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Notes Quantum Coherence and Conscious Experience

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Abstract

I propose that quantum coherence is the basis of living organization and can also account for key features of conscious experience - the "unity of intentionality", our inner identity of the singular "I", the simultaneous binding and segmentation of features in the perceptive act, the distributed, holographic nature of memory, and the distinctive quality of each experienced occasion.

Andrew's [1] assessment that brain science is in a "primitive" state is, to some extent, shared by Walter Freeman [2], who, in his recent book, declares brain science "in crisis". At the same time, there is a remarkable proliferation of Journals and books about consciousness, which brain science has so far failed to explain, at least in the opinion of those who have lost faith in the conventional reductionist approach. One frequent suggestion is the need for quantum theory, though the theory is interpreted and used in diverse, and at times conflicting ways by different authors.

1. Andrew, A. M. (1995). "The decade of the brain - some comments", Kybernetes 24, 54-57.

2. Freeman, W.J. (1995). Societies of Brains. A Study in the Neuroscience of Love and Hate, Lawrence Erlbaum Associates, Hove.

Data from … magnetic tomography and EEG …show … largescale spatiotemporal coherence of brain activities that cannot be satisfactorily explained by conventional mechanisms. The brain functions, not as a collection of specialized brain cells, but as a coherent whole.

How the brain functions as a coherent whole is inseparable from how the organism functions as a coherent whole. I

In the ideal, the organism is a quantum superposition of coherent activities, with instantaneous (nonlocal) noiseless intercommunication throughout the system.

I do not think quantum theory per se will lead us through the mechanistic deadlock to further understanding. Instead, we need a thoroughly organicist way of thinking that transcends both conventional thermodynamics and quantum theory [7,12]. I have focused on the notion of quantum coherence and the attendant nonlocal intercommunication.

In this paper, I shall briefly summarize the arguments for quantum coherence in the living system, then go on to explore how certain key features of conscious experience may be understood. How is energy mobilization so well-coordinated? That is partly a direct consequence of the energy stored, which renders the whole system excitable, or highly sensitive to specific weak signals.

Connective tissues make up the bulk of all multicellular animals. They are flexible, highly responsive, yet ordered phases which are connected, via transmembrane proteins to the intracellular matrices of individual cells [15, 16]. The extracellular and intracellular matrices together constitute an excitable

continuum for rapid intercommunication permeating the entire organism, enabling it to function as a coherent whole [13]. The existence of this liquid crystalline continuum has been directly demonstrated in all live organisms by a noninvasive optical imaging technique recently discovered in my laboratory [17 - 19]. It constitutes a "body consciousness" that precedes the nervous system in evolution [16]; and I suggest, it still works in tandem with, and independently of the nervous system

Quantum coherence gives rise to correlations between subsystems which resolves neatly into products of the self-correlations so that the sub-systems behave as though they are independent of one another. One can also picture the organism as a coherent quantum electrodynamical field of many modes, with an uncertainty relationship between energy and phase [21] So, when phase is defined, energy is indeterminate, and vice versa. From the perspective of the whole organism, the brain's primary function may be the mediation of coherent coupling of all subsystems…The reason macroscopic organs such as the four limbs can be coordinated is that each is individually a coherent whole, so that a definite phase relationship can be maintained among them.

The hand-eye coordination required for the accomplished pianist is extremely impressive, but depends on the same inherent coherence of the subsystems which, I suggest, enables instantaneous intercommunication to occur. There simply isn't time enough, from one musical phrase to the next, for inputs to be sent to the brain, there to be integrated, and coordinated outputs to be sent back to the hands (c.f. Hebb [28]).
I raised the posssibility, above, that a "body consciousness" works in tandem with, but independently of the "brain consciousness" constituting the nervous system. I suggest that instantaneous coordination of body functions is mediated, not by the nervous system, but by the body consciousness inhering in the liquid crystalline continuum of the body. Ho and Knight [29] following Oschman [16], review evidence suggesting that this liquid crystalline continuum is responsible for the direct current (DC) electrodynamical field, permeating the entire body of all animals, that Becker [30] and others have detected. Becker has further demonstrated that the DC field has a mode of semi-conduction that is much faster than nervous conduction.

A cylinder of bound water surrounds the triple-helical molecule, giving rise to an ordered array of bound water on the surface of the collagen network that supports rapid "jump conduction" of protons. Proteins in liquid crystals have coherent residual motions, and will readily transmit weak signals by proton conduction, or as coherent waves [31]. Thus, extremely weak electromagnetic signals or mechanical disturbances will be sufficient to set off a flow of protons that will propagate throughout the body, making it ideal for intercommunication in the manner of a proton-neural network [32].

The liquid crystalline nature of the continuum also enables it to function as a distributed memory store. As the bound water forms a global network in association with the collagen, it will have a certain degree of stability, or resistance to change. The corollary is that it will retain tissue memory of previous experiences. Thus, consciousness is distributed throughout the entire body, brain consciousness being embedded in body consciousness. The "self" is the domain of coherence [7], a pure state or pure duration that permeates the whole of our being
One thing seems clear. Quantum coherent systems can bind and segment simultaneously and nonlocally by virtue of their factorizability (see above), which is how living processes are organized. Circulation,

metabolism, muscular and nervous acitivities all go on simultaneously and independently, yet nevertheless cohering into a whole.

Strong evidence that memory storage is delocalized, at least over the whole brain, is the finding that it is able to survive large brain lesions. This has already led a number of people to suggest that memory storage is holographic… If quantum coherence is characteristic of the organism as conscious being, as I have argued here, then the conscious being will possess something like a macroscopic wave-function. This wave function is ever evolving, entangling its environment, transforming and creating itself anew [7]. I agree with Bohm and Hiley's [47] ontological interpretation of quantum theory to the extent that there is no collapse of the wave function. In their model, the wave function, with quantum potential playing the role of active information to guide the trajectories of particles, simply changes after interaction to become a new one. What would our wave function look like? Perhaps it is an intricate supramolecular orbital of multidimensional standing waves of complex quantum amplitudes. It would be rather like a beautiful, exotic flower, flickering in and out of many dimensions simultaneously