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Consciousness and Cosmos

Building an Ontological Framework

Abstract: *Contemporary theories of consciousness are based on widely different concepts of its nature, most or all of which probably embody aspects of the truth about it. Starting with a concept of consciousness indicated by the phrase ‘the feeling of what happens’ (the title of a book by Antonio Damasio), we attempt to build a framework capable of supporting and resolving divergent views. We picture consciousness in terms of reality experiencing itself from the perspective of cognitive agents. Each conscious experience is regarded as composed of momentary feeling events that are combined by recognition and evaluation into extended conscious episodes that bind cognitive contents with a wide range of apparent durations (0.1 secs to 2 or more secs, for us humans, depending on circumstances and context). Three necessary conditions for the existence of consciousness are identified: a) a ground of reality, envisaged as a universal field of potentiality encompassing all possible manifestations, whether material or ‘mental’; b) a transitional zone, leading to; c) a manifest*

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world with its fundamental divisions into material, 'informational', and quale-endowed aspects. We explore ideas about the nature of these necessary conditions, how they may relate to one another and whether our suggestions have empirical implications.

Keywords: consciousness; cosmos; monism; experience; matrix; energy; feeling.

1. Introduction

Academic interest in consciousness has flourished over the last 40 years, to an extent not seen since the late nineteenth century. The main contemporary lines of thinking about conscious activity can be assigned to four main categories:

- a) Reductive physicalism: The assumption that the physical world is a mind-independent reality, adequately described by (mainly classical) physics. Consciousness, within this paradigm, is generally treated as either a sort of illusion or alternatively as an emergent property of neural activity, rather as liquidity is an emergent property of H₂O molecules;
- b) Idealism: The belief that consciousness is the ground of reality, while the material world derives from it;
- c) Dualism: The attribution of substantial and partially independent realities to both consciousness and the physical world. It comes in a variety of 'strengths' or 'flavours', ranging from substance (Cartesian) to property dualisms (e.g. based on dual aspects of information, as proposed by Chalmers, 1996);
- d) Panpsychism: The belief that consciousness in some form or other is intrinsic to reality, being present in varying degrees in all experienced reality. It is rarely clear whether or how this proposal may differ from property dualism, except that it is most often bottom-up, from micro to macro. Panpsychism is currently quite popular, but there are many versions and it is not clear which should be preferred. Constitutive and non-constitutive panpsychism are examples, as well as panexperientialism (Griffin, 1998b; Nixon, 2010a; Rosenberg, 2004), cosmopsychism (Nagasawa and Wager, 2017), animism (Abram, 1996), etc. There are various ontological explanations for panpsychism, as well (*cf.* Clarke, 2012; Strawson, 2006), especially as illustrated in edited collections (e.g. Brüntrup and Jaskolla, 2017; Nixon, 2017; Skrbina, 2009). What they have in common is that experience is

taken to be universal — or primary elements can combine to make it so, as in panprotopsychism (Hameroff, 1998; Chalmers, 2017).

Many of us are unhappy with this taxonomy as each of its components is of questionable adequacy in relation to a wide range of both logical and empirical considerations. (Our own publications that relate to these issues include Pereira Jr. *et al.*, 2010; Pereira Jr., 2013; 2014; Nixon, 2010b; 2015; Nunn, 2013; 2015; 2016.)

This paper offers what we hope will prove to be a more useful framework on which to base enquiries into the nature of consciousness, a framework able to indicate where the categories of opinion outlined above may be pointing in useful directions and where they may go astray.

Starting with a concept of consciousness indicated by the phrase ‘the feeling of what happens’ (see Damasio, 2000), we attempt to build a framework capable of supporting and resolving divergent views. We picture consciousness in terms of (actual) reality experiencing itself (its potentialities) from the perspective of cognitive agents. Each conscious experience is regarded as composed of momentary quale-endowed feeling events that are combined by recognition and evaluation into extended conscious episodes.

Relative to the ambition of the project, this paper represents a modest starting point. We present a schema or outline of an ontological framework for consciousness, which is in effect an attempt to provide a useful, coordinated summary of extensive writings published elsewhere by ourselves (and many other authors).

2. The Framework

The diagram below (Figure 1) shows three ‘phases’ of reality (from left to right) and three aspects (from the bottom to the top) contributing to the basis of our manifest (‘actual’) world. Arrows represent principal interrelationships between the various named phases and components.

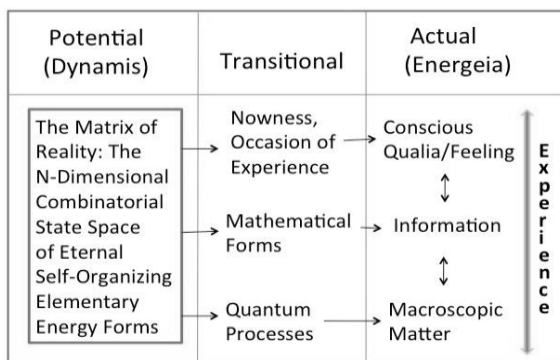


Figure 1. Diagram of the becoming process of reality. *Dynamis* and *Energieia* are Aristotelian terms that refer to, respectively, the potency and the act of being. The split of the common potentiality into the three actual (i.e. manifest in experience) aspects of being, as well as the inclusion of a transitional phase, are our original proposals.

The existence of a common cause of the three aspects of experience (physical, informational, and conscious) is an imperative to preserve the monist view of reality — otherwise, Popper's (1972) view of three independent 'worlds' should be assumed — while preserving the irreducible status of the aspects. The three mutually irreducible aspects are parts of the same reality, but how to conceive of their unity? We adopt a particular branch of the neutral monist metaphysics (explained in the next section), which envisages a ground of existence with the *potential* to originate the three aspects identified in Figure 1, in a process that can be regarded as involving self-organizing elementary energy forms (EEF). This system is called the *Matrix*. Besides material particles originated by quantum processes (transitional), it is also claimed to originate mathematical forms (transitional) that result in information (experiential), and occasions of experience (transitional) that fuse to become conscious qualia and feelings (experiential), as indicated in the above diagram.

Several rather general considerations about the nature of the 'actual' underlie construction of the diagram. Important ones include:

- a) In our conscious experiences there are many systems within manifest reality (i.e. the 'actual') that appear to lack conscious experience of that reality, including some of our own neural and somatic systems; there are also conscious systems, especially ourselves. A *potentiality* for conscious experience (in the 'Matrix

of Reality' in the diagram) must therefore exist, in some form or other. This Matrix thus provides, or indeed is, the condition of possibility for our conscious experience to be as it is. It has the potentiality to evolve towards both conscious and non-conscious systems;

- b) The properties of conscious activity, usually described as the experience of subjective feelings and *qualia*, occur only in conscious systems. They cannot be attributed to exclusively physical or informational processes; in other words, there is likely to be something irreducible in a conscious mental experience that comes directly from fundamental principles of reality, not from other components of the 'actual' (*cf.* Chalmers, 1995; Pereira Jr., 2013; Hunt, 2014);
- c) The consideration that conscious experiences — at least for biological systems — require a material body, exchanges of information, and sets of rules or 'laws' governing materiality, causality, and mentality. All these phenomena are equally 'real' features of the actual world, which implies origin in a common ground (the Matrix) that can be referred to as 'neutrally monistic': it is not a combination or merging of the aspects but a third term; the neutral common source of matter and mind.

The above picture leads to a fifth category in the taxonomy of theories of consciousness: a *multi-aspect monist ontology* (the experiential reality being composed of mutually irreducible aspects) combined with a *neutral monist metaphysics* (the postulate of a common source of the three aspects in the reality process of continuous *becoming*). The expression 'multi-aspect monism' (as suggested by Holmgren, 2014) encompasses dual-aspect (Velmans, 2009), reflexive monism (Velmans, 2012), triple-aspect monism (Pereira Jr., 2013), and other possible formulations of differentiated monisms. The diagram displays three mutually irreducible aspects of reality manifest in experience, all deriving from a primitive neutral Matrix.

The next step of our investigation involves trying to unpack some of the meanings implicit in our schematic framework, starting with 'potential' and working our way to the right-hand side (the domain of 'actual' experience). This combination is compatible with some varieties of panexperientialist and panprotopsychoist metaphysical frameworks.

3. Potential

We picture this as a neutral unity that is the source of the universe and everything in it. It is eternal (timeless) and contains the power to generate all aspects that manifest themselves in experience.

We interpret the Aristotelian concept of ‘potentiality’ as both ‘possibility of being’ and ‘power of becoming’. In this sense, what is potential is not just something that is not actual; the domain of potential is the domain of the powers (the elementary energy forms: EEF) that self-organize to generate a dynamic reality.

In the philosophy of religion, the neutral unity can be compared to the Whiteheadian theology of Hartshorne (1981).⁵ However, we do not favour such a theological interpretation, for the greatest challenge of consciousness studies in the last twenty years has been constructing a coherent interdisciplinary — philosophical and scientific — Theory of Consciousness. Connection with conflicting religious beliefs would make the necessary agreement even more difficult. Besides, any postulate of deity or deities as ultimate ontological forces implies spiritual idealism or Cartesian dualism, either one the antithesis of our neutral monist thesis.

In the realm of physics, there are four well recognized powers: the four fundamental forces (weak and strong nuclear, gravitational, and electromagnetic forces). Although many theoretical physicists try hard to build a *Theory of Everything*, we view a complete description of these powers as epistemically inaccessible to us in principle, as well as in practice. We do not argue for any theoretical proximity between proposals in our diagram and current string, p-brane, and m-theory, or alternatively loop quantum gravity, for example, which in our view illustrate the difficulty of trying to describe the inaccessible with their ‘discovery’ of a nearly infinite range of possible universes. We take the Matrix to be a speculative or metaphysical postulate, unamenable to any precise or detailed description. When we attribute qualities or properties to it, these must be regarded as never more than partial expressions of potentialities within it — those potentialities that we take as generators of the aspects of our experiences.

Neutral monism is here understood as complementary to multi-aspect monism. The neutral Matrix is a dynamic source, which has

⁵ Whitehead’s own stance on deity seems to have been mainly agnostic, though he did consider a universal mind composed of compound experiences (see Griffin, 1998a, p. 204).

been postulated as related to the dynamic processes of quantum field theory (*cf.* Coleman, 2017). However, in the diagram the coherent (superposed/entangled) quantum wave function is not the only manifestation of the primal reality. Our framework suggests that besides manifesting itself in material particles (and corresponding macrostates that result from the decoherence process), the primal reality *also* manifests itself as ‘mathematical form’ leading to ‘information’, and as ‘occasions of experience’ leading to ‘conscious qualia/feelings’.

This form of neutral monism is different from previous versions of the concept proposed by William James, Ernst Mach, and Bertrand Russell (see Stubenberg, 2016; Russell, 1921). We favour the approach assumed in the Pauli-Jung conjecture, considering the neutral reality as ‘something that is always immanent’ (see Atmanspacher and Fuchs, 2014), thus not just the source but also the ever-present *ground of being* (see also Velmans, 2012). The Matrix is not only a common cause of the three aspects, but underlies their manifestations in our experience and their complementarity. Although not conceived as existing in a separate world (as were Plato’s Ideas), but instead being immanent in the natural world (as were Aristotle’s Forms), we understand that the basis of the EEF cannot be directly observed or measured; only their combinations, manifest in our experience, can become objects of study for empirical and experimental sciences, or for the interpretations of common sense.

A first attempt at conceiving of such a neutral primitive reality was the reference to ‘Energy’ in ancient Buddhism (see Wallace, 2004), as well as Anaximander’s ‘apeiron’ (‘the boundless’, a primitive essence that was conceived as infinite and undetermined) in classical Greek Pre-Socratic philosophy. The idea of regarding energy as a fundamental concept in physics emerged towards the end of the nineteenth century — mixed with epistemological considerations — for example in the work of Rankine (1855), Ostwald (1907), and Ernst Mach’s reaction to the atomist concept of matter (see Banks, 2003).

Brenner (2008) has described the primal source (i.e. our Matrix) as ‘energy’, which must be true in a sense, but it is a form of ‘energy’ able to encompass all aspects of reality, not only those belonging to physicality, and is prior to space, time, and all other categories.⁶ To

⁶ ‘Energy’ as a descriptor of our ‘potential’ should probably be regarded as a qualitative rather than a quantifiable entity since it may well amount to zero, at least from our perspective, in a manner analogous to the suggestion made by some cosmologists that

avoid confusion with the ordinary use of the concept of energy in physics, we refer to this primitive potentiality with a capital letter: *Energy*.

Actually, Energy appears to be the only scientific conceptual category that can be claimed to originate the three aspects of experienced reality:

- a) Einstein's equation ($E = mc^2$, where c = speed of light) explains the equivalence of Energy and Matter;
- b) Boltzmann's approach (the distribution function that describes the temporal evolution of position, direction, and kinetic energy of particles in a many-body closed system) explains how the spatial distribution of Energy relates to negative entropy (the non-Gaussian distribution of physical energy in space, allowing the production of work), which is related to Shannon-Weaver's quantity of information transmitted between a source and a receptor (both have the 'P log P' form, which measures the probability of physical states in regard to the factors that determine their occurrence — the permutability of microstates in Boltzmann, and the matching of source and receiver in Shannon-Weaver; see discussion in Pereira Jr., 2013, and Pereira Jr., Vimal and Pregnolato, 2016); and
- c) The 'dynamical signature' of consciousness (Pereira Jr., Foz and Rocha, 2017) connects conscious experience with the structured distribution of Energy in time; more precisely, Energy is pictured as patterned within a dynamical amplitude-modulated hydro-ionic wave containing a temporal form.

It is important to distinguish our account of the Matrix from the panpsychist view of Galen Strawson. He argues against the possibility of a transition from an absolute zero-mind to some degree of mind (Strawson, 2006). However, neutral monism does not suggest an 'absolute zero-mind', but the *potential* for experience. In other words, we do not apply the 'principle of the excluded middle' to the problem of origination; besides zero-mind and mind there is a third state of mind: the potential mind (as in panprotopsyichism).

the 'positive' energy of matter is exactly cancelled out by 'negative' gravitational potential energy, thus leaving the sum total of energy present at the 'big bang' as zero. However, we are *not* equating our 'potential' to the 'big bang' — only suggesting that the 'energy' considerations involved might be similar.

4. Transitional

Clearly the universal symmetry of ‘potential’ must break in order to allow manifestation of our varied world. And this appears to happen in stages. We are agnostic about the number of stages (i.e. there may be more stages of ‘transition’ on the way to the ‘actual’ than the one that we have pictured), but overall transitional characteristics can be identified. Those leading to macroscopic matter are described in exquisite detail by Schrödinger wave functions and/or Heisenberg matrices. A further symmetry break occurs in the course of ‘quantum measurements’ on these entities to give the outcomes that comprise objective aspects of our ‘actual’ world. However the origins of rules governing these outcomes would seem to need separate consideration, while contemporary quantum theory offers no place for two central features of our existence, namely subjective experience or ‘feeling’ and temporality (position in time, unlike position in space, is *not* a ‘quantum observable’). We therefore identified a further two *transitional* categories (‘nowness’ and ‘mathematical forms’) to give us some sort of handle on issues arising from the incompleteness of quantum theory in these respects (i.e. the fact that it has nothing to say about either the origins of basic organizational features of the world, including many of its own rules, nor about the ‘feelings’ that we experience in present moments).

Our proposal seems compatible with Whiteheadian panexperientialism (as in Griffin, 1998a,b; Nixon, 2010b). Neutral monism (which refers to something that is neither subjective nor objective, but has the potentiality for both) may refer to the neutral background from which momentary *occasions of experience* (‘active singulars’) arise. Griffin’s position is somewhat related to panprotopsychism in that both accept experience as existing before the experiencers become conscious of themselves, which is similar or identical to the view we’re presenting. However, Griffin (from Whitehead) sees the creative advance of reality as intrinsically experiential while panprotopsychism envisions non-experiencing particulars that must merge to enable subjective experience.

Our concept of ‘nowness’ owes a lot to Henri Bergson’s idea of ‘duration’, especially as developed by Alfred North Whitehead (1929/1978) in his process philosophy. Whitehead famously averred that reality is always *becoming* (in process) but never *becomes* static being (cf. Prigogine and Stengers, 1984). The reality process is always in a state of ‘creative advance into novelty’ headed by the ‘actual

occasions of experience', as close to a 'now' as Whitehead will accept.

These flashes of experience involve the concrescence of 'the many' — already existing concrete entities of matter-energy — into a new 'one' — the *occasion of experience* — also teleologically influenced toward *novelty* by universal creativity. In Whitehead's famous phrase, 'The many become one and are increased by one' (1929/1978, p. 21). The momentary experience completes itself and becomes part of the many, and the process continues. The reality process is constrained by what already exists (somewhat in the actual past) but is also always novel since it is inspired by unmanifest creative potential (the *eternal objects* in the 'future'). It should be noted that the flash of experience just *happens*, but is not associated with a central experiencer, so it has no extra qualities, like feeling-tones, that a *conscious experience* in an organic, 'compound entity' (like us) comes to have.

Whitehead and Bergson both considered that general relativity's account of time relates only to the structure of classical causal relationships (Canales, 2015), leaving out any basis for the present moments that we experience or indeed for the 'creativity' that manifests as relativistic time passes (*cf.* Prigogine, 1997). The 'block universe' implications of relativity theory are hard to reconcile with the occurrence of genuine novelty. We think that 'nowness' and 'occasions of experience' can usefully be regarded as alternative terms referring to the same transitional entity or dynamic reality process.

Mathematical forms are direct manifestations of the Matrix; they refer to patterns that manifest in reality, including the so-called 'Laws of Nature' and Principles, which can often, or perhaps always, be described mathematically. Plato regarded them as deriving from his 'archetypes', which appear to have a role equivalent to Aristotle's 'formal causes'. We picture them as consequent on patterns of symmetry breakage as the 'potential' becomes 'transitional', perhaps owning the same sort of reality as Schrödinger wave functions; indeed, wave functions may be regarded as a particular (but not the only) class of these forms — a class distinguished by its direct relationship to outcomes of 'quantum measurements'.

The human *description* of these patterns, of course, belongs to the 'informational' and 'conscious' aspects of reality. As far as the description corresponds to the potentialities of the Matrix, we belong in the realist camp in the philosophy of mathematics.

5. Actual

This refers to the world that we experience from both subjective and objective points of view. Of course all conscious experience is subjective and objectivity is only inferred. Nevertheless there is overwhelming evidence that ‘objectivity’ is a valid category and that the ‘actual’ can usefully be subdivided. Here we follow triple-aspect monism (Pereira Jr., 2013), dividing the ‘actual’ into categories referring to subjective conscious experience and to objective matter, with an intermediate category of ‘information’ (as originally proposed by Velmans, 2009). The latter category is needed because ‘information’ clearly relates to both objective and subjective worlds but is not confined to either. It has a quasi-independent existence, or at least aspects of it appear to own independence. While in Velmans’ formulation information mediates the material and the conscious mental aspects, in Pereira Jr. (2013) information composes a third aspect that refers to non-conscious cognitive processes, while the conscious aspect is defined by the conjunction of cognition with feeling.

Both the Shannon information of classical information theory and Bateson information (‘a difference that makes a difference’) are clearly grounded on physical processes, belonging with ‘macroscopic matter’ in the sense that they derive from causal happenings in the objective world. Shannon weightings, though, depend on ‘expectation values’ that are less clearly ‘physical’. The meaningful information in which conscious experience deals is entirely dependent on relating incoming Bateson information to memories of various sorts (ranging from genetic to sociocultural) and is thus even more detached from direct physicality, with links that get ever more vague and longer as chains of causation stretch out. Then there is ‘information’ conceived in Aristotelian terms as ‘that which imparts form’. This sort of ‘information’ is best regarded as deriving directly from the ‘mathematical forms’ of the ‘transition’ zone. Our ‘information’ category is thus something of a hotchpotch, but we think it is nevertheless a useful one.

In the proposed approach, the mark of conscious experience is feeling. The concept of feeling was discussed by Pereira Jr. (2013) and proposed to encompass emotional feelings (as discussed in Wang and Pereira Jr., 2016), cognitive feelings (as ‘the feeling of knowing’ identified by Burton, 2008), the feeling of decision making (the will), basic sensations, as well as all kinds of perceptual ‘qualia’. *Feeling* is conceived as reality experiencing itself from the perspective of

cognitive agents. This view is also implicit in Velmans' *reflexive monism* (2009) when he states that phenomenal experience is a process of 'real-izing' (*making real*), implying a reflexive relation between consciousness and cosmos. It should be noted that 'reflexive' in this case avoids linear cause and effect and involves, instead, a mutually intertwined 'onflow' (Pred, 2005) or 'chiasm' (Merleau-Ponty, 1968) of cosmos and consciousness.

Having outlined what we mean by our categories, the next step is to look at what arrows linking them may imply.

6. Connections

Arrows going from left to right in the diagram refer to a wide variety of relationships involving symmetries or symmetry breaks. The process that we know most about is the one leading from 'quantum processes' to 'macroscopic matter' and is referred to by a variety of terms: 'quantum measurement', 'collapse of the wave function', or 'decoherence'. There are many ideas about its basic nature and about its causes, but all we know for sure is that it involves broken symmetries and is temporally irreversible.

Arrows leading from 'potential' through 'mathematical forms' to 'information', on the other hand, refer to symmetries that are preserved in the case of basic conservation laws (i.e. natural laws with a basis in Noether's theorem⁷) and their consequences for the natural world, although symmetry breakage is likely to be involved in other cases. The arrow from 'nowness' to 'qualia/feeling' is of particular interest here and we will offer ideas about its interpretation in sections following this one.

The bidirectional, vertical arrows in the 'actual' zone refer to all the causal relationships that are studied by people ranging from particle physicists to sociologists. We think it very likely that similar arrows would be appropriately placed in the 'transitional' zone, but have not shown any in our diagram since virtually nothing is known about them.

⁷ In 1915, Emmy Noether proved that any differentiable symmetry of the action (i.e. Lagrangian) of a physical system has a corresponding conservation law (see e.g. Neuenchwander, 2017). Hamiltonians are generally thought to be equivalent to Lagrangians in this context.

7. Origins of Consciousness

Our diagram shows qualia/feelings as causally related to both the ‘transitional’ zone and, via ‘information’, to macroscopic matter. Several related theories of mind and consciousness have been proposed in recent decades (see for instance the reviews in Pereira Jr. *et al.*, 2010; Pregmolato, 2010; Zizzi and Pregmolato, 2012). Within the scope of our model, the working hypothesis we choose is that the neural basis of conscious experience (i.e. its connection with ‘macroscopic matter’) may be found in wavelike, patterned ion fluxes in the brain, principally involving calcium ion fluxes supported by both neurons and astrocytes (Nunn, 2015; Pereira Jr., 2017).

Each conscious experience is regarded as composed of momentary feeling events that are combined by recognition and evaluation into extended conscious episodes with a wide range of apparent durations (0.1 secs to 2 or more secs, for us humans, depending on circumstances and context; see Pereira Jr., Foz and Rocha, 2017). The most fully developed version of this view has been named the ‘calcium wave model’ (Pereira Jr. and Furlan, 2010, Pereira Jr., Barros and Santos, 2013) and more recently ‘hydro-ionic wave theory’ (Fernandes de Lima and Pereira Jr., 2016; Pereira Jr., 2017). The general idea behind the theory is that ions in solution, forming *hydro-ionic waves* in the living tissue of our bodies, are the adequate vehicle for feeling, because they have the degrees of freedom required to embody temporal amplitude-modulated patterns capable of resonating with potential patterns of the reality’s Matrix.

Playing the violin provides a useful metaphor for what may be going on. The vibrations of the strings mostly generate the music. Of course, the pressure of the fingers on the strings, the wood body, the arch, the representation of the music on paper, the player, the audience, the room, etc. are all part of the phenomenon. However, the part of the instrument that has the required degrees of freedom to generate the music is the violin string. In the same way, our brains offer a variety of materials and processes that might embody mental states. Narrowing the field down are arguments (e.g. Nunn, 2016, chapters 2 and 3) for supposing that processes allowing sufficient ‘degrees of freedom’ to support our form of ‘mentality’ must involve both temporally and spatially fractal patterns, which probably excludes all classical processes and structures in the brain other than ion fluxes and their associated electromagnetic fields. Calcium ions are particularly important in this connection because of their close

association with early stages of memory processes (Alkon *et al.*, 1998; Rocha, Pereira Jr. and Coutinho, 2001; Pereira Jr. and Furlan, 2010).

Given this picture of the nature of consciousness, it is possible to develop ideas about the ‘nowness’ → ‘qualia/feeling’ connection. We have two such ideas to offer, which may well turn out ultimately to be equivalent, rather as Schrödinger wave functions and Heisenberg matrices are equivalent. At present, though, we don’t know whether they are equivalent so we will describe them separately in succeeding sections.

It’s worth emphasizing here that our picture of the neural basis of conscious experience is insufficient on its own to *explain* consciousness. It is a picture of the neural *correlates* of consciousness that does no more than account for origins of its content. Our two suggestions for what might put the phenomenality into the neurology are termed ‘recoherence’ and ‘SoS theory’, which are not unrelated to Whiteheadian process.

8. Recoherence

This hypothesis was raised in a previous publication by Pereira Jr., Vimal and Pregnolato (2016). In the nervous system of living individuals, including the human brain, the instantiation of macrostates is spatially distributed and unconscious. The formation of conscious episodes requires the formation of a recoherent collection of these macrostates. When all necessary conditions of consciousness (such as activation of neural networks, wakefulness, re-entry, attention, activation integration, working memory, stimulus contrast at or above threshold, and potential experiences embedded in the neural network) are satisfied, a recoherent state (corresponding to a conscious episode) emerges, from a collection of *non-conscious* qualitative macrostates instantiated in spatially distributed neural circuits. Brain recoherent macrostates result from the activity of entropy reducers, as ion channels and proteins composing intracellular signal transduction pathways.

The recoherence process possibly also includes unconscious quantum computations (Rocha, Pereira Jr. and Coutinho, 2001; Rocha, Massad and Pereira Jr., 2005; Pereira Jr., 2012) executing non-algorithmic operations that support creativity (Zizzi and Pregnolato, 2012). According to Vitiello (2001), the role of external stimulation in perception is to select — for each occasion of experience — one integrated set of patterns to appear in consciousness. This set is

selected at each conscious present time ('nowness') among the several possibilities afforded by quantum field processes underlying brain activity.

An explanation of the role of entropy reduction in the creation of the structured fractal complexity of hydro-ionic waves in living tissue demands three steps. First, it is necessary to recall the mechanism of a Maxwell Demon, which — in a thought experiment — reduces the entropy of a gas system by means of a small gate that separates molecules according to their kinetic energy (the Demon needs useful energy to make his work; in living systems, this energy is obtained from external sources, in the form of food). Ion channels in living cells probably have this role of entropy reduction, as argued by Nobelist Jacques Monod (1972). Second, an effect of this kind of mechanism in living tissue is to keep the system far from thermodynamic equilibrium, then making possible the operation of Nicolis and Prigogine's (1989) proposed mechanism of 'order from fluctuations'. Third, in Pereira Jr., Vimal and Pregolato (2016) it was argued that order from fluctuations affords the recoherence process, by which spatially distributed dendritic fields in the brain (embodying different information patterns) become superposed and entangled, giving rise to experienced conscious episodes (for a cognitive system interacting with her environment). Conscious contents (qualia, feeling, and their cognitive expressions) can be described by means of a N-dimensional state space (Pereira Jr. and Almada, 2011) that recovers the unity of the Matrix of reality from the first-person perspective of the individual conscious agent.

Qualities instantiated in unconscious brain macrostates are integrated into conscious experiences when such a set of conditions is fulfilled, including distance from thermodynamic equilibrium and operation of biological self-organizing mechanisms. Using this explanatory strategy, we can explain why some natural systems have subjective conscious experiences while others do not. The progressive interaction of the elementary energy forms (EEF; see the diagram of Figure 1) generates a complex state space, of which some regions correspond to the first-person conscious activity of living individuals.

The existence of these regions is derived from the potentialities of EEF, in a strongly emergent process. Other regions do not display conscious activity, because the necessary conditions (such as formation of neural networks, wakefulness, re-entry, attention, information integration, working memory, stimulus contrast at or above threshold,

and potential experiences embedded in neural network) are not satisfied.

The theoretical and experimental basis of the above hypothesis is outlined below:

1. The conscious system is kept at low entropy regions of its state space;
2. There is an ‘order from fluctuation’ (Nicolis and Prigogine, 1989; Prigogine and Stengers, 1984) mechanism that supports the self-organization of the system;
3. The mechanism generates dynamical ‘dissipative structures’ similar to Belousov-Zhabotinski ‘clocks’;
4. Information is embodied in the wave as (spatial and temporal) amplitude, frequency, and phase modulations of the energy; some of this information may be retrieved from unconscious quantum computations (Zizzi and Pregnolato, 2012);
5. The system is metastable; it oscillates between decoherence and recoherence phases in the scale of nanoseconds;
6. We consciously experience only the recoherent phases; the decoherent/classical phases are unconscious! Therefore, we can live with fast decoherence times, provided that there are recoherent phases that dominate the system in the next nanoseconds, generating in our conscious mind the appearance of continuity (the flux of consciousness, the specious present, duration).

The flow chart below (Figure 2) pictures this idea, with the dotted arrows on the left representing the proposed ‘nowness’ → ‘qualia/feeling’ connection, which has now become bidirectional:

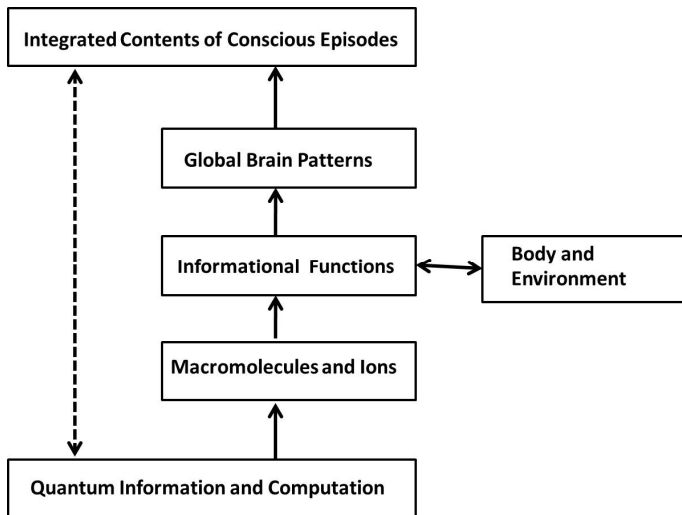


Figure 2. The (possible) circular topology of reality. We picture consciousness in terms of reality experiencing itself from the perspective of cognitive agents. Quantum N-dimensional states furnish the mind with patterns that may be brought to consciousness, in a biophysical process that involves a mechanism of (macro-)molecules and ions. At the macro level, these patterns are selected (as proposed by Vitiello, 2001) by stimuli from the body and environment. Recoherent conscious states, built on informational functions (intercellular signalling) reconnect with the reality's N-dimensional Matrix, revealing a circular topology. The resulting hydro-ionic waves in living tissue make actual one among the practically infinite first-person 'narratives' contained in the potential domain. Figure originally published in Pereira Jr. (2004; copyright by APJ).

Hydro-ionic waves can be regarded as recoherent phenomena, providing a two-way relationship between 'nowness' and 'qualia'. Superposition and entanglement of patterns instantiated at (classical) dendritic fields and the hydro-ionic waves they induce generate a conscious episode; within the episode, these patterns are 'bound' to each other in a 'Gestalt' experienced only by the system. The hydro-ionic wave has the 'key code' to actualize the potentialities of feeling in living tissue, constructing qualia directly from the potentialities of the fundamental reality — thus completing the full circle of reality, as indicated in the flow chart above. Searle (2013) says consciousness is macroscopic; in the above flow chart, consciousness is 'meta-macroscopic' (beyond the three-dimensional space of macroscopic physics) and meets the fundamental reality. Assuming the hydro-ionic model of

the embodiment of qualia/feelings, the picture implies the existence of isomorphisms between the spatio-temporal patterns of the hydro-ionic wave and our conscious lived experiences, since they are all aspects of the same becoming process of reality.

The explanation here is not *a priori* or deductive, but based on scientific results that suggest that the role of hydro-ionic waves corresponds to the integration of brain distributed patterns and construction of episodes, as reviewed in Pereira Jr. and Furlan (2009; 2010), Pereira Jr. (2012; 2013; 2014; 2017), Pereira Jr., Barros and Santos (2013), and Pereira Jr., Foz and Rocha (2015; 2017). A version of global workspace theory (GWT) is implicit in this proposal; the hydro-ionic wave can be regarded as constituting a dynamic workspace (compatible with the original GWT) that integrates information, generating a ‘Gestalt’. This Gestalt is not only cognitive, but also affective, including cognitive and enactive feelings. Cognitive feeling corresponds to the ‘feeling of knowing’ discussed by Burton (2008). Enactive feeling is the feeling of consciously acting: *the will*, which is not necessarily ‘free’ from natural causes, but, on the contrary, the will is elicited by brain processes.

9. SoS Theory

This is based on the idea that the two types of time pinpointed by McTaggart in 1908 (i.e. ‘tensed time’ referred to in terms of past, present, and future in contrast to ‘untensed time’ referred to in terms of before, simultaneous with, and later) are both equally ‘real’ but belong in different categories of reality. McTaggart himself regarded incompatibilities between his two types as proof of the unreality of time. Whitehead (1922) argued that the ‘present’ of his actual occasions of experience can satisfactorily be accounted for by splitting general relativity’s single tensor into two entirely separate tensors.⁸ Primas (2003; 2008) has argued that ‘tensed time’ may be the ‘carrier’ of mental phenomena, while ‘untensed time’ is equivalent to the *time* of physics — i.e. the temporal component of general relativity. SoS

⁸ Whitehead’s two tensors made identical predictions to Einstein’s single tensor for all phenomena that were known about in their lifetimes, though they have subsequently been shown to fail for very high-energy phenomena. It can be argued (Nunn, 2018) that a better strategy to allow the place for ‘nowness’ that Whitehead sought would have been to postulate the existence of two ontologically distinct types of time, corresponding to the two concepts identified by MacTaggart, rather than two tensors.

theory (Nunn, 2015; 2016) takes the *transitional* zone ‘nowness/occasion of experience’ component of our diagram as referring to the *present* component of McTaggart’s ‘tensed time’, interpreting it as a subjective but nevertheless ‘real’ entity.

Because of the non-commutative relationship between time and energy in quantum theory, the relevant symmetry break is most appropriately regarded as coinciding with energy eigenstate ‘measurements’, thus allowing an ‘untensed time’ duration to be attributed to each manifestation of a tensed time ‘present’ (termed a ‘Scintilla of Subjectivity’, related to Whitehead’s occasion of experience), via Heisenberg’s time/energy uncertainty relationship. This provides an explanation for the fact that time is not a quantum observable, unlike position in the otherwise equivalent position/momentum uncertainty relationship. The time described by the relationship isn’t an observable because it relates to subjectivity not objectivity.

Because SoSs have clock-time durations, the theory shows how patterns of macroscopic energetic activity in brains, such as those described by ‘hydro-ionic theory’, can get *translated* into patterns of subjective experience. It doesn’t suggest that qualia are retrieved from any truly fundamental reality, but does allow a possibility that they are connected with ‘mathematical forms’ in the ‘transition’ zone — specifically, perhaps, with knot theoretical forms (Nunn, 2015).

10. Implications

We can conclude from this small endeavour to deal with very large topics that cosmos and consciousness are mutually interdependent, mutually creative processes, and that these processes, acting through the medium of information, are necessary to the ongoing existence of each other. This is multi-aspect monism, in which the ontological source of the aspects is in itself neutral. The only metaphysical ultimate is the Matrix of dynamic process, endlessly becoming, in the dance of reality.

On the strictly scientific side, the idea of ‘recoherence’ in recoherence theory may cause some unease as decoherence is, to the best of our knowledge, always irreversible. However, the inherent *fuzziness* of the clock-time durations involved in ‘Scintillae of Subjectivity’, which is quite different from the inexorable march of infinitesimal ‘instants’ described by the mathematics of quantum theory, may well support an appearance of ‘recoherence’ in suitable systems (i.e. systems encompassing very precise ‘measurements’ of

objective energy eigenstates and hence ‘present instants’ with relatively lengthy clock-time durations). In that case — and we believe it to be a reasonable case — recoherence and SoS theories can be regarded as equivalent for most practical purposes, differing only on details of the supposed origins of the characteristics of qualia. Recoherence also seems related to the constraining influence of the time-delayed objective entities on Whitehead’s experiential occasions, leading to continuity of the unfolding reality process.⁹

Generally, our proposals indicate that research focusing on the rhythmicities and other temporal characteristics associated with conscious experience are likely to prove especially helpful in advancing understanding. Moreover, as our framework shows that the subjective and objective worlds, springing from the same neutral source that remains immanent to both, develop a degree of independence from one another, study of phenomena that appear to demonstrate a combination of dependence and independence, for example near-death experiences, should prove enlightening.

There is one rather specific implication of our proposals, however, that is testable at least ‘in principle’. It is that the ‘transitional processes’ connected with ‘qualia/feelings’ should serve as a source of potential *Energy* undetectable by ‘objective’ methodology. Hence apparent violations of physical energy conservation can be expected to sometimes manifest in the context of consciousness-related activities — in effects on the timing and rhythmicities of neural behaviour, for instance, that appeared to be getting their power from nowhere (rather as a pendulum might be regarded as breaking energy conservation if gravitation was not a feature of the objective world). Any such violations would normally be very short-lived, but perhaps we should keep open minds about the possibility of finding larger ones (Nunn, 2018).

An important theoretical consequence would be that the principle of energy conservation (first law of thermodynamics) would apply only to Energy (with capital ‘E’), but not to (physical) energy. It follows from Noether’s theorem (e.g. Neuenschwander, 2017) that ‘physical’ energy conservation might sometimes be violated in any process that

⁹ Whitehead suggests that continuity in the reality process is maintained by the constraining effect of the *many* objective entities upon the *one* occasion of experience that emerges from them (but happens ‘in advance’ of them). Otherwise, the creative pull toward novelty from the teleological potentials in the eternal objects could break the continuity of the reality process in a moment of creative strong emergence. *Recoherence* supports continuity in a comparable fashion.

involved non-smooth temporal transitions, such as might occur between ‘untensed’ and ‘tensed’ times; however, the first law of thermodynamics states the conservation of energy. Our proposed metaphysical claim can reconcile the implication of Noether’s theorem that objective energy conservation might sometimes be violated with the first law, by means of applying the first law to the totality of Energy. The balance of Energy would happen in the totality of reality, as assumed in the ancient Buddhist tradition, not in the physical aspect alone.

Future experimentation in physics, neuroscience, and psychology (including transpersonal approaches to paranormal phenomena) will reveal if some of our more objective postulates have the significant truth-value we anticipate. However, our metaphysical proposals and those to do with more primitive levels of experience or self-transcendent awareness are likely to be explored by subjective means, such as phenomenology, meditation, artistic expression, or altered states of consciousness. Some promising methods for the investigation of conscious states can be cited, among them the systematic introspection proposed by Weger, Meyer and Wagemann (2016) and the clinical approach to cases of limited consciousness developed by Laureys and his research team (Laureys, Owen and Schiff, 2004; Laureys, 2005; 2015).

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