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Consciousness as a phenomenon in the operational architectonics of brain organization: Criticality and self-organization considerations

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ABSTRACT

In this paper we aim to show that phenomenal consciousness is realized by a particular level of brain operational organization and that understanding human consciousness requires a description of the laws of the immediately underlying neural collective phenomena, the nested hierarchy of electromagnetic fields of brain activity – operational architectonics. We argue that the subjective mental reality and the objective neurobiological reality, although seemingly worlds apart, are intimately connected along a unified metastable continuum and are both guided by the universal laws of the physical world such as criticality, self-organization and emergence.

"all human behaviors, including thoughts, undirected or goal oriented actions, or simply any state of mind, are the outcome of a dynamical system – the brain – at or near a critical state."

Chialvo (2007)

"Understanding the brain is among the most challenging problems to which a physicist can be attracted. As a system with an astronomical number of elements, each one known to have plenty of nonlinearities, the brain exhibits collective dynamics that in many aspects resemble some of the classic problems well studied in statistical physics."

Chialvo (2010)

"What we require now are approaches that can unite basic neurobiology and behavioral sciences into a single operational network."

Purpura (1975)

1. Introduction

Given human evolutionary sophistication, our brain, that makes us the feeling, talking, knowing, society-building, socially complex species, gave us at some point in the history of the physical world an unprecedented gift – *consciousness* – the entity that none can still easily define, but nearly all accept that it exists [4,5]. This entity turns a mammal into a *human being* capable of self- and environmental awareness. From this point in time, the faded pieces of the external physical world are transformed as images into nonmaterial clusters of reality, and these clusters form what is called mental or "*virtual*"[1] reality [8]. Having unlimited degrees of freedom, infinite combinatorial power and being momentarily accessed for self-presentation, these mental images become subjects of the

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[1] Here the term "virtuality" is used in the same way as in the computer engineered "virtual reality" [6]. A virtual reality is a computer-generated world simulation (in which the subject is immersed) that does not exist as a world anywhere inside the computer or even in the program. This is exactly the same with phenomenal subjective world which could not be found in the brain's anatomy. Phenomenal world is thus "virtual" for precisely the same reason [7]: it provides complete immersion for the embodied subject in the middle of a perceptual (virtual) world where he/she is surrounded by patterns, objects, people and events.

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remarkable theater of mental psychological reality [9]. Thus, in humans and through humans nature becomes *aware of itself*. Indeed, without us, conscious human subjects, the physical world has absolutely no way of knowing of its own existence, neither is there reality of lived subjective experience or sensation [7].

We have argued previously [10] that phenomenal consciousness refers to a higher level of organization in the brain and captures all immediate and undeniable (from the first-person perspective) phenomena of subjective experiences (concerning hearing, seeing, touching, feeling, embodiment, moving, and thinking) that present to any person right now (subjective present) and right here (subjective space). In this definition *phenomenal* means *subjective*: someone possesses phenomenal consciousness if there is any type of subjective experiences that is currently present for him/her. This notion follows a biological realism approach to consciousness proposed by Revonsuo [7]; according to which subjective consciousness is a real and a natural phenomenon that is *tightly anchored* to a biological reality found in the human brain. Thus, human brains are those specific "locations" in the physical world, where these two realities, the subjective mental reality and the objective neurobiological reality, although seemingly worlds apart, are intimately connected along a *unified metastable continuum* [11].

This approach is currently supported by most researchers working in the field [12–24] and is distinct from alternative ideas according to which consciousness is either a supernatural phenomenon that is entirely beyond the reach of science [25–28], or is a phenomenon found at the quantum level [29–32], or pervades the whole human body [33–37], or is instead present across the whole physical universe (so called panpsychism) [38–41].

If phenomenal consciousness is a biological phenomenon within the confines of the brain,[2] then there must be a specific level of brain organization and a specific spatial–temporal grain in it where consciousness resides. In other words, we could expect that at the *lower* (in comparison with the phenomenal consciousness) level of brain organization there should be nonexperiential entities (some complex electrophysiological mechanisms) that function as the direct realization base of the phenomenal world. Additionally, phenomenal consciousness, being a real phenomenon, should have *causal powers*[3] distinct from the purely neurophysiological (nonphenomenal) realm [7]. However, to explain the features of consciousness such as phenomenal unity and continuity, together with a succession of discrete thoughts and images, a reference to mechanisms outside the phenomenal realm is necessary [43]. If it could be done, then we would be closer to understanding how it is possible that a particular level of brain functional organization manifests itself as a subjective world.

Before moving on, an important clarification should be made about the most frequent error/confusion that appears systematically when researchers try to explain consciousness: usually *constitutive* and *etiological* explanations are mixed. At the same time, they belong to different dimensions, and only one of them is interesting in the context of the present discussion. Constitutive explanation "looks" *downward* and describes what constitutes the phenomenon, while etiological explanation "looks" *backward* and specifies the causal pathway that either brought about or modulated the phenomenon [44]. In the case of consciousness, the constitutive basis includes such *immediately lower-level entities* on which consciousness as a whole is *ontologically* dependent (Fig. 1), meaning that consciousness could not exist without them to be present. In other words, a constitutive explanation describes immediate lower-level processes that as a whole is consciousness [7]. On the contrary, an etiological explanation considers the causal history or *pathway chain of events* that lead to consciousness and it is neutral about the constitutive entities (Fig. 1), because causal dependence does not entail ontological dependence [7]. Thus, as it is clearly stated by Revonsuo [7], "consciousness can in principle exist even in the absence of the entities and activities that make up its etiological pathway, while it cannot, even in principle, exist without the entities and activities that make up its constitutive basis." For the purposes of our discussion we are interested only in the constitutive basis of phenomenal consciousness.

In the following we will describe and analyse the functional architecture of the brain whose organization and dynamics could in principle be *isomorphic* to the architecture of a mind and thus constitute the subjective experience. However, it makes sense to look at the lower level of explanatory mechanisms (neurophysiology) only after there is a clear description of the phenomenon (phenomenal consciousness) that these mechanisms are supposed to explain. Once we have a clear description of the important principles of the higher phenomenal level, it will suggest what sorts of immediate lower-level neural phenomena might be closely associated with it and constitute it through the entangled complementary isomorphism principle [11].

2. Phenomenal consciousness level

Since a complete analysis of spatial–temporal organization of the phenomenal mind has been provided by us before [11,10], here we will concentrate on the principles that are the outcome of collective phenomena in any complex dynamical system – *criticality* and *self-organization* – and which are important for situating the phenomenon of consciousness within universal laws of the physical world [1,45,24,46].

In physics, the notions of "phase space transitions", "renormalization group" and "spatial–temporal separability principle" are powerful tools for interpreting complex systems phenomena involving many scales of space and time. According to Werner [24] the significance of these concepts is expressed in a detailed and systematic

[2] Importantly, this claim does not imply that consciousness is localized in some particular area of the brain, – on the contrary, all available experimental data point against such a possibility. The statement only postulates that consciousness is realized somewhere within the brain's reality rather than anywhere outside it [7].

[3] For the argumentation that to be real is to have causal powers see [42].

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