

Subjective Experience Aspect of Consciousness Part II Integration of Classical and Quantum Concepts for Emergence Hypothesis

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Abstract

Previously, we proposed a *superposition*-based hypothesis (H_1) in the dual-aspect-dual-mode PE-SE framework to address the Type-1 explanatory gap (how subjective experiences (SEs) aspect of consciousness can *emerge* from non-experiential matter) as follows: (1) fundamental entities (strings or elementary particles: fermions and bosons) have material and mental aspects and are *carriers* of SEs/proto-experiences (PEs) in their mental aspect in superimposed form (Vimal, 2008b), and (2) a specific SE is embedded in a neural-net via *neural Darwinism* and is selected by matching and selection processes (Vimal, 2009b). In Part I of this series (Vimal, 2009f), we unpacked the quantum view of superposition in terms of subquantum dual-aspect primal entities (*bhutatmas*) and discussed Type-2 explanatory gap: 'how it is possible that some SEs (such as happiness, sadness, painfulness, and similar SEs) were already present in primal entities, whereas there is no shred of evidence that such SEs were conceived at the onset of universe'. To address both gaps, we extended the working hypothesis H_1 as follows: (3) Some of the SEs that entails Type-2 explanatory gap can be derived from the fundamental SEs/PEs and the stimulus-context. (4) In addition, the fundamental SEs/PEs follow the principle of the *emergence* of SE and anti-SE (or *bhutatma* and *anti-bhutatma*) in a dual-aspect vacuum at the onset of universe; and/or the mechanism of cycles of universe (that may have memory) might have preserved irreducible fundamental SEs/PEs superposed in the primal entities. In the current Part II of this series, we propose two alternative hypotheses (*superposition-then-integration-emergence* based H_2 , and *integration-emergence* based H_3 where superposition is not required) in addition to other speculative hypotheses: (H_2) fundamental entities and inert matter are the *carriers* of superimposed fundamental PEs (not SEs), which are *integrated* by interaction processes and *neural-Darwinism* (co-evolution via the evolutionary process of adaptation and natural selection, co-development, and sensorimotor co-tuning). In H_3 , a string or an elementary particle has its own PE; a matter is not a *carrier* of PE(s) in superposed form as it is in H_2 , rather it is a proto-experiential entity and has two aspects at every level; this is a dual-aspect panpsychism. In H_2 and H_3 , a specific SE *emerges* in a neural-net from the interaction of its constituent neural-PEs, namely, from the interaction between the feed forward stimulus-dependent neural signals and the fronto-parietal feedback attentional signals, in analogy to water *emerges* from the interaction of hydrogen and oxygen. In all hypotheses, (a) interaction processes and *neural-Darwinism* are active, (b) there is a PE attached to every level of evolution (such as atomic-PE, molecular-PE, genetic-PE, bacterium-PE, neural-PE, neural-net-PE, and so on), and (c) SEs *emerge/arise* when essential ingredients of SEs (such as wakefulness, attention, re-entry, working memory and so on) are satisfied.

Key Words: Subquantum metaphysics, classical and quantum physics, dual-aspect model, explanatory gaps, superposition and integration, interaction processes, *neural-Darwinism*, Orch-OR model, information

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1. Introduction

The current mainstream neuroscience is mostly materialistic emergentism (the null hypothesis H_0), which proposes that subjective experiences (SEs) somehow *emerge* from non-experiential matter such as the neural-nets of brain. This science has done excellent job in linking *structure* and *function*; however, it has failed totally to link and explain subjective *experiences* (SEs). This is because of the well-known Levine's explanatory gap (Chalmers, 1995; Levine, 1983): how precisely SEs *occur/arise/emerge* 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. To address this gap, we proposed the dual-aspect-dual-mode PE-SE framework with three competing hypotheses: *superposition* based H_1 , *superposition-then-integration-emergence* based H_2 , and *integration-emergence* based H_3 where superposition is not required (Vimal, 2008b, 2009b, 2009f, 2009g).²

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² According to (Vimal, 2008b), "The adaptation, natural selection (fittest survive), and calibration 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 (neural Darwinism). When a stimulus is presented to the system, the associated subjective experience is selected from the embedded neural-net proto-experiences. Alternatively, 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. 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 (Chalmers, 2003), 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 (Chalmers, 2003), panpsychism (Strawson, 2000, 2006), Hindu-Buddhist views (De & Pal, 2005; Pal & De, 2004; Rao, 1998, 2005; Sarasvati, 1974-89; Wallace, 1999, 2007), PE-SE framework (Bruzzo & Vimal, 2007; MacGregor & Vimal, 2008; Vimal, 2007, 2008b), and so on.

In H_1 , dual-aspect fundamental entities (that has material and mental aspects) and dual-aspect inert matter are the *carriers* of superimposed fundamental SEs/proto-experiences (PEs). In H_2 , the fundamental entities and inert matter are the *carriers* of superimposed fundamental PEs (not SEs), which are *integrated* by *neural-Darwinism* (co-evolution, co-development, and sensorimotor co-tuning by the evolutionary process of adaptation and natural selection). In H_3 , a string has its own string-PE; a matter is not a *carrier* of PE(s) in superposed form as it is in H_2 , rather it is a proto-experiential entity and has two aspects (material and mental) at every level. These two aspects are rigorously *integrated* together by *neural-Darwinism*. In H_1 , a specific SE is selected by the matching and selection processes and experienced by the related neural-network (Vimal, 2009b). In hypotheses H_2 and H_3 , a specific SE *emerges* in a neural-net from the interaction of its constituent neural-PEs, such as in feed-forward stimulus-dependent neural signals and fronto-parietal feedback attentional signals, in analogy to water *emerges* from the interaction of hydrogen and oxygen. In all three hypotheses, SEs *emerge/arise* when the necessary ingredients of SEs (such as wakefulness, attention, re-entry, working memory, stimulus at or above threshold level, and neural-net-PEs) are satisfied (Vimal, 2009d).

Abbreviations list

1T-physics : one time physics
2T-physics : two time physics
EPR : Einstein, Podolsky, and Rosenberg
LGN : lateral geniculate nucleus
MDR : mind-dependent-reality
MIR : mind-independent-reality
MT : microtubule
Mya : million years ago
NCC : neural correlates of consciousness
OR : objective reduction
Orch OR : orchestrated objective state-reduction
PE(s) : proto-experience(s)
R-G : Red-Green
SE(s) : subjective experience(s)
SQ : subquantum
TOE : Theory of Everything
V1 : visual area 1

In Part I (Vimal, 2009f) of current series, we unpacked the superposition of SEs/PEs of H_1 further using subquantum physics. While doing

that, we came across another type of explanatory gap. This 'Type-2 explanatory gap' arises at quantum and subquantum levels: how it is possible that some of our SEs (such as happiness, sadness, painfulness, and similar SEs) were already present in primal entities, whereas there is no shred of evidence that such SEs were conceived at the onset of universe.

In Part I (Vimal, 2009f) of this series, we extended hypothesis (H_1) of (Vimal, 2008b, 2009b) to address Type-2 explanatory gap. This resulted the following premises:

“(i) Fundamental entities and inert matter are the ‘carriers’ of superimposed irreducible/fundamental SEs/PEs (Vimal, 2008b),

(ii) a specific SE *occurs/arises* in a neural-net via matching and selection processes (Vimal, 2009b),

(iii) some of the SEs (such as happiness, sadness, and the like) that entails Type-2 explanatory gap can be derived from fundamental SEs/PEs (such as emotion-related PEs) and the stimulus-context (such as emotional stimuli), and

(iv) to eliminate any the residual gap in Type-2 explanatory gap, it is assumed that fundamental SEs/PEs follow the principle of the *emergence* of SE and anti-SE (or *bhutatma* and *anti-bhutatma*) in a dual-aspect vacuum at the onset of universe, in analogy to the principle involved in the *emergence* of matter and anti-matter in vacuum. In addition, the cycles of universe (that may have memory (Corichi & Singh, 2008)) might have preserved irreducible fundamental SEs/PEs in primal entities.

(v) SEs *occur/arise/emerge* when essential ingredients of SEs (such as wakefulness, attention, re-entry, working memory and so on) are satisfied” (Vimal, 2009f).

The premise (iv) will be hard to digest by most neuroscientists. To address this problem, we propose four alternative³ hypotheses: the

superposition-then-integration-emergence based H_2 , the *integration-emergence* based H_3 , and *intelligent mechanism* based H_4 , and *vacuum/Aether-based* H_5 in Section 2. We found that hypothesis H_3 has a number of problems including the combination problem and the restricted panpsychism problem, H_4 is too religious (entails successive never ending explanatory gaps), and H_5 is speculative (SEs and anti-SEs arise in a dual-aspect ethereal vacuum) and lacks evidence. In addition, a part of the hypothesis H_5 can be considered as a part of the hypothesis H_1 because some of the content and the rationale of hypothesis H_5 were used in the hypothesis H_1 to address the residual Type-2 explanatory gap (Vimal, 2009f). From the modern neuroscience point of view, hypotheses H_2 and H_3 are more interesting; however, they have their own problems that need further research. We concluded that, so far, the *superposition-based* H_1 is the most optimal working hypothesis (Vimal, 2008b, 2009b, 2009f) because it has the least number of problems.

2. Alternative Hypotheses to Address the Two Types of Explanatory Gaps

2.1. Superposition-then-integration-emergence based hypothesis H_2

In hypothesis H_2 , the fundamental PEs (not SEs) are superposed in the mental aspect of fundamental particles and inert matter; when neural-nets are formed, a specific SE *emerges* from the interaction between the stimulus dependent feed forward neural-PE signals and cognitive feedback neural-PE signals.

To investigate further, one could follow the idea of unification as in material entities (for example, all elementary particles can be derived from string, i.e., the unification of all four fundamental forces in strings is possible). In other words, all SEs might be unified into a single PE or superposed cardinal/fundamental PEs (not

³ Another quantum based alternative hypothesis is due to (Gao, 2008): “a unified theory of matter and consciousness includes two parts: one is the psychophysical principle or corresponding principle between conscious content and matter state, and the other is the complete quantum evolution of matter state, which includes the definite nonlinear evolution element introduced by consciousness and relating to conscious content. [...] The complete evolution may include three evolution terms: the first is the linear Schrödinger term as in the existing quantum theory, the second is

the stochastic nonlinear term resulting in the dynamical collapse of the wave function, and the last is the definite nonlinear term introduced by consciousness and relating to the concrete conscious content [which can change the energy distribution among the parts of the entangled system, but not the whole energy of the system]”. However, this view needs to address its problems as discussed in (Vimal, 2009b).

SEs) at string level. For example, since all colors can be psychophysically derived from three primaries: dominant long wavelength light ('red'), dominant middle wavelength light ('green'), and dominant short wavelength light ('blue') primaries. One could similarly argue that all color related SEs might also be derived from three cardinal color SEs (redness, greenness, and blueness). However, then one has to address why every color appears unique, fundamental, and irreducible (see below). In any case, the 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 pleasing 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 very large number (close to almost infinite if we include all animals as well) of SEs into fundamental PEs may be useful. In other words, we start from human SEs and investigate the unification into PEs in single cell bacteria,⁴ then to inert matter (such as salt, water, stone and so on) to fundamental entities (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 a string has dual-aspect: mental aspect in terms of the *carrier* of a unified PE and material aspect. In other words, the unified superposed string-PE co-evolved, co-developed, and co-tuned (*neural Darwinism*) with its material aspect into *emerged* SEs and their neural correlates in brain, respectively.

However, one could argue that although mixing 'red' and 'green' primaries at appropriate proportion leads to yellow appearing light (Vimal, Pokorny, & Smith, 1987), but yellowness is a unique SE and cannot be reduced to redness, greenness or their mixture. The same might be true for all SEs, i.e., it may not be 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 argue that a set of fundamental PEs (not SEs) superposed in the mental aspect of a string is possible in hypothesis **H₂**.

On the other hand, one could take the help of *emergence* principle of material world. For example, the physical property of salt (NaCl) *emerges* from the interaction of its constituents Na⁺ and Cl⁻ ions.⁵ In the same way, a specific SE, such as *redness*, can *emerge*⁶ in a neural-net

⁴ 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 (Falkner, Plaetzer, & Falkner, 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. Furthermore, since PE co-evolves with matter, PE (the mental aspect of an entity) is interdependent on the *structure* and *function* of material aspect of that entity. For example, the water-PE (liquidity/liquidness) is interdependent on the *structure* and *function* of the liquid water, ice-PE (solidity/solidness) on that of ice, steam-PE on that of steam. Similarly, the SE redness is interdependent on the *structure* and *function* of redness-related V4/V8/VO Red-Green neural-net and somehow *emerges* during the interaction of two types of signals (feed forward and feedback neural signals). SEs/PEs are irreducible but they are *emergent* entities in hypothesis **H₂**; in this sense, they are fundamental entities; at the same time they are reducible to their constituents in the sense that if their constituents are combined or interacted in a specific way, they (SEs/PEs) *emerge* from their constituents. This apparent contradiction has caused a great deal of confusion between reductionists and non-reductionists views.

⁵ 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 ..." (Mandel, 2008).

⁶ 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 Darwinism*). 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 the *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* 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

from the interaction of its constituent neural-PEs in the 'V4/V8/VO' color neural-net.⁷ For example, the reportable SE *redness* might have *emerged* during the interaction of two types of signals: (i) the feed forward long wavelength (say 650 nm) stimulus dependent PE-carrying-neural-signal from retina to LGN (lateral geniculate nucleus) to V1 to V4/V8/VO color area (call it FF_{650}) and (ii) the feedback fronto-parietal attention related re-entrant PE-carrying-neural-signal (call it FB), i.e., the *redness* related to 650 nm light is $SE_{redness_{650}} = (FF_{650}) * (FB)$, in analogy to $NaCl = (Na^+) * (Cl^-)$. Another analogy is water *emerges* from the interaction of hydrogen and oxygen; water is entirely new entity that is not in any way the sum of its parts. This is consistent with Schier, who argued, "the colour visual facts are structurally emergent" (Schier, 2007). However, the mind-dependent-reality (MDR) vs. the mind-independent-reality (MIR) (Müller, 2007a) and how they are related to SEs need to be addressed. It should be noted that $FF_{650} = \sum \alpha_i (FF_{650})_i$ and $FB = \sum \beta_k (FB)_k$ where i and k represent i^{th} and k^{th} neural-signal, and α and β are weighting factors; for non-reportable phenomenal SE, $FB = 0$.

Furthermore, in the hypothesis H_2 , fundamental entities and inert matter are the *carriers* of superimposed fundamental PEs only (not SEs); whereas SEs are excluded even in superimposed and *carrier* form to deflate Type-2 explanatory gap. The hypothesis H_2 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 fundamental entities *emerged* from the interaction of PEs of relevant constituents by the same reasoning as the entity salt (NaCl) *emerged* from the interaction of 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 'superposition' until neural-nets are formed and then 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. It is a different story if this assumption is correct or not because experimental evidence is lacking. The hypothesis H_2 follows the principle of superposition of PEs (not SEs) to escape from Type-2 explanatory gap of H_1 and from the problems of panpsychism (Vimal, 2009e). H_2 then follows the principle of *integration* via evolution (from string to neural-net) and the principle of *emergence* (a specific SE *emerges*) to deflate the Type-1 explanatory gap of materialism because SEs *emerged* from PEs (mental aspect), not from non-experiential material aspect. However, a gap still remains because one has to address precisely how SEs can *emerge* from PEs (call it **Type-1a explanatory gap**). The matching and selection mechanisms of H_1 may still be useful because the matching (interaction) and *emergence* processes will lead to the *emergence* of SEs that would be embedded in related neural-network as memory-traces during *neural Darwinism*. Later when old stimulus is presented the related specific SE is selected from the embedded SEs after matching. Thus, the *emergence* process will be used for novel stimuli and the selection process for old stimuli. The matching process will always be used in all hypotheses. H_2 is somewhat closer to the current trend in neuroscience. Thus, the hypothesis H_2 addresses both Types 1 and 2 explanatory gaps; in addition, unlike the hypothesis H_1 , the extension of quantum physics to subquantum field is not needed. However, one could still argue that how precisely SEs *emerge* from PEs and hence need to address the Type-1a explanatory gap, whereas we know how salt and water *emerge* from their constituents.

mind-brain problem because it will be less 'brute emergence' than that from non-experiential matter.

⁷ The color area 'V8/V4/VO' refers to visual area V8 of Tootell-group (Hadjikhani, Liu, Dale, Cavanagh, & Tootell, 1998; Tootell, Tsao, & Vanduffel, 2003), visual area V4 of Zeki-group (Bartels & Zeki, 2000), and VO of Wandell-group (Wandell, 1999); they are the same human color area (Tootell et al., 2003). VO is ventral-occipital cortex.

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 *emergence*, see also (Sompolinsky, 2005; Sperry, 1981)).⁸ For example, the saltiness of sodium chloride is not present in sodium or chlorine. Similarly, SE *redness emerges* in V4/V8/VO-neural-net whereas this SE may not be present in any of the neurons of the neural-net.

Furthermore, one could argue that the various colors can be derived from the three primaries that appear as 'red', 'green', and 'blue' to trichromats by the method of combination or color mixing (Vimal et al., 1987).⁹ For example, 'yellow' appearance is due to the combination of 'red' and 'green' primaries, 'purple' appearance

is due to the combination of 'red' and 'blue' primaries, and cyan appearance is due to the combination of 'green' and 'blue' primaries. However, it is not clear that SEs related to above color appearances follow similar color-mixing principle; most likely they do not because each SE appears irreducible and fundamental entity. But, it can be argued that these color SEs are *emerged* entity in the hypothesis H₂ as explained above; but precisely how is not clear (Type-1a explanatory gap).

To address this mysterious *emergence* problem, we may need to investigate how color vision evolved (Bowmaker, 1998; Jacobs & Rowe, 2004) or in general how consciousness evolved (Merker, 2005). At any rate, if we cannot solve this mystery, then we cannot reject one of the standard straightforward materialist *identity* view: 'SEs are simply the neural activity in neural nets', which eliminates the *emergence* phenomenon (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 (*neural Darwinism*). However, a question still haunts, for example, from where the SE *redness* appeared that was assigned to neural activity of red-green V4/V8/VO-neural-net by natural selection. This is partly addressed in (Vimal, 2008b). As MacGregor commented (personal communication), 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. To sum up, simply assuming that the *emergence* of SEs is similar to the *emergence* of water and salt may not be satisfactory because it is still mysterious. We really need to address 'precisely how SEs *emerge* from PE(s)' in hypothesis H₂ (the Type-1a explanatory gap), in the same way as done in hypothesis H₁ (a specific SE is selected and

⁸ Jordan and Ghin propose (proto-)consciousness as a contextually emergent property of self-sustaining systems (Jordan & Ghin, 2006). The concept of contextual emergence is 'a non-reductive, yet well-defined relation between different levels of description of physical and other systems', such as 'the relation between neurobiological and mental levels of description' (Atmanspacher, 2007). Their framework and also all materialistic frameworks, such as (Crick & Clark, 1994; Edelman, 1989; O'Regan & Noë, 2001; Thompson & Varela, 2001), are valid only if the PE-SE framework (Vimal, 2008b) is accepted in a complementary way. Otherwise they all fail to address Type-1 explanatory gap: how subjective experiences (such as redness) can emerge from matter (such as self-sustaining cerebral neural-nets). The six classifications (Type A-F) of various views by (Chalmers, 2003), summarized in (Vimal, 2008b), have been passionately discussed over 6000 years since RigVedic period. There are 3 entities that need to be addressed and linked: *structure*, *function*, and *experience*. If PE-SE framework (Vimal, 2008b) is ignored then materialistic frameworks can address only *structure* and *function*; they will never be able to address SEs. There is no way out, but to accept the dual-aspect-dual-mode PE-SE framework with hypothesis H₁ because this has the least number of problems compared to other views. In dual-aspect view, the concept 'causality' is paired with 'physical', but 'physical' includes PE/SE; so both aspects are causally closed. In materialism, however, 'physical' does not include PE/SE and hence causality is paired with 'material', i.e., material world is causally closed and PE/SE is mere epiphenomenon. Furthermore, Theory of Everything (TOE) must address consciousness, i. e., the unification/integration of SE/consciousness with string theory might be useful, in my view. In this way the term 'physicalism' is broadened to include PE/SE, whereas the term 'materialism' can still be used the way it always has been, i.e., physicalism = materialism + PE/SE.

⁹ Trichromats and achromats have different SEs for the same stimuli. For example, an achromat reported that his world is shade of black, white and grey: "I experience the colour called red as a very dark grey, nearly black, even in very bright light. On a grey-scale the blue and green colours I see as mid-greys, somewhat darker greys if they are saturated, somewhat lighter greys when unsaturated, like pastel colours. Yellow is usually a rather light grey to me, but is usually not confused with white. Brown usually appears as a dark grey and so does a very saturated orange." (Nordby, 1996).

experienced in the related specific neural-network by the matching and selection process, precisely and rigorously (Vimal, 2008b, 2009b)).

2.2. Integration-emergence based hypothesis H_3

In hypothesis H_3 , as physical aspect (such as mass, charge, spin, and space-time) of an entity evolves, the mental aspect (its PE) also evolves, i.e., they co-evolve. In other words, it follows the principle of *integration* from elemental level to neural-net level. In every level of co-evolution, an entity has its own specific PE obtained from the integration of its constituent PEs leading to the *emergence* of a specific PE/SE via co-evolution and *neural Darwinism*, for example, elemental-PE, atomic-PE, molecular-PE... genetic-PE, neural-PE, neural-net PE, and eventually a specific SE. However, the hypotheses H_2 and H_3 have *combination problem*: “how low-level proto-experiential and other properties somehow together *constitute* our complex unified conscious experiences” (Chalmers, 1997; Seager, 1995), i.e., how a specific SE can *emerge* from the PEs of constituent elements in a related neural-net. This is addressed by using the principles of *integration*, *emergence*, and *neural Darwinism* (co-evolution, co-development, and sensorimotor co-tuning), in analogy to that of matter. The hypothesis H_3 is close to proto-experientialism and proto-panpsychism view (Type-F view: (Chalmers, 2003)) and is a dual-aspect panpsychism. H_3 has at least the following problems in addition to the ‘combination problem’, (Seager, 1995; Vimal, 2008b, 2009e): (i) The ‘**unconscious mentality problem**’ is “accepting the mentality of the elemental units of mind while denying that they are actually conscious experiences” (Seager, 1995). (ii) The ‘**completeness problem**’ is that the inert system should also show sometime causal power of proto-experiences, which is not the case; this leads to incompleteness of physical picture of world. (iii) The ‘**no sign problem**’ is, “there is no evidence whatsoever of a nonphysical dimension to the elemental units of nature” (Seager, 1995) and there is no ‘sign’ of mentality in the basic features of the world. (iv) The ‘**not-mental problem**’ is “if there was some feature of these

units we chose to label as ‘mental’, what possible ground could one provide to justify this label” (Seager, 1995). (v) **Restricted panpsychism problem**: “Quantum thermofield dynamics does in fact prescribe a lower boundary below which there can be no cooperative dynamics, and without cooperative dynamics there is nothing mind-like [...] If qualia were tied to the coherence of cooperative dynamics, then the descent into panpsychism would halt at the coherence length [of about 50 microns]” (Globus, 2009). Other problems of panpsychism and H_3 are discussed in (Vimal, 2009e).

The hypothesis H_2 falls between H_1 and H_3 . H_2 follows the principle of *superposition* of PEs (not SEs) to escape from Type-2 explanatory gap of H_1 and to avoid the above problems of H_3 . H_2 then follows the principle of *integration-emergence* (as in H_3) to address the Type-1 explanatory gap and be closer to the current trend in neuroscience. This is because the *superposition* part of H_2 bypasses the above problems and the *integration-emergence* part is closer to the *emergence* of materialism (null hypothesis H_0). However, a specific SE *emerges* from the interaction of neural-PEs in the mental aspect of activities in feed forward and feedback pathways in H_2 and H_3 (have Type-1a explanatory gap: how SEs can *emerge* from PEs) whereas a specific SE *emerges* from the interaction of non-experiential material activities in those pathways in H_0 (has Type-1 explanatory gap: how SEs can *emerge* from non-experiential matter). In all hypotheses including materialistic *emergence* (H_0), SEs *emerge/arise* when *essential* or *necessary* ingredients of SEs (such as wakefulness, attention, re-entry, working memory, stimulus at or above threshold level and neural-net PEs) are satisfied (Vimal, 2009d).

To sum up, “from a dual-aspect perspective, one can envisage a variety of possible relationships between objective aspects of matter, proto-experience (PE) and subjective experience (SE) – see (Vimal, 2008b) and also (Vimal, 2008a, 2009b). Matter may be the *carrier* of both PEs and SEs (Vimal, 2008b); or it may *carry* PEs only, with *emergence* of SEs in the course of neural evolution (Vimal, 2009d, 2009f,

2009g); or the three may be ontologically inseparable (Vimal, 2009g) though possessing different epistemic aspects. [...] This framework is a *non-reductive physicalism*, (where *physicalism* = materialism + *experience*)” (Vimal, 2009c). Therefore, the triad (*structure, function, and experience*) can be better addressed in the PE-SE framework. In this framework, it seems that zombie cannot be created because once a creature is (*molecule-by-molecule*) identical with us, it will have SEs like us when the *necessary* ingredients of having SEs (such as wakefulness, re-entry, attention, memory, stimulus above threshold, and neural-net PEs) are satisfied (Vimal, 2008b, 2009d).

2.3. Hypothesis related to cosmic-consciousness, subquantum field, RigVedic-Buddhist primordial consciousness, Universal Mind and Supreme Unified Consciousness

2.3.1. Hypothesis (H₄): To address Type-2 explanatory gap, one could postulate an ‘intelligent mechanism’, such as cosmic-consciousness (Schäfer, 1997, 2006), subquantum (SQ) field (Boyd & Klein, 2007) based on Bohm’s Implicate Order (Bohm, 1983), RigVedic-Buddhist primordial consciousness, unitary dimension of fundamental reality, Supreme Unified Consciousness, unified quantum field, or Universal Mind (De & Pal, 2005; Lepine, 2008; Pal & De, 2004; Rao, 1998, 2005; Sarasvati, 1974-89; Wallace, 1999, 2007). This mechanism might entail the dual-aspect subquantum primal entities (such as *bhutatmas*), each with a specific SE, which are then superimposed in string (Vimal, 2009f). However, this view may lead to successive never ending explanatory gaps: from where and how that the ‘intelligent mechanism’ *arose/emerged*; how He can be omnipresent, omnipotent and omniscient; who created Him; if this mechanism is continuum then how this happened and so on.

According to (Lepine, 2008), “In Buddhism the deeper-lying monistic entity is the pure wisdom of the Supreme Unified Consciousness which can give rise to matter and/or mind. In scientific terms it is the quantum geometry at the tiniest level (Planck scale) of the universe, which is called the unified quantum

field.” According to (Bohm, 1990), “As with electric and magnetic fields, the quantum field can also be represented in terms of a potential which I call the quantum potential. But unlike what happens with electric and magnetic potentials, the quantum potential depends only on the form, and not in the intensity of the quantum field. Therefore, even a very weak quantum field can strongly affect the particle. [...] It seems clear from all this that at least in the context of the processes of thought, there is a kind of active information that is simultaneously physical and mental in nature. Active information can thus serve as a kind of or ‘bridge’ between these two sides of reality as a whole. These two sides are inseparable, in the sense that information contained in thought, which we feel to be on the ‘mental’ side, is at the same time a related neurophysiological, chemical, and physical activity (which is clearly what is meant by the ‘material’ side of this thought). [...] From the mental side, it is a potentially active information content. But from the material side, it is an actual activity that operates to organize the less subtle levels, and the latter serve as the ‘material’ on which such operation takes place. Thus, at each level, information is the link or bridge between the two sides. [...] quantum potential may be regarded as information [...] the quantum potential constitutes active information that can give form to the movements of the particles [...] At each such level, there will be a ‘mental pole’ and a ‘physical pole’. Thus as we have already implied, even an electron has at least a rudimentary mental pole, represented mathematically by the quantum potential. Vice versa, as we have seen, even subtle mental processes have a physical pole. But the deeper reality is something beyond either mind or matter, both of which are only aspects that serve as terms for analysis [...] These can contribute to our understanding of what is happening but are in no sense separate substances in interaction. Nor are we reducing one pole to a mere function or aspect of the other (e.g. as is done in materialism and in idealism).” This seems to imply that ‘information’ has two aspects: material and mental. Compare this with string or elementary particles have two aspects: material (mass,

charge, spin, spacetime) and mental (such as SEs/PEs) (Vimal, 2008b). If both are correct, 'string or elementary particles' are 'information'. (Chalmers, 1995) has also used the term 'information' in a dual-aspect sense.¹⁰

The framework of (De & Pal, 2005; Pal & De, 2004) is mostly Hindu-Buddhist idealism: matter—such as bosons being thought carrying particle (TCP) and fermions being thought retaining particle (TRP)—*emerges* from Universal Mind (UM). It has the explanatory gap opposite to the 'Type-1 explanatory-gap': how non-experiential matter can *emerge* from experiential mind,¹¹ and from where and how Universal Mind arose/existed. Speculating that UM always exists does not deflate these gaps. One has to precisely show how the material entity such as 'V4/V8/VO-redness-related neural-net' *emerges* from its associated mental entity/subjective experience (SE) 'redness' or from UM in their TCP-TRP framework, in analogy to what we have done in our dual-aspect-dual-mode PE-SE framework (Vimal, 2008b, 2009b). On the other hand, materialism must address how mind *emerges* from matter. 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 (*Lokāyata* or *Cārvāka* view: (Feuerstein, 2002)(p.96), (iii) dualism: mind and matter on equal footing and can exist independently but can interact via *manas* somehow as in Eccles' mind-brain liaison/interface (Beck & Eccles, 1992), (iv) dual-aspect/neutral-monism: 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" (McQueen, 2008). 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 (De & Pal, 2005; Pal & De, 2004) arguments are remarkable in this respect. However, they should clearly differentiate eastern term '*manas*'¹² 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 includes consciousness (Vimal, 2009e). It would be better argument for their articles (De & Pal, 2005; Pal & De, 2004) 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.

According to Dalai Lama, (i) since a phenomenon can arise from similar phenomenon and since consciousness is radically different from non-experiential matter (mass-energy), "consciousness can arise only from a continuum of phenomena similar to itself, in the same way that formations of mass-energy give rise to formations of mass-energy"; (ii) Buddhist framework argues for beginningless continuum of consciousness (or sentient beings) and presumably beginningless continuum of matter ("The origin or substantial cause of the first matter in this universe was preceding matter"); and (iii) "evolution of the physical universe as intimately interdependent with the

¹⁰ "Sometimes a system is said to be conscious of some information when it has the ability to react on the basis of that information, or, more strongly, when it attends to that information, or when it can integrate that information and exploit it in the sophisticated control of behaviour. [...] The basic principle that I suggest centrally involves the notion of *information*. I understand information in more or less the sense of Shannon (Shannon, 1948). Where there is information, there are *information states* embedded in an *information space*. [...] information (or at least some information) has two basic aspects, a physical aspect and a phenomenal aspect. [...] Experience arises by virtue of its status as one aspect of information, when the other aspect is found embodied in physical processing" (Chalmers, 1995).

¹¹ Both the idealism and the materialism make category mistake (Feigl, 1981; Vimal, 2009b) between mental and material aspects.

¹² They ((De & Pal, 2005; Pal & De, 2004)) did not use it, they used the term 'mind' instead but see (Rao, 1998, 2005).

sentient beings who inhabit and experience the external world” (Luisi, 2008). This argument is a form of (substance) dualism and hence one has to address the problems of dualism, even though it appears to bypass the explanatory gap of Type-2. The problems of (substance) dualism are as follows (Vimal, 2009e): (i) **Association or mind-brain interaction problem**: how does the non-material mind interact with the brain, i.e., how to associate redness with red-green cells of V4/V8/VO neural-net; this is a problem of unexplained epistemic gap: how is the jump made from the mental entity redness to material entity V4/V8/VO neural-net (and vice versa). (ii) **Problem of mental causation**: how can a mental cause give rise to a behavioral effect without the violation of the conservation of energy and momentum? (iii) **‘Zombie’ problem**: Dualism “allows us to subtract the mind from the brain while leaving the brain completely intact. This possibility implies an “epiphenomenalism” that claims that mind does not matter, that it makes no difference what happens in the world, because it does not cause behavior. My zombie twin behaves just like me but it has no mind at all.” (Eerikäinen, 2000) (iv) **‘Ghost’ problem**: It is “the converse of the zombie problem. If the mind is separate from the body, then not only can the brain exist without the mind but also the mind can exist without the brain. Thus, the so-called “disembodiment” becomes a real possibility” (Eerikäinen, 2000). According to Buddhist centrist framework (Wallace, 1989), “Our thoughts, intentions, and emotional states maneuver our bodies and thereby other physical objects; likewise, material things are constantly influencing our mental states. [...] Both subject and object exist in interdependence, both are evident to experience, and the distinction between them is conventional, not intrinsic. [...] Physical and mental events occur in mutual interaction and are therefore interdependent. Thus, neither can be considered absolute in the sense of being independent; nor is one more real than the other. [...] We thereby accept a dualism of a conventional sort, not of an absolute, Cartesian variety. [...] Mental states arise from previous mental states in an unbroken continuum, much as physical entities

arise from preceding physical entities. [...] Indeed, it may be more accurate to think of a single entity—the continuum—bearing physical and mental attributes [this seems like a dual-aspect view]. It is at this level that the duality of physical and mental events disappears. [...] Modern neuroscience regards human sensory and mental cognitions as being emergent properties of the brain. Buddhist contemplative science, in contrast, regards them as emergent properties of the very subtle energy/mind”. Perhaps Buddhist centrist framework (Wallace, 1989) does not contradict our dual-aspect PE-SE framework with ‘property dualism and substance monism’ because consciousness can arise from the mental aspect of primal entities. The difference is that matter is the *carrier* of PEs/SEs in the PE-SE framework, as in hypotheses H₁ and H₂. Wallace (personal communication, 6-Feb-2008) commented, “*Mahayana* Buddhism, especially in accordance with the *Madhyamaka* view, rejects the substantial nature of all phenomena, so it does not accept a substance dualism between body and mind along the lines proposed by Descartes. As I have argued in my book (Wallace, 2007), Buddhism as a whole asserts the existence of a ‘form realm’ (*rupa-dhatu*) that exists prior to and at a more fundamental level than our human conceptual constructs of ‘mind’ and ‘matter’. On a deeper level, *Vajrayana* Buddhism asserts the existence of ‘absolute space of phenomena’ (*dharma-dhatu*), which transcends all conceptual categories, including those of mind and matter. So that view, too, rejects any notion of substance dualism in favor of aspect dualism similar to what you propose.” Thus, Buddhist centrist framework (Wallace, 1989) does not contradict the dual-aspect PE-SE framework.

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 the 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 [(Vimal, 2007)]. 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 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 Subquantum (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 H₂ and H₃. Since hypothesis H₄ may entail successive never ending explanatory gaps, it is beyond the scope of current proposal and is not elaborated further.

2.3.2. Hypothesis (H₅): This hypothesis is the extension of the principle of the *emergence* of SE and anti-SE (or *bhutatma* and *anti-bhutatma*) in a dual-aspect 'vacuum or *Aether*' at the onset of universe discussed in the Part I of this series (Vimal, 2009f). According to (Duchesne, 2008),

"Aether is the empty space on which the Universe sits. Empty space is real but does not exist as matter, right? Einstein was right, the Universe is background free. The Aether does not exist, yet, it is the physical but immaterial substance from which the Universe emerged. [...] Einstein's aether [(Einstein, 1920)] is the seat to an all relating process which he called spacetime. [...] the Aether has no capacity to hold any information, just qualities which are used by active information as energy is turned into quantities, or quantized, in spacetime [...] Aether is the physicalists' God."

According to (Einstein, 1920), "Thus the endeavour toward a unified view of the nature of forces leads to the hypothesis of an ether. *...More careful reflection teaches us, however, that the special theory of relativity does not compel us to deny ether.* [...] We may assume the existence of an ether, only we must give up ascribing a definite state of motion to it, i.e. we must by abstraction take from it the last mechanical characteristic which Lorentz had still left it. [...] *Mach's idea finds its full development in the ether of the general theory of relativity.* [...] According to the general theory of relativity space without ether is unthinkable; for in such space there not only would be no propagation of light, but also no possibility of existence for standards of space and time (measuring-rods and clocks), nor therefore any space-time intervals in the physical sense. But this ether may not be thought of as endowed with the quality characteristic of ponderable inedia, as consisting of parts which may be tracked through time. The idea of motion may not be applied to it."

If everything *emerges* from the vacuum and empty space, such as Aether, then SEs can also *emerge* whenever they are needed. This is possible if matter + antimatter = vacuum/empty space and if SE + anti-SE = vacuum/empty space (mental aspect). This seems to imply that the ethereal 'vacuum/empty space' also has dual-aspect. Can complementary SEs such as color SEs redness and greenness or emotional SEs happiness and sadness be considered as SE and anti-SE with respect to each other (if redness is SE then greenness is its anti-SE and *vice-versa*), respectively? The answer is not clear because

the equal mixture of 'red' and 'green' primaries appears yellow color to trichromats, i.e., they do not annihilate each other as the combination of SE and anti-SE are supposed to do. However, although mixing "matter and antimatter would lead to the annihilation of both in the same way that mixing antiparticles and particles does," this gives "rise to high-energy photons (gamma rays) or other particle". In analogy to this, one could argue that the equal mixture of 'red' and 'green' primaries leads to the appearance of yellow color (neither red nor green) to trichromats, i.e., they indeed annihilate each other, but it gives rise to the SE yellowness. This is in analogy to giving rise to gamma rays when mixing electron and antielectron (positron) leads to annihilation of each other. If it were true, matter and SEs can be created any time during evolution as needed. For example, when for the first time red-green color opponent neural-net was formed, SEs 'redness' to 'greenness' could have *emerged* from Aether, perhaps, during Cambrian explosion about 540 million years ago (Mya) (Hameroff, 1998a). Then, the *neural Darwinism*, and the matching and selection processes (Globus, 1998; Globus, 2005; Vimal, 2009b) may have embedded SEs in respective neural nets. This information could have been eventually coded in DNA. This is our hypothesis H₅. This hypothesis is interesting because it reduces the load (on evolution) of *carrying* superposed SEs/PEs in strings or elementary particles since the birth of universe as in hypothesis H₁. This is the main difference between hypotheses H₅ and H₁. In other words, we have assumed that SE-antiSE pairs are created at the onset of universe in hypothesis H₁; whereas they are created whenever need arises in hypothesis H₅, perhaps during Cambrian explosion about 540 Mya or during the interaction between the stimulus dependent feed forward signals and the cognitive feedback signals in a neural-net for novel stimuli. The problem with the hypothesis H₅ is that the statement "everything *emerges* from Aether" awaits validation, and H₅ is close to the substance dualism that has a number of problems as discussed in Section 2.3.1. In addition, hypotheses H₄ and H₅ have common problems that they are speculative and lack

evidence. The hypothesis H₃ is a dual-aspect panpsychism, which is respectable metaphysical view (Skrbina, 2003; Skrbina, 2005; Skrbina, 2009a, 2009b), but it has a number of problems as summarized in (Vimal, 2009e), especially the well-known and well-criticized combination problem and the restricted panpsychism problem. Therefore, hypotheses H₃-H₅ will not be discussed further.

2.4. The two competing hypotheses: the superposition based H₁ and the superposition-then-integration-emergence based H₂

As discussed above, hypotheses H₃-H₅ have significant problems. Therefore, to address Types 1 and 2 explanatory gaps, we now have only two competing working hypotheses (H₁ and H₂) in the PE-SE framework:

(1) The hypothesis H₁ includes (a) the concept of fundamental and derived SEs/PEs, (b) the fundamental SEs/PEs being superimposed in fundamental entities (Vimal, 2008b), (c) fundamental entities and inert matter are *carriers* of fundamental SEs/PEs (Vimal, 2008b), (d) the *neural Darwinism* generates a specific SE and embedding process embeds it in a neural-net, and the matching and selection processes select it based on external/internal stimulus (Vimal, 2008b, 2009b), and (e) the cycles of universe preserve irreducible fundamental SEs/PEs in primal entities, and/or the fundamental SEs/PEs follow the principle of the *emergence* of SE and anti-SE (or *bhutatma* and *anti-bhutatma*) in a dual-aspect vacuum/Aether at the onset of universe, which is similar to the principle involved in the *emergence* of matter and anti-matter in a vacuum (Vimal, 2009f). In the premise (d), the embedding process and the selection process involve *neural Darwinism* for generating specificity as discussed in (Vimal, 2008b, 2009d). The premises (a)-(d) address Types 1 explanatory gap, and the premise (e) closes Type-2 explanatory gap.

(2) The alternative hypothesis H₂ suggests that (a) each fundamental entity or inert matter is a *carrier* of one 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. In other words, all SEs can be considered as fundamental mental entities because they *emerge* from the interaction of their constituent neural-PEs, which in turn *emerge* from their constituent PEs, and so on. The important question is precisely how SEs *emerge* from PEs. Perhaps, one of the most important leads is that our brains possess a hierarchical structure from elementary particles (such as electrons in electric signal and ions across neural-membrane) to neural-nets, and it is possible for PEs to result SEs via *emergence* process by **functional integration** of such structures (Chauvet, 1996). This leads to the important point that the PE \rightarrow SE *emergence* is possible in neural-nets. However, one could still argue that the explanatory gap is not completely deflated because it is still not clear how precisely a specific SE can *arise/emerge* from PEs in hypothesis H₂; this is called Type-1a explanatory gap (Section 2.1). Therefore, so far, the dual-aspect-dual-mode PE-SE framework with hypothesis H₁ is the most optimal framework because it has the least number of problems.

2.5. Other relevant models

The PE-SE framework is sympathetic to two other models: (1) The *emergence* mechanism can be unpacked by assuming that SEs might arise by the process of chaotic self-organization¹³ of brain to cope with its environment during co-evolution and co-development (see also (Bruzzo & Vimal, 2007)); 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.

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 seems to assume all types of SEs as Platonic values embedded in spacetime geometry (Hameroff, 1998b). (ii) Then one can assume that V4/V8/VO color related neural-net has all types of color SEs superimposed in it. (iii) In addition, one can assume that specific SE say redness related V4/V8/VO neural-net state is assigned to SE redness. In that way, evolution will have less load to co-evolve from elemental level. This is an interesting idea and needs further research; however, it is closer to dualism, which has the problem of association or mind-brain interaction and the mental causation problem as discussed in Section 2.3. This is also a sort of an explanatory gap because it needs explanation in dualistic framework. However, (Hameroff & Powell, 2009) defend neutral monism "[q]uantum spacetime geometry is the neutral reality, and Penrose OR is the psycho-physical bridge", which is somewhat consistent with a dual-aspect view. Thus, so far, the dual-aspect-dual-mode PE-SE framework with hypothesis H₁ appears to be the optimized solution.

One could argue that the 'emergent property' can be unpacked in terms of localized inherent property: all fundamental SEs/PEs are superimposed in fundamental and/or higher level entities. The problems 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 they are assigned. The 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. Furthermore, without essential ingredients (such as wakefulness, re-entry, attention, working memory, stimulus at

¹³ 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.

above threshold, and neural-net PEs) (Vimal, 2009d), SEs would fail to occur even if there is objective reduction (OR) in MT network. Therefore, there is a causal link: for example, when long wavelength light is presented then only redness *emerges*, ignoring phosphenes (Bókkon & Vimal, 2009; Vimal & Pandey-Vimal, 2007) and the context dependent color experiences. Dichotomies (McCrone, 2006) (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 (such as in the stimulus duration of 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). The Orch OR framework, the PE-SE framework, and the 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 ideas: "(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 mind-independent reality (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, $MDR = MIR + SEs + \text{subjective biases} \sim MIR + SEs$, when subjective biases are close to zero; note that observer is always present. It is almost impossible to know MIR; this is consistent with (Kant, 1929)(p.286): "A thing can never come before us except in appearance". However, one wonders whether it is possible to transform the conclusions drawn in MDR frame of reference to MIR by some subject-based transformation rule. The SE liquidness of water is MDR. However, the liquid water *emerges* from the interaction of water molecules, which depends on (a) "physical properties of a water molecule", (b) "the angulation of its atoms", and (c) "its likelihood of forming bonds with other molecules" (Goldberg, 2009)(p.37). This is closer to MIR.

Furthermore, Jaspers' statement "we are in the encompassing and we ourselves are the encompassing" (Jaspers, 1948/1991) needs elaboration and interpretation in the 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 and other subjects. Similarly, I am also objects for other conscious entities such as other conscious human beings and conscious animals that satisfy the essential ingredients (wakefulness, re-entry, attention, stimulus at above threshold, working memory, and neural-net PEs (Vimal, 2009d)) 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 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) (Humphrey, 2000); this animal detects the red light and makes a characteristic wriggle of activity; this behavior may be considered as its PE. According to (Müller, 2008), "Matter is a structure that crystallizes within mind". This can be unpacked using the PE-SE framework (Vimal, 2008c). 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 retinal, LGN, V1, V2 to visual cortical areas such as V4/V8/VO 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 (say, reflected in gamma synchrony). When essential ingredients (wakefulness, re-entry, attention, stimulus at above threshold, working memory, and neural-net PEs (Vimal, 2009d)) of SE are satisfied in neural-nets, SE of 'objects and subject' *emerges*, i.e., "matter crystallizes within mind" via two complementary mechanisms (Vimal, 2008b, 2009d): (i) via classical axonal-dendritic mechanism, 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 PEs

What are the proto-experiences (PEs), exactly? PEs are those experiences that are not *expressed*-SEs. The *expressed*-SEs are those experiences that satisfy the essential ingredients (wakefulness, attention, reentry, working memory, stimulus above threshold) of SE, and that are *expressed* (i.e., that are not latent or covert or unexpressed). In hypothesis H₁, we have defined that elemental-PEs are all types of irreducible/fundamental unexpressed-SEs/PEs superimposed in fundamental entities. For example, the SEs (redness, greenness, and

blueness) related to primaries ('red', 'green', and 'blue') should be included in the list because they are primary SEs and appear irreducible/fundamental SEs.¹⁴ 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 for minimizing the burden on evolution and matter because they are *carried* by inert matter over billions of years. Further investigation is needed to list all fundamental SEs.¹⁵

In hypothesis H₂, a PE is specific to a specific fundamental entity or inert matter. There are PEs at every step of evolution and development, such as inert matter as the *carrier* of PE (such as string-PE, a PE for a fermion such as electron-PE, a 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

¹⁴ According to (Robbins, 2007), "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. [...] 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."

¹⁵ 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 (Vimal, 2008b, 2009b).

gorillas, and neural-PEs and neural-net-PEs in humans.

One could also argue that a non-experiential inert matter is simply the *carrier* of SEs as in for hypothesis H_1 or the *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 for generating SE, PEs are expressed as SEs. For example, these *carrier* type PEs might be expressed into organism-PEs for the first time about 600 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* (Lamb et al., 2007); perhaps, 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, the two attributes (intensity and wavelength) of light are transduced into the single attribute (amplitude) of electrical signals by the phototransduction process using the univariance principle. 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. In other words, there are L-cone-related-neural-PEs and M-cone-related-neural-PEs. One can proceed further with similar analysis in visual pathways until the Red-Green (R-G) opponent channel is formed in the R-G V4/V8/VO-neural-net with associated embedded neural-net PEs. Since we do not yet know exactly how color SEs *emerge*, it would be safe to state that they might *emerge* from the interaction between (a) feed forward signals related to stimuli (such as light reflected from objects) that activate photoreceptors, retinal, LGN, and cortical areas, (b) feedback signals related to cognition, and (c) signals related to 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 $E = hv = hc/\lambda$ may have information related to color-PEs, where h is Planck's constant, and v , 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, (Byrne & Hilbert, 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 (Chalmers, 2003). However, satisfactory evidence is lacking for these speculations.

In the PE-SE framework, strings, bosons (such as photons, gravitons), fermions (such as electrons), and inert matter are the *carriers* of fundamental SEs/PEs in unexpressed form. If we expand the definition of PEs,¹⁶ and if we interpret the interaction between feed forward and feedback signals in hypothesis H_2 as necessary condition for *neural Darwinism*, and embedding, matching, and selection processes as in hypothesis H_1 , then hypothesis H_2 will be closer to hypothesis H_1 . Further research is needed to investigate if both competing working hypotheses (H_1 and H_2) can be integrated.

3. Conceptual Analysis and Philosophical basis for Hypothesis H_2

3.1. Conceptual analysis for hypothesis H_2

Consider the following premises related to hypothesis H_2 , where (1) is conceptual analysis and (2.1)-(2.9) are scientific explanations for

¹⁶ SEs are those experiences that arise when the essential ingredients of SEs (wakefulness, attention, re-entry, working memory, stimulus at above threshold, and neural-net-PEs) are satisfied (Vimal, 2009d). In other words, some experiences at various levels may fall under PEs, such as experiences during drowsiness, dream, subconscious level, change blindness (Beck, Levin, & Angelone, 2006), motion-induced blindness (Bonneh, Cooperman, & Sagi, 2001), driving but attention is on conversation, wriggles in primitive amoeba-like animal (Humphrey, 2000), and so on. Experience during thinking without SEs could be considered as PEs of thoughts, which could be two types: (i) fast, implicit, and unconscious and (ii) slow, explicit, and conscious thoughts (Carruthers, 2006; Evans & Over, 1996; Stanovich, 1999).

experiencing redness. This does not need subquantum extension as needed for H_1 .

(1) Redness is a SE of a 'red-color' object (such as a ripe tomato) and is typically caused in an experiencing normal healthy trichromat when that trichromat looks at a red-color object that reflects long wavelength light. The term 'red-color' refers to a property of objects (such as reflectance property of object: (Byrne & Hilbert, 2003)) and may also refer to the content of 'redness'.

(2.1) Fundamental entities (strings or fermions such as electrons and bosons such as photons and gravitons) have two aspects: material aspect (such as charge, mass, spin, spacetime) and mental aspect (such as one or more fundamental PEs).

(2.3) If there is a single fundamental PE, then each fundamental entity has its own PE in latent/covert/unexpressed form. For example, a string will have string-PE, an electron will have electron-PE, a photon will have photon-PE, or a graviton will have graviton-PE as its mental aspect.

(2.4) If there is more than one fundamental PE then they are in superimposed form, which leads to non-specificity.

(2.5) Each fundamental entity or inert matter is a *carrier* of a fundamental PE (or superimposed fundamental PEs if it has more fundamental PEs), which implies that these particles behave as if they are material-entities. This property is necessary to bypass the problems of panpsychism (Vimal, 2009e).

(2.6) The material aspect and the mental aspect of fundamental entities co-evolve. This means that inert matter will be a *carrier* of its associated PE(s) because its constituent fundamental entities are *carriers* of associated PE(s) (i.e., inert matter does not experience anything; it is simply a *carrier* of PE(s) in unexpressed form). It also implies that 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 of matter co-evolve and co-develop into neurons and associated neural-PEs, respectively. Still no experience is generated; they are simply *carriers*.

(2.8) Neural signals interact so are the related neural-PEs in a neural-net; neural-net PEs *emerge* because of the interaction and are embedded in the neural-net during co-development and sensory motor tuning (*neural Darwinism*). For example, red-green V4/V8/VO color related neural-net PEs *emerge* in this neural-net, which are embedded in it. A color related PE might have *emerged* because of the 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. That is, the interaction in neural-net leads to the *emergence* of neural-net PEs.

(2.9) Subjective experience 'redness' is selected from the set of embedded color related subjective experiences (that were embedded in 'red-green V4/V8/VO neural-net' during *neural Darwinism* as in the premise (2.8)) when long wavelength light is presented to our visual system for the matching and selection processes (Vimal, 2009b). In other words, a specific SE emerges *somehow* in hypothesis H_2 , which is then embedded in the specific neural-network during *neural Darwinism* and then selected from the embedded SEs/PEs. Furthermore, we call the specific state of 'red-green V4/V8/VO neural-net' as specific 'redness-related-V4/V8/VO-neural-net-state'.

(2.10) From (2.1)-(2.9), the 'redness-related V4/V8/VO neural-net' that embeds the specific SE 'redness' plays a red-color related role.

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

(4) From (3), the redness related Type-1 explanatory gap is deflated. The premises (2.1)-(2.5) close the 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) The 'redness-related V4/V8/VO neural-net' that embeds 'redness' plays a red-color related role.

(3) Hence, the 'redness-related V4/V8/VO neural-net' is the neural correlate of SE

'redness', i.e., the SE 'redness' *emerges* in this net.

3.2. The philosophical basis of hypothesis H_2

The philosophical basis of hypothesis H_2 can be examined similar to that of H_1 as in Section 4.2 of (Vimal, 2009f). Here, it is assumed that the SE redness *emerges* during the interaction between the 'long wavelength light dependent feed-forward neural signals that carry redness related neural-PE' and the 'feedback fronto-parietal attentional signals' in the redness-related-V4/V8/VO-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 3.1. Here, SEs might have *emerged* from 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 3.1 to close the gaps.

Types A-C materialism might be rejected because the Type-1 explanatory gap remains, whereas the dual-aspect PE-SE framework is 'non-reductive physicalism' (Pereira Jr., 2007), where the gaps are deflated. However, a close scrutiny reveals that Types A-C have apparent explanatory gap in the following sense: it appears real gap because (i) materialists assume that physicalism \neq (materialism + SE/PE) and (ii) use the *emergence* of SEs from non-experiential matter, and hence they make category mistake (Feigl, 1981; Vimal, 2009b) between mental and material aspects. Once 'emergence' is unpacked by introducing PEs/SEs in physics (i.e., when materialism is extended to physicalism) then the gaps are deflated.

It should be noted that P1 = 'ionic/neural PE' is not specific to Q because P1 is involved in other Q's belonging to other modalities such as visual (Dow, 2002; Gegenfurtner & Kiper, 2003), 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 wavelength light is necessary for co-tuning during developmental sensorimotor

interaction (*neural Darwinism*) to have the specific SE redness.

4. Future Direction

All frameworks have some problems. Whenever we try to propose a new framework to address the problems of other frameworks, new problems arise. For example, to address the Type-1 explanatory gap of the materialistic emergentism (the null hypothesis H_0), we proposed the dual-aspect-dual-mode PE-SE framework with hypothesis H_1 , but we faced the Type-2 explanatory gap. To address this gap, we proposed 'cyclic universe with memory' hypothesis and 'SE-antiSE' hypothesis (Vimal, 2009f), but they lack evidence. Therefore, we proposed the dual-aspect PE-SE framework with hypotheses H_2 and H_3-H_5 and ended up with the Type-1a explanatory gap and a number of other problems, as discussed in Section 2. However, so far, the dual-aspect-dual-mode PE-SE framework with hypothesis H_1 is the most optimal framework because it has the least number of problems, namely, (i) the Type-2 explanatory gap and (ii) the 'brute fact' of dual-aspect. The Type-2 explanatory gap has been addressed in (Vimal, 2009f) to some extent. Nevertheless, further research is needed to address these problems to the level of general consensus.

Furthermore, to address the Type-2 explanatory gap, one could argue that SEs and anti-SEs can be created in a dual-aspect vacuum, in analogy to the creation of matter and anti-matter in the vacuum (see also Section 2.4 of (Vimal, 2009f) that includes Section 2.3.2 of current article, namely, hypothesis H_5). This creation of SEs could have occurred during Cambrian explosions about 540 Mya (Hameroff, 1998a) and/or it can occur whenever a need arises, such as in the case of novel SEs. The adaptation and natural selection of co-evolution, the *neural Darwinism*, and the matching and selection processes could appropriately assign specific SE to specific neural-net-state, embed them in the neural-network as memory trace, and then select a specific SE from the embedded SEs for experiencing it. In this scenario, the problems are: (i) the hypothesis H_5 is close to substance dualism that has a number of

problems, and (ii) one has to address which processes are responsible for the creation of SEs and anti-SEs in vacuum if it is indeed true. One could argue that chaotic process and self-organization might also be involved (Bruzzo & Vimal, 2007), which needs further research. The hypothesis of cyclic universe predicted from the quantum bounce model (Ashtekar, Pawłowski, & Singh, 2006; Bojowald, Kagan, Singh, Hernandez, & Skirzewski, 2007; Corichi & Singh, 2008) in loop quantum gravity (LQG) and the hypothesis of cyclic universe having memory (Corichi & Singh, 2008) are also interesting enough to explore further. If it were true, then it would help in deflating the Type-2 explanatory gap. It is emphasized that the materialistic emergentism is our null hypothesis H_0 , and it must be taken seriously even though it has the Type-1 explanatory gap. All researches must be critically examined with respect to H_0 .

5. Conclusions

1. The dual-aspect-dual-mode PE-SE framework was discussed in (Vimal, 2008a, 2008b, 2009a, 2009b), where we proposed that the fundamental particles have dual-aspect: material and mental. It has three competing hypotheses: *superposition* based H_1 , *superposition-then-integration-emergence* based H_2 , and *integration-emergence* based H_3 where *superposition* is not required. In H_1 , the mental aspect of fundamental particles *carries* the superposed SEs/PEs (Vimal, 2008b). A specific SE is selected in a neural-net via the matching and selection processes (Vimal, 2009b) and is experienced by the related specific neural-net when essential ingredients of SEs (such as wakefulness, attention, re-entry, working memory and so on) are satisfied. We closed the Type-1 explanatory gap (how SEs can *emerge* from non-experiential matter), but still needed to address the Type-2 explanatory gap (how it is possible that our SEs — such as happiness, sadness, painfulness, and similar SEs— were already present in primal entities).

2. In Part I (Vimal, 2009f) of the current series, we extended the PE-SE framework to subquantum level to investigate the

finer/deeper meaning of a very large number of superposed SEs/PEs. We unpacked the quantum view of superposition in terms of subquantum dual-aspect primal entities (*bhutatmas*). To address the Type-2 explanatory gap, (a) we assumed that fundamental SEs/PEs follow the principle of the *emergence* of SE and anti-SE (or *bhutatma* and *anti-bhutatma*) from the dual-aspect vacuum at the onset of universe, which is similar to the principle involved in the *emergence* of matter and anti-matter from vacuum; and/or (b) the cycles of universe (that may have memory [(Corichi & Singh, 2008)]) might have preserved irreducible fundamental SEs/PEs in the mental aspect of primal entities (Vimal, 2009f).

3. In this article, we discussed four more hypotheses of the dual-aspect framework: hypotheses H_2 , H_3 , H_4 , and H_5 . Our conclusions related to H_2 are as follows:

(i) Fundamental entities and inert matter are the *carriers* of one or more 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).

(iii) A specific SE *emerges* in a neural-net from the interaction of its constituent neural-PEs, i.e., the interaction between feed forward and feedback signals in the associated neural-net, in analogy to the physical property of salt (NaCl) *emerges* from the interaction of its constituents Na^+ and Cl^- ions.

(iv) The *emerged* SEs are then embedded in the specific neural-network during *neural Darwinism* and then a specific SE is selected from the embedded SEs/PEs when stimulus is presented to the system. However, the premise of *emergence* remains a mystery because one has to address precisely how SEs can *emerge* from PEs (this is the Type-1a explanatory gap).

(4) In addition, we discussed the hypothesis H_3 that is a dual-aspect panpsychism, but it has a number of problems, such as the combination problem and the restricted panpsychism problem. In addition, we discussed hypothesis H_4 that postulates an *intelligent mechanism*, which has never ending explanatory gap: from where and how that the intelligent mechanism

arose/emerged. We also discussed vacuum/*Aether*-based H_5 that speculates SEs could have *emerged* from *Aether* during Cambrian explosion and then *neural Darwinism* may have embedded SEs in respective neural nets. This information could have been eventually coded in DNA. Although there is a vacuum concept in physics, but it is not clear how SEs might have arisen. These were beyond the scope of current article. Moreover, hypothesis H_5 can be considered as a part of the hypothesis H_1 and was used to address the residual Type-2 explanatory gap.

(5) So far, we came across four types of explanatory gaps: (i) the Type-1 is related to the materialistic *emergentism*, (ii) the Type-1a is related to the *emergentism* in the dual-aspect view for hypotheses H_2 and H_3 , (iii) the Type-2 is related to hypothesis H_1 (how it is possible that our SEs were already present in primal entities), and (iv) the Type-3 explanatory gap is related to mind-independent reality (MIR): how can we say that physics is MIR when mind (subjective experience) is always used in setting up theories and observation. Further research is needed to address them satisfactorily and to investigate if

the hypotheses H_1 and H_2 can be unified (see at the end of Section 2.6). Since it is hard to prove scientifically any metaphysical view, we need to investigate which view has the least problems. So far, the dual-aspect-dual-mode PE-SE framework with hypothesis H_1 passes this 'litmus test'.

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