A POSSIBLE SOLUTION TO THE HARD PROBLEM OF CONSCIOUSNESS USING MULTIDIMENSIONAL APPROACH

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Abstract. In this work a new solution to the hard problem of consciousness using multidimensional approach [1-3] is proposed. It is shown that our perceptions may be interpreted as elastic oscillations of a two dimensional membrane with closed topology embedded in our brains. According to the model our universe is also a three dimensional elastic membrane embedded into the higher dimensional space-time. The model allows us to create a unified world picture where physical and perceptual aspects of the reality are complementary. We can observe our 2d self-membranes through our perceptions, which are encoded in elastic oscillations of the elastic membrane. According to the theory, elastic membranes occupy energetically favorable positions around microtubules involved into Orch OR. Elastic membranes responsible for qualia interact with our brains and provide them with information about the character of incoming stimuli (pleasant or unpleasant), they squeeze to preserve quantum coherent states producing pleasant perceptions and stretch to avoid unpleasant ones.

INTRODUCTION

The **hard problem of consciousness** is the problem of explaining how and why we have qualia or phenomenal experiences — how sensations acquire characteristics such as colors and tastes [4]. David Chalmers [5], who introduced the term, contrasts this with the "easy problems" of explaining the ability to discriminate, integrate information, report mental states, focus attention, etc. Easy problems are easy because all that is required for their solution is to specify a mechanism that can perform the function. That is, their proposed solutions, regardless of how complex or poorly understood they may be, can be entirely consistent with the modern materialistic conception of natural phenomena. Chalmers claims that the problem of experience is distinct from this set, and he argues that the problem of experience will "persist even when the performance of all the relevant functions is explained" [5].

Erwin Schrödinger had this counter-materialist take: "The sensation of color cannot be accounted for by the physicist's objective picture of light-waves. Could the physiologist account for it, if he had fuller knowledge than he has of the processes in the retina and the nervous processes set up by them in the optical nerve bundles and in the brain? I do not think so."[6]

Although it does not actually mention the word "qualia," Thomas Nagel's paper "What Is it Like to Be a Bat?" [7] is often cited in debates over qualia. Nagel argues that consciousness has an essentially subjective character, a what-it-is-like aspect. He states that "an organism has conscious mental states if and only if there is something that it is like to *be* that organism — something it is like *for* the organism."[7, p.436] Nagel also suggests that the subjective aspect of the mind may not ever be sufficiently accounted for by the objective methods of reductionist science. He claims that "[i]f we acknowledge that a physical theory of mind must account for the subjective character of experience, we must admit that no presently available conception gives us a clue how this could be done." [7, p.450] Furthermore, he states that "it seems unlikely that any physical theory of mind can be contemplated until more thought has been given to the general problem of subjective and objective."[7, p.450]

It is obvious that drastic modifications in our ways of thinking are needed to solve the hard problem of consciousness. And these ways of thinking will require new non-reductionist scientific methods. In this work a new solution to the hard problem of consciousness is proposed. The solution is based on the concept of elastic membrane introduced in the recent papers [1-3].

THEORIES OF CONSCIOUSNESS

According to a simplified account, the human brain consists of about ten billion neurons -- and a neuron is, on average, connected to several thousand other neurons. By way of these connections, neurons both send and receive varying quantities of energy. One very important feature of neurons is that they don't react immediately to the reception of energy. Instead, they sum their received energies, and they send their own quantities of energy to other neurons only when this sum has reached a certain critical threshold. The brain learns by adjusting the number and strength of these connections. Even though this picture is a simplification of the biological facts, it is sufficiently powerful to serve as a model for the neural net (See Fig.1).

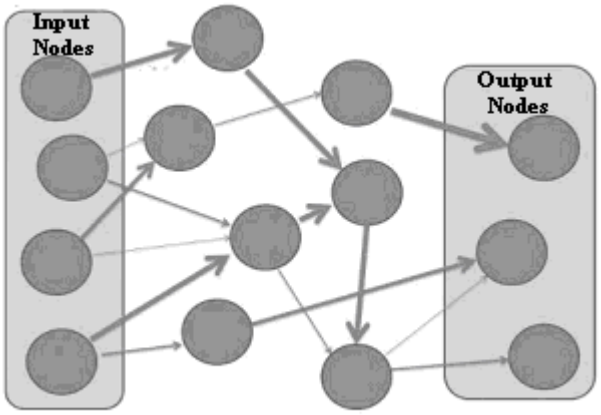

FIGURE 1. Neural net model.

The difficult philosophical question is this: can a computer program, running on a digital machine that shuffles the binary digits of zero and one, duplicate the ability of the neurons to create minds, with mental states (like understanding or perceiving), and ultimately, the experience of consciousness? Neurobiologists believe all these problems will be solved as we begin to identify the neural correlates of consciousness: the actual relationship between the machinery in our heads and its collective properties; such as the mind, experience and understanding. Some of the harshest critics of artificial intelligence agree that the brain is just a machine, and that consciousness and intelligence are the result of physical processes in the brain.

Searle goes on to argue that actual mental states and consciousness require (yet to be described) "actual physical-chemical properties of actual human brains."[8] He argues there are special "causal properties" of brains and neurons that gives rise to minds: in his words "brains cause minds."[8]

But even precise correlation of neuronal firing patterns with cognitive activities fails to explain certain critical aspects. These include a unitary sense of binding, non-computational aspects of conscious thinking, difference and transition between pre-conscious and conscious processing, (apparent) non-deterministic free will and the essential nature of our experience. Features of consciousness difficult to understand in terms of conventional neuroscience have evoked application of such aspects of quantum theory as quantum coherence and a phenomenon of quantum wave function "self-collapse"(objective reduction: OR -Penrose, 1994). The most specific and plausible model for consciousness yet proposed which offers possible solutions to each of these problematic features is Orch-OR (Orchestrated Objective Reduction). ORch OR is a theory of consciousness, which is the joint work of theoretical physicist Sir Roger Penrose and anesthesiologist Stuart Hameroff. According to this theory cytoskeletal microtubules, which regulate intra-neuronal activities and have cylindrical paracrystalline structure, are the best candidates for sites of quantum action and OR, and of "orchestrated OR"(Orch OR).[9, 10]

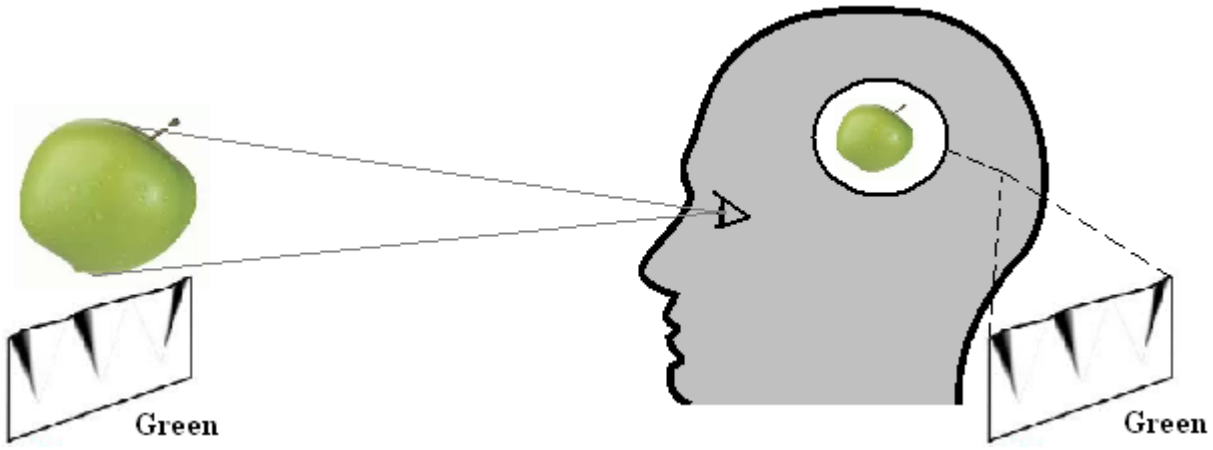

FIGURE 2. Process of perception.

The quantum gravity threshold for self-collapse is relevant to consciousness, according to the theory, because macroscopic superposed quantum states each have their own spacetime geometries. These geometries are also superposed, and in some way "separated," but when sufficiently separated, the superposition of spacetime geometries becomes significantly unstable and reduces to a single universe state. Quantum gravity determines the limits of the instability; we contend that the actual choice of state made by Nature is noncomputable. Thus each Orch OR event is a self-selection of spacetime geometry, coupled to the brain through microtubules and other biomolecules.

Several theorists have proposed that consciousness can be understood as an electromagnetic phenomenon. Their theories differ in how they relate consciousness to electromagnetism.

The field theories of consciousness do not appear to have been as widely discussed as other quantum consciousness theories, such as those of Penrose, Stapp or Bohm. However, David Chalmers [11] argues that quantum theories of consciousness suffer from the same weakness as more conventional theories. Just as he argues that there is no particular reason why particular macroscopic physical features in the brain should give rise to consciousness, he also thinks that there is no particular reason why a particular quantum feature, such as the EM field in the brain, should give rise to consciousness either.

HOW DO WE HAVE QUALIA?

Undoubtedly the Penrose-Hameroff Orch OR model may be considered as a good theory for describing information processing mechanisms and holistic phenomena in the human brain [1-3]. The theory explains both physical and biological aspects of consciousness such as

1. Non-computability of consciousness;
2. Relation of consciousness to space-time geometry;
3. The role of microtubules as suitable candidates for information processing;
4. Mechanisms for macroscopic quantum computing – dendritic webs.

But the theory doesn’t give us satisfactory explanation of human perception: it cannot explain indivisibility, privateness and two dimensional character of qualia. The theory also does not answer the question which physical structure is responsible for our experience. The theory fails to explain how multiple separate ORch OR processes may coexist simultaneously.

According to Ramachandran: “since qualia are generated for someone or something - presumably 'the self' - the problem of the self and the problem of qualia are really just two sides of the same coin. The self, however, may be just a "form of adaptive self-deception or delusion", which we must nevertheless explain.

Perception cannot be explained in terms of elementary particles: interactions between separate entities - the elementary particles of our bodies cannot establish a feeling of having perceptual experience, because the notion of "elementary particle" is very abstract and is derived from our perceptions. And there may be objects of higher priority around us. Obviously, such fundamental processes as the processes of perception should be explained using objects of the highest priority. A more fundamental object which incorporates all physical objects around us is our Universe. We explore it from inside and, therefore, our knowledge about it is incomplete. The empty space we see from the inside of the Universe may be only the result of internal observation. Einstein's full theory of space-time, called General Relativity can be extended easily to higher space dimensions. This fact is a good argument in favor of the multidimensional science concept.

A new model of multidimensional geometry was proposed recently [2]; the model is based on smooth infinitesimal analysis and allows embedded surfaces to have dual metric: internal and external – they can change their form in the bulk without changing the internal metric. The model is very useful for describing nervous system–like branchy structures. From Fig. 3 you can see how one-dimensional surface is stretched to take the form of some branchy figure. Thickness of the surface depends on the coefficient of stretching: squeezed regions are thicker than stretched ones. The squeezed regions of the surface will correspond to the neuron's dendrites; regions corresponding to more active dendrites will be thicker.

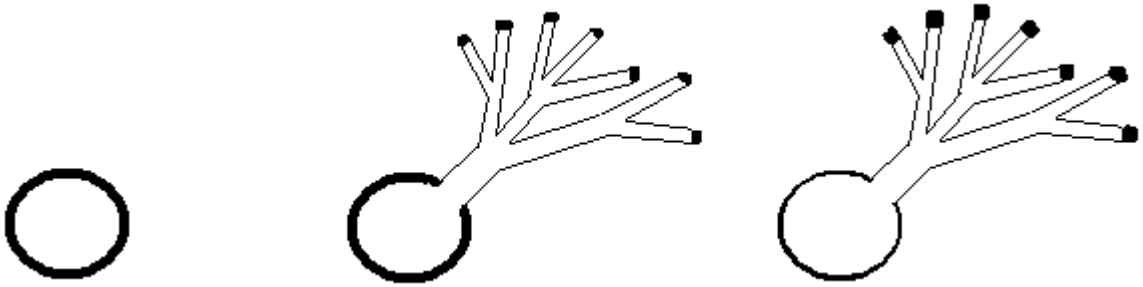

FIGURE 3. Transformation of the one-dimensional elastic surface into a branchy figure.

As it was shown in [3] this new geometry gives rise to a new multidimensional physics which considers reality as the process of time evolution of holistic macro objects - elastic membranes. An embedded membrane in this multidimensional world will look different for the external and internal observers: from the outside it will look like a material object with smooth infinitesimal geometry, while from the inside our Universe-like space-time fabric. When interacting with elementary particles and other membranes, a membrane will transform their energy into its elastic energy (a new form of energy) - the energy of stretching of the infinitesimal segments. For example, living organisms play the role of internal observers of the Universe, and at the same time they serve as external observers for 2D membranes embedded into our Universe.

The new multidimensional physics may be useful for explaining our perception. It is supposed that our perception may be considered as the result of elastic oscillations of two dimensional (2D) elastic membranes with closed topology embedded in our bodies. Only one elastic membrane responsible for its perceptions will correspond to the selected organism, but there may be other membranes, even at the living cell level. We can observe our 2D self-membranes through our perceptions, which are encoded in elastic oscillations of the elastic membrane.

There are two types of elastic deformation of the elastic membrane: longitudinal when the direction of elastic deformation is tangent to the surface of the membrane and transverse when deformation happens perpendicularly to the membrane's surface. The first changes density of the membrane and the second causes oscillations of the membrane (See Fig. 4). While transverse deformations are responsible for our visual, audio and etc. perceptions longitudinal deformations change sensitivity of the elastic membrane.

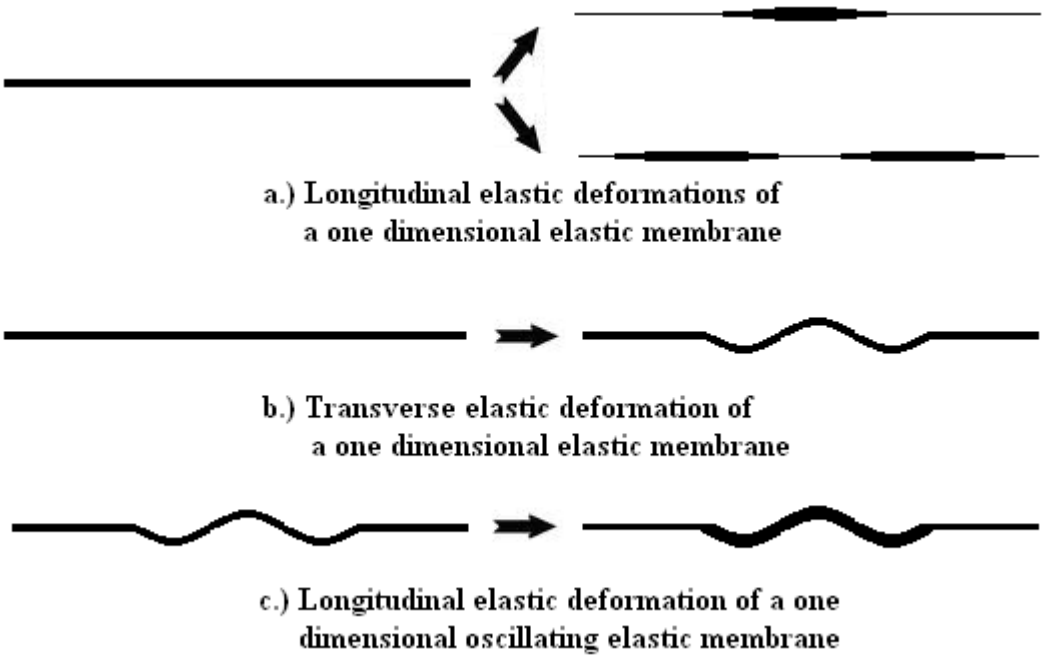

FIGURE 4. Longitudinal and transverse deformations of a one dimensional elastic membrane.

According to the proposed model elastic membranes occupy energetically favorable positions around microtubules involved in ORch OR (See Fig. 5). During gamma synchronization an elastic membrane starts stretching and propagating along the direction of attentive focus. Stretched regions have lower density and are less sensitive. When ORch OR happens the membrane occupies energetically steady positions around ORch OR region and starts squeezing in order to keep the position of steady equilibrium. The squeezed regions of the membrane have greater density and are more sensitive. This explains why during conscious attention our perception in the direction of the attentive focus becomes more vivid, while in other directions our perception has a damping character.

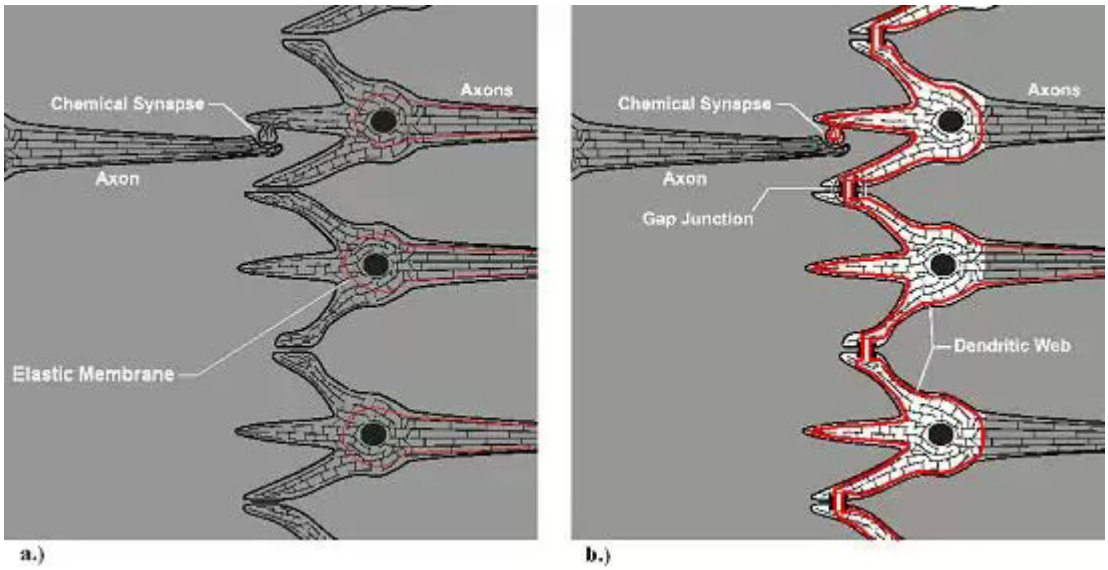

FIGURE 5. a.) The elastic membrane is stretched along the direction of the attentive focus, b.) The elastic membrane is squeezed around microtubules involved in ORch OR.

From Fig. 6 we see how elastic membranes propagate through the neural net and which position they occupy in the human brain.

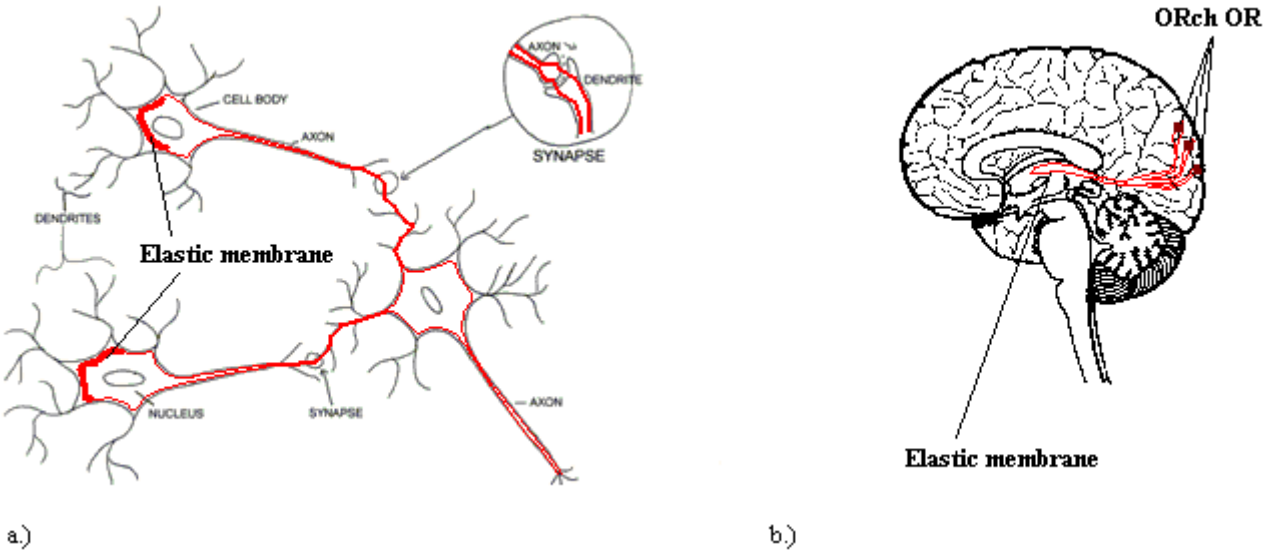

FIGURE 6. a.) Elastic membrane propagating through the neural network, b.) The position of an elastic membrane in the human brain.

The model explains some features of our perception which cannot be explained using other models:

1. quasi two dimensional character of our perceptive experience;
2. feeling of self awareness as being one whole;
3. active character of our perception: we aren't zombies because in our brains physics of perception is separated from the information processing physics. But at the same time both mechanisms are tightly connected and under certain conditions can affect each other.

WHY DO WE HAVE QUALIA?

In the previous section we demonstrated how elastic deformations of a two dimensional material object – elastic membrane embedded in our brain can produce elastic oscillations responsible for our phenomenal experiences – qualia. Another important question is: why do we need qualia?

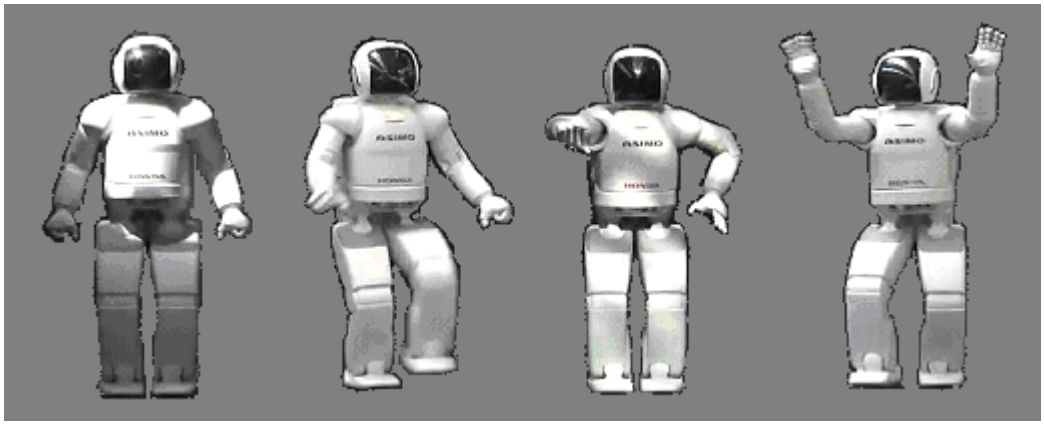

FIGURE 7. Honda's robot ASIMO.

In robotics, engineers have created machines with multiple points of articulation. Some robots have an array of sensors that can gather information about the environment, allowing the robot to maneuver through a simple obstacle course. Honda's ASIMO robot (See Fig. 7) can climb stairs and run. From manufacturing to military applications, robots are making a big impact.

Though computers and robots are more advanced than ever, they're still just tools. They can be useful, particularly for tasks that would either be dangerous to humans or would take too long to complete without computer assistance. But robots and computers are unaware of their own existence and can only perform tasks for which they were programmed.

FIGURE 8. Digital represantation of information in computers.

Let's consider a simple analogy of a human mind - a computer. The picture that you see on a computer monitor is made up by the computer to represent the states inside it. Just like the brain, inside the computer, everything is coded in electrical spikes. Yet you see pictures and text on the computer's monitor. This is to help you interface with the computer, just as qualia help you to interface with your brain which is connected by your senses to your world.

Modern computers and humanoid robots can interact with the real world, they can collect visual, audio and other signals, they even can perform precise and complex operations that humans cannot. But a computer itself hasn't feelings and emotions and, therefore, it hasn't qualia. We see that qualia can be divided into two subtypes: perceptive – visual, audio, tactile and etc. perceptions and sensitive – the reaction of the elastic membrane on the generated perceptions. If the first has just informative character the second is more complicated. These qualia have valence: there is a fundamental bipolar dimension about some of our conscious states: the continuum from pleasurable to unpleasurable. Classic example: emotions, feelings („emotional valence").

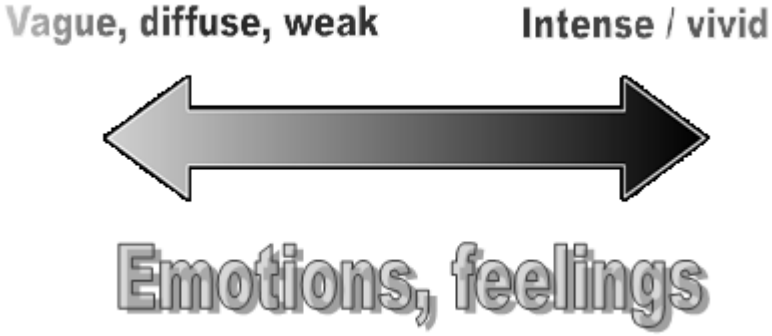

FIGURE 9. "Emotional valence" of emotions and feelings.

It's possible to create programs that mimic thought. These programs might give a machine the ability to recognize and respond to patterns. But ultimately, a machine isn't aware of itself. It is simply responding to commands.

The main tendency of human activity is to improve our lives by achieving persistent pleasant emotions and feelings and avoiding unpleasant ones. In most cases our brains can predict the result of our actions. The prediction is based on the previous experience. But in some cases we aren't sure about the character of expected phenomenal experience. For example, when we change our job, or we taste new dishes, or we communicate with unfamiliar people. In such situations we will need extra information to understand whether the situation is pleasant or not. This is qualia which will help us to do that (See Fig. 10).

According to the elastic membrane model of human perception an elastic membrane will squeeze along the directions with pleasant elastic oscillations and stretch along the directions with unpleasant ones. Elastic membranes serve like shields preserving coherent quantum states. More dense regions will preserve pleasant perceptions. The regions with minimal density will assist to destroy unpleasant elastic oscillations.

Our brains are able to detect these longitudinal elastic transformations of the elastic membrane and, therefore, they can understand the character of perceptions (pleasant or unpleasant) and store the results in the memory. The model explains why people have different emotions and feelings when having almost the same perceptual experiences. For example, some people enjoy dishes that other people don't like. The character of our emotions and feeling depends on the parameters of the elastic membrane, its structure and other yet unknown physical factors.

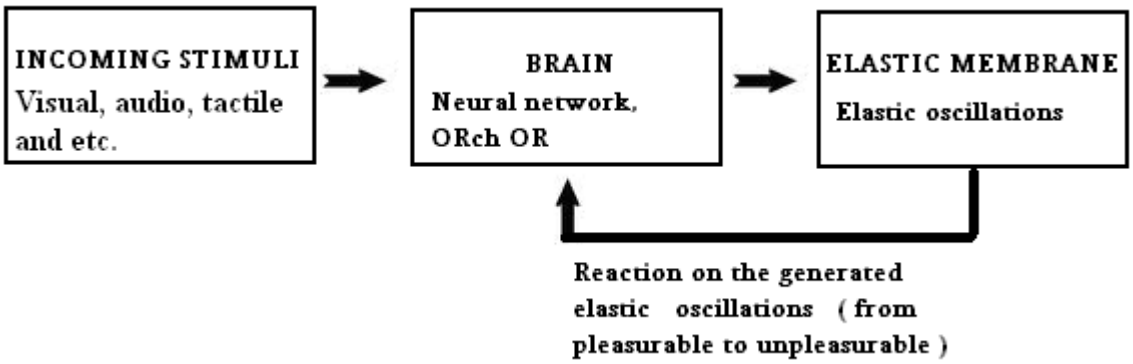

FIGURE 10. The process of conscious perception.

In summary, qualia are simply how we experience our world when we are conscious. We are not conscious of the electrical spikes that are buzzing in our brain, but we are conscious of the qualia which represent these spikes. The experience of colors represents the electric spikes conveyed from our color sensitive cells in our eyes, and that of sound from sound sensitive cells in our ears and so on for all the other senses.

There are a few reasons why do we have qualia:

1. Elastic membranes responsible for qualia interact with our brains and provide them with information about the character of incoming stimuli (pleasant or unpleasant). We need this information when we have new unfamiliar experiences.

2. Elastic membranes occupy energetically favorable positions around microtubules involved in ORch OR and play the role of shields preserving quantum coherent states. ORch OR creates the basis for qualia and self awareness through space-time geometry and elastic membranes undergo elastic deformations in this gravitational field.

3. Elastic membrane will try to preserve pleasant perceptions and destroy unpleasant ones. This fact reflects the global tendency of the human mind to enjoy pleasant feelings and emotions and avoid unpleasant ones.

4. The feeling of being a whole thing. The elastic membranes are holistic objects so that they apriori have this feature.

We see that elastic membranes are ideal candidates for structures which can work with a quantum computer.

They are holistic: all longitudinal elastic deformations – stretchings and squeezings will occur simultaneously and in coordination. So that elastic membranes can be used for controlling and managing quantum computers, because they can simultaneously interact with distant blocks of the quantum computer.

They are sensitive to space-time geometry at the distances relevant to ORch OR: according to multidimensional physics elastic membranes are almost homogeneous structures embedded into the higher dimensional elastic membrane – our Universe and, therefore, they are apriori connected to space-time geometry through the embeddance procedure.

And, finally, elastic membrane can simultaneously control multiple ORch OR processes.

CONCLUSION

From the works of worldwide known scientists we see that the hard problem of consciousness needs a new non-reductionist conceptual basis to be solved. It also needs new understanding what is objective and what is subjective to solve the problem of existence - how a physical object may be aware of its own existence.

Among the existing theories of consciousness the most successful is the Penrose-Hameroff ORch OR model which gives good explanation for holistic processes in the human brain and basic features of self awareness and qualia. By it hasn't explanation why particular quantum features in the brain should give rise to qualia.

In this work a new solution to the hard problem of consciousness using multidimensional holistic approach is proposed. It is shown that our perceptions may be interpreted as elastic oscillations of a two dimensional holistic elastic membrane with closed topology embedded in our brains.

We can observe our 2d self-membranes through our perceptions, which are encoded in elastic oscillations of the elastic membrane. During gamma synchronization an elastic membrane starts stretching and propagating along the direction of attentive focus. Stretched regions have lower density and are less sensitive. When ORch OR happens the membrane occupies energetically steady positions around ORch OR region and starts squeezing in order to keep the position of steady equilibrium.

Elastic membranes responsible for qualia interact with our brains and provide them with information about the character of incoming stimuli (from pleasant to unpleasant); they squeeze to preserve quantum coherent states producing pleasant perceptions and stretch to avoid unpleasant ones.

The model explains how and why do we have phenomenal experience and is well integrated with mainstream science theories such as general relativity, quantum mechanics, string theory and ORch OR. In the next stage of our investigation existence of elastic membranes must be proved experimentally. This seems to be possible because elastic membranes are supposed to have a certain effect on our mental activity and will be detectable experimentally.

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