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Quantum Mechanics of 'Conscious Energy'

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ABSTRACT

This paper is aiming to investigate the physical substrate of conscious process. It will attempt to find out: How does conscious process establish relations between their external stimuli and internal stimuli in order to create reality? How does consciousness devoid of new sensory input result to its new quantum effects? And how does conscious process gain mass in brain? This paper will also try to locate the origins of consciousness at the level of neurons along with the quantum effects of conscious process.

Keywords: Consit, conscious energy, neural signal, special relativity, new memory.

1. INTRODUCTION

Consciousness has been defined as: sentience, awareness, subjectivity, the ability to experience or to feel, wakefulness, having a sense of selfhood, and the executive control system of the mind (Farthing 1992). Different authors believe that different brain structures support consciousness, structures with forbidding names, such as the intralaminar thalamic nuclei, reticular nucleus, mesencephalic reticular formation, tangential intracortical network of layers I-II, and thalamocortical loops. Does the primary visual cortex contribute to conscious experience or not? Are areas of the brain that project directly to the prefrontal cortex more relevant than those that do not? Does only a particular subset of cortical neurons play a role? If so, are these neurons characterized by a special property or location? Do cortical neurons need to oscillate at 40 Hz or fire in bursts to contribute to conscious experience? Do different areas of the brain or groups of neurons generate different conscious fragments – a kind of micro consciousness? (Zeki & Bartel 1998: 85). Before we may speculate the creation of consciousness in any specific region of the brain we must first prove the existence of consciousness. From the neurophysical perspective I will attempt to develop an explanation of the substrates of consciousness through the use of quantum mechanics.

2. The Problems of Consciousness

2.1. *The "hard problem" (Chalmers 1996)*

The distinctions between conscious and non-conscious processes are not addressed; consciousness is assumed to emerge at a critical level (neither specified nor testable) of computational complexity mediating otherwise nonconscious processes (Penrose & Hameroff 2011: 3). I have attempted to minimize this differences between conscious and non-conscious processes in my article named 'Twin Memory' (Rizvi 2016) (where in this article I have tried to show that unconscious process reflects onto conscious process with the phenomenon of twin memory to keep both the processes alive; a further research on this topic is required).

2.2. *Binding and synchrony*

The problem of how disparate neuronal activities are bound into unified conscious experience, and how neuronal synchrony, e.g. gamma synchrony EEG (30 to 90 Hz), the best measurable correlate of consciousness does not derive from neuronal firings (Penrose 2011: 3).

2.3. *Causal efficacy of consciousness and any semblance of free will.*

Because measurable brain activity corresponding to a stimulus often occurs after we've responded (seemingly consciously) to that stimulus, the brain-as-computer view depicts consciousness as epiphenomenal illusion (Dennett 1991, 1995; Wegner 2002).

2.4. *Cognitive behaviours of single cell organisms*

Protozoans like Paramecium can swim, find food and mates, learn, remember and have sex, all without synaptic computation (Sherrington 1957). How exactly do the lower-level neuronal firings at synapses cause all of the enormous variety of our (conscious subjective, sentient, aware) experiences? Perhaps we are wrong to think that neurons and synapses are the right anatomical units to account for consciousness, but we do know that some elements of brain anatomy must be the right level of description for answering our question. We know this because we know that brains do cause consciousness in a way that elbows, livers, television sets, cars and commercial computers do not, and therefore, we know that the special features of brains, features that they do not have in common with elbows, livers, etc., must be essential to the causal explanation of consciousness (Searle 1998).

2.5. *Consciousness without a cerebral cortex*

With some notable exceptions (e.g. Scheibel & Scheibel 1977; Panksepp 1982; Thompson 1993; Bogen 1995; Watt 2000; Parvizi & Damasio 2001), brainstem mechanisms have not figured prominently in the upsurge of interest in the nature and organization of consciousness that was ushered in with cognitivism in psychology and neuroscience (Mandler 1975; Miller 1986; Baars 1988). Few cognitivists or neuroscientists would today object to the assertion that “cortex is the organ of consciousness” (Merker 2006: 3). This is, in a sense, a return to an older view of the supremacy of the cerebral cortex from which a fundamental discovery of the late 1940s had stimulated a partial retreat. In keeping with the sense that the cerebral cortex is the organ of higher functions it had been widely assumed that the regulation of its two primary states – sleep and wakefulness – was a cortical function as well. Then, in the late 1940s, Moruzzi & Magoun (1949) discovered that local stimulation of circumscribed cell groups in the pons and midbrain of experimental animals exerts a global activating influence on the cerebral cortex as well as on behavioural state, and that experimental lesions in these brainstem sites are capable of rendering animals somnolent and even comatose (Magoun 1954; cf. Parvizi & Damasio 2003). This came as a shock to the corticocentric perspective, and stimulated an avalanche of research on brainstem regulation of sleep and wakefulness and its relationship to the conscious state (Adrian, Bremer & Jasper 1954; Jasper et al. 1958; and Eccles 1966).

2.6. *Consciousness without brain*

First described in *The Lancet* in 2007, the case of the man with the missing brain may put us forth to question the very existence of consciousness. The 44 years old French man suffering from hydrocephalus lived most of his life without being mentally disturbed. In this context, Axel Cleeremans, a cognitive psychologist from the Université Libre de Bruxelles in Belgium says, "Any theory of consciousness has to be able to explain why a person like that, who's missing 90 percent of his neurons, still exhibits normal behaviour" (MacDonald 2016). This condition clearly shows that it is unlikely that one specific region in the brain of the man is responsible for consciousness. In such condition of neurodegeneration the man surviving with only 10 percent of his brain still can generate consciousness.

2.7. *Mind-body problem*

Just as the brain needs the body to create conscious activity, so the body needs the environment to create conscious activity (Watts 1950). Mind and body are though interdependent on each other for their functions but at the same time they are one entity but not different. Phantom limb syndrome may be helpful to show us the unification of mind and body.

2.8. *Consciousness is lost and found.* If the cerebral blood flow (CBF) is completely interrupted, as, for example, in cardiac arrest, then consciousness is lost within seconds, and irreversible pathological changes develop within minutes. To satisfy the brain's great demand for oxygen the rate of cerebral blood flow must be proportionately high (Sokoloff 1999).

2.9. *Cosmic Zone*
If consciousness and the brain activity associated with conscious states measured at the level of the brain does not wholly emerge from the brain, where might it originate? One solution to this problem is to hypothesize that a pervasive force or proto-consciousness permeates the cosmos which interacts with all matter and imbues some subset of matter with consciousness (Penrose & Hameroff 2011).

3. BRAIN ENERGY

It has been (and is still) very difficult to elucidate the pathways and regulation of brain energy metabolism for several reasons:

1. The brain is not a homogenous tissue, and it contains many different types of cells such as neurons, astrocytes, oligodendrocytes, microglial cells, and others.
2. Even within a single major cell type, like neurons, brain energy metabolism is not equal but works differently in different types of neurons. Similarly, also glial cells show a so far underappreciated heterogeneity within a single cell type.
3. Glial cells crucially contribute to brain energy metabolism. These cells elaborate extensive metabolic interactions with neurons and other glial cells thereby making brain energy metabolism very complex. In addition, at least astrocytes contribute crucially to blood flow regulation.
4. The analysis of metabolites of brain energy metabolism with a sufficient spatial and temporal resolution to investigate the contribution of different cell types in vivo is still a major technical challenge.
5. Some key metabolites which are involved in energy metabolism, like glutamate, have additional functions within the brain (glutamate is the major excitatory neurotransmitter), thereby adding additional complexity to the pathways and regulation of brain energy metabolism (Hirrlinger 2014: vii).

4. External Stimuli and Internal Stimuli

As we know that neurons communicate through electrochemical activity. Stimuli from the external world enter the neural network through physical energies (mechanical, acoustic, light) transduced by sensory cells. In addition to changes in internal state, the brain can affect the body by control of hormones as well as by control of muscles, which can also serve to effect interactions with the external world ranging from simple reflexes to complex sequences of gestures. Synchrony of gross electrical activity of neural networks may account for attention and consciousness (Arbib 2013). As the activity level in the brain stem decreases, the source of pattern propagation (transmission) to the sensory systems of the brain switches in dominance from external to internal (Hobson 1989, 1994; Kissin 1986). As we pay less attention to information coming through our senses externally, we are able to pay more attention to internal information resulting from the dynamic interplay between internally replicated patterns in the brain called memory, which are influenced in part by the external environment (Furman 2000: 261). This change in brain activity can be readily seen on an EEG, which measures extracellular magnetic waves (Nunez 1995). Thus, faculties such as visualization, memory, attention, and volition will be accessible at one activity level (frequency) and not at another. This can be thought of as a fundamental phase transition from one activity level to another where each activity level represents a discrete attractor landscape and its state-bound attractors (Haken & Koepchen 1991; Haken 1983, 1988). As the activity level in the brain stem decreases, there is a switch in dominance between norepinephrine (NE) and acetylcholine (ACh). As NE decreases and ACh increases, visual images become more vivid and the ability to voluntarily direct our own attention and exert volition decrease (Hobson 1989, 1994; Kissin 1986).

5. Microscopic and Macroscopic Dynamics of Reality

It would be consistent with what is understood about reality at the sub-atomic level to say that the smallest "particles" known are actually fields of energy rather than “solid” material (Davies & Gribbin 1991). Thus, matter has become “dematerialized” by modem quantum theory, and this property of “thinglessness” in the quantum worldview is closely connected to the property of “interconnectedness.” The emphasis is no longer on isolated objects, but on relations, exchanges, interdependences, on processes, fields, and wholes. Quantum theory is a non-local theory (Stapp 1997). It is important to see that it is not sufficient to retain the classical world of objects and only add the interconnectedness as a supplementary property of these objects. They are two of the complimentary descriptions or aspects of reality which Primas has alluded to and cannot be used simultaneously; thus they rather should be considered as different dimensions of reality. The holistic interpretation of quantum theory in fact may also be taken as implying a multidimensional structure of reality (Shacklett 1991; Friedman 1997). In this view, there are, besides the world of objects, one or several more fundamental levels of reality where interconnectedness rather than separatedness dominates. Fields certainly belong into this category; however, apart from electromagnetic and other physical fields which are still among the phenomena considered as belonging to the four fundamental forces of the observable world, we must assume the existence of additional field-like levels of reality not directly observable at present, which may be beyond space-time and represent the realm of potentiality (Heisenberg 1958), or of the “noumena,” the realm behind the phenomena assumed by Newton, in contrast to the actuality of the observable. The Schroedinger wave function of quantum theory actually describes this hidden domain of potentiality, of the non-observable, unmanifested, pre-physical world of nonlocal correlations and superluminal, instantaneous connections, rather than the world of observable phenomena (Friedman 1997). Only with the act of measurement this infinity of potentialities, described in the Schroedinger equation as a superposition of all possible quantum states, is “collapsed” into one single actuality. Connected to the concept of potentiality is the concept of “entanglement” which describes the characteristic of interconnectedness (Shimony 1988). In the absence of any interaction (such as a measurement), two systems are in an entangled state in which neither system by itself can be said to be in a "pure state", i.e., can be fully specified without reference to the other. This hidden domain can be considered as a fundamental dimension of reality, a domain of dynamical connectivity, from which the patterns of the physical world arise. According to some authors, this realm of prephysicality is not only the basis of the physical world and of matter, but also seems to be connected to, consciousness, which some see as the fundamental field underlying it (Bohm 1980; Hagelin 1987; Goswami 1989, 1993, 1994; Shacklett 1991; Gough & Shacklett 1993; Laszlo 1995, 1996; Friedman 1997; Grandpierre 1997). In physics, it is treated by the various models of the physical vacuum. Its possible relevance to biophysics as a basis for a true quantum biology (Josephson & Pallikari-Viras 1991; Zeiger 1998; Zeiger & Bischof 1998; Thaheld 1998, 2001) seems obvious to us. Therefore we postulate the development of a "vacuum biophysics". The "hidden domain" of connectivity has characteristics completely different from those of the classical, macroscopic world of separated objects. For a long time, the quantum description that reveals the properties of phenomena belonging to this domain, or arising from it, was taken to apply only to the microscopic world of atoms and molecules, while the world of macroscopic phenomena of our experience was considered to be purely classical and not to manifest quantum properties. However, today we know that this is not true, and that there are many macroscopic quantum manifestations, although our knowledge about them is still limited (Leggett 1986, 1992, 1996; De Martino et aI., 1997; Sassaroli et al. 1998). Biological systems obviously possess the characteristics of macroscopic quantum systems (Fritz-Albert & Beloussov 2003: 62).

At first it may appear unlikely that a complex system with many degrees of freedom like the brain could be modelled with the right causal dynamics, but without taking into account the smallest parts. Micro stimulation of individual neurons can influence sensory decisions (Houweling & Brecht 2008), showing that very small disturbances can – under the right circumstances – scale up to behavioural divergences. However, state variables of complex systems can be quantitatively predicted when there is “scale separation”: when different aspects of the system exist on sufficiently (orders of magnitude) different scales (of size, energy, time etc.), they can become uncoupled (Hillerbrand 2008). A typical example is how the microscopic dynamics of a laser (atoms interacting with an oscillating electromagnetic field) gives rise to a macroscopic dynamics (the growth and decay of different laser modes) in such a way that an accurate simulation of the system using only elements on the macroscale is possible. Another example is the scale separation between electric currents and logic operations in a computer, which enables bit based emulation. When there is no scale separation (such as in fluid turbulence) macroscale predictions become impossible without simulating the entire microscale (Sandberg 2008: 12).

While practically all neuroscientists subscribe to the dogma that neural activity is a phenomenon that occurs on a classical scale, there have been proposals (mainly from physicists) that quantum effects play an important role in the function of the brain (Penrose 1989; Hameroff 1987). So far there is no evidence for quantum effects in the brain beyond quantum chemistry, and no evidence that such effects play an important role for intelligence or consciousness (Litt et al. 2006). There is no lack of possible computational primitives in neurobiology nor any phenomena that appear unexplainable in terms of classical computations (Koch & Hepp 2006). Quantitative estimates for decoherence times for ions during action potentials and microtubules suggest that they decohere on a timescale of 10^{-20} – 10^{-13}s, about ten orders of magnitude faster than the normal neural activity timescales. Hence quantum effects are unlikely to persist long enough to affect processing (Tegmark 2000). This, however, has not deterred supporters of quantum consciousness, who argue that there may be mechanisms protecting quantum superpositions over significant periods (Rosa & Faber 2004; Hagan et al. 2002).

6. ADDITIONAL DISCRETE "ENERGY"

The application of quantum mechanics of consciousness state that the energy levels of the field become discrete or 'quantized.' Unlike a classical field, whose propagating waves can have any amplitude and can thereby possess arbitrary energy, the stable propagating states of a quantum field of consciousness are constrained to have discrete energies (Hagelin 1987). Consciousness is energy in various states of manifestation and transformation. Our consciousness define our perspectives that how we explore the field of energy and how we store them because almost all behaviours ranging from single synapse resolution to neural circuits somehow rely on neural computations widely distributed throughout the brain and body. Synaptic transmission and axonal transfer of nerve impulses are too slow to organize coordinated activity in large areas of the central nervous system. Numerous observations confirm this view (Reinis et al. 2005). The duration of a synaptic transmission is at least 0.5 ms, thus the transmission across thousands of synapses takes about hundreds or even thousands of milliseconds. The transmission speed of action potentials varies between 0.5 m/s and 120 m/s along an axon. More than 50% of the nerves fibers in the corpus callosum are without myelin, thus their speed is reduced to 0.5 m/s. How can these low velocities (i.e. classical signals) explain the fast processing in the nervous system? We believe that quantum theory is able to explain some of the above mysteries. As an example, recently it has been shown theoretically that the biological brain has the possibility to achieve large quantum bit computing at room temperature, superior when compared with the conventional processors (Musha 2009). Consciousness is an active force or mechanism that can, among other things, control or cause change in the human energy field, as well as, potentially, the universal field. Consciousness is a four or higher-dimensional force that can operationalize the C-choosing function and affect our trajectory through four-dimensional space. Recent work in physics seems to indicate that higher dimensional forces may be at work (Lansky 2011).

Consit

Additionally, there exist other energy states of both optical and vibrational nature (Jelínek & Pokorný 2001; Pokorný et al. 1997; Deriu et al. 2010) which tubulin and the whole microtubule can support. These states can be excited by energy supply provided by mitochondria (Cifra et al. 2010). Please read the table given below:

Table 1. *Information about consit*

Name	**Consit**
Composition	Elementary particle
Statistics	Unidentified energy released statistics
Interactions	Consciousness
Status	Hypothetical
Symbol	C_f
Antiparticle	Self
Theorized	2010
Mass	0
Mean lifetime	Stable
Electric charge	0 *e*
Spin	2

The above table states that in theoretical physics, consit is a hypothetical elementary particle that mediates the force of consciousness in the framework of quantum field theory of the brain. If it exists, the consit is expected to be massless (because the consciousness force appears to have unlimited range) and must be a spin-2 boson.

Spin is a very fundamental quantum process associated with the structure of space-time (Dirac 1928; Penrose 1967). Indeed, modern physics leads us right down to the microscopic domain of space-time where various models of elementary particles and even space-time itself are built with spinors (Budinich 2002). On the other hand, neural membranes are saturated with spin-carrying nuclei such as ^{1}H, ^{13}C and ^{31}P. Indeed, both MRI and fMRI are based on the abundance of ^{1}H in human body. Neural membranes are matrices of brain electrical activities and play vital roles in the normal functions of a conscious brain and their major molecular components are phospholipids, proteins and cholesterols. Each phospholipid contains 1 ^{31}P, 1.8% ^{13}C and over 60 ^{1}H its lipid chains. Similarly, neural membrane proteins such as ion channels and neural transmitter receptors also contain large clusters of spin carrying nuclei. Therefore, we strongly believe that Nature has utilized quantum spin in constructing a conscious mind (Wu 2007). On the theoretical front, there are quite a few quantum theories of mind (Penrose 1989; Donald 1990; Stapp 1993; Penrose 1994; Hameroff 1996). Among these, Penrose's Objective Reduction (OR) together with Hameroff's microtubule computation is perhaps the most popular, and the combination of the two produced the Orchestrated Objective Reduction (Orch OR) in microtubules (Penrose 1989; Penrose 1994; Hameroff 1996). According to Penrose, each quantum state has its own space-time geometry, thus superposition of quantum states entails superposition of different space-time geometries (Penrose 1989; Penrose 1994). Under certain conditions, such space-time geometric superposition would separate under its own "weight" through a non-computable process, which in turn would collapse said quantum state superposition (Penrose 1989; Penrose 1994). Hameroff suggested that such self-organized OR could occur in microtubules because of their particular structures, thus, born the Orch OR. According Orch OR, each collapse of macroscopic space-time geometry superposition corresponds to a discrete conscious event. In addition, it seems that Penrose accepts a separate mental world with grounding in the physical world (Penrose 1989; Penrose 1994). There are also a number of theories based on conventional neuroscience (Edelman 1989; Crick 1994).

7. Quantum Mechanics of "Conscious Energy"

Another commonly held view is that consciousness is unrelated to quantum mechanics because the brain is a wet, warm system where decoherence destroys quantum superpositions of neuron firing much faster than we can think, preventing our brain from acting as a quantum computer (Tegmark 2015). No doubt there are important quantum mechanical behaviours within ion channels and within synapses and elsewhere, since ions and their electrons are small and subject to quantum theory. One interesting hypothesis suggests quantum computing within the microtubules of neurons, proposed to generate higher consciousness (Hameroff 2003; 2007). Others see quantum tunnelling of electrons between synapses as creating consciousness (Walker 2000). The coherence of such quantum states among brain proteins has been suggested to lead to material changes in brain physiology through orchestrated collapse of quantum coherent clusters of tubulin proteins, triggered by quantum gravity expressed at the spin (Planck scale) level. On the basis of a recent theory on the nature of gravity (Verlinde 2011), postulating that gravity is not a force but rather an entropic compensation for the movement of mass/information, it was speculated that consciousness may arise from a gravity-mediated reaction on the entropic displacement of information as it occurs in high density in the human brain (Meijer 2012). But no such particles and forces have been identified that could produce consciousness. The effect that quantum coherence in the brain would be too short lived to have a functional role in neural processing (Tegmark 2000). Quantum-coherent oscillations are difficult to demonstrate on living systems – heat effects, due to resonance in thermal frequency modes, all too readily intrude, jumbling the experimental picture (Loewenstein 1999: 314). Brains operate much like a resonance chamber, oscillating pulses and patterns of neural excitations ripple through our brains much like never-ending waves in a dynamic pond of subtle electrical matter. The brain is an electrochemical organ; and speculations are that a fully functioning brain can generate as much as 10 watts of electrical power. More conservative investigators calculated that if all 10 billion interconnected nerve cells discharged at one time that a single electrode placed on the human scalp would record 5 millionths to 50 millionths of a volt. Electrical activity emanating from the brain is displayed in brainwaves (2006). The higher the frequency of our brain waves, the higher our consciousness. Our brain waves are governed by the same rules of quantum mechanics and by the same equations governing the electromagnetic spectrum, light, particles and everything in the universe. Theta oscillations are defined as activity in the 4 to 8 Hz range, the alpha rhythm operates in the 9 to 12 Hz range, while beta oscillations occur around 20 Hz. Gamma oscillations are produced when masses of neurons fire at around 40 Hz but can occur as low as 26 Hz to upwards of 70 Hz. It has been argued that transient periods of synchronized firing over the gamma waveband of neurons from different parts of the brain may integrate various cognitive processes to generate a concerted act of perception (Fries 2009). Conscious perception is also accompanied by increases in power and synchrony in the gamma band (>30Hz) (Schurger et al. 2006; Melloni et al. 2007; Doesburg et al. 2009; Wyart &Tallon-Baudry 2009). A small number of studies have, however, also found fronto-parietal activation and gamma activity during unconscious processing of sensory stimuli (Diaz & McCarthy 2007; Luo et al. 2009). In the alpha and low beta bands (10-20Hz), long-distance phase synchrony shows consistent changes for consciousness-related activity (Gross et al. 2004; Gaillard et al. 2009; Hipp et al. 2011). More generally, consciousness-related activations are frequently found in higher-order sensory areas (e.g., Tong et al. 1998; Grill-Spector et al. 2000) and in bilateral parietal and pre-frontal cortical areas (Dehaene et al. 2001; Lau & Passingham 2006; Boly et al. 2007a; Farrer et al. 2008; Desmurget & Sirigu 2009; Sadaghiani et al. 2009; Bor & Seth 2012; Tse et al. 2005; Tallon-Baudry 2011). Presently, a number of studies suggest that conscious perception may not be necessary for the operation of various complex cognitive processes, such as attention (Koch & Tsuchiya 2007), cognitive control (van Gaal et al. 2011), conflict monitoring (van Gaal et al. 2010), volition (Soon et al. 2008), arithmetic (Sklar et al. 2012), or feature binding (Mudrik et al. 2011), and semantic analysis (Kouider & Dehaene 2007; Kang et al. 2011). It is important to remember, however, that the effect size of these complex cognitive processes in the absence of consciousness is typically much smaller, compared to that obtained in the presence of consciousness (van Gaal & Lamme 2012).

In order to put forward the classical theory of the brain waves we first quantize the brain wave field. In the model

(Marciak-Kozlowska & Kozlowski 2012) we assume that; (i) The brain is the thermal source in local equilibrium with temperature T. (ii) The spectrum of the brain waves is quantized according to formula $E=hv$ where E is the photon energy in eV, $\hbar$ =Planck constant, v -is the frequency in Hz. (iii) The number of photons emitted by brain is proportional to the $(\text{amplitude})^2$ as for classical waves (Baierlein 1998). Even consciousness demands energy to keep its mechanism working, and to keep us conscious. While the brain is a high energy-consuming organ, it contains little energy reserves and is therefore highly dependent upon the uninterrupted supply of energy substrates from the circulation. Impairment in this process results in perturbation of neurological functions, loss of consciousness, and coma within minutes. As already mentioned, brain cells can efficiently utilize various energy substrates in addition to glucose, including lactate, pyruvate, glutamate, and glutamine (Zielke et al. 2009).

Now to calculate quantum mechanics of “conscious energy” I have developed my own formula in support with Albert Einstein’s special relativity theory ($E=mc^2$). Henceforth, to investigate “conscious energy” and its transformation into mass my formula is given below:

$$\textbf{Conscious energy} = \textbf{mass of brain waves} \times (\textbf{speed of signal})^2$$

or

$$E = m \times (\textbf{amplitude})^2$$

The above equation tries to show the basis of conscious energy (e.g. consit) in connection to its mass of brain waves. In the equation where m is the change in mass of the brain waves and E is the energy added to the consciousness. For example, when we become conscious then it increases signals in our brain. When the signals are increased (e.g. signals are the complex behaviour of ion channels on the branches of the neurons) then they contribute to the shape of brain waves, and the physical stimuli that gave rise to signals no longer available. For example, if we add neural energy by recalling a memory or by adding a new memory then the mass of the memory may increase at each recall or addition, and if the neural energy is taken away from the neuron, it decreases its mass.

Similar variations in the amount of energy directed to the synapses causes variations in the tension across the synaptic clefts. As these energy levels drop, the synaptic gaps gradually widen. This does not completely inhibit the transmission of messages, but will slow them down and make that transmission less efficient. Thus the level of tension across the neural networks determines the state of consciousness. The type and volume of traffic over those networks determines the experiences of consciousness (Ross 2009: 3). In human brain, cognition and consciousness are, at any one time, thought to involve tens of thousands of neurons. Hebb's (1949) "cell assemblies", Eccles's (1992) "modules", and Crick & Koch's (1990) "coherent sets of neurons" are each estimated to contain some 10,000 to 100,000 neurons which may be widely distributed throughout the brain (Scott 1995). As long as we add more neurons, we will need more speed and energy to recall or recycle them, and this will repeat in an endless cycle. This gives a situation similar to Einstein's special relativity theory ($E= mc^2$), where the letters in the equation mean that the mass m going at the constant speed of light c equals the amount of energy E needed to reach that speed. It represents the relation between energy and mass. It tells us that energy is converted totally into mass. Similarly, I have included speed of "signal squared" in my equation because it shows that as much distance a signal (e.g. neural electromagnetic waves) would travel in brain its mass would increase and this would eventually slow its speed; because nothing can travel faster than the speed of light, so signal also cannot travel faster than speed of light.

Neural electromagnetic waves do not, of course, travel at the speed of light, about 30 cm/ns in free space. In the axon of a neuron, electromagnetic speeds are closer to 30 nm/ns, because of the low current densities from ionic current sources and the high capacitance per unit area of a membrane (Burger 2009: 39). As the wavelength of electromagnetic radiation decreases, the amount of energy it emits increases (McDowell 2015: 52). Memory is enhanced not only by the rate of spike firing but equally by their relative timing. The spiking of neurons in the hippocampus and the visual cortex with which it interacts are greatly influenced by synchronous oscillations of brain waves (Sejnowski & Delbruck 2012). As more neurons are added to hippocampus area of your brain then they will increase the capacity to learn new memories. The only area of the brain where neurogenesis has been shown to continue throughout life is the hippocampus, an area essential to memory encoding and storage. For example:

Case 1: London cab drivers
London taxi drivers provide a proof of the brain's ability to reshape itself with experience, and they also show within individuals how the structure of the hippocampus can change with external stimulation. In the 2006 study, researchers compared taxi drivers' brains with those of bus drivers. The former showed increased gray matter density in their posterior hippocampi – a region linked to map like spatial navigation and memory. That probably comes as no surprise to London cabbies, who spend years memorizing a labyrinthine system of 25,000 streets (including 320 routes within a six mile radius of Charing Cross, and 20,000 landmarks and places of interest), whereas bus drivers have set routes (Mosher 2011).

Case 2: Learning a new language
The Swedish MRI study showed that learning a foreign language has a visible effect on the brain. Young adult military recruits with a flair for languages learned Arabic, Russian or Dari intensively, while a control group of medical and cognitive science students also studied hard, but not at languages. MRI scans showed specific parts of the brains of the language students developed in size whereas the brain structures of the control group remained unchanged. Equally interesting was that learners whose brains grew in the hippocampus and areas of the cerebral cortex related to language learning had better language skills than other learners for whom the motor region of the cerebral cortex developed more (Mackey 2014).

8. Conclusions

The neural processing of information is metabolically expensive. Although the human brain is 2% of the body's weight, it accounts for 20% of its resting metabolism (Kety 1957; Sokoloff 1960; Rolfe & Brown 1997). This is a general accountability of energy usage by the brain in comparison to the body which may vary from person to person depending on age, profession, gender, size and health. But if you start using your brain more than its capacity then in this situation temporary exhaustion is a genuine phenomenon. Most of us are familiar with everyday mental tiredness. We can say that a complex mental task requires more energy than usual thought processes. If we are not good at a particular task, then we have to exert more mental effort. If we are more skilled then our brain is more efficient to perform the task. But more skilful brains recruit more energy, and thus, it may require extra blood, oxygen and glucose. As a more difficult mental task requires more neural energy but there is more neural activity and much more neurons available to support the task in the brain. No worries.

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