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Brain-Mind Operational Architectonics: At the Boundary between Quantum Physics and Eastern Metaphysics

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Abstract:

The Operational Architectonics (OA) of brain-mind functioning is a theory that unifies brain and mind through nested and dynamic hierarchy of electromagnetic brain fields. Recently, it has been enriched by concepts from physics like time, space, entropy, and self-organized criticality. This review paper advances OA theory further by delving into the foundations of quantum physics and Eastern metaphysics in relation to mind function. We aim to show that the brain-mind OA is the boundary between and integration point of quantum physics and Eastern metaphysics, and that it may inspire building a richer and more inclusive paradigm of the brain-mind relation, where quantum physics and Eastern metaphysics are inherently intertwined.

Keywords:

External physical space-time, internal physical space-time, operational space-time, phenomenal space-time, thought, mind, brain, neuronal assembly, nested hierarchy, electromagnetic field, operation, quantum process, active information, implicate order, uncertainty principle, Bohm, Western thought tradition, Eastern thought tradition.

"*Even if we could describe the brains functions in terms of classical theory alone, the analogy between thought and quantum processes would still have important consequences: we would have what amounts to a classical system that provides a good analogy to quantum theory. At the least, this would be very instructive. It might, for example, give us a means for describing effects like those of the quantum theory in terms of hidden variables.*"

Bohm [1].

"*Western Science is approaching a paradigm shift of unprecedented proportions, one that will change our concepts of reality and of human nature, bridge the gap between ancient wisdom and modern science, and reconcile the differences between Eastern spirituality and Western pragmatism.*"

Grof [2].

1. Introduction

This review paper takes forward the authors previous conceptualization on the brain-mind operational architectonics in relation to classical physics and modern thermodynamics of complex systems [3,4]. In the first paper [3], a coherent picture of brain–mind functioning based on general concepts of *space* and *time*, as they are known in contemporary theoretical physics, was described in detail. We substantiated our general approach by an experimentally backed framework of the Operational Architectonics (OA) of brain and mind functioning [5–7], according to which the mind phenomenological nested architecture and brain operational nested architectonics represent complementary aspects of the same unified metastable[1] continuum [16]. In accordance with this perspective, the brain constructs a continuum of dynamic spatial–temporal patterns from a multisensory stream of neural events caused by the spatial–temporal patterns of the outside physical world – *external physical space-time* (EPST). The *internal physical space-time* (IPST) of the brain is responsible for such operations, that is, the reordering and recombination of signals from the outside physical world

[1] Metastability refers to the interplay of two complementary tendencies of cooperative integration and autonomous fragmentation [8]. In general terms, metastability, by reducing the strong hierarchical coupling between the parts of a complex system while allowing them to retain their individuality, leads to a more flexible, more secure form of function that can promote the creation of new information [9]. More recently, metastability has been acclaimed as the new principle of brain functioning [10–15].

(EPST). The brain IPST level transforms external spatial–temporal relations of the EPST into highly structured and dynamic spatial–temporal patterns of the nested local extracellular electric fields of neuronal assemblies, where volumetric, *operational spatial–temporal* patterns (OST level) originate [3] (see Fig. 1). These operational patterns of electromagnetic fields (that are named operational modules – OMs) directly self-present phenomenal spatial–temporal patterns at the higher level of abstractness – *phenomenal space-time* (PST). The PST, as a whole, in its turn, serves as a transparent surrogate[2] of the EPST of the world. Such a view posits in a clear way how brain–mind OA reflects the organization of the physical world, with which brains (including their subjective "virtual" worlds) interact [3]. This overall perspective is similar to the philosophical analysis of Russell [21], who concluded that external physical events are known "so far as their space–time structure is concerned, for this must be similar to the space-structure of their effects upon percipients" (p. 229), as well as to Smythies [22] and Dainton [23] views, both suggesting that the neurophysiological activity of the brain is using physical space–time which it faces from moment to moment in order to realize phenomenal qualities with inherent spatiality and temporality.

In the second paper [4], the focus was on the structure, organization, dynamics, constitutive and causal relationships of the neural collective phenomena that underly consciousness – the nested hierarchy of spatiotemporal patterns of 3D electromagnetic fields produced by neuronal assemblies. Our detailed analysis has lead us to draw the following scenario of brain-mind dynamics that could be summarized as following [4]: every current (present) quasi-stable period (reflecting an emergent electromagnetic field of the collective behavior of many neurons) is formed so that the neuronal assembly could perform an immediately present simple operation guided by either external stimulation or internal aim (intention). Over time, when conditions naturally change, energy flows into an open system (neuronal assembly) leading to an increase in entropy. This process continues until it reaches a critical threshold – a rapid transitional process (RTP). At the RTP, the old system (an emergent electromagnetic field of the neuronal assembly) gets dissolved under the stress of entropic fluctuations (reflected by a sudden increase of entropy) and abruptly reorganizes itself into a new system so as to offload entropy through negentropy [24] and thus meets the new requirement(s) – execution of a new operation to present a new situation [4]. The sequence of RTPs is in fact a mathematical definition of a well-known physical phenomenon of "intermittency" and is compatible with self-organized criticality

[2] According to this notion, the phenomenal contents subjectively experienced are fully *transparent*, in a sense that they give only the impression of being actual patterns, objects or scenes out there in the physical world rather than some sort of virtual simulations (transparent surrogates) of these things in the physical world that they are presenting [17]. Further, the brain (and consequently the mind) does not have means to distinguish the "surrogate of the object" from the object itself: it just "looks through" the surrogate as if it is the real physical object itself in the world [18–20].

in physical systems [25]. This same process repeats at all levels higher in a nested hierarchy[3], when local fields that are generated by spatially dispersed local neuronal assemblies are coupled among one another to form ever increasing in complexity OMs, as well as further synchronized many OMs, thus bringing into existence the wholeness of subjectively "perceived" or "imagined" [4]. Such combinatorial power of local fields within OMs and also among several OMs makes it possible to present subjectively a nearly infinite number of different qualities, patterns, objects, scenes and concepts [28].

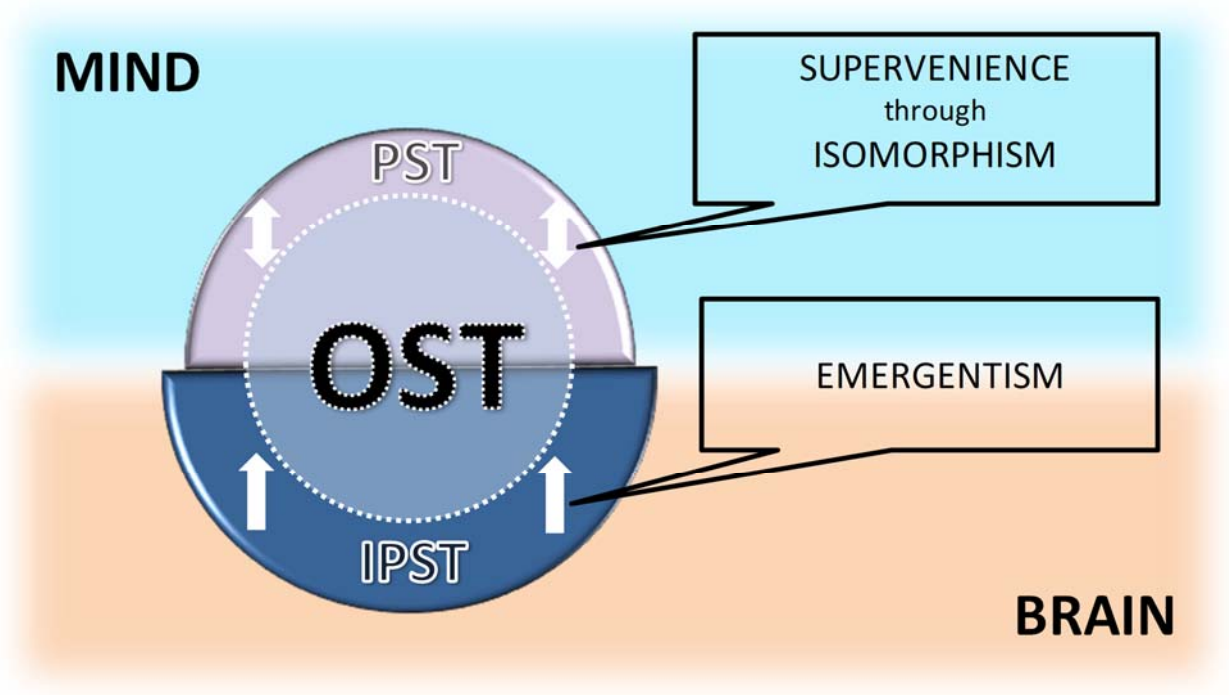

Figure 1. Schematic illustration of the brain-mind operational architectonics. Electromagnetic brain field presents the operational space-time (OST) level, which is the emergent phenomenon of brain internal physical space–time (IPST) level. Phenomenal space–time (PST) level supervenes on the OST. In this model the OST level represents the constitutive mechanism of phenomenal consciousness by fastening the phenomenal (subjective) and neurophysiological (physical) levels together. This figure is modified from the Ref. [58].

The current paper takes the OA conceptualization outlined above further by delving into the foundations of quantum physics and Eastern metaphysics. Throughout this review essay we aim to show that the brain-mind OA is the boundary between and integration point of quantum physics (Western thought tradition) and Eastern metaphysics. To realize this aim we shall first demonstrate and

[3] Such hierarchy sometimes referred to as a fractal or self-similar hierarchy, with repeated encapsulation of smaller elements in larger ones across different spatial, temporal, topological, and functional neural scales (for a discussion see Ref. [26]. It has been also proposed [27] that usage of topological tools may allow researchers to reveal the hidden nested multilevel correlations and translate them into an abstract space of different dimensions.

discuss the analogies between quantum and mental processes (using Bohm's interpretations[4]) and relate them to OA theory. Then we will consider the analogies between Eastern metaphysics (as the opposite of the Western one) and conceptual view of the mind (mostly focusing on Daoism and Buddhism as illustrative examples) in their relation to OA theory. Finally, we will conclude with a brief integration of all views under a unified perspective.

2. Quantum physics

In this section we will discuss some aspects of David Bohm's scientific and philosophical work in regards to the interpretation of quantum physics and a number of striking resemblances between quantum processes and the mind. However, we are proposing to look at these analogies[5] through the brain-mind OA theory [3–7,16], which has the scope that is ideally situated to tie up brain functioning, quantum processes and mind dynamics, and in such way helps to see more clearly how the physical and mental sides of reality are just aspects of the same dynamic structure.

Bohm has developed the notion of the enfolded or implicate order [29]. In his own words [30] "*The essential feature of this idea was that the whole universe is in some way enfolded in everything and that each thing is enfolded in the whole. From this it follows that in some way, and to some degree everything enfolds or implicates everything, but in such a manner that under typical conditions of ordinary experience, there is a great deal of relative independence of things.* […] *It follows that each thing is internally related to the whole, and therefore, to everything else. The external relationships are then displayed in the unfolded or explicate order in which each thing is seen, as has already indeed been indicated, as relatively separate and extended, and related only externally to other things.* […] *Because the implicate order is not static but basically dynamic in nature, in a constant process of change and development, I called its most general form the holomovement. All things found in the unfolded, explicate order emerge from the holomovement in which they are enfolded as potentialities and ultimately they fall back into it. They endure only for some time, and while they last, their existence is sustained in a constant process of unfoldment and re-enfoldment, which gives rise to their relatively*

[4] David Bohm was chosen among many researchers from the field of quantum physics due to several reasons: first, most of his conceptualizations and interpretations of the quantum physics are accessible to non-physicists; second, he did a great deal of work trying to analyze the analogies between quantum processes and mind without claiming that thought process literally involves quantum processes (in contrast to what is claimed by some quantum physicists) – his idea was by using the quantum physical intuitions to analyze human subjective experience in a new, productive way. However, we will occasionally refer to other researchers in the field of quantum physics to support our argumentation.

[5] The proposed analogies do not imply that mind or thinking process, or the brain functioning literally involve the quantum processes. In general terms, the analogy appreciates the fact that the theoretical models or intuitions developed and valid in one area or domain of science, for instance in quantum physics, could be equally valid in totally different areas/domains, for example in cognitive neuroscience. Analogies help to see the phenomena under exploration in a new light.

stable and independent forms in the explicate order" (p. 273). Bohm proposed further that "a similar sort of description" applies even more directly and obviously to the mind [30]. While it could be seen this way, in our view, the proposed relation feels like too general. To overcome this seeming drawback, we propose to introduce into the discussion the intermediate operational (OST) level of brain OA that intervenes between internal physical brain architecture (IPST) on one side, where it literally resides, and experiential/subjective phenomenal structure of the mind (PST), to which it is isomorphic[6], on the other side [3,4]. This operational level ties these two (neurophysiological and subjective) aspects ontologically together, and thus acts as a natural bridge for Bohm's suggestion of matter and mind relation.

In what follows we aim to show that the dynamic nested brain OA is consistent from one side with Bohm's conjecture and from the other side with the dynamic structure of the mind. In order to do so we are going to briefly present the brain OA theory and highlight where within the nested OA the analogous to quantum physics principles are in force.

The central notion of the OA framework of brain–mind functioning is *operation* [3,5,7]. This notion has many important features: it is a process lasting in time and simultaneously an event (a discrete operation which has a beginning and an end), it is present in both brain and mind functioning, as well as in the quantum physics (as we will discuss shortly), and it has combinatorial nature (increasing complexity of nested operations/processes) and complementarity (in the sense that it is at the same time physical and mental, and the type of measurement determines which property is expressed). While Bohm did not use the word "operation", the notion of process is central to his interpretation of quantum physics, for example: "[…]*in the quantum theory, what was measured was an operator. To me, this signified a movement. Once again, this suggested to me a being that was movement.* […]" (cited from [32]). As we see from above citations, these ideas later led him to develop the notion of the "holomovement" dynamic [30]. It should be made clear that holomovement is not just a concept in physic. As was noted by Pylkkänen [32], Bohm realized that in quantum theory the wave function evolves over time in a movement of unfolding and enfolding. This led to Bohm's view of cosmology, where the universe (with its space-time) unfolds from an enfolded state in a pre-space or implicate order; thus making Bohm's *process* ontology similar to Whitehead[7] [33]. Refining his

[6] The isomorphism that we have in mind here refers to a second-order functional similarity, that claims that functional relations between representations are similar to relations between physical events (for a discussion, see Ref. [31]). Elsewhere (see Ref. [3]), we have discussed the strict definition of functional isomorphism, which states that the two systems that are functionally isomorphic are, in virtue of this fact, different realizations of the same kind. In other words, two systems can share a pattern of functional relations without sharing the physical properties upon which those relations depend [3].

[7] Whitehead is probably the best-known protagonist of a "process-based" philosophy [33], even though such a view can be traced back to Heraclitus, who focused on change and processes of becoming. In the past few decades, several physicists have attempted to relate Whitehead's approach to modern concepts in quantum theory. For example, Stapp argued that an

interpretations, Bohm together with Hiley [37] suggested that a change in the form of the process constitutes *active information*, in a somewhat Aristotelian fashion – as a "formative cause" [38]. This means that a small change in the form of the wave function can produce large effects in the dynamics of the system. In this way, quantum potential can enforce influences on the systems that are separated by large distances – the concept of *non-locality*[8] [39]. Thus, the notion of operation as a process represents an important concept central to quantum physics, brain nested functional architecture, and mind dynamics, lending itself especially well-suited to a discussion of the complementarities between brain, mind and quantum processes.

According to the general theory of brain–mind OA [3–7], simple mental/cognitive operations (responsible for elemental phenomenal qualia or simple computations) are presented in the brain in the form of local 3D-fields produced by transient functional neuronal assemblies, which by themselves are the result of cooperative behavior (synchronization of individual electric potentials) of involved neurons to perform a specific computation (operation). At the same time, complex mental/cognitive operations (responsible for complex phenomenal objects, images or thoughts) are brought into existence by joining a number of simple operations (temporal coupling of local 3D-fields) in the form of so-called operational modules (OM) of varied complexity and life-span. Therefore, the brain OA is presented as a highly structured and dynamic *extracellular electric field* that is nested in spatial and temporal domains and spanning over a range of temporal scales, thus forming a particular operational space–time (OST) in the brain [3,5,7] (see Fig. 1). In other words, the OA model allows for fields emerging within fields, with multiple temporalities where various processes exist over different durations, with some durations containing and integrating others[9] – more broadly conceived as a nested hierarchy of "individualities and communities" in terms of Ho [41]. The most important aspect of brain-mind OA theory is that it privileges the concept of field[10], which still remains a challenge to mainstream Western thought.

Such description of the brain–mind OA reveals a number of striking resemblances with quantum processes described in the above Bohm's citations [30]. Indeed, there is a constant process of change (recurrent movement) in the form of processes (operations) at the level of electric potentials of myriad

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essential aspect of quantum events is *process non-locality* [34]. Filk and von Muller [35] used the notion of an event that refers to "*the process of becoming*", which is also compatible with "generalized quantum theory" of Atmanspacher [36].

[8] For the sake of clarity, we need to note, that non-locality (in contrast to "quantum potential" and "active information") is an important and unanimously accepted feature in quantum physics.

[9] This view resonates with complex temporality developed by Bergson [40].

[10] Field theory was first put forward by Faraday who argued that what exists are extended, enduring forces rather than objects with properties [42]. And the "*action*" is the most important feature of a field not the "actors" [43]: "In the concept of field the "action" is more fundamental than the actors, and there cannot exist one isolated, single actor, but only a multitude of them" (p. xi).

of neurons (so called potentialities[11]), and this process can give rise to space, time and relatively stable and independent forms (particle-like manifestations) in the explicate order, when transient neuronal assemblies get formed and establish 3D local electromagnetic fields. At this new emergent[12] level of the nested OA hierarchy the multiplicity of local 3D-fields again represents a constant process of change (recurrent movement) of operations that present simple qualia or subjective features, with explicate order emerging when particular 3D-fields get temporally coupled to form OMs – concrete spatio-temporal structures that now present phenomenal objects, full scenes, thoughts and even abstract ideas in a conscious mind [3,4,16]. Such OMs could be conceptualized, following Bohm, as actualized, relatively stable and independent forms in the explicate order [30] that somehow "freeze" for some time the ever changing and multiform stream of our conscious experiences.

Now the question is whether we could observe similar analogies/resemblances between quantum processes and the mind. Bohm claimed that 'yes', stating that [30]: "[…] *It takes only a little reflection to see that a similar sort of description will apply even more directly and obviously to mind, with its constant flow of evanescent thoughts, feelings, desires, and impulses, which flow into and out of each other, and which, in a certain sense, enfold each other (as, for example, we may say that one thought is implicit in another, noting that this word literally means 'enfolded'). Or to put it differently, the general implicate process of ordering is common both to mind and to matter*" (p. 273). As noted by Pylkkänen [32], Bohm's thinking in this respect was strongly influenced by Krishnamurti [46] and to some extent also by Dalai Lama and aimed to show the importance and priority of the whole, where consciousness could be seen as echoing the kind of wholeness and relationality that is evident in quantum processes [1]. While this description is apt, it is quite holistic and abstract, and does not allow to envision the necessary detail and complexity of the nested hierarchy of the mind. Introducing the brain-mind OA could fill this gap in the most natural way since it, as we have noted in the introduction, resides at the boundary between matter (brain) and subjectivity (mind) (Fig. 1).

The most fundamental level in the mind can be described as a 3D-bounded volume (some kind of coordinate system) in which every location has the capability to realize a characteristic variety of self-presenting, *qualitative (phenomenal) features*[13] and thereby to construct transparent surrogates or

[11] Potentialities are thought [44] "to be conceived of as propensities of existing fields in their extensive and durational becoming, including possibilities for, or propensities to interact with other fields and to participate in the emergence of new fields" (p. 83). This concurs with quantum theory that pays special attention to potentialities and propensities or dispositional states [30,37,39]. Here it is important to keep in mind that while possibilities are infinitely divisible, what actually exists is not [44]: "The primary beings of the universe only exist as processes of extensive, durational becoming which sustain possibilities or dispositions, including dispositions which if realized, are incompatible with the realization of other dispositions" (p. 83).

[12] Further discussion of emergent levels in the brain is presented in Ref. [45].

[13] Phenomenal features (qualities) can be described as simple phenomenal contents (sound, color, touch, emotion, taste, smell, and so on). They are the identity, the "stuff" that experiences per se are made of [16].

"virtual" models of the objects present in the physical world [16]. One could readily see the analogy with the quantum physics potentiality and probability of becoming, where the "intrinsic" nature of each part depends to some degree on its relationship to its surroundings [47]. Within the brain OA, this level is presented by the laminar organization of the brain neocortex with parallel and re-entrant loops which is responsible for the 3D bounded and structured volume (coordinate system) in which every local neuron has the potential capacity to realize and process some simple attribute of the physical object or scene in relation with behavior of other neurons [3,4,16] – in that sense resembling the nonlocality principle[14] of quantum physics.

The next level in the nested hierarchy of the mind is presented by *phenomenal objec*ts that are complex patterns of qualities which are spatially extended and bounded with each other to form a unified frame (Gestalt window) with a particular meaningful categorization (semantic window) immediately present for the subject. Any such object can be further organized hierarchically as parts (or features) of a more complex object (or image, thought, scene, concept), or be decomposed into its constituents and realized as separate simpler virtual objects independent of one another and with their own inherent Gestalt and semantic windows [16]. Importantly, the phenomenal objects that are not actualized at the moment (for example, being preattentive or not in the focus of awareness) can be described as "raw" (or be a potentiality) objects that possess no Gestalt and semantic windows, but rather some phenomenal undefined "stuff" [16]. In the brain OA model, 3D-fields of neuronal assemblies that present different modalities (for example, visual, auditory, directional and so on) are spatially distributed but temporally integrated, so that the different features belonging to the same object are phenomenally realized in the same virtual location and same time within the given OM [3,4] – again the nonlocality principle is in force[15]. The continuity of every OM exists as long as the set of spatially distributed neuronal assemblies keeps synchronicity between their discrete operations. We argue that at the phenomenological level, one would subjectively experience this as the continuity of presence [48]. OMs (being by themselves the result of synchronized operations going on in distributed brain structures), in their turn, could be operationally synchronized between each other on a new time scale, and thus form ever more abstract and complex OMs, which constitute a new integrated subjective

[14] Nonlocality principle in quantum physics means that, under certain conditions, particles that are at macroscopic orders of distance from each other appear to be able, in some sense, to affect each other, even though there is no known means by which they could be connected. It is easy to see how a non-locality principle is applied here: different neurons, even those that are far from each other, can synchronize their operations even without any physical (anatomical) connections between each other [3].

[15] Using the quantum physics terminology, the "quantum state" of the whole system (in this case – OM) cannot be defined simply as a pre-assigned interaction between all the particles (local fields produced by distant neuronal assemblies). This description constitutes the causal interpretation of the quantum theory, where "interaction" depends upon the wave function of the entire system, which is not only contingent on the state of the whole but also temporally evolves according to Schrodinger's equation [39,47].

experience [3,4]. Importantly, each of the new OMs is not just a sum of simpler OMs, but rather is a natural union of abstractions about simpler OMs[16]. At the same time, complex OMs could be decomposed to simpler ones and all the way down to the most basic operations [3,4]. One can see that this brain nested and dynamic OA is functionally isomorphic with the nested hierarchy of the mind and analogous to quantum physics notions of non-locality, diversity in unity and multi-temporality containing multiple durations embedded in a hierarchy of durations [41]. Reinterpreting Bohm and Hiley [39] one can propose that within the given OM, during the period of interaction of local 3D fields that constitute this OM, all contributing systems (local 3D fields) move according to "*a single and more complex pool of information, so that they are carrying out a common "dance". It then follows that what happens in the over-all process described above can better be regarded as a mutual transformation of observed system*" (p. 334). Interestingly, the same single complex pool of information determines (among other things) a set of bifurcation points – rapid transitional periods (RTP) in our interpretation [3,5–7] – when complex OMs reorganize themselves. In terms of Bohm et al. [39] the bifurcation points mark moments when the wave function factorises and the participating systems (local 3D-fields in our case) begin to move according to independent pools of information, and therefore start executing separate "dances". As argued by Pylkkänen [49] following Bohm [30], it is by virtue of this dynamic complexity that we recognize enduring forms within a milieu of change utilized by thought and sharing many characteristics with quantum dynamics.

This dynamic is explicit in the thought process, where a succession of phenomenal moments is integrated into the flow of subjective thoughts as evident from the first-person perspective [3,4,48]. Here the actualization of full-fledged phenomenal objects, images or scenes is realized on a "one-at-a-time" basis, moving serially from one phenomenal pattern within a specious present to another [50]. This process gives rise to a stream of consciousness (or stream of thought) that was conceptualized by James using the metaphor of kaleidoscope [51]. According to OA, the succession of phenomenal images or thoughts is presented by the succession of discrete and relatively stable OMs that are punctuated by RTPs, i.e. abrupt changes of OMs [3,4]. Experimental studies have shown that at the critical point of transition in mental state or thought, the OM undergoes a profound reconfiguration: a set of local 3D-fields (which together constitute an OM) produced by transient neuronal assemblies located in several brain areas, rapidly loses functional coupling with one another and establishes new couplings within another set of local bioelectrical fields, thus demarcating a new OM in the volumetric

[16] In quantum physics terms this can be summed up within a notion of quantum wholeness, which implies that in the system (including world/universe) the interaction of the particles may be thought of as depending on a common pool of information belonging to the system as a whole, in a way that is not analyzable in terms of pre-assigned relationships between individual particles [30].

OST continuum of the brain [3]. In Bohm's own words these complex processes are analogous to active information[17] processes in quantum physics [30]: "*in our subjective experience action can, in some cases at least, be mediated by reflection in conscious thought, whereas in the various examples of activity of objective information given here, this action is immediate.* […] *For such reflection follows on the suspension of physical action. This gives rise to a train of thought. However, both the suspension of physical action and the resulting train of thought follow immediately from a further kind of active information implying the need to do this.* […] *Active information can thus serve as a kind of link 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)*" (p. 282). Furthermore, the whole nested hierarchy of brain OA which is functionally isomorphic with a nested hierarchy of the mind is analogous with the interpretations of quantum physics which Bohm proposed [30]: "*It is interesting in this context to consider the meaning of subtle which is, according to the dictionary 'rarefied, highly refined, delicate, elusive, indefinable'. But it is even more interesting to consider its Latin root, sub-texere, which means 'finely woven'. This suggests metaphor for thought as a series of more and more closely woven nets. Each can 'catch' a certain content of a corresponding 'fineness'. The finer nets can not only show up the details of form and structure of what is 'caught' in the coarser nets; they can also hold within them a further content that is implied in the latter. We have thus been led to an extension of the notion of implicate order, in which we have a series of inter-related levels in which the more subtle—i.e. 'the more finely woven' levels including thought, feeling and physical reactions—both unfold and enfold those that are less subtle (i.e. 'more coarsely woven'). In this series, the mental side corresponds, of course, to what is more subtle and the physical side to what is less subtle. And each mental side in turn becomes a physical side as we move in the direction of greater subtlety*" (p. 282–283). In this context, it is important to note that one can extend these interpretations to quantum fields (see, for example, Vitiello [53,54], Flanagan [55], Umezawa [56]) which, as we have shown previously, is not incompatible with brain-mind OA theory [57].

To sum up this section, we may conclude that the quantum-like principles could be seen as the fundamentals of both brain OST and mind (including consciousness) PST levels (Fig. 1). Furthermore, introducing brain OA level into the discussion, while relating mind and matter (brain), opens up the possibility that the mind may be regarded as a nested and dynamic hierarchy of processes taking place at a higher level of organization of the brain with both mental and physical aspects – so called

[17] A detailed discussion of the notions of active information and implicate order could be found in [37,39,52].

"*emergentist monism*" [58], which is a variant of the "aspect monism" or "neutral monism" [38,59,60] according to which the relationship between the mental and the physical (neurophysiological) is hierarchical and metastable, where the mind could be seen as being relatively autonomous[18] [3,4]. This view emphasizes monism in the sense of the mentioned above "priority of the whole" [59] and resonates well with contemporary ontic structural realism, according to which relationships are ontologically more fundamental than individual objects with their intrinsic properties [61]. The same view draws attention to a number of striking resemblances with Eastern metaphysics (such as Daoism and Buddhism) which will be discussed in the next section.

3. Eastern metaphysics

In this section we will see what Eastern thought traditions have to say about the mind, and then combine this with the brain-mind OA model and relevant quantum physics processes to see new analogies between all of them. In the words of Pylkkänen [62], such an approach "[…] *opens up the possibility of a less mechanical and* […] *more accurate description of human experience than what, say, cognitive science currently offers*" (p. 85). And according to Gare [44], "[…] *it is not simply a matter of advancing science. All this work should be seen as an effort to free science, and culture more broadly, from deep assumptions that have dominated European and then Western culture. While these assumptions associated with an extreme form of objectivism are partly responsible for the success of European and Western science, they have engendered a dualism between the objective and the subjective which is not only hindering the further advance of science, but is having a damaging effect on civilization and its relationship to the rest of nature*" (p. 88).

We will start our exploration with Daoism. Dao (sometimes written Tao), by convention translated as 'the Way'[19], is a widely recognized concept and a central idea in Chinese philosophy [64]. The roots of Daoism go back at least to the 4th century BCE. Early Daoism drew its cosmological notions from the School of Yinyang (Naturalists), and was strongly influenced by old Chinese texts, in which a philosophical system of how to govern human behavior in accordance to the alternating cycles of nature was described [65]. Analyzing the main classic text of the Dao, Dao-de-Jing text, Hall and Ames [64] wrote: "*Continuity makes dao one; difference makes dao myriad; change makes dao processional and provisional. Dao is thus both the One and the many, or better, the field and foci through which it is entertained. The Chinese 'world as such' is constituted by 'worlding' (ziran), a process of spontaneous*

[18] In an analogous way as superconductivity can be seen as an emergent property in particular physical systems [38].
[19] Since Chinese nouns lack pluralization, the word dao functions grammatically like a singular or mass term and semantically like a plural [63]. Therefore, a more accurate description of dao is the *part-whole sum* of ways.

arising, or literally, uncaused 'self-so-ing', which references no external principle or agency to account for it. The one and the many stand in a holographic relationship: there is the indiscriminate field (dao) and its particular focus (de). Dao as field is always entertained and focused from some perspective or another, from some particular. Just as in a holographic display where each detail contains the whole in an adumbrated form, so each item of the totality focuses the totality as its particular field" (p. 1965). Even in this sketchy presentation, it is easy to see that such description of Dao is very similar to "non-local", "containing diversity in a unity" and "potentiality becoming" principles of quantum physics, mental dynamics and brain OA model discussed above. Indeed, in quantum physics these principles determine how the potentialities enfolded in the implicate order are actualized as relatively stable and independent forms in the explicate order by means of active information [30,29,39]. More generally, these principles determine how the quantum level potentialities/possibilities contained in the wave function are actualized in interactions (in the quantum mechanics all interactions cause abrupt changes and these interactions include measurements that are affected by a conscious choice [47]). In the mind, they govern the emergence and dynamics of phenomenal objects/images/thoughts within a nested phenomenal architecture [50,66]. In the brain OA, they provide a mechanism for the creation of nested dynamic hierarchy of brain fields (OST level), where fields emerge from and within other fields, with multiple levels of fields, and fields being mutually constitutive of other fields, to collectively present in the mind a nested and dynamic phenomenal world [3–7,16]. Here the OA level serves as an intermediary between brain (matter) and phenomenality (mind), tying the mental and material aspects of reality together (Fig. 1). Keeping the revealed analogies in mind, one may safely conclude that all analyzed conceptualizations could be seen as monism variants in the sense that they all put priority of the whole or totality [59,60].

These same principles, namely, "non-locality", "diversity in a unity" and "potentiality becoming", can also be found in the Buddhist philosophy. To illustrate this, we will focus here on the early Yogācāra school[20], which is generally considered to be the mature view of Buddhism in relation to mind metaphysics. In the process of analyzing subjective experience, the Buddhist philosophers of this school proposed two related concepts/notions: the *basic or storehouse mind* (ālaya-vijñāna) and *afflictive mentation* or self-consciousness (kliś a-manas) [67]. The first term describes some-kind of a subliminal mind or baseline (unmanifest) consciousness that carries along in it seeds of all karmic potentials and latent dispositions [68,69], including forthcoming manifest conscious states that are

[20] According to Chadha [67], Yogācāra is one of the most important schools within the Abhidharma traditions which emerged in India at the beginning of the third century BCE. Specifically, the Yogācāra school emerged around the fourth century CE. "Abhidharma traditions represent the first attempts in Buddhism to develop systematic, analytically rigorous and terminologically precise accounts of the content and character of experience, and a rigorous metaphysics of mind and mental states" [67].

bound to arise from a series of moments [68]. In the words of Dreyfus [70], "*The basic consciousness is the baseline of consciousness, the passive level out of which more active and manifest forms of awareness arise in accordance with the implicit preferential patterns that structure emotionally and cognitively this most basic level of awareness*" (p. 144). The second term can be thought of as an awareness of perceptions, including the innate sense of self, arising from apprehension of the basic mind [67,69,70]. In this context all conscious perceptions like for example, seeing, hearing, etc. depend on the subliminal mind, in that it provides a substratum for the senses and also fuels them [69], as well as establishing the source of phenomenal unity [67] when the relevant fundamental elements (dharmas) are co-present together [71]. In the words of Chadha [71], "*the phenomenal form supervenes on the arrangement of co-present dharmas and is at the same time luminous or [self-presenting]. In other words, the production of the phenomenal form, which encompasses the subjective and the objective aspects, coincides with the awareness of the [object] and the awareness of the perception of the [object]*" (p. 284). The analogy of such descriptions of Buddhist notions with the quantum principles is striking. The "subliminal or baseline (unmanifest) mind" of Buddhists could be interpreted in terms of the uncertainty principle of quantum physics[21], with indeterminacy, potentiality, uncontrollability, and indivisibility features present. From this level spatiality, temporality and causality emerge, signifying the "awareness of perceptions" principle described above. Bohm has two propositions that can unpack these relations further [1]: "*Similarly, some of the characteristic properties of a quantum system (for example, wave or particle nature) depend on indivisible and incompletely controllable quantum connections with surrounding objects. Thus, thought processes and quantum systems are analogous in that they cannot be analyzed too much in terms of distinct elements, because the "intrinsic nature" of each element is not a property existing separately from and independently of other elements but is, instead, a property that arises partially from its relation with other elements. In both cases, an analysis into distinct elements is correct only if it is so approximate that no significant alteration of the various indivisibly connected parts would result from it*" (p. 169). And "*As for the appearance of apparently exact causal laws on a macroscopic scale, when only the probability of each elementary quantum transfer is determined, we merely note that, where many quanta are involved, the probability becomes almost a certainty (but not quite). This is very similar to the exact prediction, by insurance statistics, of the mean lifetime of a person within a large group, even though an exact prediction of the lifetime of a single individual in the group is not possible*" (p. 30).

[21] This principle relates also to Bohr's principle of "complementarity" [72] and his idea that the boundary between the subject and the object glides (where to draw this boundary depends on the context) [47].

Brain-mind OA offers an even more striking analogy with Buddhist philosophy due to a fact that it describes the level (OST), that from one side emerges from the brain (IPST level), but is not material since it relates to a nested hierarchy of brain fields, and from the other side it constitutes the phenomenal level itself (PST) [3–7,16] (Fig. 1). Specifically, the Buddhist notion of the "subliminal or baseline (unmanifest) mind" with all its potentials and latent dispositions corresponds to the level of totality of electromagnetic potentials and multitude of 3D-electromagnetic fields produced by transient and dynamic neuronal assemblies that constitute the spatially organized subphenomenal matrix. This matrix is in constant flux (recurrent movement) in the form of processes (operations or dharmas) and carries potentialities that can give rise to space, time, and relatively stable and independent forms (particle-like manifestations[22]) in the explicate order (in the form of 3D local electromagnetic fields and their more complex and non-local aggregates in the form of OMs). The latter is analogous to the Buddhist notion of "manifest forms of awareness" that supervenes on the arrangement of co-present dharmas and is at the same time luminous or self-presenting [71], thus providing immediate access to how things subjectively appear to the mind.

Further, Buddhist philosophers conclude that what we perceive as a temporally extended, uninterrupted flow of mind is, in fact, a rapidly occurring sequence of causally connected moments with its particular discrete objects [67]. Generally, this process could be described in the following way [69]: "*basic consciousness insofar as it contains seeds or predispositions produces conscious states (sometimes in association with sense faculties and their objects) say, of seeing a mango, which, in turn, accumulate further seeds, say, desire for a mango, into it. Thus, the Sūtra presents a dynamic model of the mind, wherein conscious perceptions and other mental dispositions are tied together in a continuous feedback cycle*" (p. 96–97). While in Bohm's interpretation of quantum physics it could be related to the active information that produces a change in the form of the process of thought [37,38], according to the brain-mind OA, this process directly represents the stream of thoughts (as it is evident from the first-person perspective) [51] where the succession of phenomenal images or thoughts is presented by the succession of discrete and relatively stable OMs that are punctuated by RTPs (i.e. abrupt changes of OMs) [3–5,48]. In Section 2 above we have already analyzed the way how a nested brain-mind OA is analogous to quantum processes in this respect.

In this context the nested brain-mind OA, whilst being the fundamental constituent of both brain and mind, is at the same time a conceptual boundary between quantum physics and Eastern metaphysics. Summarizing this section, we may therefore entertain the proposition that the link

[22] In the sense that the form of the wave function manifests itself in the movements of the particles [30,47].

between Western and Eastern thought traditions in respect to mind and matter happens to be much tighter than is traditionally appreciated. In fact, it is only recently that quantum physics has broken the strict limits of classical physics (materialism vs dualism) which opens up the possibility of looking at Eastern phenomenological traditions through the lens of Western science and vice versa.

Before closing this section, we would like to consider yet another thought tradition that traditionally is considered to be Western, even though it takes its origin at the East – we speak about Christianity [73]. The idea of bringing in the Christian metaphysics[23] was motivated by another Bohm citation [30]: "*For the human being, all of this implies a thoroughgoing wholeness, in which mental and physical sides participate very closely in each other.* […] *Extending this view, we see that each human being similarly participates in an inseparable way in society and in the planet as a whole. What may be suggested further is that such participation goes on to a greater collective mind, and perhaps ultimately to some yet more comprehensive mind in principle capable of going indefinitely beyond even the human species as a whole*" (p. 284). In fact, the well-known concepts and notions from the Christian metaphysics are analogous to quantum theory. For Bohm, the reality unfolds from a *higher context*, which contains entities that manifest themselves as somatic configurations [29]: "*In terms of the implicate order one may say that everything is enfolded into everything. This contrasts with the explicate order now dominant in physics in which things are unfolded in the sense that each thing lies only in its own particular region in space (and time)*" (p. 225). Analogously, for Christian thinkers God is the supreme source of all being and reality; He is the ultimate reality; humans can understand the creation and Creator because He made them in His image with the capacity to understand Him and His intelligent order; the orderly universe was conceived in the orderly mind of God [74]. Further, He is both eternally one and eternally many. God imposes unity upon and guarantees order in the created universe. In the words of Van Til [75], "*All aspects being equally created, no one aspect of reality may be regarded as more ultimate than another. Thus the created one and many may in this respect be said to be equal to one another; they are equally derived and equally dependent upon God who sustains them both*" (p 27). Such conceptualization resonates nearly literally with the Bohm's implicate order – the unfolding of the universe from the totality of higher contexts [29] and further with the idea developed together with Hiley and Pylkkänen of the higher-level "mind-field" [38].

[23] In the proposed analysis we consider the Christian notions and concepts not as belonging to a religion, but as elements of Christian thought tradition (basically the Christian philosophy and metaphysics).

4. Conclusions

In this review essay we explored some important analogies between quantum physics, Eastern metaphysics and brain-mind OA. Our review has shown that all of the analyzed epistemological domains contain some radically holistic and relational features, where the behavior of the part (particle / neuron / neuronal assembly / brain local field / agglomerate of local fields – operational module / phenomenal feature / phenomenal object / thought) is strongly dependent upon its surrounding context, emphasizing wholeness and relationality. At the same time, if we wish to go beyond the general claim about a certain ontological holism, and get a detailed description of how mind (subjectivity) and matter (brain) relate to one another in a productive way, we need a level of description that would capture, within the unified framework, both aspects of the single reality, such as mind and the brain. In this review we have tried to show that brain-mind OA, that is centered around the notion of operation (a process or a quantum of action), has the necessary explanatory power to bring together mind and the brain and also illuminate the important analogies between brain-mind OA, quantum physics and Eastern metaphysics. Thus, we can say accordingly, that in this way, the brain-mind OA resides at the boundary between quantum physics (which has blurred the concept of "matter") and Eastern metaphysics (which considers mind to be a "subtle matter") and brings the link between them into sharper focus. It is hoped that future more comprehensive analysis of the revealed analogies may inspire and help to build a richer and more inclusive paradigm of brain-mind relation, where quantum physics and Eastern metaphysics are inherently intertwined and to illuminate related aspects of the same dynamic structure of reality.

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References

[1] Bohm D. Quantum theory. Englewood Cliffs: Prentice Hall; 1951.
[2] Grof S. Beyond the brain: Birth, death, and transcendence in psychotherapy. Albany, NY: State University of New York Press; 1985.
[3] Fingelkurts AA, Fingelkurts AA, Neves CFH. Natural world physical, brain operational, and mind phenomenal space–time. Physics of Life Reviews 2010;7:195–249.
[4] Fingelkurts AA, Fingelkurts AA, Neves CFH. Consciousness as a phenomenon in the operational architectonics of brain organization: Criticality and self-organization considerations. Chaos, Solitons & Fractals 2013;55:13–31.
[5] Fingelkurts AA, Fingelkurts AA. Operational architectonics of the human brain biopotential field: Towards solving the mind-brain problem. Brain and Mind 2001;2:261–96. https://www.bm-science.com/images/bms/publ/art18.pdf
[6] Fingelkurts AA, Fingelkurts AA. Mapping of the brain operational architectonics. In: Chen FJ, editor. Focus on brain mapping research. New York: Nova Science Publishers, Inc.; 2005. p. 59–98. https://www.bm-science.com/images/bms/publ/chapt3.pdf
[7] Fingelkurts AA, Fingelkurts AA. Brain-mind Operational Architectonics imaging: technical and methodological aspects. The Open Neuroimaging Journal 2008;2:73–93.
[8] Kelso JAS, Engstrøm D. The complementary nature. Cambridge: MIT Press; 2006.
[9] Afraimovich V, Tristan I, Varona, P, Rabinovich M. Transient dynamics in complex systems: Heteroclinic sequences with multidimensional unstable manifolds. The interdisciplinary Journal of Discontinuity, Nonlinearity, and Complexity 2013;2:21–41.
[10] Fingelkurts AA, Fingelkurts AA. Making complexity simpler: Multivariability and metastability in the brain. The International Journal of Neuroscience 2004;114:843–62.
[11] Freeman WJ, Holmes MD. Metastability, instability, and state transition in neocortex. Neural Networks 2005;18:497–504.
[12] Werner G. Metastability, criticality and phase transitions in brain and its models. Biosystems 2007;90:496–508.
[13] Kelso JAS. Multistability and metastability: Understanding dynamic coordination in the brain. Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences 2012;367:906–18.
[14] Tognoli E, Kelso JAS. Enlarging the scope: Grasping brain complexity. Frontiers in Systems Neuroscience 2014;8:122.
[15] Fingelkurts AA, Fingelkurts AA. Information flow in the brain: Ordered sequences of metastable states. Information 2017;8:22. doi:10.3390/info8010022
[16] Fingelkurts AA, Fingelkurts AA, Neves CFH. Phenomenological architecture of a mind and Operational Architectonics of the brain: the unified metastable continuum. Journal of New Mathematics and Natural Computation 2009;5:221–44.
[17] Fox I. Our knowledge of the internal world. Philosophical Topics 1994;22:59–106.
[18] Tye M. Representationalism and the transparency of experience. Nous 2002;36:137–51.
[19] Kind A. What's so transparent about transparency? Philosophical Studies 2003;115:225–44.
[20] Gennaro RJ. Representationalism peripheral awareness, and the transparency of experience. Philosophical Studies 2008;139:39–56.
[21] Russell B. Human knowledge: Its scope and limits. New York: Simon and Schuster; 1948.
[22] Smythies J. The walls of Plato's cave. Aldershot: Avebury; 1994.
[23] Dainton B. Unity in the void: Reply to Revonsuo. Psyche 2004;10(1). https://pdfs.semanticscholar.org/e33e/6a6a5ca52c2edb1434362e8028c71e747031.pdf
[24] Prigogine I. Introduction to the thermodynamics of irreversible processes. New York: Interscience; 1961.
[25] Bak P, Tang C, Wiesenfeld K. Self-organized criticality: an explanation of the 1/f noise. Physical Review Letters 1987;59:381–4.
[26] Badcock PB, Friston KJ, Ramstead MJD. The hierarchically mechanistic mind: A free-energy formulation of the human psyche. Physics of Life Reviews 2018; this issue.
[27] Tozzi A. The multidimensional brain. Physics of Life Reviews 2018; this issue.
[28] Benedetti G, Marchetti1 G, Fingelkurts AA, Fingelkurts AA. Mind operational semantics and brain operational architectonics: A putative correspondence. The Open Neuroimaging Journal 2010;4:53–69.

[29] Bohm D. Wholeness and the implicate order. London: Routledge; 1980.
[30] Bohm D. A new theory of the relationship of mind and matter. Philosophical Psychology 1990;3:271–86.
[31] Duch W. Mind as a shadow of neurodynamics. Physics of Life Reviews 2018; this issue.
[32] Pylkkänen P. The role of Eastern approaches in David Bohm's scientific-philosophical odysseia. Progress in Biophysics and Molecular Biology 2017;131:171-8.
[33] Whitehead AN. Process and reality. New York: The Free Press; 1978.
[34] Stapp, HP. Mind, matter and quantum mechanics, third ed. Berlin: Springer; 2009.
[35] Filk T, von Muller A. Quantum physics and consciousness: The quest for a common conceptual foundation. Mind and Matter 2009;7:59–79.
[36] Atmanspacher H, Filk T, Römer H. Weak quantum theory: Formal framework and selected applications. In: Adenier G, et al, editors. Quantum theory: Reconsideration of foundations, 3 ed. New York: American Institute of Physics; 2006. pp. 34-46.
[37] Bohm D, Hiley BJ. The undivided universe: An ontological interpretation of quantum theory. London: Routledge; 1993.
[38] Hiley BJ, Pylkkänen P. Can mind affect matter via active information? Mind & Matter 2005;3:7–27.
[39] Bohm D, Hiley BJ, Kaloyerou PN. An ontological basis for the quantum theory. Physics Reports (Review Section of Physics Letters) 1987;144:321–75.
[40] Bergson H. Duration and Simultaneity, edited by Durie R. Manchester: Clinamen Press; 1999.
[41] Ho M-W. The rainbow and the worm: The physics of organisms, 3 ed. New Jersey: World Scientific; 2008.
[42] Faraday M. Experimental researches in electricity. Twenty-eighth series. Philosophical Transactions of the Royal Society of London 1852;142:25–56.
[43] Globus GG, Pribram KH, Vitiello G (Eds.) Brain and being: At the boundary between science, philosophy, language and the arts. Amsterdam: John Benjamins; 2004.
[44] Gare A. Chreods, homeorhesis and biofields: Finding the right path for science through Daoism. Progress in Biophysics and Molecular Biology 2017;131:61–91.
[45] Ellis G. Top-down effects in the brain. Physics of Life Reviews 2018; this issue.
[46] Krishnamurti J, Bohm D. The Limits of Thought. London: Routledge; 1999.
[47] Kallio-Tamminen T. Quantum metaphysics. The role of human beings within the paradigms of classical and quantum physics. Helsinki: Helsinki University, 2004.
[48] Fingelkurts AA, Fingelkurts AA. Present moment, past, and future: mental kaleidoscope. Frontiers in Psychology 2014;5:395. doi:10.3389/fpsyg.2014.00395
[49] Pylkkänen P. Can quantum analogies help us understand the process of thought. In: Globus GG, Pribrum KH, Vitiello G, editors. Brain and being: At the boundary between science, philosophy, language and the arts. Amsterdam: John Benjamins; 2004. chap.10.
[50] Revonsuo A. Inner presence: Consciousness as a biological phenomenon. Cambridge: MIT Press; 2006.
[51] James W. The principles of psychology, Vol.1. New York, NY: Dover; 1890.
[52] Pylkkänen P. (Ed.) The search for meaning. Thorsons: Wellingborough; 1989.
[53] Vitiello G. My double unveiled: The dissipative quantum model of brain. Amsterdam: John Benjamins; 2001.
[54] Freeman WJ, Vitiello G. Nonlinear brain dynamics as macroscopic manifestation of underlying many-body field dynamics. Physics of Life Reviews 2006;3:93–118.
[55] Flanagan BJ. Are perceptual fields quantum fields? NeurQuantology 2003;1:334–64.
[56] Umezawa H. Advanced field theory: micro, macro and thermal concepts, New York: American Institute of Physics; 1993.
[57] Fingelkurts AA, Fingelkurts AA. Dissipative many-body model and a nested operational architectonics of the brain. Comment on "Dissipation of dark energy by cortex in knowledge retrieval" by Antonio Capolupo, Walter J. Freeman and Giuseppe Vitiello. Physics of Life Reviews 2013;10:103–5.
[58] Fingelkurts AA, Fingelkurts AA, Neves CFH. Emergentist monism, biological realism, operations and Brain-Mind problem. Physics of Life Reviews 2010;7:264–8.
[59] Schaffer J. Monism: the priority of the whole. The Philosophical Review, 2010;119:31–76.
[60] Atmanspacher H. 20th century variants of dual-aspect thinking. Mind & Matter 2014;12:245–88.
[61] Ladyman J, Ross D (with Spurrett D, Collier J.). Every Thing Must Go: Metaphysics Naturalized. Oxford: Oxford University Press; 2007.
[62] Pylkkänen P. Can quantum analogies help us to understand the process of thought? Mind & Matter 2014;12:61–91.

[63] Hansen C. Daoism. In: Zalta EN, editor. The Stanford Encyclopedia of Philosophy (Spring 2017 Edition). URL = <https://plato.stanford.edu/archives/spr2017/entries/daoism/>.
[64] Hall D, Ames R. Dao. In The Routledge Encyclopedia of Philosophy. Taylor and Francis; (1998). Retrieved 20 Feb. 2018, from https://www.rep.routledge.com/articles/thematic/dao/v-1.
[65] Creel HG. What is Taoism? and other studies in Chinese cultural history. Chicago and London: The University of Chicago Press; 1970.
[66] Feinberg TE. The nested hierarchy of consciousness: a neurobiological solution to the problem of mental unity. Neurocase 2000;6:75–81.
[67] Chadha M. Meditation and unity of consciousness: a perspective from Buddhist epistemology. Phenomenology and the Cognitive Sciences 2015;14:111–27.
[68] Schmithausen L. Ālaya-vijñāna: on the origin and early development of a central concept in Yogacara philosophy. Tokyo: The International Institute for Buddhist Studies; 1987.
[69] Waldron WS. The Buddhist unconscious: the alaya-vijnana in the context of Indian Buddhist thought. London and New York: RoutledgeCurzon; 2003.
[70] Dreyfus G. Self and subjectivity: a middle way approach. In: Siderits M, Thompson E, Zahavi D, editors. Self, no-self? Perspectives from analytical, phenomenological, and Indian traditions. Oxford: Oxford University Press; 2011. pp. 114–44.
[71] Chadha M. Reflexive awareness and no-self: Dignāga debated by Uddyotakara and Dharmakīrti. In: Ganeri J, editor. The Oxford handbook of Indian philosophy. New York, NY: Oxford University Press; 2017. pp. 272–88.
[72] Plotnitsky A. Epistemology and probability. Bohr, Heisenberg, Schrödinger and the nature of quantum-theoretical thinking. Springer: Berlin; 2010.
[73] Humphries M. Early Christianity. London: Routledge; 2006.
[74] Noebel D. Understanding the times: the collision of today's competing worldviews, rev 2nd ed. Summit Press; 2006.
[75] Van Til C. The defense of the faith, 3rd ed. Philipsburg, New Jersey: Presbyterian and Reformed Publishing; 1967.