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Running title: Integration of classical, quantum, and subquantum concepts in PE-SE Framework

PROTO-EXPERIENCES AND SUBJECTIVE EXPERIENCES: INTEGRATION OF CLASSICAL, QUANTUM, AND SUBQUANTUM CONCEPTS

RAM LAKHAN PANDEY VIMAL

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
rlpvimal@yahoo.co.in
<http://www.geocities.com/rlpvimal/>

Abstract

In the previous issue of JIN (Vimal, 2008a), I hypothesized that elementary particles (strings, or fermions and bosons) have two aspects: (i) material aspect such as mass, charge, and spin and (ii) mental aspect such as elemental proto-experiences (PEs). PEs were conceptualized to be the properties of elementary particles and their interactions, which are composed of all types of irreducible fundamental subjective experiences (SEs)/PEs that are in superimposed form in elementary particles and in their interactions. That is, the classical view of 'emergence' of SEs in neural-nets was unpacked in terms of quantum view of the superposition of fundamental SEs/PEs in elementary particles. This current article further unpacks the quantum view of superposition in terms of subquantum dual-aspect primal entities (*bhutatmas*). *Bhutatmas* are based RigVedic dual-aspect *Adi-shiva* primal entities, Bohm's Implicate Order, and fractional quantum Hall effect. This subquantum concept appears to integrate eastern and western perspectives related to reductive and non-reductive metaphysical views, physics, psychophysics and neuroscience related to consciousness. However, this view leads to another type of subquantum explanatory gap: how it is possible that our SEs (such as happiness, sadness, painfulness, and similar SEs) were already present (*a priori*) in primal entities, whereas there is no shred of evidence that such SEs were conceived at the onset of universe. To address this gap, we used the concept of fundamental and derived SEs/PEs. SEs/PEs that can be derived from the irreducible fundamental SEs/PEs are called 'derived' or 'secondary' SEs/PEs; they appear to imply subquantum Type-2 explanatory gap. Type-1 explanatory gap is how SEs can emerge from non-experiential matter. To address these gaps, two working hypotheses are proposed: (1) elementary particles and inert matter are the carriers of superimposed fundamental (not derived) SEs/PEs, and the resonance process generates a specific SE in a neural-net; in addition, a mechanism of creation-maintenance-annihilation cycle of universe might have preserved irreducible fundamental SEs/PEs (*a priori*) in primal entities, or (2) elementary particles and inert matter are the carriers of superimposed fundamental PEs (not SEs); there is a PE attached to every level of evolution (such as atomic-PE, molecular-PE, genetic-PE, neural-PE and so on); and a specific SE emerges in a neural-net from interaction of its constituent neural-PEs, in analogy to the physical property of salt (NaCl) emerges from the interaction of its constituents Na^+ and Cl^- ions. Further research is needed to find reasons to reject one of them.

Keywords: Subquantum metaphysics; quantum physics; classical physics; dual-aspect model; primal entities; elementary particles; string; fermions; bosons; *bhutatmas*; RigVeda; *Adi-shiva* primal entities, Bohm's implicate order; fractional quantum Hall effect; proto-experiences; subjective experiences; fundamental and derived subjective experiences/proto-experiences, explanatory gaps; hard problem; access and phenomenal awareness; attention; re-entry; memory; wakefulness; co-evolution and co-development of mind and brain; chaos theory; self; self-organization.

1. Introduction

In previous article (Vimal, 2008a), the PE-SE framework was presented where classical and quantum concepts related to subjective experiences (SEs) and proto-experiences (PEs) were discussed.^a To address the explanatory gap of monistic materialism and the relationship problem between mind and brain in dualism, we proposed dual-aspect framework (non-reductive physicalism) where we hypothesized that all types of fundamental SEs/PEs are superimposed in elementary particles (string, or fermions and bosons). This implies that inert matter is simply the *carrier* of SEs/PEs because it contains all types of fundamental SEs/PEs and hence it is non-specific to SEs/PEs, and it behaves as a non-experiential entity. When the specificity is higher than its critical value (such as in neural-nets of brain), a specific SE emerge by resonance process discussed in Section 4.2 of (Vimal, 2008a). In this framework, co-evolution and co-development and sensorimotor tuning play important role as discussed in (Vimal, 2008a). It is more or less accepted truth that fundamental SEs are irreducible and they appear unique and independent to each other. Therefore, each fundamental SE/PE must exist on its own. In this article, the superposition of all types of fundamental SEs/PEs in elementary particles is further unpacked in terms of subquantum dual-aspect primal entities. While doing that, we encounter another type of explanatory gap. This suggests further investigation.

2. PE-SE Framework and Classical, Quantum, and Subquantum Concepts

2.1. The PE-SE framework

In previous article (Vimal, 2008a), we hypothesized that elemental PEs are the properties of elementary particles (strings, or fermions and bosons) and their interactions, i.e., all types of fundamental SEs/PEs are **superimposed** in elementary particles. Therefore, elementary particles are not specific to any SE/PE and hence appear as non-experiential material entities. The difference between PE-SE framework and materialism is that the former acknowledges the existence of proto-experiential entities in physics whereas latter proposes that consciousness somehow emerges from non-experiential matter. In PE-SE framework, elementary particles are *carriers* of SEs but they are not proto-conscious, whereas they are proto-conscious in panpsychism (Strawson, 2000, 2006).

2.2. String theory and PE-SE framework

In string theory (including superstring theory, M-theory, or theory of everything) both bosons (force carriers, such as photons) and fermions (constituents of matter, such as electrons) are simply the same string vibrating in different modes; harmonics of strings give rise to the whole of the field of matter (Robbins, 2007); their interactions are simply ‘splitting or joining’ of strings. For example, emission of a photon from an electron is the splitting of a string into two strings; whereas the absorption of a photon by an electron is the joining of two strings into one.

The theory of everything must explain SEs or consciousness (Chalmers, 1996).^b String theory and consciousness might be connected.^c In PE-SE framework, the superposition of all fundamental SEs/PEs in one or more dimensions (3 spatial, 1

^a In general, the term ‘consciousness’ may includes self (subjective or first person experience of subject), subjective experience (SE) of object, processing of SE, thought processing, memory, attention, access and phenomenal awareness, free will, qualia, initiation of activities, and/or other cognitive processing. However, in PE-SE framework (Crick & Clark, 1994; Crick & Koch, 2003), consciousness and SE are interchangeably used. Therefore, the term NCC (neural correlates of consciousness) initiated by (Northoff et al., 2006) may differ from the use of term ‘consciousness’ in this article. NCC may also differ from the term ‘self-referential processing’ used by (Northoff et al., 2006); however, our use of the term ‘Self’ for SE of subject may be somewhat closer to (Chalmers, 1995b).

^b According to Chalmers, “a complete theory will have two components: physical laws, telling us about the behavior of physical systems from the infinitesimal to the cosmological, and what we might call psychophysical laws, telling us how some of those systems are associated with conscious experience. These two components will constitute a true theory of everything.” (Fechner, 1860/1966).

^c According to Ruquist, “Spin of a collection of particles or loops equal to zero [in his 26D superstring mode] is the basis of both the EPR experiments and the Conway-Kochen ‘Free Will’ Theorem, which may be a connection to consciousness. ... Similar to human consciousness, Burrows divides the 12 dimensions into (i) a 4d loop for the model of the outside world, (ii) a second 4d loop for the model of the self in the world and (iii) the third 4d loop for the Self itself. It may be that all forms of consciousness require this three-fold separation for self-reflection. ... The highest level is within the Self 4d loop and would be fixed, and perhaps similarly for the self model and the world model. The next level of entanglement down would be between the Self and either the model of the self or the world model. According to Burrow the Self can Will an increase of entanglement with specific aspects of the self model or the world model.” (<http://tech.groups.yahoo.com/group/MindBrain/message/11616>).

time, and 7 mostly curled space) of string implies that if a string is split into two during emission of say photon or if two strings join into one during absorption, all SEs are conserved and passed on to resulting particles. This is the conservation of SEs during interaction.

2.3. Three level treatment of mind-brain problem

In PE-SE framework, the mind-brain problem is addressed at 3 levels:

(i) At classical-quantum-neuronal level, we hypothesize that SEs (or consciousness) emerge/arise/spring up in neural-nets of brain. Here the term ‘emerge/arise/spring up’ is packed and needs unpacking. On evolutionary scale, consciousness or SEs might have emerged during Cambrian explosions about 540 Mya (Hameroff, 1998a). The fundamental SEs are irreducible mental entities.

Penrose-Hameroff model (Hameroff, 1998b; Hameroff, 2007b; Penrose, 1994, 1996; Penrose, 2001; Penrose & Clark, 1994; Penrose & Hameroff, 1995) is based on (a) the brain action being ‘both physically controlled and beyond computational simulation’ and (b) consciousness being non-computational (and non-random) activities at the quantum/classical borderline (Penrose, 2001). This hypothesis bypasses Gödel’s incompleteness theorem^d of mathematical logic (Penrose & Clark, 1994). The model appears to imply that SEs reside in spacetime geometry (‘Platonic values in fundamental spacetime geometry’) and a specific SE is selected during orchestrated objective state-reduction (Orch OR) in microtubule (MT) network (dendritic web or hyper-neuron)^e (Hameroff, 1998b, 2001, 2003; Hameroff, 2007b; Penrose, 1994, 1996; Penrose, 2001; Penrose & Clark, 1994; Penrose & Hameroff, 1995). According to Hameroff (2003), “Taking spin as an irreducible, fundamental entity, spin networks define spectra of discrete Planck scale volumes and configurations which dynamically evolve and define spacetime geometry ...So the universe may be constructed of Planck scale spin networks whose configurations and dynamics lead to all matter and energy. If, as Whitehead and others proposed, consciousness derives from fundamental, irreducible entities which are ‘proto-conscious’ (what philosophers call ‘qualia’), then proto-conscious qualia must also be embedded in Planck scale spin networks (where else could they be embedded? Fundamental spacetime geometry is all there is!). We can envision proto-conscious qualia as specific, nonlocal distributed configurations of Planck scale spin networks.” Furthermore, “Within the OR scheme, we consider that consciousness occurs if an appropriately organized system is able to develop and maintain quantum coherent superposition until a specific ‘objective’ criterion (a threshold related to quantum gravity) is reached; the coherent system then self-reduces (objective reduction: OR). We contend that this type of objective self-collapse introduces non-computability, an essential feature of consciousness which distinguishes our minds from classical computers. Each OR is taken as an instantaneous event—the climax of a self-organizing process in fundamental spacetime—and a candidate for a conscious Whitehead ‘occasion of experience’ ... Sequences of OR events give rise to a ‘stream’ of consciousness. Micro- tubule-associated proteins can ‘tune’ the quantum oscillations of the coherent superposed states; the OR is thus self-organized, or ‘orchestrated’ (‘Orch OR’)” Hameroff (2001). In addition, “The quantum computation is algorithmic but at the instant of OR a non-computable influence (i.e. from Platonic values in fundamental spacetime geometry) occurs. ... The Planck scale is approached in modern physics through string theory, quantum gravity, twistor theory, spin networks etc. Although the correct description is unknown, it is known that the Planck scale is quantized and nonlocal, and the level at which Penrose suggests quantum superpositions occur as separations, and where Platonic values exist. It is also at this ubiquitous level that proto-conscious qualia are proposed to be embedded (Hameroff & Penrose, 1996), hence pan-protopsychism.” (Hameroff, 2007a).

The above concept, especially SEs residing in space-time geometry, needs further unpacking. As discussed in (Vimal, 2008a), there are at least two complementary mechanisms for the selection of a specific SE: (i) resonance process where the SEs embedded in neural-net resonate with SEs superimposed in external or internal stimuli, and (ii) the quantum Orch OR in MT network that also in a way needs to resonate with stimuli (for example, SE redness is selected from SEs embedded in spacetime geometry when long wavelength light is presented).

^d The Gödel’s incompleteness theorem implies, “for any potential algorithm for determining mathematical truth, no matter how intricate, there must be propositions whose truth it cannot determine”; Penrose argued, “the human mind has a capacity which is not wholly algorithmic” (Penrose & Clark 1994). For further detail see http://en.wikipedia.org/wiki/G%C3%B6del%27s_incompleteness_theorems.

^e The rationale for the hypothesis that consciousness is via dendritic web rather than action potentials includes (i) gamma synchrony being NCC can be explained by dendritic web rather than action potentials, and (ii) there may be billions of distinguishable states of consciousness and hence billions of corresponding distinguishable neural states, which can be supported better by larger scale structures (interference fringes, fractals, braids, etc in dendritic/astroglial plexi) rather than axonal-dendritic pathway [(ii) is adapted from Nunn’s <http://tech.groups.yahoo.com/group/jcs-online/message/5789>].

The neural-net-PEs embedded in neural-nets can be considered as neural-correlates of Penrose Platonic values encoded in fundamental space-time geometry (Hameroff, 2007b), however, this mechanism is not clear. The number of possible subjective experiences (SEs) for Orch OR can be reduced by sensorimotor tuning during development in a neural-net. For example, the X-linked red-green V4/V8-neural-net embeds only red-green color related SEs as neural-net PEs. In sub-quantum (SQ) framework (Boyd & Klein, 2007), the activity in neural-net resonates, which assigns a specific neural-net state to a specific SE embedded in SQ-field. In PE-SE framework, the specificity for SE is addressed in Section 4.2 of (Vimal, 2008a).

There may exist a mechanism by which SEs emerge in the neural-nets of brain, such as chaotic process of self-organizing system. According to chaos theory, a self-organizing system, such as brain, is an *open* system, which is intimately connected with its environment; it can create novel structures and new modes of behavior (Bruzzo & Vimal, 2007). SEs are emerged during the interaction of feed-forward and feedback neural-PE signals in neural-nets; this may be either by the chaotic process of self-organization (because this process has ability to create novel entities to meet the environmental demands) or by resonance process or by Orch OR. Since a self-organizing system, such as brain, can create novel structures and new modes of behavior, it can also create complex subjective experiences (such as *redness*) to cope with its environment during co-evolution. In chaos theory, attractors (SEs) need to pre-exist, which is equivalent to SEs in resonance mechanism or in Orch OR. Although, Orch OR mechanism has its own problems, there is significant effort to address them (Hameroff, 1998b, 2001, 2003; Hameroff, 2007b; Penrose, 1994, 1996; Penrose, 2001; Penrose & Clark, 1994; Penrose & Hameroff, 1995). Further investigation is needed.

(ii) At quantum-elementary-particle level, the classical concepts of ‘emergence’ and ‘space-time geometry’ are unpacked by postulating that all types of fundamental SEs/PEs are superimposed in elementary particles (strings or fermions and bosons), which are considered as ‘carriers’ of SEs (Vimal, 2008a). SEs residing in space-time geometry in Orch OR framework is unpacked as the superimposition of fundamental SEs/PEs in elementary particles in PE-SE framework. Further details are given in (MacGregor & Vimal, 2008; Vimal, 2008a, 2008b, 2008c; Vimal & Davia, 2008).

(iii) At subquantum level, the topic of current article, the quantum concept of superposition of fundamental SEs/PEs in one or more of the dimensions of string is further unpacked into dual-aspect primal entities, which are called *Bhutatmas*^f, *Adi-shiva*, or sub-strings. Since fundamental SEs/PEs are irreducible, each of them can be considered as fundamental subquantum mental entity. Even string, the smallest quantum entity, is packed with all types of fundamental SEs/PEs in superimposed form. It is true that each fundamental SE/PE appear to be independent of other SEs/PEs in the sense that one cannot be derived from other; for example, SE redness cannot be derived from SE blueness. This implies that each SE/PE must exist somehow somewhere independently. This necessitates postulating dual-aspect primal entities, each with unique SE/PE. In other words, each *bhutatma* must have a specific SE as its mental aspect. For example, there should be a *bhutatma* that has SE/PE redness as its mental aspect; we can call it redness-*bhutatma*; similarly we can have greenness-*bhutatma*, blueness-*bhutatma* and so on. Thus, each *bhutatma* type is in all types of elementary particles and each elementary particle has all types of *bhutatmas* in superimposed form. Since primal entities do not satisfy the essential ingredients of having SE, each *bhutatma* must be considered to carry simply *bhootatmic* proto-experience. This avoids proto-panpsychism that proposes inert matter is proto-conscious or panpsychism that proposes inert matter is also conscious (Strawson, 2000, 2006). The PE-SE framework is dual-aspect proto-experiential ‘non-reductive physicalism’ and is close to Type-F view (Chalmers, 2003) with property-dualism and substance-monism.^g

2.4. Hypotheses to address the two types of explanatory gaps

^f Alternative less common spelling is *bhootatmas*.

^g In Chalmers’ framework, there appears to be 3 steps: (i) treat consciousness as irreducibly fundamental entity, (ii) describe its correlations with fundamental physical phenomena, (iii) which will then entail fundamental psychophysical laws (McQueen: <http://tech.groups.yahoo.com/group/MindBrain/messages/11855>). For example, logarithmic law in visual psychophysics: In (Vimal, 2008a), “Fechner’s aim in the Elemente was to establish an exact science of the functional relationship between physical and mental phenomena. Distinguishing between inner (the relation between sensation and nerve excitation) and outer (the relation between sensation and physical stimulation) psychophysics, Fechner formulated his famous principle that the intensity of a sensation increases as the log of the stimulus ($S = k \log R$) to characterize outer psychophysical relations. In doing so, he believed that he had arrived at a way of demonstrating a fundamental philosophical truth: mind and matter are simply different ways of conceiving of one and the same reality.” (<http://serendip.brynmawr.edu/Mind/Consciousness.html>).

The first explanatory gap is the famous Levine's explanatory gap (Chalmers, 1995a; Levine, 1983): the gap between what we believe subjectively about our qualitative experiences (i.e. SE), and scientific descriptions (i.e., internal representation or associated neural correlates) of those experiences. In other words, how precisely SEs emerge/arise/spring up from non-experiential material entity such as neural-nets of brain. This gap can be called as Type-1 explanatory gap of materialism at classical neural level.

The second explanatory gap arises at subquantum level: how it is possible that some of our SEs (such as happiness, sadness, painfulness, and similar SEs) were already present (*a priori*) in primal entities, whereas there is no shred of evidence that such SEs were conceived at the onset of universe. This gap can be called as Type-2 explanatory gap of dual-aspect proto-experientialism at subquantum level. To address this gap, one could argue for the following hypotheses:

2.4.1. Hypotheses related to fundamental PEs/SEs superimposed in elementary particle

(H₁) One could argue that those SEs which cause Type-2 explanatory gap might not be fundamental SEs. They could be derived from some fundamental proto-experiences (PEs), such as from feeling-related-PEs. However, let us suppose some of them cannot be derived and still leads to this gap, then one could further hypothesize that *Shiva's* creation-maintenance-annihilation cycle of universe (Sarasvati, 1974-89) or Big-Bang↔Big-Crunch cycle of universe might have somehow preserved all fundamental SEs/PEs in space-time geometry or somewhere for future cycles. First cycle might not have all fundamental SEs/PEs superimposed in string, *a priori*, at the onset of first cycle; however, later cycles may have this mechanism of superimposing all fundamental SEs/PEs in string. The current cycle of our universe might not be the first one; it might be second or one of the later cycles. If this hypothesis is correct, then those SEs which appear to cause Type-2 explanatory gap might have emerged somehow with help of other fundamental SEs/PEs using unreliable difficult chaotic processes^h of self-organization in the first cycle. One could also argue that it would be the same question for the material aspect as well: how precisely string appeared at the onset of universe. Whatever the mechanism is for the material aspect; it has to be the same mechanism for the mental aspect as well because both aspects are not separate; they are glued together.

To elaborate further, consider again the following: The problem is how the system at the onset of universe will know or forecast that emotion related SEs such as happiness, sadness, painfulness, and the like are going to be human SEs so they must exist *a priori*. However, one could ask: are these types of SEs fundamental or can they be derived from some fundamental PEs? If they can, then it will help in deflating the Type-2 explanatory gap. For example, since elementary particles were formed within 1 second after the on-set of Big-Bang (MacGregor & Vimal, 2008), system might have predicted photon related fundamental SEs/PEs, charge related fundamental proto-experiences, and so on. One could argue that the emotion related SEs might have evolved from the emotion related fundamental PEs and other relevant PEs in the context of self-organization.ⁱ One could also argue that although each color SE appears to be irreducible and fundamental, all colors can be derived from cardinal opponent unique colors (such as red, green, yellow, blue, white and black). These cardinal color SEs can be considered as fundamental PEs, which can be candidate for superposition in string. In other words, we need to investigate cardinal SEs and then fundamental PEs. These fundamental PEs are superimposed in string as its mental aspect. This hypothesis addresses both types of explanatory gap.

In our email correspondence (12 September 2007), Baer commented as follows, "According to the least action principle, a particle's behavior (*choosing* the path of minimum action in the alternative possibilities between times t_1 and t_2) can be anthropomorphically interpreted as *feeling*. However, such interpretation is a projected feeling, PE, placed onto the particle by the physicist observer and falls in the same category as a conscious feeling, SE, projected onto other living humans by our first person selves for the purpose of understanding their behavior. To make further progress this association, or projection of feeling, must itself be identified with the measurement and state preparation processes of quantum theory. This theory is in my opinion is still incomplete. The work of eliminating the independent external world model of particles and fields in physics, in favor of interacting processes (Whitehead, 1978) implemented as action cycles (measured in units of angular momentum), is a work in progress (see (Baer, 2007)). If we are to speculate on the world view emerging from such development then you would not simply be a body in a space time-continuum looking at independent objects in front of

^h A major question is how do non-specific proto-experiences leads to specific subjective experience and/or how do SEs emerge from neural signal interactions related to PEs? This is addressed in this Sections 3 and 4 of (Abraham, 1995). The embedding process may itself be chaotic memory consolidation process (Falkner, Plaetzer, & Falkner, 2007) with neural-net PEs being chaotic attractors.

ⁱ The SE in 'love' may be a form of human entanglement, which may be due to the Bose-Einstein-Condensate of discrete Calabi-Yau manifolds inside the brain as they are involved in every particle interaction (Ruquist: <http://tech.groups.yahoo.com/group/MindBrain/message/11616>).

yourself. Instead you would be a process that can be modeled by action cycles. In this world view these letters in front of you would be manifestations in your personal action cycles and not independent external objects. You *see* (i.e. incorporate disturbances in your base state action cycles) by first absorbing action quanta from external processes as internal deviations from your own ground state process and second interpreting those disturbances as conscious and illusionary external experiences. For example, this word *Now* is in you. The photon that brought the information so you could build *Now* inside of you, hit your retina some time ago. You can never see the source from whence the experience *Now* in you came, directly, but only experience your accommodation of its interactions. So, in my opinion, your PE concept is correct to the extent that primitive experience should be incorporated into physics and personal experiences SE should be cumulative PE's. If collective PE are combined to form your SE, then the SE associated with the ground state process feels like your experience of empty space. The SE associated with deviations from that ground state process is your experience of particles and fields that constitutes your every day experience. However it should not be associated with classic particles and fields. Such an association simply returns us to the mysterious mind body connections of dualistic theories, which have already been identified with the measurement process in post classic physics, and is a step backwards. Instead it should be associated with action cycles defining your actual independent self, because such action cycles describe the entire object, measurement, subject, state preparation process within which conscious experience is held." In the PE-SE framework, (i) the PE associated with ground state process of a particle is "a bit of space" which can be combined to form a cumulative SE identified as the pure experience of space called *Nirvana* (which is free of paradoxes: (Müller, 2007b)) in isolated human consciousness, and (ii) the oscillations in Whitehead framework can represent every day SE (a set of many SEs embedded as neural-net PEs in neural-nets) as long as the neural net identified as classic objects is recognized as the object phase of an entire object, measurement, subject, or state preparation process.

2.4.2. Hypothesis related to fundamental PE as mental aspect of primal entity

(H₂) One could follow the idea of unification as in material entities (for example, all elementary particles can be derived from string, i.e., unification of all 4 fundamental forces in physics). In other words, all SEs might be unified into a single proto-experience at string level. For example, since all colors can be psychophysically derived from 3 cardinal colors (red, green, and blue), all color related SEs might also be derived from 3 cardinal color SEs (redness, greenness, and blueness). Therefore, first level of unification could be to investigate cardinal SEs by psychophysical experiments. Second level of unification might be investigated by traveling backwards along evolutionary time period. For example, SEs derived using human language (such as hearing sweet words lead to experience of happiness) might be unified into related PEs in latent unexpressed form in our ancestors such as apes and monkey. Following this reverse evolution methodology for further investigation on unification of SEs into PEs may be useful. In other words, start from human SEs and investigate the unification into PEs in single cell bacteria,^j then to inert matter (such as salt, water, stone and so on) to elementary particles (string, or fermions and bosons). Since there is no shred of evidence that inert matter and elementary particles experience anything even in terms of proto-experience, they must be considered simply *carriers* of PEs in unexpressed form. In this method, one may conclude that string has dual-aspect: mental aspect in term of the *carrier* of a unified PE and material aspect. In other words, the unified string-PE co-evolved with its material aspect into SEs and their neural correlates in brain, respectively. However, one could argue that although mixing red and green light yields yellow light, but yellowness is unique SE and cannot be reduced to redness, greenness or their mixture; the same is true for all SEs, i.e., it is not possible to reduce all SEs into a single unified PE at string level. Therefore, this approach in its entirety may not be useful to acquire a single unified PE. However, one could take help of emergence property in material world. For example, the physical property of salt (NaCl) emerges from the interaction of its constituents Na⁺ and Cl⁻ ions.^k In the same way, a specific SE, such as redness, can emerge in a neural-net from interaction of its constituent neural-PEs in V4/V8 color neural-net. For example, the reportable SE redness might have emerged during the interaction of two types of signal: (i) feedforward long

^j There are PEs at every step of evolution and development, such as neural-PEs and neural-net-PEs in humans, ..., PEs in gorillas, cougars, crocodiles, spiders, flatworms, jelly fish, coral colonies, algae, viruses, and bacteria (Robbins, 2007), genetic-PEs, ..., and inert matter as *carrier* of PEs (such as molecular-PEs, atomic-PEs, elemental PEs). The specificity of a system to a specific SE decreases as we go down to lower level in evolution, but unification factor increases from zero at human level to 1 at string level.

^k According to Mandel, "... just as salt is made of two poisons [Na and Cl], consciousness could be made of constituents which by themselves appear to have nothing to do with consciousness. It should also be clear that it may be that consciousness is a property of the universe, that it is our assumption that consciousness is a property of the brain, an assumption which we have no scientific basis other than subjective/materialistic/restrictive opinions to base it on ..." (<http://tech.groups.yahoo.com/group/jcs-online/message/5709>).

wavelength (say 600 nm) stimulus dependent PE-carrying-neural-signal from retina to LGN to V1 to V4/V8 color area and (ii) feedback fronto-parietal attention related re-entrant PE-carrying-neural-signal (call it FB), i.e., redness related to 600 nm light is $SE_{redness_{600}} = (FF_{600}) * (FB)$, in analogy to $NaCl = (Na^+) * (Cl^-)$. Furthermore, elementary particles and inert matter should be the carriers of superimposed fundamental PEs only; whereas SEs are excluded even in superimposed and carrier form to deflate Type-2 explanatory gap. This hypothesis implies that there is a PE attached to every level of evolution, such as atomic-PE, molecular-PE, genetic-PE, neural-PE and so on. In other words, all kinds of SEs such as redness, happiness, painfulness, saltiness, and so on are not fundamental but reducible to the PEs of relevant constituents by the same reasoning as emerged entity salt (NaCl) can be reduced to its constituents Na^+ and Cl^- ions. Furthermore, one could argue that there is no apparent problems related to the ‘co-evolution and co-development of mind and brain’ and Type-F monism, such as ‘combination problem’, the ‘unconscious mentality problem’, the ‘completeness problem’, the ‘no sign problem’, and the ‘not-mental problem’ (Seager, 1995). This is because we are using the concept of ‘emergence’, where the term ‘emergence’ implies that a new entity is created during interactions of two or more entities and its property is not present in the interacting and constituent entities. Type-1 explanatory gap is deflated because SEs emerged from PEs (mental aspect), not from non-experiential material aspect. Thus, the hypothesis H_2 addresses both Types 1 and 2 explanatory gaps; in addition extension of quantum physics to subquantum field is also not needed.

We can elaborate further as follows: The term ‘emergence’ implies that a new entity is created during interactions of two or more entities and its property is not present in the interacting entities. For example, the saltiness of sodium chloride is not present in sodium or chlorine. Similarly, SE *redness* emerges in V4/V8-neural-net whereas this SE may not be present in any of the neurons of the neural-net. Furthermore, the SEs related to various colors can be derived from the 3 cardinal SEs *redness*, *greenness*, and *blueness* for trichromats by the method of combination or color mixing (Vimal, Pokorny, & Smith, 1987). For example, *yellowness* is the combination of *redness* and *greenness*, *purpleness* is the combination of *redness* and *blueness*, and *cyanness* is the combination of *blueness* and *greenness*. In other words, the mysterious emergence problem may be limited to cardinal SEs/neural-net-PEs. To address the problem, we may need to investigate how color vision evolved (Bowmaker, 1998; Jacobs & Rowe, 2004) or in general how consciousness evolved (Merker, 2005). In any rate, if we cannot solve this mystery, then we cannot reject one of the standard straightforward physicalist views: ‘SEs are simply the neural activity in neural nets’, which eliminates the emergence phenomenon and the explanatory gap (email communication with Bjorn Merker in January 2007). Different SEs are due to different neural-nets with different neural states, which may involve appropriate calibration and sensorimotor tuning with external stimuli during co-development. However, a question still haunts, for example, from where the SE *redness* appeared that was assigned to neural activity of red-green V4/V8-neural-net by natural selection. This is partly addressed by resonance process in Section 4.2 of (Vimal, 2008a). As MacGregor commented, the understanding of co-evolution and co-development processes “will develop around a broad, full, deep consideration of the underlying physics and neurobiology of the dynamic physiological processes of the brain and its supportive glial structures and, indeed, molecular biological structures generally – a tall, but fascinating challenge”; see (MacGregor & Vimal, 2008) for further extension of PE-SE framework.

2.4.3. Hypothesis related to cosmic-consciousness, subquantum field, RigVedic-Buddhist primordial consciousness and Universal Mind

(H_3) To address Type-2 explanatory gap, one could postulate an intelligent mechanism, such as cosmic-consciousness (Schäfer, 1997, 2006), sub-quantum (SQ) field based on Bohm’s Implicate Order (Boyd & Klein, 2007), RigVedic-Buddhist primordial consciousness, unitary dimension of fundamental reality, or Universal Mind (De & Pal, 2005; Pal & De, 2004; Rao, 1998, 2005; Sarasvati, 1974-89; Wallace, 1999, 2007). This mechanism might cause dual-aspect subquantum primal entities, each with a specific SE, which are then superimposed in string. However, this view may lead to successive never ending explanatory gaps: from where and how that the intelligent mechanism arose/emerged, how it can be omnipresent, omnipotent and omniscient, who created it, and so on.

The framework of (De & Pal, 2005; Pal & De, 2004) is mostly Hindu-Buddhist idealism: matter—such as their thought carrying particle (TCP) or bosons and thought retaining particle (TRP) or fermions—emerges from Universal Mind (UM). It has explanatory gap: from where and how Universal Mind arose/existed, and how non-experiential matter can emerge from experiential mind. Speculating that UM always exists does not deflate these gaps. One has to precisely show how the material entity such as ‘V4/V8-redness-related neural-net’ emerges from its associated mental entity/subjective experience (SE) ‘redness’ in their TCP-TRP framework, in analogy to what we have done in our dual-aspect PE-SE framework (Vimal, 2008a). Materialism has to do just reverse. Thus, both (idealism and materialism) have serious problems. It should be noted

that various views were passionately debated over 6000 years in India, similar to that in western world. Various views were: (i) idealism: matter (*Prakriti, Brahma*) from mind (*Purusha, Vishnu*), (ii) materialism: mind from matter, (iii) dualism: mind and matter on equal footing and can exist independently but can interact somehow as in Eccles' mind-brain interface (Beck & Eccles, 1992), (iv) dual-aspect: mind and matter being two aspects of the same primal entity (*Ādi-Shiva*), and so on. According to McQueen, "EVERYONE (except Leibniz), both physicalists and dualists alike, take phenomenal consciousness to be generated by the brain. The important distinction concerns the nature of the 'generation relation'. For dualists, the relation is causal (or nomological), for physicalists, the relation is identity. And these relations are mutually exclusive, hence the incompatibility of dualism with physicalism."¹ Quantum mechanics has interesting (but mysterious) premises that can accommodate various views such as, idealism, materialism, dualism, dual-aspect and other views depending on how one interprets them. Their arguments are remarkable in this respect. However, they should clearly differentiate eastern term '*manas*' [they did not use it, they used the term 'mind' instead but see (Rao, 1998, 2005)] from western term 'mind'. They are not equal. *Manas* is a finer matter and is liaison between brain (*Prakriti*) and Universal Mind (*Purusha*), whereas western term 'mind' is mental entity and is almost equivalent to term 'consciousness'. It would be better argument for their articles if they use the term 'consciousness' (that includes also irreducible/fundamental subjective experiences and thoughts) in place of 'thought' in TCP and TRP. This is because it would be hard to produce SEs ('redness', 'happiness', 'painfulness', 'saltiness' and so on) out of thoughts.

In our email correspondence (6 September 2007) Schäfer commented as follows: "I have a suggestion to make from the point of view of my own framework [Cosmic Consciousness], combining it with yours: electrons, protons and atoms do not in themselves have a psyche or consciousness [consistent with PE-SE framework: matter as the *carrier* of PEs/SEs], but their 'proto-experiences' are those in a Cosmic Consciousness. Electrons feel nothing, they do not have proto-experiences, but they act like they have mindlike properties in a rudimentary way (as I described, they can react to the flow of information and they can act spontaneously, like a mind). How is that possible, if they do not have in themselves a psyche? It is possible because the mindlike properties are not their own. Rather, they are the properties of the wholeness of reality; they are expressions of a Cosmic Consciousness. Here I am using the argument by Kafatos and Nadeau (from their book 'The Conscious Universe'): if reality has the nature of a totality or wholeness, and since our mind has come from it and is part of it, it is possible to conclude that consciousness is an aspect of the universe or of all of reality, like a Cosmic Consciousness. Since Cosmic Consciousness is a wholeness, it is everything and it feels everything. It can feel the 'experiences' of any one of its sub-totalities, like electrons, which are ultimately nothing but fleeting vortices (like Bohm says) in a cosmic flux. Thus it is the Cosmic Consciousness - the wholeness which is the ultimate reality - who seeks proto-experiences in the interactions of elementary particles, i.e. experiences like attraction, spin, and so on, as you describe. In fact, one could say that the elementary entities of reality are not mass particles, but proto-experiences. From these proto-experiences the Consciousness of the Whole builds up its more and more complex experiences, setting up neural networks, constructing increasingly complex systems, where information is used in a systematic and not automatic way, up to our own consciousness, as you describe. So, rather than saying that (as I have done) 'electrons react to the flow of information in an automatic and mechanical way,' it is better to say that Cosmic Consciousness reveals itself in a rudimentary way in the automatic and mechanical reactions to information at the level of elementary particles. What this amounts to is a revival of certain aspects of Leibniz' concept of monads: monads are the ultimate building blocks of reality, but they are NOT mass particles. Rather, they are spiritual elements which can be understood as atoms or quanta of spirit, the 'true elements of things'. The simplest of them resemble your proto-experiences. But the mind who is conscious of the proto-experiences is the Cosmic Mind. This is how your system fits into mine (Schäfer, 1997, 2006). From the view that a Cosmic Spirit – i.e. the capability or aspect of the Wholeness of being conscious – reveals itself in the actions of its elementary particles, one can easily extend to Hegel's idealism: It is the Cosmic Spirit who is thinking in us. Since the Cosmic Spirit is Wholeness, the experiences of even the smallest sub-totalities of this Wholeness are his own."

According to Klein (email correspondence of 30 August-4 September 2007), "The list of elementary PEs is quite incomplete because it is not addressing the still more elementary constituent: the Information Unit operating at sentient reality's very fundamentals. Relational effects or dynamic ones are derived basically from Information inherent in the structure. The particle's inherent structural complexity is the result of a more fundamental PE than its behavior. Before *feeling* attracted to its opposite charged equivalent, it *feels* being an entity that is attracted or moving according to a spin. This is a fundamental pre-proto-experience. Starting analysis by a relational or behavioral level misses the point. Physical

¹ Adapted from <http://tech.groups.yahoo.com/group/MindBrain/message/11849>

entities are primary experiential entities as a Space-Time manifestation of a given Information structure. Assessing the emergence of SE from experiential entities equals assessing the direct emergence of complex neural networks from biochemistry. It is a disguised physical reductionism of Information at different scales of complexity to *organized* molecular or atomic components thus establishing a coercive causal link between nonequivalent epistemological domains - which is the unfortunately perpetuated misleading start for erroneous conclusions piling up exponentially as cumulative errors. Furthermore, energy *may have information* is a rough underestimating of its real nature as Information expressed in SpaceTime. Quantum effects as the signature of any energetic process are derived from and operate under Information control injected in the system from beyond its own coordinates as related to SpaceTime. Our Sub-Quantum (SQ) model (Boyd & Klein, 2007) postulates as explanatory model the SQ entity's hyperdimensional rotation into Information fields, which at a descriptive level would support the (Hut & Shepard, 1996) model of extended reference frame for sentient reality. At fundamental emergence level, the SQ model reminds in a certain extent a type-F neutral monism/panprotopsyism - while at mesocosmic phenomenal scale it resonates rather with the dualist/interactionist interpretation. Thus the SQ concept is not reducible to previous philosophical explanation frameworks, nor to a mere combination thereof." Klein further commented, "One could argue that this evolutionary track can be traced back along chreodic channels expressing morphogenetic control in the physical systems' tuning into time-dependent variables of ambient consistency. From this perspective, the redness is rather a random individual effect rather than [than] something that randomly emerged by co-evolution and definable as a constant in nature. Would my red be the same with your green as subjective experience, this will no way affect our ambient integration efficiency and will never be detected. Experiential Qualia are but an integration code system the Self relies upon for its successful navigation through implication levels of reality, different from its own one." The SQ framework requires extending physics, and it assumes that the cardinal subjective experiences (SEs) such as redness, greenness, and blueness are SQ structures. In the PE-SE framework, cardinal SEs 'emerge' from the interaction of neural-PE signals in respective neural-nets as elaborated in hypotheses H₁ and H₂. Since hypothesis H₃ leads to successive never ending explanatory gaps, it is beyond the scope of current proposal and is not elaborated further.

2.4.4. Two alternative hypotheses

To sum up, in PE-SE framework, we propose two working hypotheses, which address Types 1 and 2 explanatory gaps:

(1) The hypotheses H₁ includes (a) the concept of fundamental and derived SEs/PEs, (b) the fundamental SEs/PEs being superimposed in elementary particles and in their interactions, (c) elementary particles and inert matter are carriers of fundamental SEs/PEs, (d) the resonance process generates a specific SE in a neural-net, as in (Vimal, 2008a), and (e) a mechanism of creation-maintenance-annihilation cycle of universe that preserved irreducible fundamental SEs/PEs (*a priori*) in primal entities. As argued in (Vimal, 2008a), SEs arise/emerge because of the resonance process. Embedding process and selection process involve resonance mechanism for generating specificity: SEs superimposed in ionic/electronic neural-PEs resonate with that in stimuli.

(2) Alternative hypothesis H₂ suggests that (a) each elementary particle or inert matter is a carrier of a fundamental PE or more superimposed fundamental PEs (but not SEs), (b) there is a PE attached to every level of evolution (such as atomic-PE, molecular-PE, genetic-PE, neural-PE and so on), and (c) a specific SE emerges in a neural-net from the interaction of its constituent neural-PEs, in analogy to the physical property of salt (NaCl) emerges from the interaction of its constituents Na⁺ and Cl⁻ ions. For example, SE redness₆₀₀ = (FF₆₀₀)*(FB), in analogy to NaCl = (Na⁺)*(Cl⁻). Further research is needed to find reasons to reject one of them.

2.5. Other relevant models

The PE-SE framework is sympathetic to two alternative models: (1) 'Emergence' mechanism can be unpacked by assuming that SEs might arise by the chaotic and self-organization processes^m of brain to cope with its environment during co-evolution and co-development; this will not require extending physics, but needs further unpacking to close the gaps. (2) Another hypothesis related to 'panpsychism based on macro-experiencers, rather than micro-experiencers, as fundamental ingredients of reality' may deflate the gaps (Lloyd, 2007); this appears to be close to dualism and also needs unpacking. Both alternatives can be unpacked. The unpacking process might need extending quantum physics to subquantum level, as done in Section 2.4.

^m Klein (email correspondence of 30 August 2007) doubts that the chaotic self-organization occurs in the neural net, with its neo-Darwinist hue, and neural-net PE should be seen rather as well-orchestrated matrices evolving under higher order control than mere chaotic attractors.

Furthermore, one could argue that instead of assuming all kinds of SEs superimposed at elemental level, assume all (or some) types of SEs superimposed at neural-net level. For example, (i) Orch-OR model assumes all types of SEs as Platonic values embedded in spacetime geometry (Hameroff, 1998b), (ii) assume that V4/V8 color related neural-net has all types of color SEs superimposed in it, or (iii) assume that specific SE say redness related V4/V8 neural-net state is assigned to SE redness. In that way, evolution will have less load to co-evolve from elemental level. This is interesting idea and needs further research; however, it is closer to dualism, which has the problem of association or mind-brain relationship problem. This is also an explanatory gap because it needs explanation in dualistic framework. Thus, so far, the PE-SE framework appears to be the optimized solution.

In PE-SE framework, ‘emergent property’ is unpacked in terms of localized inherent property: all fundamental SEs/PEs are superimposed in elementary particles or in entities at some higher level. Problem with superposition at higher level are (i) association or relationship problem between SEs and brain as in dualism, and (ii) how and where SEs are stored in and how there are assigned. Superposition in entities at levels below critical specificity level may lead us to either consider those entities as *carriers* (so they behave like non-experiential material entities), or consider them as proto-experiential entities (for which we do not have evidence). Furthermore, SE does pop out in a suitable system, but that SE would also be in the elements of the system in latent superimposed form. So, here, the term ‘emerge’ has little different meaning. Without essential ingredients (such as wakefulness, attention, re-entry, memory, and PEs), SEs would fail to occur even if there is objective reduction (OR) in MT network; so there is causal link (when long wavelength light is presented then only redness emerges, ignoring phosphenes). Dichotomiesⁿ (such as SE and content of SE, or form and substance) need to be (or can be) integrated to reveal the truth. In OR, superposed SEs collapse into one specific SE (say when a stimulus is presented), but if you do not attend then you will not have that (reportable) SE. Attention is not needed for phenomenal SE (for example, less than 17 msec presentation in Sperling type experiments (Sperling, 1960)), but attention is needed for access or reportable SE. Presumably, OR needs to be orchestrated to make attention, re-entry, and working memory active in wakefulness (ignoring dreams). Orch OR framework, PE-SE framework, and Dichotomistic framework are complementary to each other, with the understanding the axonal-dendritic, dendritic web, astro-glia-neuronal, and extra-cellular field type transfer of information all play important role in SEs depending on the context. We should try various techniques (such as multiple regression) to address their percent contributions.

In (Müller, 2007b), there are two interesting views: “(i) The constructivist option of using working-entities ... structured within otherwise not-structured experience (of mind-and-world)... (ii) the traditional metaphysical-ontological option of postulating pre-structured, persistent, and usually also mind-independent, and indeed mind-exclusive, reality (MIR) and truth.” This may be related to first person experience vs. third person MIR physics. MIR appears to have an explanatory gap of Type-3: how can we say physics is MIR when mind (subjective experience) is always used in setting up theories and observation, or “How Do We Know What We Believe We Know?” (Glaserfeld, 1985)”. However, one could argue that in what ways physical laws might be different if physics were completely MIR; perhaps, physical (third person) laws will be invariant with respect to MIR vs. MDR (mind-dependent reality or radical constructivism). This is because subjective biases are minimized by well designed experiments, such as by using the method of constant stimuli (Vimal, Pokorny, Smith, & Shevell, 1989) or randomized double staircases (Vimal, 1998) in psychophysical experiments), and by repetitions and replications at various laboratories world wide. That is, $MDR = MIR + \text{subjective biases} \sim MIR$ when subjective biases are close to zero, even though observer is always present. Furthermore, Jaspers’ statement “we are in the encompassing and we ourselves are the encompassing” (Jaspers, 1948/1991) needs elaboration and interpretation in PE-SE framework: We are objects for other subjects and we are subjects for other objects. In other words, I have first person experience or SE of all external objects which also includes my external body parts. Similarly, I am also objects for other conscious entities such as other conscious human beings and conscious animals that satisfy the essential ingredients (wakefulness, attention, re-entry, and memory) of reportable SE. Jaspers’ statement seems to be silent on materialism, idealism, dualism, and dual-aspect views because his observation is empirical and is made after mind and brain appeared in spacetime; it is also not clear if his statement is sympathetic to panpsychism or proto-panpsychism. In the PE-SE framework, inert matter is a *carrier* (not experiencer) of SEs/PEs. A system may have proto-experience (PE) but not SE if it does not satisfy SE’s essential ingredients. For example, consider the red light falling on the skin of primitive amoeba-like animal (floating in the ancient sea); this animal detects the red light and makes a characteristic wriggle of activity; this behavior may be considered as its PE. According to (Müller, 2007c), “Matter is a structure that crystallizes within mind”. This can be unpacked using the PE-SE framework. For example, consider ‘red moving car’: long wavelength reflected from the moving car hits photoreceptors and the phototransduction process converts wavelength and intensity of light into electrical signals which then travel via

ⁿ For McCrone’s Dichotomistic framework, see http://www.dichotomistic.com/logic_dichotomies_intro.html.

retinal, LGN, V1, V2 to visual cortical areas such as V4/V8 for processing of color, V5 for motion, and IT for shape. Neural-signals carry SEs/PEs. The re-entry process binds all attributes of car (reflected in gamma synchrony). When essential ingredients (wakefulness, attention, re-entry, and working memory) of SE are satisfied in neural-nets, SE of 'objects and subject' emerges, i.e., "matter crystallizes within mind" via two complementary mechanisms (Vimal, 2008a): (i) via resonating the SEs/PEs carried by neural-signals with that by external stimuli, and/or (ii) via Orch OR of Hameroff-Penrose. Thus, the PE-SE framework is complementary to the constructivism-framework (Jaspers, 1948/1991; Müller, 2007a, 2007b).

2.6 Types of elemental-PEs

What are the proto-experiences, exactly? In hypothesis H_1 , we have defined that elemental-PEs are all types of irreducible/fundamental SEs/PEs superimposed in elementary particles and their interaction. For example, color opponent SEs (redness, greenness, yellowness, blueness, whiteness, and blackness) should be included in the list because they appear irreducible/fundamental SEs.^o Secondary or derived SEs/PEs should not be included in the list because they can be derived from the fundamental SEs/PEs and lead to Type-2 explanatory gap. The number of fundamental SEs/PEs should be as small as possible for the optimization of the system and to minimize the burden on matter because they are carried by inert matter over billions of years. Further investigation is needed to list all fundamental SEs.^p

In hypothesis H_2 , PEs are specific to specific elementary particle or inert matter. There are PEs at every step of evolution and development, such as inert matter as *carrier* of PE (such as string-PE, PE for a fermion such as electron-PE, PE for a boson such as photon-PE, element-PEs, atomic-PEs, molecular-PEs), ..., genetic-PEs, PEs in bacteria (Lamb, Collin, & Pugh, 2007), viruses, algae, coral colonies, jelly fish, flatworms, spiders, crocodiles, cougars, and gorillas, and neural-PEs and neural-net-PEs in humans.

One could also argue that non-experiential inert matter is simply *carrier* of SEs as in for hypothesis H_1 or carrier of its own specific PE as in hypothesis H_2 . When the specificity of an organism-neural-net is higher than the critical value, PEs are expressed as SEs. For example, these carrier type PEs might be expressed into organism-PEs for the first time about 600 million years ago (Mya) in early organisms with specificity higher than critical value, in which photoreceptors were evolved to signal light (Lamb et al., 2007). Later during Cambrian explosion (~ 540 Mya), animal body plans began evolving very rapidly and image-forming eyes and visual systems emerged (Byrne & Hilbert, 2003); probably the specificity of animal's neural-net was high enough to express their PEs into some rudimentary SEs.

Furthermore, when photons interact with photoreceptors in retina, electrical signals arise due to phototransduction process. These electrical signals have PEs because PE is inherent in electrons. Later, neurotransmitters play role in signal transmission, so electrochemical neural signal have neural-PE. Since the output of both L-cone and M-cone is electrical signal (univariance principle), PEs of both electrical signals are also the same. One can proceed further similar analysis in visual pathways until Red-Green (R-G) opponent mechanism is formed in R-G V4/V8-neural-net with associated embedded neural-net PEs. Since we do not yet know exactly how color SEs emerged, it would be safe to state that they might have emerged from the interaction between light reflected from objects, photoreceptors, retinal, LGN, and cortical feed forward and feedback signals and supporting internal and external environment. In other words, light may have information for color related PEs. For example, in some sense, 650 nm light may have information for redness-related PE, 580 nm light may have information for yellowness-related PE, and so on; this entails energy $E = h\nu = hc/\lambda$ may have information related to color-

^o According to (Vimal, 2008a), "The matter-field is intrinsically qualitative, and the specification of scale is the underpinning of perceived qualia. ... Color can now be construed as a property of the matter-field. ... [coding problem is the hard problem] ... The external world is encoded in the form of neural firing patterns [representations]. ... This encoding resides in the strange, dark, internal world of the brain. How, we ask, can a code, which is supposed to stand in for something known, i.e., for the external world, be itself the means by which the external world is known? ... How is a code unfolded as the external world without already knowing what the external world looks like? ... we must cease viewing the world as being encoded or represented within the brain; rather, we must see the brain as itself the decoder. ... The dynamical apparatus supporting this specification [representation], with its L cones, M cones, etc., is selecting out information from the matter-field relative to action, just as a reconstructive wave selects information from the holographic plate. ... [he appears to follow Gibson's direct perception]... the problem of qualia is an offspring of abstract space and its correlate, abstract time. ... Semantics rests in the realm of mind, mind embedded in the concrete, indivisible, time-evolution of the matter-field."

^p Chalmers commented, "it looks like a form of type-F monism to me -- the contrast that you mention is in fact shared by most forms of type-F monism. The key questions of course for any such view are (i) what are the proto-experiences, exactly, and (ii) how do they combine into subjective experiences. It would be nice if you could extend your account into one that gives answers to these questions!" (Email communication on August 24, 2007). These are excellent questions and need further investigation; in preliminary form, the first question is addressed in this section and the second question is addressed in .

PEs, where h is Planck's constant, and ν , c , and λ are frequency, speed, and wavelength (700–400 nm) of light. These information in light might have contributed to the co-evolution and co-development of color-neural-nets, associated color-neural-net-PEs and color-SEs. Moreover, (Chalmers, 2003) argued, “colors are physical properties, specifically, types of reflectance”. Furthermore, if we assume that energy has information related to PEs, then $E=mc^2$ entails that mass m may also have information related to PEs. Thus, one could argue for proto-panpsychism, such as Chalmers' Type-F monism (Vimal, 2008a). However, satisfactory evidence is lacking for these speculations. In PE-SE framework, inert matter is the *carrier* of fundamental SEs/PEs in unexpressed form.

3. Subquantum Bhutatma for Hypothesis H₁

Our hypothesis implies that non-experiential matter (mass, charge, and space-time) and related elemental proto-experiences (PEs) co-evolved and co-developed, leading to neural-nets and associated PEs, respectively. This is discussed in Section 4 of (Vimal, 2008a). A hypothesis in the neural-based PE-SE framework is that there exist a virtual reservoir that stores all possible SEs, which is discussed in (Boyd & Klein, 2007) in classical and quantum terms. Here subquantum concept is introduced. An alternative ‘neurally backed *modus operandi*’ model^q for *virtual reservoir* using some of terms of sub-quantum (SQ) framework (Bohm, 1983) —which requires extending physics and is the extension of Bohm's Implicative Order (Boyd & Klein, 2007; Radhakrishnan, 1993) from a bi-directional vector connecting a couple of mutually complementary domains (the implicate and explicate ones) to information based infinite array of SQ complexity states— is as follows:

(i) SQ-field composed of a large number of complexity-sensitive implicate orders reminding the Vedic concept of *bhutatmas* (Chalmers, 1995a) or *Ādi-Shiva* entities that are infinitesimal, irreducible, fundamental primal structures with ‘pure information’.

(ii) Each *bhutatma* has two aspects: material aspect (*Brahma, Prakriti*) and mental aspect (*Vishnu, Purusha*) such as proto-experience (*bhutatmic-PE*); dual-aspect *bhutatma* view is consistent with double-aspect model (Franck, 2004; Globus, 2003; Umezawa, 1993) and complex-conjugate framework (Kaivarainen, 2001). Sub-quantum dual-aspect primal entities can be considered as units of subjective experiences.

(iii) I assume that *bhutatmic-PEs* are subjective experiences (SEs) or first person fundamental experiences (1Es), such as redness. They are PEs because *bhutatma* cannot experience redness, as humans do. To experience redness, redness-related neural-net is needed, which satisfies the essential ingredients of SEs, namely, wakefulness, re-entry, attention, and memory. The number of *bhutatmas* is at least equal to the number of fundamental SEs/PEs; the available SQ combinatorial options are practically infinite. This is consistent with fractional quantum Hall effect.^f The set of all fundamental SEs/*bhutatmic-PEs* is called *virtual reservoir*.

(iv) SE, such as redness is a SQ structure displaying resonant associative properties both with lower and higher orders of PEs. A specific SE such as redness is specific to a specific *bhutatma* (call it redness-*bhutatma*).

(v) SE redness is experienced by redness-related neural-net (that includes self-related areas) because it has complexity index greater than its critical threshold value; every mental or physical entity is SQ-field with different complexity indices.

(vi) Different PE/SE levels can be ascribed to different Information-based orders of reality corresponding to specific complexity indices and combinations thereof.

A quantum particle, such as electron, is composed of a large number of *bhutatmas* of SQ-field and hence a large number of superimposed *bhutatmic-PEs/SEs*. In addition, the electrons in neural signals are involved in all neural-nets at classical level. Therefore, electrons in neural signals (or otherwise) are non-specific with respect to SEs/PEs. However, the neural signals in the redness-related V4/V8-neural-net are specific to SE redness of Red-Green color opponent channel. When long wavelength light is presented to our visual system, we experience redness. This is because redness-*bhutatmic-PE* from SQ-based ‘virtual reservoir’ is assigned to the redness-specific state of our red-green V4/V8-neural-net by resonating with the PE ‘redness’ of long wavelength light (as described before, bosons are also the carriers of fundamental SEs/PEs).

Furthermore, the quantum elemental PEs can be unpacked a little bit using Bivacuum model (Kaivarainen, 2001), which is a dynamic matrix of the Universe, composed of sub-quantum particles and antiparticles, forming vortical structures. In this model, attraction (or repulsion) is caused by the shifts of opposite (or similar) Bivacuum dipoles charge symmetry. The

^q The author takes full responsibility; the model does not necessarily reflect the views of other investigators/commentators.

^f See http://en.wikipedia.org/wiki/Fractional_quantum_Hall_effect and http://nobelprize.org/nobel_prizes/physics/laureates/1998/laughlin-lecture.pdf.

attraction (or repulsion) between opposite (or similar) charges is a consequence of exchange interaction between Bivacuum fermions with opposite (or similar) sign virtual clouds. The virtual clouds and virtual anticlouds “exist in form of collective excitation of subquantum particles and antiparticles of opposite energies. [...] They can be considered as ‘drops’ of virtual Bose condensation of subquantum particles of positive and negative energy” (Boyd & Klein, 2007). In other words, the Bivacuum-PEs are composed of all kinds of sub-quantum (Baer, 200x, 2007) *bhutatmic*-PEs in superimposed format.

In PE-SE extended framework (under neurally backed *modus operandi*), I emphasize that *bhutatmic*-PEs — such as redness, greenness, blueness, and so on — are not subjectively experienced by *bhutatmas*. In other words, universe is not ‘conscious’ rather inert matter of universe is carrier of ‘proto-conscious’ (and hence has potential or possibility of being conscious after evolution when neural-nets are formed otherwise inert entities are *carriers* of SEs/consciousness) except humans and some lower species that satisfy the essential requirements of consciousness and have complexity indices or specificity greater than the critical threshold value. Here, the term consciousness is used for the first person experience. The *bhutatmic*-PEs are superimposed and packed in elemental-PEs as ‘virtual reservoir’; these are further packed in neural signals as neural-net PEs. However, the non-specificity of elemental-PEs is evolved into higher specificity of neural-net-PEs. These *bhutatmic*-PEs are virtual because they are simply ‘potentials’ or ‘possibilities’ and cannot be experienced unless neural-net with essential ingredients of SEs (such as wakefulness, re-entry, attention, and memory) are satisfied and ‘collapse’ or ‘objective reduction’ occurs when a stimulus is presented. That is why, one could argue, it took billions of years to evolve and create neural-nets in brains. One could argue that these superimposed ‘possibilities’ in ‘virtual reservoir’ might be one of the motivations for Nature to evolve *bhutatmas* into neural-nets and associated PEs in various species for various SEs.

The *bhutatma*-dual-aspect model is consistent with Baer’s model (Franck, 2004) based on the extension of Whiteheads actual occasions as a cyclic process with subjective experience on one node (sensation node) and material basis of that experience on the other (explanation node).

In our neural-based PE-SE framework, at classical level, our hypothesis is that (i) both SE redness and ‘redness related V4/V8-neural-net’ are SQ-structures, (ii) the redness related V4/V8-neural-net is the neural correlate of SE redness, (iii) redness *emerges* from the interaction of ‘long wavelength light dependent feed-forward signals’ and ‘reentrant feedback attentional neural signals’ in red-green V4/V8-neural-net in neural-correlated *modus operandi* of SE under certain given associative circumstances, and (iv) redness is experienced by the red-green V4/V8-neural-net.

The PE of a neuron (neural-PE) is the PE that emerged during interaction of ions in spike-generation, and has specificity higher than elemental-PEs. One could argue that the ions may be the proto-experiencers of this neuronal ionic-PE and neuron may be the proto-experiencer of the neural PE; i.e., they are *proto-conscious*, which is different from our regular consciousness. However, it would be parsimonious to state that they are *carriers* of SEs.

The major problem is how neural-net PEs emerge in the above complex sensorimotor interactions of neural PEs during co-development, co-calibration, and co-tuning with external stimuli. Neural PE seems to be ionic (elemental) PEs such as PEs related to a large number of sodium, potassium, and chlorine ions that rush across cell membrane during the surge of ions to generate action potential (spikes); neural signals are carriers of these PEs. One could try explaining neural-net-PEs or SEs by employing procedures such as the method of combining neural-PEs or the method that uses the principle of emergence in respective neural-nets. For example, simple SEs such as in thought processing, touch, motion, pain, and various climaxes may be explained using some types of combination of neural-PEs. However, complex cardinal SEs such as *redness*, *greenness*, and *blueness* certainly need the principle of emergence/resonance because it is not clear that any combination of neural-PEs will result such SEs. In any case, this emergence may be the *optimized* solution of the mind-brain problem because it will be less ‘*brute emergence*’ than that from non-experiential matter.

As discussed in Section 2.3, one could explain SEs (consciousness) at all 3 levels: classical (coarse), quantum (fine), and sub-quantum (SQ: very fine) levels. Only subquantum (SQ) treatment for hypothesis H₁ needs extending physics to include dual-aspect *bhutatmas*. At classical level, we need to use the mysterious term ‘emergence’: SEs *somehow* emerges from the interaction between stimulus-dependent feed-forward neural signals and re-entrant feedback signals in neural-nets. The term ‘emergence’ can be unpacked a little bit at quantum level using quantum superposition (Vimal, 2008a): all types of fundamental SEs/PEs are superimposed in elementary particles (strings, or fermions and bosons) and a fewer types of SEs are superimposed in neural-net-PEs that are embedded in a neural-net, which ‘collapse’ to a specific SE when a specific stimulus is presented. The elemental-PEs can be further unpacked at SQ-level (under neurally backed *modus operandi*) by hypothesizing that elementary particles are non-specific and composed of a set of dual-aspect *bhutatmas*, where mental aspect of a *bhutatma* is a specific *bhutatmic*-PE (such as redness-*bhutatmas*) that resides in the ‘virtual reservoir’. The

elemental-PEs are the properties of the interaction between *bhutatmas* of one elementary particle and that of another one because this corresponds to the concept of subquantum informational resonances. In this view, for mental entities, it appears that the specific *bhutatmic*-PEs at sub-quantum level (such as redness-Ädi-Shiva or redness-*bhutatmas* entity) transform into non-specific elementary-PEs at quantum level (such as in electron), which then evolve into specific entities at classical level (such as in redness related neural-net). The same goes for physical aspect. In RigVedic terms, a dual-aspect primal Ädi-Shiva entity has two aspects: its material aspect is Brahma and its mental aspect is Vishnu. Thus, the co-evolution can be elaborated as Brahma aspect → elementary particles → neural-net and Vishnu aspect → elementary PEs → neural-net-PEs. The neural-net PEs can collapse into a specific SE redness upon the presentation of long wavelength light. These transformations are necessary because a neural-net is needed to have a subjective experience in addition to essential ingredients of awareness such as wakefulness, re-entry, attention, and memory. Without these ingredients, a system such as an inert matter is the carrier of associated proto-experiences. That is why specific primal entities such as redness-*bhutatma* cannot have SE redness; it has only redness-*bhutatmic* PE in unexpressed form, i.e., it is a carrier its PE, and it behaves as if it is non-experiential entity. This entails a possible motivation for Nature to create specific neural-net to have specific SE, such as redness related V4/V8 neural-net to have SE redness. This took billions of years.

In PE-SE framework, the terms specificity and non-specificity need further clarification. For example, electron (quantum particle), is non-specific because it has all fundamental SEs/PEs superimposed and is found everywhere; however, redness-related neural-net, in classical domain, is specific because it has single SE/PE redness (a neural-net will have SE when all essential ingredients of SE is satisfied in neural-net, otherwise the neural-net carries PE in embedded form). On the other hand, redness-*bhutatma* (primal dual-aspect entity) is specific because it carries single PE redness in subquantum domain. Thus, change of specificity can be elaborated as specificity in subquantum domain → non-specificity in quantum domain → specificity in classical domain.

Richard Wilson commented (personal email communication on October 12, 2007), “I cannot see anything in your paper that closes the explanatory gap. [...] The hard problem of how (some) brain activity generates conscious experiences remains.” To address this comment, elemental-PEs need to be unpacked. Unpacking process leads to speculation without solid evidence. In other words, elemental-PEs are packed and I have assumed that *somehow* they carry proto-experiential entities and hence the PE-SE framework is less ‘brute’ than straightforward materialism (types A-C). To summarize the unpacking process, elemental-PEs are composed of a set of all fundamental SEs/PEs (dual aspect primal entities: *bhutatmic*-PEs) in superimposed form and hence they are non-specific. Co-evolution and co-developmental processes (via sensorimotor tuning) yield neural-nets and associated neural-net PEs and higher degree of specificity arises. For example, redness-related V4/V8-neural-net and associated neural-net color PEs are co-developed, which is basically the red-green opponent channel containing all color SEs between redness and greenness. This has higher specificity than elemental PEs. When long wavelength light is presented, specific SE redness is selected out of these color-SEs by resonance process. Thus, the PE-SE framework helps in closing the explanatory gaps using hypothesis H₁. If we can unpack quantum elemental-PEs or classical ‘emergence’ without extending physics to subquantum domain, it will be a great achievement because associated problems will be minimized. This is done via hypothesis H₂, however, mystery of ‘emergence’ is not fully addressed for both material and mental domains: (a) precisely how and why the material property of salt (NaCl) emerges from the interaction of its constituents Na⁺ and Cl⁻ ions, and (b) precisely how and why the mental property SE redness of V4/V8-redness-related-neural-net emerges from the interaction of its constituent PEs.

4. Conceptual Analysis

A conceptual analysis is provided for the integration of subquantum, quantum, and classical concepts in the PE-SE framework using analytical philosophy (Vimal, 2008a), which addresses both Types 1 and 2 explanatory gaps.^s Let us take the example of color related subjective experience ‘redness’. The term ‘redness’ refers to a property of subjective experience (SE), i.e., the first person experience; this SE is more or less the same for all trichromats. The term ‘red-color’ refers to a property of objects (such as reflectance property of object) and may also refer to the content of ‘redness’.

(I) We have color related subjective experience (SE) ‘redness’.

(II) We have redness related V4/V8-neural-net that includes self-related areas such as cortical midline structures.

^s Part of this was also posted at <http://tech.groups.yahoo.com/group/cognitiveneuroscienceforum/message/4179>, <http://tech.groups.yahoo.com/group/MindBrain/message/10910>, and <http://tech.groups.yahoo.com/group/jcs-online/message/5560>.

(III) Question is how (I) is derived from (II), i.e., how ‘redness’ emerges in its neural-net.

4.1. Conceptual analysis for hypothesis H_1

Consider the following premises related to hypothesis H_1 : (1) is conceptual analysis and (2.1)-(2.9) are scientific explanations. Details are given in (Vimal, 2008a).

(1) Redness is a SE of a ‘red-color’ object and is typically caused in an experiencing normal healthy trichromat when that trichromat looks at a red-color object that reflects long wavelength light.

(2.1) There are sub-quantum dual-aspect primal fundamental entities such as redness-*bhutatma*, greenness-*bhutatma*, yellowness-*bhutatma*, blueness-*bhutatma*, and so on.¹ Each of them represents a fundamental SE/PE, its essence might be preserved by the creation-maintenance-annihilation cycle of the universe, in analogy to the essence of material aspect might be preserved.

(2.2) These sub-quantum dual-aspect primal entities are **superimposed** in elementary particles (strings or fermions such as electrons and bosons such as photons) and their interactions. Elementary particles and inert matter are the ‘carriers’ of SEs/PEs and behaves as non-experiential entities.

(2.3) Superimposition of many *bhutatmic* proto-experiences (PEs) into one entity leads to non-specificity; therefore, electron or photon is non-specific.

(2.4) The two aspects are material aspect (such as charge, mass, spin) and mental aspect (such as SEs redness, greenness, yellowness, blueness, and so on).

(2.5) From (2.1)-(2.4), electron is a dual-aspect entity that has material aspect (such as charge, mass, spin) and mental aspect (such as SEs redness, greenness, yellowness, blueness, and so on).

(2.6) The material aspect and mental aspect co-evolve and co-develop into red-green V4/V8 neural-net and associated color related neural-net PEs (such as SEs redness, greenness, yellowness, blueness, and so on), respectively, that are embedded in that neural-net.

(2.7) Subjective experience ‘redness’ is selected from the set of color related subjective experiences (such as SEs redness, greenness, yellowness, blueness, and so on) that are embedded in ‘red-green V4/V8 neural-net’ when long wavelength light is presented to our visual system: call this specific state of ‘red-green V4/V8 neural-net’ as specific ‘redness-related V4/V8 neural-net’ that experiences the specific SE ‘redness’.

(2.8) Embedding process and selection process involves resonance mechanism (Section 4.2 of (Vimal, 2008a)) for generating specificity: SEs superimposed in ionic/electronic neural-PEs resonate with stimuli.

(2.9) From (2.1)-(2.8), ‘redness-related V4/V8 neural-net’ plays a red-color related role.

(3) From (1), (2.7)-(2.9), SE ‘redness’ is experienced by ‘redness-related V4/V8 neural-net’.

(4) From (3) redness related Type-1 explanatory gap is deflated. Premises (2.1) and (2.2) close Type-2 explanatory gap.

If one wants to be limited to quantum physics, premises (2.1)-(2.3) can be replaced by quantum scientific explanation premises (2.1) and (2.2) of Section 6 of (Chalmers, 2006). If one wants to be limited to classical physics, premises (2.1)-(2.9) can be replaced by classical scientific explanation: **(2)** ‘Redness-related V4/V8 neural-net’ that embeds ‘redness’ plays a red-color related role. **(3)** Hence, ‘Redness-related V4/V8 neural-net’ is neural correlates of SE ‘redness’, i.e., SE ‘redness’ emerges in this net. For this, the term ‘emerges’ needs to be unpacked as done above in premises (2.1)-(2.9), but then physics needs to be extended.

4.2. Conceptual analysis for hypothesis H_2

Consider the following premises related to hypotheses H_2 : (1) is conceptual analysis and (2.1)-(2.9) are scientific explanations. This does not need subquantum extension as needed for H_1 .

(1) Redness is a SE of a ‘red-color’ object and is typically caused in an experiencing normal healthy trichromat when that trichromat looks at a red-color object that reflects long wavelength light.

(2.1) Elementary particles (strings or fermions such as electrons and bosons such as photons) and their interactions have two aspects: material aspect (such as charge, mass, spin) and mental aspect (such as one or more fundamental PEs).

¹ If phenomenal SEs are irreducible/fundamental entities, they have to be precisely the same at all levels such as micro or macro level, and classical, quantum, or sub-quantum level. Therefore, prefixing dual-aspect primal entities *bhutatmas* with associated SE is justified. It is basically extension of Chalmers’ dual-aspect model (Chalmers, 1995) for color.

(2.3) If there is a single fundamental PE, then each elementary particle has its own PE; for example, a string will have string-PE, an electron will have electron-PE, or a photon will have photon-PE as its mental aspect.

(2.4) If there are more than one fundamental PEs then they are in superimposed form, which may lead to non-specificity.

(2.5) Each elementary particle or inert matter is a carrier of a fundamental PE (or superimposed fundamental PEs if it has more fundamental PEs).

(2.6) The material aspect and mental aspect of elementary particles co-evolve. This means that inert matter will be a carrier of its associated PE (i.e., inert matter does not experience anything; it is simply a carrier of PE in unexpressed form). Thus, there will be atomic-PE, molecular-PE, genetic-PE, and so on at each level of evolution.

(2.7) The material aspect and mental aspect co-evolve and co-develop into neuron and associated neural-PE, respectively. Still no experience is generated, they are simply carriers.

(2.8) Neural signals interact so are neural-PEs in a neural-net, and neural-net PEs emerge because of interaction and are embedded in the neural-net during co-development and sensory motor tuning. For example, red-green V4/V8 color related neural-net PEs emerge in this neural-net, which are embedded in that neural-net. This may be first time, a color related PE might have emerged because of interaction of feed forward and feedback signals in associated neural-net, in analogy to the physical property of salt (NaCl) emerges from the interaction of its constituents Na^+ and Cl^- ions.

(2.9) Subjective experience 'redness' is selected from the set of color related subjective experiences as described in premise (2.7) of Section 4.1.

(2.10) From (2.1)-(2.9), 'redness-related V4/V8 neural-net' plays a red-color related role.

(3) From (1), (2.8)-(2.10), SE 'redness' is experienced by 'redness-related V4/V8 neural-net'.

(4) From (3) redness related Type-1 explanatory gap is deflated. Premises (2.1)-(2.5) close Type-2 explanatory gap.

If one wants to be limited to classical physics, premises (2.1)-(2.10) can be replaced by classical scientific explanation: **(2)** 'Redness-related V4/V8 neural-net' that embeds 'redness' plays a red-color related role. **(3)** Hence, 'Redness-related V4/V8 neural-net' is neural correlates of SE 'redness', i.e., SE 'redness' emerges in this net.

4.3. The philosophical basis of the PE-SE framework

The philosophical basis of the hypothesis H_1 of PE-SE framework can be examined using (Pereira Jr., 2007a, 2007b; Pereira Jr. & Furlan, 2007a, 2007b):

(I) Let P be the redness related neural-net-PE, which is embedded in V4/V8 redness related neural-net during co-development and sensorimotor tuning.

(II) Let Q be SE redness.

(III) Let us assume that the neural-net for Q has related signature in terms of P. For example, assume that sodium, potassium, chlorine, calcium ionic activities (such as in NMDA-receptors (Chalmers, 2006)) in the interaction between 'the long wavelength light dependent feedforward neural signals that carry redness related neural-PE' and 'the feedback fronto-parietal attentional signals' in the redness-related-V4/V8- neural-net can represent subject's SE redness.

(IV) If assumption **(III)** is correct, then one could explain the truth of Q wholly in terms of the truth of P; therefore, the truth of Q is deducible by *a priori* reasoning from the truth of P.

Furthermore, all 3 arguments in (Chalmers, 2006) can be satisfactorily addressed for the thesis $C =$ 'PE-SE framework: the co-evolution and co-development of elementary particles and associated PEs lead to neural-nets and associated SEs, respectively':

(i) C is true because P and Q are true.

(ii) Physically identical zombie with Q—after appropriate sensorimotor tuning/training same as human twin, share our epistemic situation and beliefs—is conceivable in C (and hence the explanatory gap is deflated for P-Q). This is consistent with "Option 3: Assert That Zombies Share Our Epistemic Situation" in (Pereira Jr., 2007b); in addition beliefs are also the same for both human and zombie twin. Moreover, $P \& \sim Q$ is inconceivable because P and Q are true in C. Conceivability and explanation are linked, i.e., explaining Q in terms of P is consistent with the conceivability of Q with P.

(iii) Both P and hence Q can be explained in physical terms, where physicality includes dual-aspect in elementary particles. It should be noted that the hypothesis $P =$ 'fundamental SEs/PEs superimposed in elementary particles' needs unpacking by extending physics to subquantum dual aspect primal entities (such as redness-*bhutatma*) that are superimposed in P.

Alternatively, hypothesis H₂ can also be similarly examined, where it is assumed that SE redness emerges during the interaction between ‘the long wavelength light dependent feedforward neural signals that carry redness related neural-PE’ and ‘the feedback fronto-parietal attentional signals’ in the redness-related-V4/V8-neural-net. This emergence is in analogy to the emergence of physical property of salt from the interaction of its constituents Na⁺ and Cl⁻ ions, as in the conceptual analysis discussed above in Section 4.2. Here, SEs might have been created by the chaotic and self-organization processes of brain to cope with its environment during co-evolution; this will not require extending physics, but needs further unpacking as done in Section 4.2 to close the gaps.

Types A-C physicalism might be rejected because the original explanatory gap remains, whereas the PE-SE framework is ‘non-reductive physicalism’ (Dow, 2002; Gegenfurtner & Kiper, 2003), where the gaps are deflated. However, a close scrutiny reveals that Types A-C have apparent explanatory gap, not real one; it appears real gap because P is packed and we cannot ‘see’ what is inside the packing and we use term ‘emergence’ to circumvent the problem. Once P or ‘emergence’ is unpacked then the gaps are deflated as done above in Sections 4.1 and 4.2.

It should be noted that P (ionic/neural PE) is not be specific to Q because P is involved in other Q’s belonging to other modalities such as visual (Vimal, 2008a), auditory, taste and so on. Other factors, such as stimuli and sensorimotor tuning during development, are also necessary to generate higher specificity. For example, long wave-light is helpful in having specific SE redness.

5. Conclusions

Our framework consists of four essential ingredients that lead to structural and functional coherence between mind and brain:

- (i) dual-aspect primal entities,
- (ii) co-evolution and co-development of subjective experiences (SEs) and associated neural-nets from elemental proto-experiences (PEs) and the associated material aspect of elementary particles, respectively,
- (iii) internal-representation, and
- (iv) sensorimotor interaction.

We face two types of explanatory gaps:

- (i) Type-1 explanatory gap (how SEs can emerge from non-experiential matter) and
- (ii) Type-2 explanatory gap (how it is possible that our SEs — such as happiness, sadness, painfulness, and similar SEs — were already present, *a priori*, in primal entities).

To address these gaps, two working hypotheses are proposed:

- (H₁): (i) Elementary particles and inert matter are the ‘carriers’ of superimposed irreducible/fundamental SEs/PEs,
 - (ii) a specific SE emerges in a neural-net via resonance process, as discussed in (Vimal, 2008a), and
 - (iii) to eliminate any the residual gap in Type-2 explanatory gap, it is assumed that the mechanism of creation-maintenance-annihilation cycle of universe might have preserved irreducible fundamental SEs/PEs (*a priori*) in primal entities.
- (H₂): (i) Elementary particles and inert matter are the carriers of superimposed fundamental PEs (not SEs);
 - (ii) there is a PE attached to every level of evolution (such as atomic-PE, molecular-PE, genetic-PE, neural-PE and so on), and
 - (iii) a specific SE emerges in a neural-net from interaction of its constituent neural-PEs, in analogy to the physical property of salt (NaCl) emerges from the interaction of its constituents Na⁺ and Cl⁻ ions.

Further research is needed to find reasons to reject one of them.

According to (Chalmers, 2003; Vimal, 2008a), “Since a self-organizing system, such as brain, can create novel structures and new modes of behavior, it can also create complex subjective experiences (such as *redness*) to cope with its environment during co-evolution. The adaptation, natural selection (*fittest survive*), calibration, and resonance processes can assign specific subjective experiences of subject and objects to the associated specific neural-nets via co-developmental processes such as sensorimotor tuning with external stimuli. When a stimulus is presented to the system, the associated subjective

experience is selected from the embedded neural-net proto-experiences. Our hypothesis (a) contributes in bridging the explanatory gaps because elemental proto-experiences are introduced, and (b) minimizes the problem of causation because our framework is within the scope of physicalism that accommodates the dual-aspect entities. The PE-SE framework seems to integrate reductive (Types A-C) and non-reductive (Types D-F) views of philosophy, and relevant models in psychology, evolution, neurophysiology, chemistry, and physics. Our framework of neural-net PEs critically challenges existing theoretical perspectives that could significantly alter the directions of future research in the neural basis of awareness.” There are many views such as 6 views (Types A-F) reviewed in (Strawson, 2000, 2006), panpsychism (De & Pal, 2005; Pal & De, 2004; Rao, 1998, 2005; Sarasvati, 1974-89; Wallace, 1999, 2007), Hindu-Buddhist idealism (Vimal, 2008a), PE-SE framework (Vimal, 2007) and so on. Since it is hard to prove scientifically any metaphysical view, we need to investigate which view has the least problems. Our PE-SE framework passes this ‘litmus test’.

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Competing interests statement

The author declares that he has no competing financial interests.

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