterium-PE, … neural-PE, and neural-net-PE). In $\mathbf{H_3}$, a string has its own string-PE; a matter is not a *carrier* of PE(s) in superposed form as it is in $\mathbf{H_2}$, rather it is a proto-experiential entity and has two aspects at every level; $\mathbf{H_3}$ is a dual-aspect panpsychism. These two aspects are rigorously *integrated* together by *neural-Darwinism*. In $\mathbf{H_1}$, a specific SE arises in a neural-net as follows: (i) there exist a *virtual reservoir* that *stores* all possible fundamental SEs/PEs, (ii) the interaction of stimulus-dependent feed-forward and feedback signals in the neural-net creates a specific neural-net state, (iii) this

specific state is assigned to a specific SE from the *virtual reservoir* during *neural Darwinism*, (iv) this specific SE is embedded as a memory trace of neural-net-PE, and (v) when a specific stimulus is presented to the neural-net, the associated specific SE is selected by the matching and selection process and experienced by this net. In hypotheses **H_2** and **H_3**, a specific SE *emerges* in a neural-net from the interaction of its constituent neural-PEs, such as in feed-forward stimulus-dependent neural signals and fronto-parietal feedback attentional signals, in analogy to water emerges from the interaction of hydrogen and oxygen. In all hypotheses, SEs occur when essential ingredients of SEs … are satisfied" (Vimal, 200x-d).

A subjective experience (SE) is an *expressed* first person experience that occurs/arises/emerges during interaction between feed-forward signals and feedback signals in a neural-net, which satisfies the *necessary* ingredients of consciousness (Vimal, 200x-a) such as wakefulness, re-entry, attention, working memory (Rowlatt, 2009), stimulus at above threshold, and neural-net proto-experiences (PEs). This is perhaps related to the *first-order*, *phenomenal,* or *access* (reportable) consciousness and is experienced by the specific neural-network; for example, the V4/V8/VO-neural-net experiences color, such as 'saw red tomato'. For *phenomenal* consciousness, feedback attentional signals are not necessary and do not get time to become active. The temporal-lobe system might be included in the neural correlates of *phenomenal/access* consciousness (Carruthers, 2007; Glover, 2004; Milner & Goodale, 1995).[7] When self or 'I' is explicitly involved, as in 'I saw red tomato', perhaps *self*-related neural-network (Bruzzo & Vimal, 2007), such as cortical midline structures (Northoff & Bermpohl, 2004; Northoff et al., 2006), might also interact with the above feed-forward and feedback signals. For inner-sense awareness (Armstrong, 1968; Lycan, 1996), self-awareness (Perrett, 2003), awareness via diagonal representation (Prosser, 2007), or *higher-order* awareness (dispositional (Carruthers, 2000; Carruthers, 2007; Dennett, 1991); non-dispositional/actualist (Rosenthal, 2009); self-representational (Kriegel & Williford, 2006; Van Gulick, 2004))[8], such as 'I am aware that I saw red tomato', perhaps related neural-network also interacts with all above networks. Further research is needed to test this hypothesis.

In general, PEs are precursors of SEs. In hypothesis **H_1**, PEs are precursors of SEs in the sense that PEs are superposed SEs in unexpressed form in the mental aspect of every entity, from which a specific SE is selected via matching and selection process. In hypotheses **H_2** and **H_3**, PEs are precursors of SEs in the sense that SEs *somehow* arise/emerge from PEs, as elaborated above and in (Vimal, 200x-b, 200x-c, 200x-d).

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[7] In temporal lobe system, (Kosslyn, 1994) envisages a complex interaction between incoming non-conceptual information and conceptual templates, the result of which may be (consciously) seeing a tomato *as* a tomato and not just a red sphere (Carruthers, personal communication). Some authors include the interactions of feedback (attentional) signals with feed forward signals in *phenomenal* (P) consciousness. In this article, the attentional feedback interactions are a part of *access* consciousness, not P-consciousness.

[8] The terms 'dispositional' vs. 'non-dispositional' are from (Prosser, 2007); and the terms 'dispositional' vs. 'actualist' are from (Carruthers, 2007): "A conscious mental event M, of mine, is one that is *disposed [or available] to cause* [*potentially causing* vs. *actually causing*] an activated belief (generally a non-conscious one) that I have M, and to cause it non-inferentially" (*italics* mine).

In (Vimal, 2009c), (a) the dual-mode concept from the framework of thermofield dissipative quantum brain dynamics (Globus, 2006; Vitiello, 1995) is explicitly incorporated in the PE-SE framework without decreasing the degree of parsimony as it was implicitly already present, and (b) *matching* and *selection* processes are further elaborated. The two modes are: (1) the non-tilde mode that is the material and mental aspect of cognition (memory and attention) related feedback signals in a neural-network of the brain, which is the cognitive nearest past approaching towards present; and (2) the tilde mode that is the material and mental aspect of the feed forward signals due to external environmental input and internal endogenous input, which is the nearest future approaching towards present and is a entropy-reversed representation of non-tilde mode. Furthermore, one could argue that there are at least five pathways for information transfer in the brain dynamics: (i) classical axonal-dendritic neural pathway, (ii) quantum dendritic-dendritic microtubule (MT) (dendritic webs) pathway, (iii) Ca-related astro-glial-neural pathway, (iv) extracellular volume transmission, and (v) soliton propagation. We propose that (a) the *quantum conjugate matching* between *experiences* in the mental aspect of the tilde mode and that of the non-tilde mode is related more to the mental aspect of the quantum MT-dendritic-web and less to that of the remaining non-quantum pathways, and (b) the classical *matching and selection* processes to the mental aspect of the remaining non-quantum pathways. In all cases, a specific SE is selected (a) when the tilde mode interacts with the non-tilde mode to *match* for a specific SE, and (b) when the *necessary* ingredients of SEs are satisfied. When the conjugate match is made between the two modes, *the world-presence* (*Now*) is disclosed; its content is the SE of subject (self), the SE of objects, and the content of SEs. The material aspects in the tilde mode and that in the non-tilde mode are matched to link *structure* with *function*, whereas the mental aspects in the tilde mode and that in the non-tilde mode are matched to link *experience* with *structure* and *function.*

Since a specific *state* of a system is *identical with* a specific SE, one could argue that the (quantum) superposition of *states* in the material aspect of the system *is identical with* or *coincides with* the superposition of SEs in its (system's) mental aspect. The occurrence (or threshold) of subjective experience (SE) aspect of consciousness may be determined by (a) the '(quantum conjugate) matching' of qualia/SEs superposed in the stimulus (such as long wavelength light) with SEs superposed in a neural-net (such as red-green V4/V8/VO-neural-net), and then (b) the 'selection' of a specific experience (such as *redness*) that is correlated to a specific state (such as *redness* related state) of the neural-net. It is a sort of Orch OR for quantum dendritic-dendritic MT pathway. A difference is that the cause of Orch OR is self-collapse and the quantum gravity threshold in microtubules is orchestrated by microtubule-associated-proteins (MAPs) etc and occurs in MT-network isolated from its environment (Hameroff & Penrose, 1996). Whereas, the cause of collapse in the PE-SE framework could be (a) environmental stimulus dependent feed-forward signals interacting with feedback signals for the matching and selection of a specific SE and/or (b) self-collapse.

It is argued that (a) this dual-mode-dual-aspect PE-SE framework has fewer problems (such as the justifiable 'brute fact' of dual-aspect), and (b) it addresses the problems of other framework including the explanatory gap in materialism (see Section 2). In addition, we have worked through double aspect theory at a level, which has not been previously elaborated.

Critique: One could critique that strings or elementary particles are not specific to any SE/PE; rather, they (and all inert matter) are carriers of SEs/PEs would require extraordinary evidence, given that the particles are at least eight orders of magnitude smaller than the chemical events that characterize brain function, and the strings are ten orders of magnitude smaller yet. However, no evidence is given for this assertion.

The evidence is that they (strings, elementary particles, inert matter, molecules, proteins, neurotransmitters and so on) behave as if they are non-experiential entities. This behavior is consistent with materialism on which all our physical science is based. It is only when a neural-network is formed and when this network satisfies the necessary ingredients of experiences, it has a specific experience via matching and selection mechanisms, for example, V4/V8/VO-neural-network for color. Furthermore, there is evidence that experiences (such as *redness*) are irreducible, fundamental and inherent; for example, one cannot reduce *redness* to any other entity. Our hypothesis is that all experiences are superposed in the mental aspect of matter (such as strings, elementary particles, molecules, proteins, neurotransmitters and so on) in unexpressed form because matter behaves as if it is non-experiential entity.

4. Definitions of consciousness

The premise for the search of *optimal* definition of consciousness is that evolution must have optimized all the systems, which have *structure*, *function*, and *experience*. Any (functional) *structure* must have some *function;* otherwise, the natural selection of evolution must have selected it out. However, Nunn (personal communication) argues that there is a term used by evolutionists for structures, which are there only because they are concomitants of something, which does have a function – namely *spandrels*. We are not including such structures that have no function. Any experience must have some *function*; otherwise, again the natural selection must have selected it out. However, Nunn argues that this may apply to classes of experience, but not to *experience* as such; for example, natural selection may not have any interest in one's liking for El Greco's pictures. We are not including such *experiences* that have no function. In addition, one could argue that 'liking' serves appropriate emotion related function. For *consciousness-as-such* (Rao, 1998), I argue that it is still an *experience* at *samadhi* state. According to (Pereira Jr. & Ricke, 2009), "*consciousness is a process that occurs in a subject (the living individual) & the subject has an experience (he/she interacts with the environment, completing action-perception cycles) & the experience has reportable informational content (information patterns embodied in brain activity that can be conveyed*

by means of voluntary motor activity)." This is an interesting definition for *access* (reportable) consciousness, where fronto-parietal feedback attentional signals are necessary. In any case, within these limitations, the *structure*, *function*, and *experience* must be linked. For example, in (Vimal, 200x-a), we have linked the structure 'V4/V8/VO' (color area for the Red-Green channel) with the *function* 'detection and discrimination of red and green color', which is linked with the subjective *experiences* redness and greenness.

4.1. Optimal definition of consciousness

The problems listed in Section 2 are addressed in the dual-aspect-dual-mode PE-SE framework (Vimal, 2008b, 2009c) where *structure*, *function*, and *experience* are linked. So far, this is the *optimal* framework because it has the least number of problems as discussed in (Vimal, 2009c). Therefore, the definition of consciousness derived from this framework should also be *optimal*. In this framework, every entity has two aspects: material and mental. The material aspect is composed of *structures*, whereas the mental aspect is composed of *functions* and *experiences*. As shown in Tables 1 and 2 of (Vimal, 2009b), "the *functions* and *experiences* together constitute the meanings attributed to the term *consciousness*." This framework is a *non-reductive physicalism*. The term *physicalism* = material aspect (materialism) + mental aspect = *structure* + (*function* + *experience*) = *structure* + (*conscious function* + *non-conscious function)* + *(conscious experience* + *non-conscious experience*) = *structure* + *consciousness* + (*non-conscious function* + *non-conscious experience*) = *structure* + *mind*. In this article, *functions* are also considered (in addition to *experiences*) as a component of the mental aspect of an entity. From this simple rationale, one could argue that consciousness can be *optimally* defined as *a mental aspect of an entity (system or process) that has two sub-aspects: conscious experience and conscious function*, where *conscious experience* involves first person subjective observations and *conscious function* involves third person objective measurements. This *optimal* definition is derived from the dual-aspect-dual-mode PE-SE framework. For example, the *conscious function* of the *structure* red-green V4/V8/VO-neural-network is the detection and discrimination of colors between red and green; the related *conscious experience* is between redness to greenness. In this case, the consciousness is a mental aspect of a system or a process that has two sub-aspects: (i) redness and greenness as *conscious experiences* and (ii) the detection and discrimination of red from green as *conscious functions*. Experiences and functions are elaborated further as follows.

According to (Velmans, 2009), "*Definitions of consciousness need to be sufficiently broad to include all examples of conscious states and sufficiently narrow to exclude entities, events and processes that are not conscious.*" Skrbina (personal communication) suggests that the term 'consciousness' should include only conscious entities (such as *conscious experiences* and/or *conscious functions*) but panpsychism should not be explicitly excluded. In addition, (Nixon, 2007) and (Pereira Jr. & Ricke, 2009) argued that experience can occur with and without consciousness. In this context,

experiences could be *conscious experiences* and *non-conscious experiences* and *functions* could be *conscious functions* and *non-conscious functions*.

Conscious experiences include all types of subjective or first person experiences including: (i) sensory experiences such as redness (Vimal, 200x-a); (ii) 'what exists when there is something that it is like to be that thing' (Nagel, 1974); (iii) phenomenal experience (Chalmers, 1996); (iv) *reportable* content experienced by living individuals (*referential nucleus*), emotional experiences such as happiness, experiences related to thoughts (such as imagination/creative thinking), the experience of *nothingness* in meditation, experiences as the result of dynamical processes in the *embodied and embedded* view of cognition, experiences related to social interactions (Pereira Jr. & Ricke, 2009); (v) experiences related to *self* (Bruzzo & Vimal, 2007) and self-awareness (Perrett, 2003), and perhaps higher-order awareness (Carruthers, 2007; Rosenthal, 2009); (vi) experiences related to phenomenal time (Vimal & Davia, 2008); and (vii) *inner/ outer* experiences, *hidden (other's)* experiences via a process of theorization or simulation or both, *singular-detachable-individual* experiences, and *shared* experiences (Torrance, 2009), and so on.

Non-conscious experiences are those experiences that are not conscious experiences; for example, experiences related to pre-conscious, subconscious, unconscious, slow-wave dreamless deep-sleep, coma, vegetative, and anesthetized state. Non-conscious experiences can include experiences related to paradoxical awareness or awareness without being aware, such as subliminal perception and *blindsight*. According to (Pereira Jr. & Ricke, 2009), "when we are sleeping without dreams we nevertheless have experiences without consciousness, e.g. the proprioceptive ones that prevent us falling out of our beds! Another good example of experience without consciousness is *blindsight*, a phenomenon in which people who are perceptually blind in a certain region of their visual field respond to visual stimuli without any associated qualitative experience ('quale'). […] In conscious experience there is a content experienced by a subject, while in the case of unconscious phenomena there may be - among other possible combinations - a subject without content (e.g. animals under general anesthesia), and informational content without a subject (e.g. information patterns in the Hard Disk of a computer). More precisely, according to the referential nucleus above, an experience is conscious when there is a reportable content being experienced by a subject, such that the content is content *for the subject*. […] If a robot has feedback mechanisms allowing the completion of action-perception cycles, then it can be considered as having experiences, but not *conscious* subjective experience, because of the lack of content and subjectivity [artificial consciousness]."

Conscious functions are those functions that operate or are active when the system is awake and attentive (feedback signals modulating the feed forward signals). According to (Faw, 2009), the *states of consciousness* such as the *active* wakefulness (*normal waking state*) should be distinguished from *quiet* (passive) wakefulness, altered forms of waking consciousness underlying trance, absorption, hypnosis, dissociation, meditative states, drug states, and out of body experiences, REM/dream state, minimal conscious state, and drowsiness. Here, their functional part is considered within the conscious functions as a 'working definition'. For the *access* consciousness

(that plays role in global-workspace theory (Baars, 1988)), attention and working memory[9] are necessary; whereas for the *phenomenal* consciousness, attention is not needed, but sensory memory (such the *iconic memory* for the visual system, the *echoic memory* for the auditory and the *odor memory* for the olfactory system) is necessary (Rowlatt, 2009; Vimal, 200x-a). Conscious functions can include functions and processes related to: (i) conscious experiences elaborated above; (ii) functions listed in Table 1 of (Vimal, 2009b) except non-conscious functions (see below); (iii) necessary ingredients of consciousness (Vimal, 200x-a), such as working memory (Rowlatt, 2009), attention, re-entry; (iii) *intentionality* ('intending to do something'; object-directed) (Faw, 2009; Perrett, 2003) and executive functions (Vimal, 200x-a); (iv) *core* and *extended* consciousness (Damasio, 1999); (v) *control* and *inner-sense/higher-order-sense* consciousness (Armstrong, 1968; Carruthers, 2007; Lycan, 1996); (vi) primary, basic, or first-order consciousness ('conscious of something') and secondary, self, reflective/reflexive consciousness (Duvall & Wicklund, 1982; Faw, 2009); (vii) higher-order consciousness ('awareness of our own mental states') (Rosenthal, 2009) (viii) *phenomenal, access,* and *reflexive (or reflective)* consciousness (Block, 2001; Rowlatt, 2009)**;** (ix) paradigmatic consciousness states (night-dreaming or day-dreaming consciousness) (Faw, 2009); (x) *transitive* and *state* consciousness with *conscious*[10] intentional and/or qualitative properties, and higher-order thoughts (Rosenthal, 2009); and (xi) thoughts (such as imagination/creative thinking), emotions (such as pain, pleasure, thirst, fear, anger, and happiness), decision/voluntary action, (Pereira Jr. & Ricke, 2009).

Non-conscious functions are those functions that are not conscious functions; for example, functions related to pre-conscious, subconscious, unconscious, slow-wave dreamless deep-sleep, coma, vegetative, and anesthetized state. Non-conscious functions can include functions related to long-term memory, paradoxical awareness or awareness without being aware, such as subliminal perception and related *state* consciousness (Rosenthal, 2009), implicit memory, and blindsight (listed in Table 1 of (Vimal, 2009b)).

Physical functions and robotic consciousness: A *physical function* is a part of *non-conscious functions* and is the function of the material aspect of an entity, for example, the function of thermostat, the break of a car, spectrometer, and so on. However, in panpsychism, one can argue that the *physical functions* are the properties of mind or mind-like entities, and hence they are mental functions, even a rock has a mind (Skrbina, 2009b). In *holoworld* framework (Globus, 1995; Globus, 1998), SEs are eliminated; instead, the experiences are denoted by the properties/qualities of objects (such as the red color of a ripe tomato) (Byrne & Hilbert, 2003; Globus, 1995; Globus, 1998). In this article, we consider the qualities of objects as a part of *physical functions*, which is considered as a part of *non-conscious functions*. In the dual-aspect-dual-mode PE-SE framework, the mental aspect of an inert matter is a *carrier* of superposed SEs/PEs in unexpressed form and hence the mental aspect is inactive; therefore, the *physical function* is the *function* of the material aspect of the inert

[9] According to (Carruthers, 200x), "the working memory system is, indeed, a kind of global workspace".

[10] To avoid circularity, the term '*conscious*' refers to 'conscious experiences' as defined before.

matter. However, (i) if neural networks, such red-green V4/V8/VO-neural-network, along with *necessary* ingredients of SEs are implemented in a robot, (ii) if the robot satisfies these necessary conditions and if it can perform all the *functions* as a human being can, and (iii) matching and selection mechanisms are active, then that robot may be considered conscious.

Furthermore, according to (Beaton, 2009), qualia are "properties of sensory experience broadly construed to include states such as seeing, hallucination, sensory memory, sensory imagination, and so on". In general, one could argue that *qualia* are (a) properties of *conscious experiences* (such as phenomenal *redness*) (Beaton, 2009; Byrne, 2008; Pereira Jr. & Ricke, 2009) and/or (b) the properties/qualities of objects (such as the red color of a ripe tomato) (Byrne & Hilbert, 2003; Dretske, 1995; Globus, 1995; Globus, 1998).[11] My discussion with Beaton (personal communication) led the following view: qualia are not consciousness rather they are the properties of consciousness. For example, an experience of a bulging red tomato has the qualia (phenomenal qualities) of phenomenal bulginess and phenomenal redness. Especially (but not only) because a single experience of the world can have multiple qualia (qualities), it does not sound right to say that qualia are experience, even though qualia are properties (arguably, the characteristic, defining properties) of consciousness experience. However, one might ask: when we think about qualia, are we really thinking about properties of experience? Or are we thinking about the power of objects to cause certain properties of experience (secondary qualities)? In addition, how do we address the conscious experience of an achromat (whose experience is equivalent to grayness) versus that of a trichromat (redness) for the same ripe tomato? Some authors, such as (Byrne & Hilbert, 2003), might claim that phenomenal bulginess and phenomenal redness are properties of actual tomatoes in the world; whereas other authors, such as (Beaton, 2009; Byrne, 2008; Pereira Jr. & Ricke, 2009), claim them as 'phenomenal' or 'qualitative' character of conscious experience. For most views, *qualia* are <u>either</u> properties of conscious experiences <u>or</u> the properties of objects. However, in idealism, matter emerges from consciousness. This implies tomatoes themselves are properties of experiences. In addition, in the dual-aspect-dual-mode PE-SE framework (with hypothesis $\mathbf{H_1}$) (Vimal, 200x-d, 2009c), SEs are superposed (in unexpressed form) in the mental aspect of inert matter (both internal and external to brain). A specific SE is expressed during matching and selection process in a specific neural-network when it satisfies the necessary ingredients of consciousness (Vimal, 200x-a). This framework implies that both neural-networks and objects are involved in qualia. Moreover, according to (Shoemaker, 1994), "the phenomenal character of the experiences consists in a certain aspect of its representational character, i.e., in its representing a certain sort of property of objects, namely "phenomenal properties" [qualia] that are constitutively defined by relations to our experience." This implies that the phenomenal character of experiences have a sort of relationship with the properties of objects for qualia. These views do not contradict with the hypothesis that qualia are both properties of experiences <u>and</u> properties of tomatoes. To sum up, the logical conjunction 'and/or'

[11] I differentiate the term 'redness' from 'red'. The term 'redness' is 'phenomenal redness' (less open to misinterpretation) or SE redness; whereas, the term 'red' is the property of object.

or equivalently symbol⊗ can be used for a *general* definition that encompasses most views; for example, see Eq. (3) of Section 4.4 for qualia.

To sum up, the *optimal* definition is: *consciousness is a mental aspect of a system or a process and is consists of conscious experience and conscious function.* This definition is based on the dual-aspect-dual-mode PE-SE framework, which is *optimal* because it has the least number of problems: the only problem is the brute fact of justifiable dual-aspect view; the justification is that SEs (superposed in the mental aspect) are fundamental, irreducible, and inherent.

4.2. General definition of consciousness

A more *general* definition requires that most views and the *context* in which the term 'consciousness' is used should be included in the definition. In other words, the definition of consciousness varies with metaphysical views (the *context*). The term *context* refers to metaphysical views, constraints, specific aims, and so on. Therefore, a more *general* definition can be '*consciousness is a mental aspect of an entity (system or process), which is a conscious experience, a conscious function, or both depending on the context*'. This definition tries to accommodate most views. This is because any investigator's finding related to consciousness has to be *conscious function, conscious experience* or both depending on the context of investigation. For example: (i) if the context or view is materialism/functionalism, then consciousness is a *conscious function.* (ii) If the context is dualism/idealism, consciousness is a *conscious experience.* (iii) If the context is panpsychism, panprotopsychism, panexperientialism and panprotoexperientialism, consciousness is a *conscious experience, a conscious function,* or both. (iv) If the context is the *holoworld* framework, consciousness is associated with the qualities of objects. And (v) if the context is the dual-aspect view, consciousness is both *conscious experience* and *conscious function*.

One could argue that *pure awareness* or *consciousness-as-such,* that mystics claim, lacks subjectivity. However, I argue that it is still a *conscious experience* though it occurs at *samadhi* state. Furthermore, according to epiphenomenalists (Type E) "physical states cause phenomenal states, but not vice versa" (Chalmers, 2003); here, they are discussing the *conscious experience* aspect of consciousness. One could also critique using Daniel Wegner's *free will*: (Wegner, 2002) showed that the experience of *free will* has no direct connection with the actuality. However, one could argue that his *free will* also addresses the *conscious experienc*e or *conscious function* aspects of consciousness; it must have some *function* otherwise natural selection would have selected out our *free will.* For example, according to (Wegner, 2004), "Experiences of conscious will thus arise from processes whereby the mind interprets itself--not from processes whereby mind creates action"; here the term 'processes' indicates *function,* as defined in the meaning 2 of Table 1 in (Vimal, 2009b). However, Nunn argues that *free will* could be an epiphenomenon, a type of *spandrel*. If that is the case then it is still a *conscious experience* as argued just above. Furthermore, one could critique that there is evidence for a range of similar disjunctions in the psychological literature and it is hard to

see, therefore, that *conscious experience* and *conscious function* could be aspects of the same 'mental entity' in such cases. This may be correct, but this mental entity, *free will*, in *general* definition, is not necessarily being both (*conscious function* **and** *conscious experience*); rather it could be *conscious function* **or** *conscious experience* depending on the *context*.[12] Thus, the *general* definition of consciousness accommodates most views.

4.3. Are optimal and general definitions of consciousness consistent with the criteria of definitions?

It would be interesting to investigate if our definitions meet the criteria discussed in (Allen, 2009). The *optimal* and *general* definitions of consciousness (i) are neither too rigid not too detailed. (ii) They are part of a theory that facilitates some empirical prediction and explanation. (iii) They reveal 'real' features and also inter-relations. (iv) They are useful for scientific or philosophical applications. (v) They are definitive or unrevisable in that they reveal its "essential nature" but they are *working definition* as well in that they can be modified based on future research. And (vi) they are *a posteriori* definitions because they are derived from observations made so far and from the categorization of all definitions in two aspects (Vimal, 2009b): *functions* (third person perspective, such as consciousness is a (multidimensional) physical/neurobiological processes (Baars, 1988; Edelman, 2003; James, 1977; Searle, 2000; Vimal, 200x-a, 2008a)) and *experiences* (first person perspective) that are linked with brain *structures* (neural networks).

In (Søgaard & Østerskov Søgaard, 2009), the format of a definition suggested by (Suppe, 2000) is discussed for consciousness. For example, (I) "A system is conscious iff [if and only if] it can interrupt or change a planned action in the absence of external stimuli" or (II) "A process is conscious iff there is a (higher order) thought about it". In this format, (i) (Nagel, 1974)'s definition (consciousness of a system S is "what it is like to be S") can be re-written as: A system (S) is conscious iff it has "what it is like to be S". (ii) (Pereira Jr. & Ricke, 2009)'s definition can be re-written as: A process is conscious iff it occurs in a subject & the subject has an experience & the experience has reportable informational content. (iii) The *optimal* definition of consciousness (Section 4.1) can be re-written as: *a system or a process is conscious iff its mental aspect is conscious experience and conscious function*. The *general* definition of consciousness (Section 4.2) that accommodates most views can be re-written as: *a system or a process is conscious iff its mental aspect is composed of conscious experiences, conscious functions, or both depending on the context*. It should be noted that these are not circular definitions because the terms 'conscious *experience*' and '*conscious function*' are already defined in Section 4.1.

4.4. Equations for consciousness, qualia, mind, and awareness

[12] Nunn commented, "This is correct in relation to 'mental entity', but unless the entity is consciously experienced, it is surely not 'conscious' from any ordinary perspective – it is only 'conscious' if one injects some theoretical (pan-psychist or whatever) notion of consciousness into it." This is true, but goal is to include most views in the *general* definition.

In summary, one can then write the following equations, where symbol & represents 'and/or':

Experiences = (conscious experiences) & (non-conscious experiences) (1)
Functions = (conscious functions) & (non-conscious functions) (2)
Qualia = (properties of conscious experiences) & (properties/qualities of objects) (3)
Consciousness (*optimal*) = (conscious experiences) and (conscious functions) (4)
Consciousness (*general*) = (conscious experiences) & (conscious functions) (5)
Mind = (consciousness (*general*)) & (non-conscious experiences) & (non-conscious functions) (6)
= (conscious experiences) & (non-conscious experiences) &
(conscious functions) & (non-conscious functions) (7)
= experiences & functions (8)
Awareness = consciousness (*general*) & (non-conscious experiences) &
(pre- and/or sub-conscious functions) (9)
= (conscious experiences) & (non-conscious experiences) &
(conscious functions) & (pre- & sub-conscious functions) (10)
= experiences & (conscious functions) & (pre- & sub-conscious functions) (11)

One can argue that the term 'consciousness' should include only conscious entities, such as *conscious experiences* and conscious functions as in Eqs. (4) and (5). In other words, non-conscious entities such as *non-conscious experiences* and *non-conscious functions* should not be included in the definitions of consciousness; rather they could be a part of *mind* as in Eqs. (6)-(8). According to (Carruthers, 200x), "mindedness requires capacities for at least perception, belief, and desire." This can be further elaborated as, "[h]aving a mind means being a subject of perceptual states, where those states are used to inform a set of belief states which guide behavior, and where the belief states in turn interact with a set of desire states in ways that depend upon their contents, to select from amongst an array of action schemata so as to determine the form of the behavior"(Carruthers, 2004). According to a panpsychist (Skrbina, 2009b), *mind* contains two *essential* components/sub-aspects: (i) the inward-directed experiential and qualitative aspect and (ii) the outward-directed relational/representational/intentional aspect. This is not inconsistent with Eq. Eq. (8) if the experiential component is the sub-aspect *experience* and if the intentional component is the sub-aspect *function*. This is because the intentionality or the directedness towards the objects of external world has representation, which might be associated to the *function* of the related *structure*. In addition, the specificity to SEs in the dual-aspect-dual-mode PE-SE framework (Vimal, 2008b, 2009c) may be somewhat related to the dimensionality/complexity of the mentality in panpsychism (Skrbina, 2009b).[13] The 'consciousness (*optimal*)' is equivalent to '*total* consciousnesses' because it includes all *conscious experiences* and *conscious functions* (Skrbina, personal communication). According to (Rosenthal, 2009), "States need not themselves be conscious to result in our being aware of things."

[13] For example, the non-specificity of electron to high specificity of a specific neural-network (such as V4/V8/VO-neural-net specific to color) in the dual-aspect-dual-mode PE-SE framework may be related to extremely low dimensionality/complexity of the mentality of electron to high dimensionality/complexity of the mentality of a specific neural-net in panpsychism. It should be noted the panpsychism has seven problems (Section 2). The continuity from unconscious state into conscious state rather than discreteness (Skrbina, 2009b) is an interesting hypothesis but needs further research.

Therefore, perhaps, *awareness* has more components than consciousness (*general*) but less than *mind*, which is shown by Eqs. (9)-(11). This is because it may not be acceptable to everybody that a rock has awareness but it may be acceptable that a rock has non-conscious functions (such as interacting with its environment via continuous exchange of energy (Skrbina, 2009b)) and hence has mind-like properties as in panpsychism. In other words, some of the non-conscious functions (such as *physical functions* as defined in Section 4.1) are excluded from *awareness*, but are included in the definition of *mind*. However, panpsychists might argue that *awareness* = *mind*.

5. Conclusions

1. According (Vimal, 2009b), "Given such a multiplicity of meanings, even within some particular paradigm such as materialism, it is hard to arrive at any single, widely acceptable, definition of consciousness; attempts to do so often lead to confusion and circular discussion. … But confusion also often arises from misunderstandings of what people mean when using the term. Therefore, the best option may be to identify its various aspects and then define each aspect." While this is true for the *theory-independent definition of consciousness*, the quest for the definition(s) of consciousness, at least *theory-dependent definition of consciousness*, continues. We have made such an attempt while accommodating most views that are categorized in (Chalmers, 2003) and discussed further in (Vimal, 2008b, 2009b).

2. The dual-aspect-dual-mode proto-experience/subjective experience (PE-SE) framework is an *optimal* framework because it has the least number of problems: the only problem is the brute fact of dual-aspect, which is justified because SEs are fundamental, irreducible, and inherent.

3. *Experiences* can be conscious experiences, non-conscious experiences, or both; and *functions* can be conscious functions, non-conscious functions that include qualities of objects, or both.

4. The *optimal* definition of consciousness, that has the least number of problems, is '*consciousness can be optimally defined as a mental aspect of an entity (system or process) that has dual-aspect: conscious experience and conscious function*. In other words, *a system or a process is conscious iff its mental aspect is conscious experience and conscious function.* However, this is for the optimal dual-aspect-dual-mode PE-SE framework. A more *general* definition can be '*consciousness is a mental aspect of an entity (system or process) that is a conscious experience, a conscious function, or both depending on the context*,' where the context/view of investigation is an important factor. In other words, *a system or a process is conscious iff its mental aspect is composed of conscious experiences, conscious functions, or both depending on the context*'. These definitions, I hope, may guide us how to design *subjective* and *objective* experiments and how to investigate theoretically to link *structure*, *function,* and *experience*.

5. Based on this above premises, (i) *qualia* are properties of *conscious experiences* and/or *qualities* of objects, (ii) *mind* includes *experiences, functions*, or both, and (iii) *awareness* includes *experiences, conscious functions,* and/or pre- and sub-conscious *functions*.

6. The above definitions are *a posteriori* definitions. This is because they are based on observations and the categorization of various definitions in two aspects (Vimal, 2009b): *functions* (third person perspective, such as consciousness is a (multidimensional) physical/neurobiological processes) and *experiences* (first person perspective: such as consciousness is '*something that it is like* to be a (conscious) subject').

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