Research Essay

On the Possible Existence of Quantum Consciousness After Brain Death

Massimo Pregnolato[*] & Alfredo Pereira Jr.[†]

Abstract: One of the main clinical signs of irreversible human death is the flat EEG. It means that in this condition neurons do not generate action potentials, and therefore cannot control body movement and vital physiological functions. However, after brain death, the rate of destruction of cerebral and other cells is different in the several body districts. We consider at least two approaches to the physical correlates of quantum consciousness in that condition. The first one is related to quantum effects in proteins, which can maintain unchanged their folding and water environment in several cells after brain death. The second one considers a part of conscious activity related to the formation of potentials in electrolyte systems containing water, ions and proteins, which can maintain charges (difference of potentials) after brain death. In the first approach the Schrödinger proteins can be considered the basis of quantum information; therefore, quantum consciousness may remain until the last folded protein exists in the body. In the second approach, since the flat EEG comes from a disturbance in the flux of some ions (mostly Na^+ and K^+, affecting neuronal firing), but not necessarily other ions (mostly Ca^{2+} in glial cells), which may still maintain a low entropy distribution, some instantiation of feelings and other conscious phenomena would take place until the system achieves a Gaussian ionic distribution, in which any functional charge is absent. On these bases, we argue for the possibility of fading quantum consciousness aspects after brain death. This claim deserves more thorough investigations, not only for its scientific boldness, but also because of the legal consequences that could be of considerable interest in a not too far future, when taking into consideration the aims of transhumanism.

Key Words: Brain Death, Quantum Consciousness, Proteins, Ions, Transhumanism.

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Introduction

We start by noting that the concepts of brain death and death are not synonymous. Brain death, as discussed with more detail in the next section of the paper, refers to the absence of neuronal action potentials, as revealed physiologically by the "flat EEG" and behaviorally by the absence of voluntary movement. Our claim in this paper is that some modality of consciousness is possible in the absence of action potentials and voluntary movement, while other vital activities remain in the brain/body of a person.

After brain death, there is a degenerative process that (in our current biomedical technological capabilities) irreversibly leads to the complete death of the body. The latter is here understood as the death of every cell, or, in other words, the complete absence of metabolism in the disintegrating body. It is very unlikely that in this condition any aspect of consciousness could remain, at least if we do not assume a dualist view of consciousness as being completely independent of the living body.

In this paper we will not discuss the metaphysical mind-body problem, but focus on the possibility of the existence of a quantum-based aspect of consciousness in a phase that begins soon after brain death while some cells and tissues of the body still present metabolic activity, keeping proteins and ionic solutions in functional states. In this kind of state, the system may still be conscious, but unable to express the conscious states behaviorally. This phase raises an ethical issue about how to treat people in this condition. For instance, it does not seem completely implausible that during the cremation the quantum consciousness of a recently brain-dead person would record that experience literally like being in hell. This condition would cause her extreme suffering that could be avoided if she is kept safe for some time after brain death, as practiced in some cultures.

The Concepts of Death and Brain Death

In the biomedical context, *death* is conceived as “the irreversible cessation of cardiopulmonary or neurological function” (Kirkpatrick, Beasley, & Caplan, 2010). The problem with this definition is that it focuses on the outcome of the process (the body

becomes dead), but does not identify the phases that lead to the result. Noting the phases, *brain death* is conceived, by the same authors, as "the irreversible loss of the brain's ability to regulate the organism". This condition "signals death, even if constituent parts can continue to function independently or with assistance". The question that emerges from these concepts is: what happens to the system while it is *signaling* death, but *is not (completely) dead* yet?

In order to answer this question, it is necessary to discuss brain physiology and our technology to measure and register it. The electroencephalogram is a century-old technology to measure brain activity and afford our interpretations of the inner state of the brain/mind. Bioelectric activity – as measured by the EEG – depends on electromagnetic fields produced by *a class of* coherent ionic movements. The absence of such movements, or their reciprocal cancellation (as in thermodynamic equilibrium) produces a flat EEG (Figure 1). There are other functional ionic movements and resulting bioelectric fields, as well as protein activities, which may continue to exist in the brain/mind system of a person, while her EEG is flat.

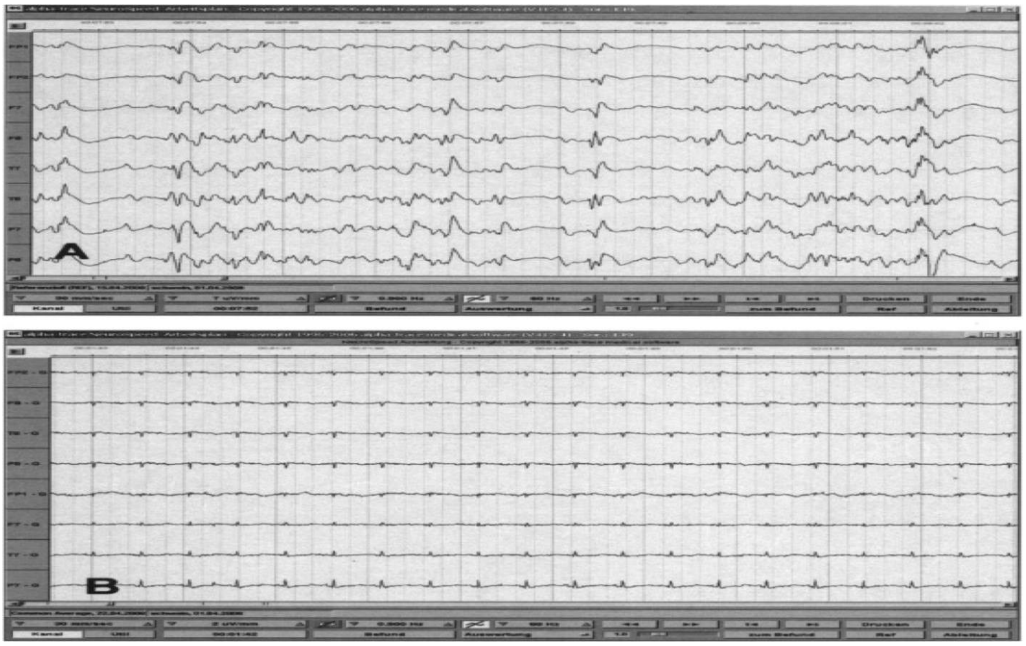


Figure 1 - Comparison of a normal and a flat EEG.
A: Normal; B: Flat EEG (Adapted from Sereinigg, 2012).

There are well known mechanisms that can produce a flat EEG while billions of brain cells are still alive. For instance, astrocytes control the homeostasis of extracellular

potassium ions. An astroglial dysfunction may cause an abnormal increase of extracellular potassium concentration, and then, neuronal repolarization, a necessary phase in the generation of action potentials (Figure 2), cannot occur. In this condition, neurons are still alive, but do not repolarize to generate action potentials.

Human life crucially depends on coherent movements of Ca^{++}, Na^{+} and K^{+} ions bound to proteins and water (Mentré, 2012), composing self-organizing processes. Coherent ionic movement is essential to heart and brain functioning, and cellular coordination of replication of macromolecules (Greer & Greenberg, 2008).

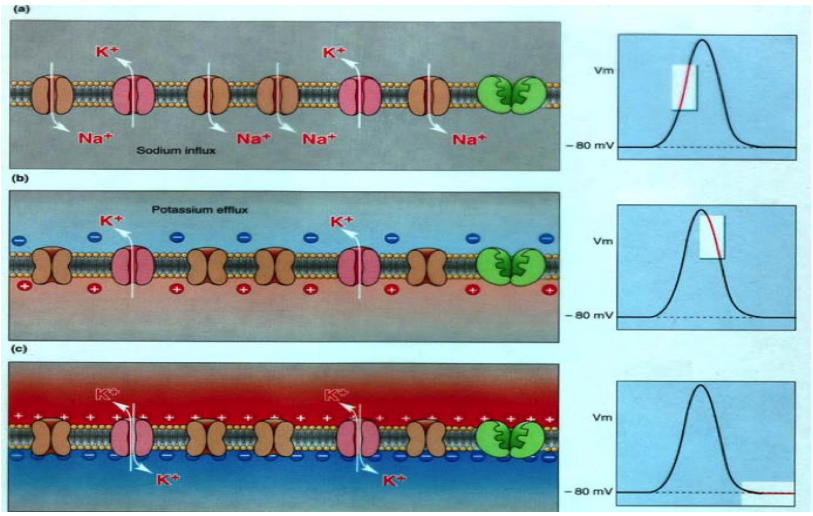


Figure 2: Neuron electric activity: a) depolarization; b) repolarization; c) resting potential
(Source: http://biologyclass.neurobio.arizona.edu/images.jpg)

Enzymes are catalysts that facilitate reactions, but they can act in both directions of the reactions, forward or backward. The actual direction is defined by a stream installed in the systemic context in which the catalysts are inserted (Guimarães, 2012). When the protein-ion-water system is disturbed, a process of irreversible death can be triggered.

A mildly depressed level of consciousness or alertness may be classed as lethargy; someone in this state can be aroused with little difficulty (Kandel, Jessell, & Schwartz, 2000). People who are obtunded have a more depressed level of consciousness and cannot be fully aroused (Porth, 2007). Those who are not able to be aroused from a sleep-like state are said to

be stuporous. Coma is the inability to make any purposeful response. Scales such as the Glasgow coma scale have been designed to measure the level of consciousness.

A lower level of consciousness can result from a variety of factors, including alterations in the chemical environment of the brain (e.g., exposure to poisons or intoxicants), insufficient oxygen or blood flow in the brain, and excessive pressure within the skull. Prolonged unconsciousness is understood to be a sign of a medical emergency (Pollak & Gupton, 2002). A deficit in the level of consciousness suggests that the cerebral hemispheres or the reticular activating system have been injured. A decreased level of consciousness correlates to increased morbidity (sickness) and mortality (death) (Scheld, Whitley, & Marra, 2004). Thus it is a valuable measure of a patient's medical and neurological status. In fact, some sources consider the level of consciousness to be one of the vital signs (Forgey, 1999).

The Body After Death

Post mortem interval (PMI) is the time that has elapsed since a person has died. If the time in question is not known, a number of medical/scientific techniques are used to determine it. This also can refer to the stage of decomposition the person is in. Many types of changes to a body occur after death (ceasing breathing, cessation of metabolism, no pulse) and some of those can be used to determine the *post mortem* interval:

- *Pallor mortis*: paleness which happens in the 15–120 minutes after death;
- *Livor mortis*: a settling of the blood in the lower (dependent) portion of the body;
- *Algor mortis*: the reduction in body temperature following death. This is generally a steady decline, until matching ambient temperature;
- *Rigor mortis*: the limbs of the corpse become stiff (Latin *rigor*) and difficult to move or manipulate
- Forensic entomology: insect activity on the corpse;
- *Vitreous humour* changes – changes in eye chemistry;
- State of decomposition – autolysis (process of self digestion) and putrefaction (process caused by bacteria found within the body). Putrefaction is the decomposition of animal proteins – especially by anaerobic microorganisms (putrefying bacteria).

> Decomposition is a more general process. Putrefaction usually results in amines such as putrescine and cadaverine, which have a putrid odor. Material that is subject to putrefaction is called putrescible.

The putrefaction of a human body with respect to time of death occurs in phases:

- 2–3 days: Staining begins on the abdomen. The body begins to swell, owing to gas formation.
- 3–4 days: The staining spreads and veins become discolored.
- 5–6 days: The abdomen swells with gas (produced by the bacteria that decompose the body), and the skin blisters.
- 2 weeks: The abdomen becomes very tight and swollen.
- 3 weeks: Tissues begin to soften. Organs and cavities are bursting. The nails fall off.
- 4 weeks: Soft tissues begin to liquefy, and the face becomes unrecognizable.

The exact rate of putrefaction is dependent upon many factors, such as weather, exposure and location. Thus, refrigeration at a morgue or funeral home can retard the process, allowing for burial in three days or so following death without embalming.

Two Models of Quantum Consciousness

According to the current neuroscientific view, consciousness fails to survive brain death and, along with all other mental functions, is irrecoverably lost (Laureys & Tononi, 2009). Nevertheless, as we read in a recent, very exhaustive review by Bob Davis (2016), the scientific principles and studies that may fall within the domain of quantum mechanical processes may eventually provide evidence to demonstrate how consciousness relates with the brain during life, as well as during brain death, to better understand the possibility of conscious activity after death.

In the literature, there are many quantum models of consciousness, some advocating a radically revisionist metaphysics and others not. It would be impossible to catalog them here or even explain in any substantial way the key features of quantum theory to which they appeal. Among them, we find those that build on findings on oscillatory synchrony (Engel &

Singer, 2001; Singer, 1999), which can be putatively related to the Orch-OR microtubule-based theory (Hameroff & Penrose, 1996, 2014; Hameroff & Powell, 2009) and astroglial calcium waves (Pereira Jr., 2012; Pereira Jr. & Furlan, 2009, 2010). The connection between the existence of oscillatory synchrony in different frequencies and conscious activity is well established in neuroscience, while the mechanism underlying the generation of conscious states and episodes is a controversial issue addressed by both the microtubule and the calcium wave approaches.

Proteins and Consciousness After Brain Death

The Penrose-Hameroff "Orchestrated Objective Reduction" (Orch-OR) model of consciousness was first proposed in 1995 and more recently revised in 2014 (Hameroff & Penrose, 1995, 2014). Orch OR asserts that microtubular protein polymers inside brain neurons act as quantum computers. Tubulin components of microtubules are understood to constitute a “Schrödinger’s protein” existing in quantum superposition of different states and hence encoding quantum bits, or qubits of information. They argue that quantum-superposed states are developed in a tubulin that gradually recruits other superposed tubulin over a time interval lasting up to 500 msec until a mass-time-energy threshold, related to quantum gravity, is finally reached (without the intervention of an observer or measurement, as in most of quantum mechanics models). This results in "objective collapses" involving the quantum system passing from a superposition of multiple possible states to a single definite state.

This model predicts dendritic webs of approximately 100,000 neurons subserving discrete conscious moments, or frames, occurring every 25 ms in gamma synchrony. According to Penrose and Hameroff, the environment internal to the microtubules is especially suitable for objective collapses, and the resulting self-collapses produce a coherent flow regulating neuronal activity and making non-algorithmic mental processes possible.

Science can measure brain electrical activity known to correlate with consciousness, for example high frequency synchronized electroencephalography (EEG) in the gamma range (*gamma synchrony*). Monitors able to measure and process EEG and detect gamma synchrony and other correlates of consciousness have been developed for use during anesthesia to provide an indicator of depth of anesthesia and prevent intra-operative

awareness, i.e., to avoid patients being conscious when they are supposed to be anesthetized and unconscious. The BIS monitor (Aspect Medical Systems, Newton, MA) records and processes frontal electroencephalography (EEG) to produce a digital *bispectral index*, or BIS number, on a scale of 0 to 100. A BIS number of 0 equals EEG silence, and 100 is the expected value in a fully awake, conscious adult.

Chawla et al. (2009) observed that in brain tissue that is metabolically dead, receiving no blood flow nor oxygen, a further end-of-life activity occurs. The BIS and SEDline numbers, indicators of level of awareness, are near zero, but then a burst of synchronized, coherent bi-frontal brain activity occurs, seemingly EEG gamma synchrony (an indicator of consciousness). As marked by BIS and SEDline numbers near 80, the activity persists for a minute or more, then it abruptly ceases. They speculate that this level of BIS/SEDline activity is related to the cellular loss of membrane polarization due to hypoxemia, but there are other proposed explanations for the end-of-life brain activity as non-functional, generalized neuronal depolarization.

Chawla et al. (2009) suggest that excess extracellular potassium causes last gasp neuronal spasms throughout the brain, but that couldn't account for the global coherence – synchronized, organized. Another suggested cause is calcium-induced neuronal death, which could implicate disruption of cytoskeletal microtubules inside neurons as the precipitating factor. But again, how and why the bifrontal coherent synchrony? According to Hameroff's approach, neuronal hypoxia and acidosis would disable sodium-potassium ATPase pumps, preventing axonal action potentials, but temporarily sparing lower energy dendritic activity, which may correlate more directly with consciousness (Hameroff, 2010). Another possibility is that consciousness is a low energy quantum process (Hameroff, 1998), in which case reduced molecular dynamics may limit thermal decoherence, providing a temporal window for enhanced quantum coherent states and a burst of enhanced consciousness. The Hameroff-Chopra (2010) approach to quantum consciousness after death explains this burst of enhanced awareness at death as the preliminary for further awakening to extraordinary levels of consciousness possibly beyond the body.

An expanded level of consciousness (ELC), also named altered state of consciousness (ASC), is any condition that is significantly different from a normal waking beta wave state.

The expression was used as early as 1966 by Arnold M. Ludwig (1966) and brought into common usage from 1969 by Charles Tart (1969). It describes induced changes in one's mental state, almost always temporary.

Altered states of consciousness can be associated with artistic creativity. They also can be shared interpersonally and studied as a subject of sociological research. Higher consciousness is a concept of a spiritual transcendence of human consciousness in various traditions of mysticism. Within monotheism, it also refers to the awareness or knowledge of an *ultimate reality* sometimes known as God. Alternative terms with similar meanings include super consciousness (Yoga), objective consciousness (Gurdjieff), Buddhic consciousness (Theosophy), cosmic consciousness, God-consciousness (Sufism and Hinduism) and Christ consciousness (New Thought). An ASC can sometimes be reached intentionally by the use of sensory deprivation, an isolation tank, lucid dreaming, hypnosis, prolonged meditation, and psychoactive drugs.

The ordinary levels of consciousness or ego can be represented (Figure 3) as a set of communicating levels (Cocchi et al., 2011):

1. Pure biological level or “primordial ego”: the proto self of Damasio (1999), attributing in a rudimentary form to his own body, feelings of hunger, thirst, pleasure, pain;
2. Bio-eco-logical level: on the conscious interaction between subject and environment, but set only the *hic et nunc* with no extension project.
3. Extended mnemonic level: belonging to a consciousness that, while expanding *back and forth*, does not yet embody in a language its being as a continuous narrative, preserved by the memory as a place of meaning of life.
4. Level of identity sense: from its original roots in biology the ego has gradually expanded to the ecological dimension or mnemonic short-range, is then passed to the mnemonic long-haul dimension, and now, through language, produces an accomplished culture.
5. Mysteric level of consciousness or abyss of consciousness. The presence in humans of a prophetic intuition, of an abyss of consciousness opens the way for intellectual freedom as liberation from the outer limits (subject, *obstacles* to overcome

in pursuit of their projects) and internal (indefinitely biological determinism or panbiologism).

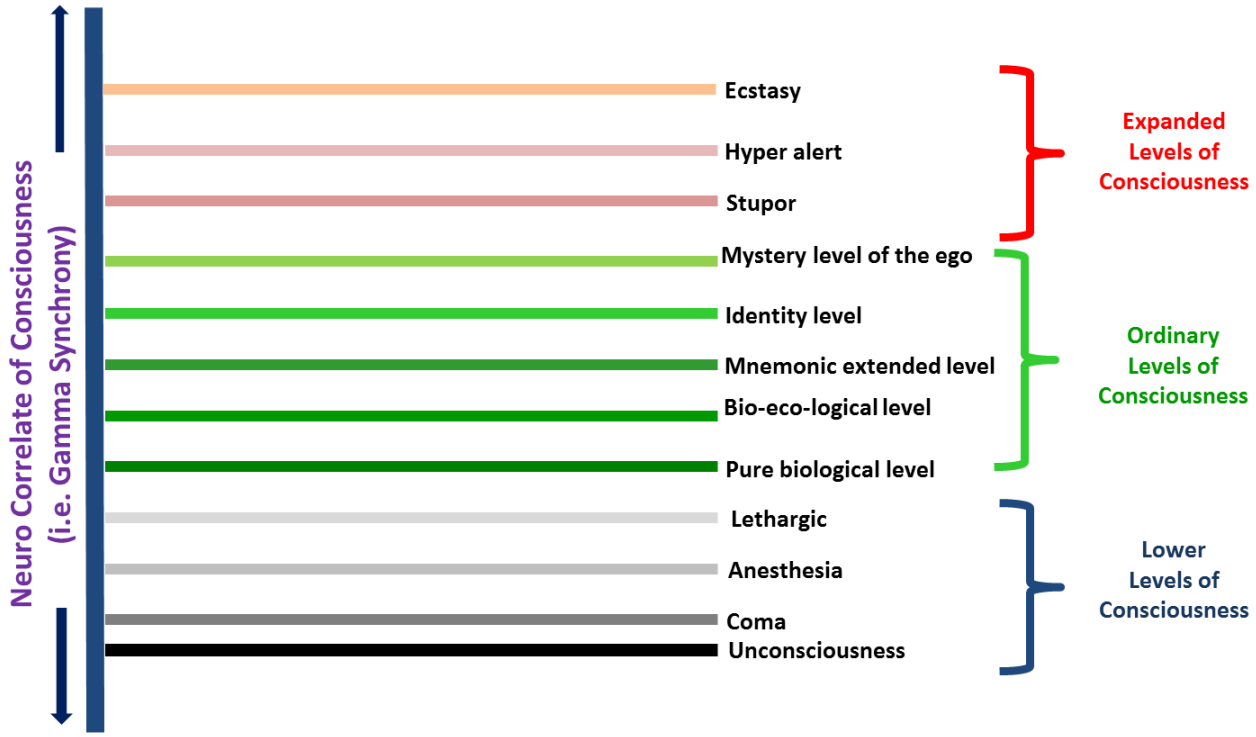


Figure 3: Levels of consciousness. (Revised from Cocchi et al., 2011).

In other words, the ego produces articulations of sense about oneself and the world that incorporates into one's experiences and one's acting out, in a narrative, intellectual and emotional, irreducible to any other, world views, social stress, scientific and cultural expressions.

According to the model of Computational Loop Quantum Gravity (CLQG) (Zizzi, 2005), the quantum extension of digital physics states that the concept of reality can be expressed as: "It from qubit", namely, reality is quantum information, QI.

Classical Information, I	Quantum Information, Iq
I = N (N = number of bits)	Iq = (N = number of qubits)
Classical digital reality (Classic truth)	Quantum digital reality (Quantum truth)
N = 1, I = 1 (Yes =1 or Not = 0)	N = 1, Iq = 2 (Yes = 1 and Not = 0)

A quantum biological system, which is a particular type of complex system based on quantum information, is a site of quantum computation. Later Zizzi (2010) showed that quantum superposition and entanglement, which characterize quantum computing, can be formalized by a particular quantum logic named Lq. The latter in turn was used (Zizzi, 2012) to describe the quantum mental processes of the unconscious mind. This was done in the framework of the quantum theory of mind of Penrose-Hameroff (Hameroff, 1994; Hameroff & Penrose, 1995) where the units of quantum information (qubits) are biologically implemented by tubulin units of brain's microtubules.

Zizzi (2012) suggests that the Mind has three different operational modes:

1- the quantum computational mode

2- the classical computational mode

3- the non-algorithmic mode.

The quantum and classical computational modes pertain to ordinary thought processes, while the non-algorithmic mode (Zizzi & Pregnolato, 2012) pertains to metathought, which is the peculiar process of thinking about our own ordinary thought. In Figure 4 we represent the hypothetic variations of quantum information contents in microtubules during the lifetime in correlation with the different consciousness states and in the birth and death phases.

For those who dare follow the implications of such thoughts this far, a quantum basis for consciousness also raises the scientific possibility of an afterlife, of an actual soul leaving the body and persisting as entangled fluctuations in quantum spacetime geometry (Hameroff & Chopra, 2010). According to this theory, when people enter clinical death, the microtubules lose their quantum state but don't lose the information they contain. Some of this quantum information might not be lost or dissipated or destroyed but could persist in some way in this fundamental level of spacetime geometry, which, it seems, is not local but more like a holographic repetition in scale and distances that persists perhaps even indefinitely at a finer scale, which would be a higher frequency – a smaller scale but also lower energy. In this way, it could continue to exist almost indefinitely.

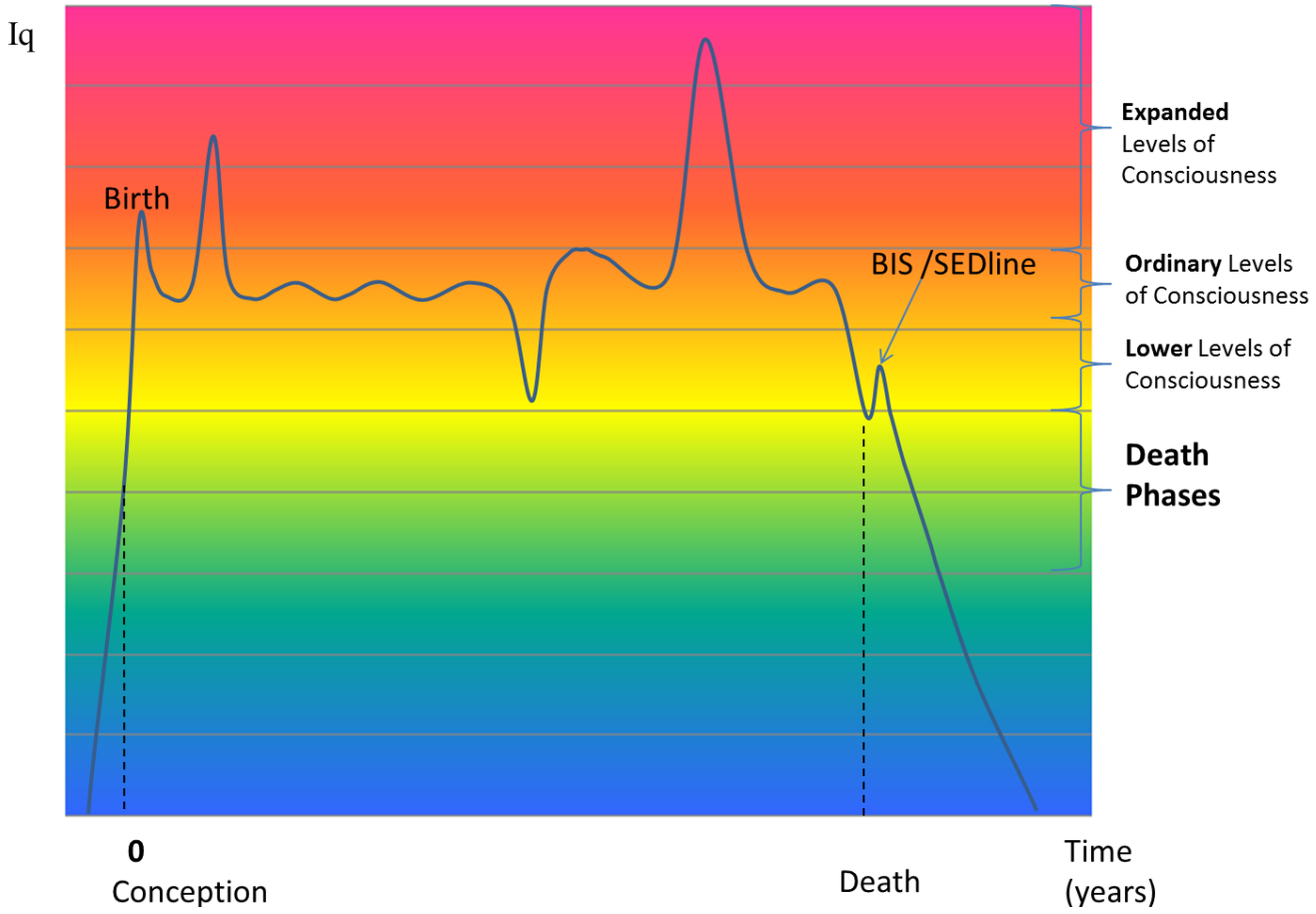


Figure 4: Scheme of possible consciousness states variations in a lifetime period (Pregnolato et al., original scheme). Iq = quantum Information.

Ions and Consciousness

There are two kinds of information processing in the brain. One (discreet) is by means of electric pulses (action potentials) in neuronal networks. The other (continuous) is by means of hydro-ionic waves guided by proteins, in glial cells, extracellular medium, cerebrospinal fluid and blood flow. Beyond the *Neuron Doctrine* formulated by Ramón y Cajal – proposing that neurons are the structural and functional unit of the mind/brain – our current theoretical framework has been updated to include neuro-glial interactions and the putative contribution of the astroglial network for conscious processes.

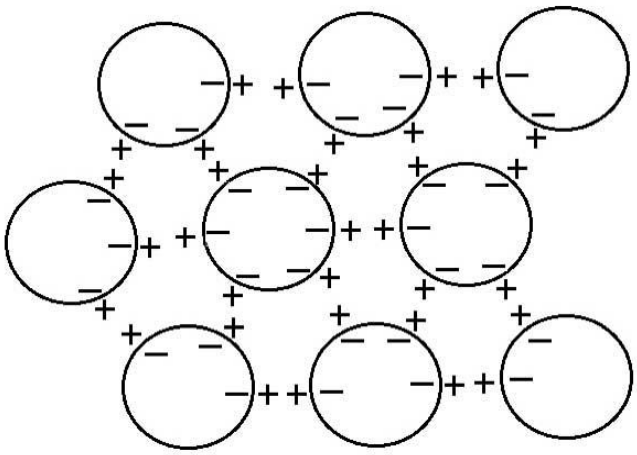
The complex interactions of ions, water and proteins in the brain, supporting conscious functions, have been deeply discussed since the work of Loeb (1900, 1906).

In the model of neuronal membrane excitation proposed by Tasaki and Chang (1958) and Tasaki (1999), consisting of a water gel inside lipid layers that is swollen and contracted according to changes in the concentration of sodium and calcium ions, it is assumed the existence of electromagnetic potentials generated by an ionic mechanism. This mechanism is different and possibly parallel to the well-known Hodkins-Huxley mechanism based on ion pumps, binding of transmitters and sodium-potassium exchanges that generate the spike trains that control muscles and glands. The Tasaki work opens the possibility of existence of electric potentials dedicated to cognitive and affective processes (covert behavior), but not to responsive action in the environment (overt behavior).

The work of Tasaki was complemented by innovative research made by Pollack (2010), revealing the existence of a negative "exclusion zone" in water that can be regarded as adequate to attract ions from the extracellular milieu and compose a *biological battery* inside the neural membrane (Figure 5). According to Ho (2014),

> Stable water clusters tens of nanometres to millimetres in dimensions can be seen under the microscope. … The clusters consist of millions to billions of water molecules and come in a wide variety of shapes and sizes. … They make up structures that are flexible, and can be deformed. … Otherwise, they remain stable for weeks, even months at room temperature and pressure. They have all the characteristics of “soft matter” – liquids, liquid crystals, colloids, polymers, gels, and foams – that form mesoscopic structures much larger than the molecules themselves, but small compared with the bulk material.

Structural changes in water are related to the loss of consciousness in general anesthesia (Kundacina & Pollack, 2016). General anesthetics also change the state of astrocytes (Thrane, 2013). Considering that the energy and the information present at hydro-ionic waves is closely related to the conscious state, we can hypothesize that in the case of brain death the *biological battery* can keep and regenerate useful energy, and use it to support consciousness for some time after the shortage of supply from mitochondria. (The independence from metabolism was suggested to APJ by Vera Maura Fernandes de Lima, personal communication).



"Coherent oscillations maintained by the electromagnetic field…produce correlations as large as several hundred microns, giving rise to a common dipole orientation…resulting in stable supramolecular clusters"

Pollack's theory of the fourth state of water (gel, crystal) and formation of exclusion zones from the dynamics of attraction and repulsion

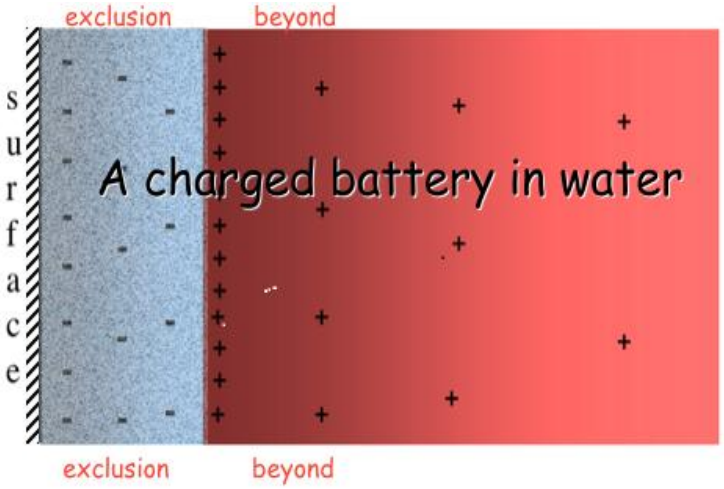


Figure 5: Structured Water (Pollack, 2010)

Tasaki and Chang (1958), soon followed by Galambos (1960), were probably the first neuroscientists to suggest that brain slow potentials related to cognitive and affective processes are mediated by glial cells. The kind of glial cells that forms a brain wide network able to propagate electric potentials is the astrocyte. Astrocytes do not have excitable membranes, but can communicate signals and exchange energy by means of calcium ion waves. These waves are generated by neural local fields potentials in tripartite synapses (composed of two neurons and one astrocyte). The local field produced by the presynaptic neuron, as well as the transmitters it releases, impact on the glial neighbors, producing small

waves that reach the astroglial network. Gap junctions between astrocytes allow the passage of the ions, and even boost their signal by means of ATP mechanisms. Astroglial intercellular communication by means of gap junctions allow the interference of the smaller waves, resulting in global wave patterns that feedback on the neurons that produced the smaller waves. This cycle of action and reaction between neurons and astrocytes has been proposed to support the formation of conscious episodes in the temporal window of 2 seconds (Pereira Jr., 2015).

The astroglial calcium wave is a very complex phenomenon, having including both travelling and standing waves. The smaller waves generated at tripartite synapses are travelling ones, based on changes of concentration of calcium ions inside individual astrocytes and in the network. Inositol triphosphate and its receptors proteins prompt the release of calcium ions previously stored in deposits and their movements through the cytosol, reaching astroglial distal branches, and then moving to other cells in the network. The result of the interference of these smaller waves is a standing waveform across brain tissue, composed of temporal patterns of vibrational energy. The structure of this waveform fits well the description made by Mentrè (2012):

> A given ion (phosphate, Ca^{2+}, H^{+}) seems to be transported along a chain (cascade) of macromolecules containing this ion (or another one) in a sequestered form. A signal (calcium, for example) occurring at the entry of the chain induces the liberation of the sequestered ion from the first element of the chain and this one, in its turn, induces the liberation of the ion from the following element, etc.: the ion entering the chain remains sequestered by the first element of the chain. The ion appearing at the end of the chain is liberated by the last element of the chain. This type of transport differs deeply from diffusion. It is not a transport of matter but a transfer of a level of energy (transduction). (p. 19)

As a consequence of the above discoveries and theories, it is possible to conjecture that the neuron has a double life. Dendrites participate in the tissue function, generating graded potentials that induce hydro-ionic waves by means of both chemical and electromagnetic signaling; the axon produces spike trains that execute cognitive and motor functions. The scalp EEG mostly captures the dendritic potentials that induce both hydro-ionic waves in brain tissue and action potentials, but not the electric potentials endogenous to the hydro-

ionic waves, which may remain active and carrying their functions for some time after the scalp EEG becomes flat and the subject is diagnosed with brain death.

The Vimal, Pereira and Pregnolato Approach

Current approaches to consciousness tend to abandon both materialism and idealism, as well as interactive substance dualism, moving towards multi-aspect monisms. In a collaborative book chapter (Pereira Jr., 2016), we proposed a qualitative biophysics helping to solve the *hard problem of consciousness* (Chalmers, 1995, 1996). The idea is that elementary waveforms (EW) that compose quantum microstates contain the *potential* for qualitative macrostates (QMSs), as those observed in the morphology and physiology of living systems. We further claim that the subjective qualities experienced in conscious episodes can be described by a hypermatrix/hypertensor composed of QMSs.

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, reentry, 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 nonconscious QMS instantiated in spatially distributed neural circuits. In this context, “recoherence” means that qualities instantiated in unconscious brain macrostates are integrated into conscious experiences when a set of conditions are fulfilled, as distance from thermodynamic equilibrium, operation of biological self-organizing mechanisms and information integration by quantum gates.

Brain recoherent macrostates result from the activity of entropy reducers, as ion channels and proteins composing intracellular signal transduction pathways. These mechanisms possibly instantiate quantum computing gates (Rocha, Pereira Jr., & Coutinho, 2001; Rocha, Massad, & Pereira Jr., 2005). The operation of these gates form recoherent states, by means of informationally integrating a collection of QMS. We note that this concept of recoherence is

different from the conceptual framework of Penrose-Hameroff; the recoherence phase after the decoherence process generates the conscious state, while in the Penrose-Hameroff model the orchestrated collapse of the wave function generates a conscious state without the recoherence phase.

Using this explanatory strategy, we can explain why some natural systems have subjective conscious experiences, while others do not. The progressive interaction of EWs generate 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 EW, in a strongly emergent process. Other regions do not display conscious activity, because the necessary conditions of consciousness (such as formation of neural-networks, wakefulness, reentry, attention, information integration, working memory, stimulus contrast at or above threshold, and potential experiences embedded in neural-network) are not satisfied.

The dynamical process above occurs in a temporal continuum. At one side of the continuum, there are forms in a potential state. When actualized, they compose physiochemical properties of substances and processes. In the middle, there are forms in an intermediary stage, such that they have mental but unconscious functions. At the other side, there are forms actualized in conscious episodes experienced by a living individual.

What's after death?

The mystery of what happens to quantum consciousness after physical death of the body is still far from being scientifically elucidated. Depending on the approach to quantum consciousness and interpretation of quantum theory adopted, several authors have sketched a possible answer to this question.

According to Penrose-Hameroff's Orch OR theory, consciousness occurs as a process on the edge between quantum and classical worlds. After the death of body, the quantum information (which constitutes consciousness) could shift to deeper planes and continue to exist, outside the brain, purely as patterns in nonlocal fractal/holographic-like space-time geometry. This could be defined as a "quantum soul" interconnected *via entanglement*

among beings and the universe, able to exist at deeper planes and scales independent of biology. Thus after life an actual soul as quantum information leaving the body and persisting as entangled fluctuations in multiple scales, or planes in quantum space-time geometry, may be scientifically possible.

Teodorani (2015) extended this hypothesis by introducing the concept of a "Cosmic Library" that exists everywhere throughout the universe, including the quantum vacuum and all atoms with their subatomic units. "Souls" exist in the form of a quantum field that can become manifest as consciousness in any biosystem that has the property of quantum coherence (such as the brain) and acts as the *terminal* of a big *supercomputer* to work as software controlling the hardware of the body to collect information about the physical world. This information is automatically and non-locally *uploaded* on a hard *disc* located in the quantum vacuum at the Planck scale (10^{-33} cm). The hypothesis is that *the void* contains or is the memory of everything thought and felt by everyone downloaded into the universal Big Library (BL) of pure information (Charman, 2016).

Robert Lanza (2010) claims that space and time are simply the tools our mind uses to weave information together into a coherent experience and adopts the *many-worlds* interpretation, where universes contain multiple ways for possible scenarios to occur. In one universe, the body can be dead and in another it continues to exist, absorbing the consciousness migrated to this universe. This means that a dead person, while traveling through the 'tunnel', ends up in a similar world he or she once inhabited, but this time alive, and so on, infinitely.

Concluding Remarks

The conjectures raised in this paper, if proven to be valid inferences, have serious ethical implications. Even in the absence of voluntary movement and in a process that irreversibly leads to death, a person may still experience *conscious* feelings. How to treat people in this condition? Even in the absence of a proof of our hypothesis, according to the precautionary principle of ethics any external intervention that may cause pain should be avoided, until signs of complete death (complete absence of metabolism; general loss of vital activity in all cells of the body) are evident.

Do the human rights and bioethical principles that apply to the normal functioning person also apply to the brain dead person? This is another ethical issue, with juridical implications, to be better discussed. The recognition of existence of feelings in non-human animals has led to the implementation of ethical rules in scientific experimentation. For the same reason, special rules could be applied to post-mortem care in the hospital, funerary, prison, battlefield and any other place where a recently dead person is sheltered.

Another problem is the lack of belief in an afterlife of transhumanists who have, among other objectives, the plan to change the *mind map* of the brain to a computer. This has an undeniable appeal for both religious and non-religious people, who are likely to delegate the commitment to defeat death to medical science and the rise of technology. The main problem is to delineate the line between perceptible and imperceptible reality, communicable and non-communicable feeling, conscious and unconscious states.

On the basis of what we exposed in this paper, the actual definition of death does not take into account the state of consciousness of the human being. The lack of knowledge of the mechanisms of consciousness, together with the (apparently obvious) feeling that our inner experience can continue after death, no doubt has led to the formulation that there must be a *soul*, and from this idea many religious approaches are still accepted by so many people, even though they are expressed in a diverse phantasmagoria of beliefs and rituals.

It may be impossible for anyone to really come to terms with the idea of life after death, and so most people easily accept a theological explanation or prefer to ignore the problem of consciousness after biological death. While theological philosophies try to assure people that death is not the end, with a supreme being that holds the answer to eternal life, atheistic philosophies are not able to comfort people with regard to the death with the same ease. This could explain the growing (almost desperate) belief in the transhumanist movements (only one step removed from the morbid fantasy of freezing the head of a dead rich person to later be transplanted back onto a renewed or entirely new body when science catches up). Transplanting a mind without a body onto a computer network is no *trans*plant at all – the mind could never be the same disembodied as when it was part of a body – but a *transmogrification*, something akin to loss of identity from joining the Borg Collective from the Star Trek series.

We can conclude that a transcendent consciousness might be possible based on quantum physics. However, our first attempt to understand the evolution of the states of consciousness after biological death need to be better explored and considered for future research, in order not to confine a important issue to the beliefs held in the various movements, like the immortalists of the singularity (Ray Kurzweil) or transhumanism.

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