

CONSCIOUSNESS AND BRAIN SCIENCE: MECHANISMS BY WHICH NATURE KNOWS THROUGH US

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ABSTRACT: The first argument in this article is that, absent what would truly be a paradigm change (for once that hackneyed term is met) 21st century brain science is already set on a sterile and unethical course. An alternative, dynamical systems approach based on the work of Freeman, Hoffman and Pribam is outlined. Moreover, it is argued that this allots physicists in the area appropriate work to do, versus the current Herculean/Augean task left behind to them by neuro"scientists". The article continues with a radical reparse of the concepts in what has become the consciousness industry. Finally, a set of promising concepts is explored, starting with the holographic idea of memory. Above all, phase and amplitude modulation of a carrier wave are given a central role, as is the possibility of quantum effects in informational processing of the attentional stream.

KEYWORDS: Consciousness; Awareness; Nous; Intentionality; Attention

INTRODUCTION

Brain science (BS) is one of the great unheralded failures of the 21st century. There is every chance that the current paradigms like integrate-and-fire are quite simply wrong as theories of cognitive and even perceptual process. The pitch is somewhat queered by the fact that "neural networks" like convolutional "neural" nets exploit massive

computational processing power to perform idiot savant tasks like winning at Go. Yet, hype aside, the smarter members of that community call their system convolutional nets, foregoing the “neural”.

The situation is described pithily by the late, great Walter Freeman (2014) in his review of the envoi of his mentor Karl Pribram. The review begins "Cognitive science is in disarray...neuroscientists cannot tell us how minds work....for example...we do not know how brains make and use symbols, or how natural languages work....or how to illuminate the mysteries of consciousness". So the "massive funding" in "Europe, North America and Asia" (ibid) will be wasted.

Famously, a complete wiring diagram for the 302 neurons of *C.elegans* has been around for a generation without any but primitive explanations of behaviour emerging (Lockery et al, 2009 end up eschewing action potentials as their title indicates). Secondly, many epilepsy sufferers signed release agreements at UCSF and elsewhere to allow their brains be fiddled with in ECOG which is beneath the hood of the skull as it were. All that emerged from this was “phonic” data, sufficient for recognizing phonemes; as it turns out this level of analysis had previously been achieved by the Suppes group at Stanford using EEG, that is without going beneath the hood. Indeed, so useless did Maya Cano of the UCSF/Cal project find the ECOG data that she went back to using EEG. (Cano et al., 2016)

Two strikes against BS so far; *C. elegans* and invasive neuroscience. Consciousness studies should be using the results from BS to develop its models; there are vanishingly few such results. As might be expected, the consciousness field is a ferment of competing paradigms, based on few data. Consciousness studies can succeed, it appears, only in the context of a new neuroscience. This section will tentatively outline such a neuroscience.

There are a few trailblazers we can use. First of all, quantum mechanics has a clearer example of veridical reference in the twin slit experiment than the whole of BS. An observation is in progress; somehow the system knows whether to behave as a wave or particle. To get that granularity of reference, even in an AI system – let alone a neural system – much programming is required.

However, there may be a deeper sense in which the physicists are right; the architecture of the brain is secondary to the noetic systems which program it, systems expressed in the language of mathematics. After Deep mind, a deeper mind. QM makes statements about a noetic reality; it has been forced to address the very foundations of what knowledge itself is in science; it is certainly relevant and may in fact be paramount.

There is abroad a notion that “semantics” gives reference, That very rarely happens; semantics is often another impenetrable layer below syntax. How we humans

understand each other is a very difficult problem; even more difficult is how complex sequences of words denote anything, and only QM has a clear paradigm here which we will expand below.

The situation is commented on with some exasperation by Kime in my 1997 collection;

“I have lost track in recent years of the number of different semantic formalisms. We now have Dynamic Predicate Logic, Dynamic Montague Grammar, Discourse Representation Theory, Situation Theory, Property Theory, Channel Theory, Linear Logic and many more.”

It is worth noting that even the necessarily artificial world of AI systems has trouble with reference for symbols, making the QM situation more desirable. For example, we at the NRC in Canada (and later Ireland) wrote a system that could visualize on a screen simple sentences like “Make the house on the right blue”. (O Nuallain, et al, 1995) The sentence was processed by a phrase structure grammar written in Lisp; event-based lambda calculus with beta reduction then produced a semantic representation. Not even close to being done; we then wrote a set of methods in CLOS (the common Lisp object system) for “Make” that would, by process of elimination, find which house and then “do” the action.

Exemplified by the twin slit experiment, QM shows a direct relation between mind and world as the electron somehow “knows” how to be wave or particle depending on whether it is being observed. To anticipate, this paper proposes an emanationist schema with the Absolute “measuring” at the physical, biological, noetic and conscious levels. The first type of measurement is decoherence and/or another type of objective reduction like spontaneous localization. Famously, Penrose has championed this. The second is biological code. The third is “authentic existence” whereby an act of subject-object differentiation reveals both subject and object. We find this in the work of Pradjan below. Finally, this paper proposes that holographic processes may be exemplified in consciousness. The adaptation of post QM by workers like Bohm and Hiley allow this type of process to have the supra-computational powers envisaged for consciousness by Penrose. In any case, determination/measurement by a conscious subject changes both the “objective” world and the brain. We cannot continue to ignore this.

Karl Pribram (1991) argued that the brain must be capable of performing Fourier/Gabor transforms. We implemented a computational model of his theory (see below); like Deep Mind, it used a nonlinear transfer rule as the basic substrate for learning. As it turns out, in this decade of massive computational processing power, that will suffice. Unlike Deep Mind, the delta rule for us referred to a change in the

membrane potential. We followed Pribram in arguing that neurons can adjust the delay by which they receive signals from other neurons. That allows the creation of what looks like an isobar map, with neurons competing to become attuned to particular frequencies.

Several consequences emerge. The causal role of neural firing is attenuated, perhaps to simply communication rather than computational processing. Moreover, networks of neurons now show sensitivity to the phase of oscillations as they interact together in non-linear ways as we demonstrate below.

It was left up to Pribram's brilliant student, Freeman, to take the next step and argue that the correct level of analysis of cortical function involves vector fields, not "neural networks". So not only is integrate-and-fire merely a limit case of the more encompassing resonate-and-fire which describes neurons' behaviour; we must continue by inveighing against "neural networks" and propose a model of brain function using the more general language of dynamical systems.

It is worth noting that the research into olfaction by Freeman agrees with the thrust of the 2004 Nobellist Axel in that both agree on distribution over many neurons; yet Pribram and Freeman, unlike Axel, strike one as several generations ahead of their time. This author had the privilege of working with both these giants and the computational work described in this paper was done under their direct supervision.

It is worthwhile noting also that there are considerable differences between their approaches, and one of the contributions of this article is to exploit the good points of each. For Pribram (see mine and Doris' paper in my 2016 collection) holographic representation of the world was achieved through the dendritic arbors of neurons. Moreover, my work has emphasized that, contrary to Freeman (1999) that Neurodynamics starts with the individual neuron, not with thousands of such.

Freeman (ibid) is willing to grant that Pribram may be right for the first stages of perception; for example, the olfactory bulb holds non-local hologram-like representations. However, he goes on to argue that this is just one stage; idiosyncratic colouring of the results from the bulb ends with a "solipsistic" world being created. It is the task of this paper to show that such world is not "solipsistic". It is indeed infected with Piagetian schemes etc. (see my 2003 book) but we outline here how a link to the transcendent can be rescued.

What Freeman means by "solipsistic" is better put, perhaps, as "idiosyncratic to the individual". This is part of a full solution to the so-called "hard problem" which is sketched in this paper. The essence of subjectivity has been encompassed in physics both by Qm and special relativity, and the contents are the result of elaboration after the midway stage of perception. Specifically, the argument below is that the

holographic perspective reinstates itself only for conscious perception. (I should note that Jack Sarfatti is developing a much more complex attack at the “hard problem” using general relativity and retro causality; I believe this to be superfluous. All Sarfatti work is personal communication received through the FOM group).

Intriguingly, Freeman (2013, 135, 235) has a concept of decoherence in the classical cortical waves that we will display in this paper. It is NOT quantum decoherence; in fact, dephasing rather than decoherence is in any case how quantum states seem to occur and unravel in nature, with surrounding “noise” actually helping the coherence. Yet, stretching science a century in the future, it may be found that the coherent self-similar waves we shall witness as possible in consciousness produce etchings in reality that change quantum states, that allow Nature to be through us.

What then of Consciousness? As it turns out, a host of new problems emerge. First of all, physicists have correctly argued that mental predicates are used in the classical Von Neumann quantum mechanics paradigm. Moreover, the decades’ long exploration of how humans acquire number by the likes of Piaget ended with – at best – an incomplete model of arithmetic, while math people consider even Hilbert space trivial. The inescapable fact of the existence of their own subjectivity has led many into an anti-science path as the gothic excesses of such as we have seen from UCSF led to naught. In fact, Platonism in math added the temptation to view Consciousness as contact with a Noosphere.

We have several brilliant physicists in FOM trying to "solve" consciousness with the implicit argument that theirs is the most elliptical and veridical language - a case that has merit. There is a confounding issue - physics is processed in some sense by the brain, so we know that any formalization has some neural correlate. There is currently some controversy about the role of fibre bundles. The comment has also been made that this is a math formalism not even used by the founder of GR: That would be Einstein:

“The point here is that the fiber bundle formalism is an empty mathematical shell that can accommodate just about any kind of physics in curved 4D spacetime, classical or quantum, and it's not clear why this formalism has any concrete implications at all about the nature of the physical spacetime represented by the base manifold.“ (Zielinski, personal communication)

Let's assume, for the sake of argument, its aptness. It still does not establish the other thesis; that the pilot wave accretes Qualia. In fact, we can reparse and argue that Qualia emerge from the intentional role of neural fiber bundles in their interaction with the pilot wave or however one terms the Absolute

In 1995, we ran the first FOM at U Sheffield and published it as "Two sciences of

mind". It ends with a breakthrough paper by the late William Hoffman called "mind and the geometry of systems". Hoffman argues that fibre bundles are approximated in a co-ordinate free flow of information in the brain and in that sense can be considered intrinsic to neural processing and particularly consciousness

Here are some quotations:

"The conveners of the recent "Foundations of Cognitive Science Workshop" noted a crisis surrounding the present approaches to cognitive science. Two main fronts were identified: (i) are mental processes best studied in terms of information processing or as phenomena of neuroscience and consciousness; and (ii) the matter of unifying consciousness, affect, and social psychology with the science of mind. The answer, I suggest, lies in firmly grounding an approach in terms of the known structures of the brain. The approach presented here involves both of the above fronts. In it there occur four main neuropsychological structures:

1. The Ascending Reticular Activating System and Baars' ... ERTAS (Extended Reticular Activating System) as a basis for the awareness fundamental to consciousness;
2. The limbic system to impart an emotional cast to percepts and cognitions;
3. The cortex of the brain as the seat of the higher mental faculties of perception and cognition;
4. The nuclei, gyri, and other subcortical centers in the midbrain and forebrain region, where the seat of consciousness lies.

All of these may be analyzed in terms of the mathematical structures of the Geometry of Systems These structures encompass Lie transformation groups, fibre bundles, fibrations and certain other structures of algebraic and differential topology Lie transformation groups and fibre bundles are fundamental to geometric structures and to the invariance of such transformations as those encountered in form memory and the psychological constancies. Many years ago, Pitts and McCulloch (1947) noted that the figures invariant under the transformations imposed by viewing conditions must be "the geometric objects of Cartan and Weyl, the Gestalten of Wertheimer and Kohler."

This is an appropriately complex neuroscience; couple it with Freeman and Pribram and we've got something! The lack of a paradigm up to now caused a Babel effect. Best perhaps to consider Consciousness (Con-scio, I know, slice up the world, together) in terms of global broadcast of a signal, perhaps through amplitude or phase modulation of a carrier wave like gamma. (We address Pockett's "refutation" of this below). Freeman argued that amplitude modulation corresponded to meaning, and

phase modulation to memory; he also pointed out that while a snapshot of brain data shows a power series, over time the correct analysis is carrier wave and modulation.

Qualia can be shaped by the brain region of the activity and colored by the limbic system. That of course leaves the issue of the existence of the “self” to whom these qualia are presented, the so-called “hard problem”. This is ironic, as 20th century science had encompassed the observer in special relativity by 1905. In fact, William Hoffman made this very argument in 1997 in my collection;

"In the fine neurons of the Central Nervous System, nerve impulses propagate at about 2 to 5 meters/second. The result, according to a basic theorem of Special Relativity Theory ..., is that this finite velocity of signal propagation forces the relation between the outside moving frame of reference and the internal egocentered frame of reference to be Lorentzian rather than Galilean ... The result is to force a relativistic distinction between the egocentered self and the external world ... This is basic self-awareness, upon which the other later developing self-directed cognitive and emotional faculties superimpose."

Yet that does not explain the enormous memory capacity of our brains, their discontinuity from those of other animals, and our ability to use math with its “unreasonable effectiveness”. Organisms like plants have tropisms (eg to follow the sun). Animals have reflexes. Humans have two types of cognition; that “coupled” directly to the environment, like what a Roomba vacuum does, and that “decoupled”, as we do when we try and post helpful comments on the internet (see my 2009 book).

Moreover, in general the former human actions are egocentric ie they consider the environment only in terms of a set of actions performable on it, while “decoupled” actions can also be non-egocentric; the comment being genuinely useful shows it's non-egocentric. It could be argued that much of symbolic human activity is egocentric, and we rarely adjust to others in a “decoupled” way.

So the action of lower organisms, while interesting, is different in kind from human cognition. Thus the problematic nature of simply construing the Fourier/Gabor as relating the implicate domain with the explicate domain (to use Bohm's terminology; we examine Bohm further below). In fact, a further set of distinctions may be introduced. Decoupled acts include the cognitive (handled in the work of Piaget et al) and are phrased in the rather hand-waving concepts of schemes, schemata etc. Also decoupled are the “noetic” acts that allow us access to realms like QM that we primates have no right to know about.

It arguably gets more complex. Presented to us also are exigent entities – we learn from an early age that we are subject to state law, and no access is available to the

primal events which initiated us. There is also a capacity for self-transcendence, be that a soccer mob's singing or – much better – a mystic's access to the infinite. The latter is a subset of the transcendent that we will, after Otto, label the “numinous”. (See my companion paper in this collection).

The architecture proposed here includes the idea that sampling incoming stimuli at different rates (gamma, theta etc) demodulates the signal so that amplitude, phase and other quantities are derived. Moreover, the brain has access to its own activity; this process is the origin of the cognitive self, which Descartes with disastrous results identified as the disincarnate “soul”. This access yields subject/object distinctions at rates which consciousness, with its sluggish sampling rate, knows only the tip of the iceberg. In moments of dissociation, we experience what Poincare called these subliminal selves.

So let's consider some phenomenology; we will be compelled to do so in Consciousness studies, absent real neural data, for at least the 21st century. Memory seems to be globally distributed in the brain; Penfield's localizations were fraudulent, and not witnessed even by his surgery nurses. This led to a radical hypothesis; the brain's memory works as a hologram!

It may even have some truth. Consciousness seems to involve a fractal self-similarity of brain waves at different frequencies, when we remember something, it is often initially through “subsidiary” awareness; perhaps a lower carrier waves than gamma. But that evokes something that leads to reconstruction of the whole memory, and with it the attendant conscious experience...

Let us, by way of recap, stress that English is notoriously impoverished when it comes to describing inner states. Yet we can note a clear distinction between consciousness, simply explicable in classical terms as the results of global cortical neural synchrony, and intentionality, the fact that minds “intend” (ie point at) the external world. We can reserve “awareness” for the contentless subjectivity complementing higher primates' underlying intentionality.

Continuing, attention is the act of giving salience to one or other of the processing streams in the brain, and this act seems to be the best bet for mind-matter interaction, synthesizing, as it does, Classical QM with cutting-edge work on perception. It is now accepted that there exist two forms of attention; that subject to voluntary control, the “downward causation” related to human free will, and automatic attention. In the schema here, only the former is a quantum event; the latter works similarly to algorithms like dynamic load-balancing.

Let us see what Freeman (1999) has to say. He is essentially in agreement on P 122 even with our terminology;

“Awareness is an experience, which in neurodynamic terms is a transient state. Consciousness is the process by which sequences of hemisphere-wide states of awareness form a trajectory of meaning.”

We have null spikes in the diagrams below indicating awareness that buttress an experience of consciousness lasting perhaps in the low single digits of seconds. After a score of pages struggling with the issue, Freeman (143) attributes to consciousness precisely what more modern work, including my 2013 paper, attributes to attention;

“Consciousness...is a state variable that constrains the chaotic activities of the parts by quenching local fluctuations.”

What my 2013 paper states, following Reynolds, is that attention does this by decorrelating local fluctuations. Moreover, attention is the only component in cognition that need have quantum participation. It is not true to say that the whole cortex goes into a superposition. All we need to be compatible with both QM and psychophysics is to have a single yes/no question being posed by an attention process prone to quantum effects. Of course, the myriad gap junctions in the retina invites explanation of sensation and perception using quantum effects to explain our senses' extraordinary acuity.

For cognition, the mechanism here of carrier waves, content, relativistic effects, and holonomic representation at the sensory level (ie a holographic type representation applicable only to that sensory modality, as Pribram avowed was the case) and a fuller holographic representation at the conscious level is rich and beautiful enough to live with for a few decades, provided it is true or cleverly conceals its infidelity to the facts!

At the moment, it aligns with the lifetime work of these two – and much else from philosophy of mind, epistemology, psychology and other fields. Moreover, the conscious holographic representation invites the explanation of nature knowing itself in a replicable universal moment of consciousness – or alternatively, a single brain remembering a previous state much as Microsoft XP does when it “remembers” the register configuration of when it booted up successfully, or an immune cell “remembers” an invader.

In classical quantum mechanics, the measuring apparatus projects itself onto the evolving system to produce an observation. Can it be the case that redintegration of a conscious experience works by awareness, connected to a Noosphere, maintaining an interaction with the phase of that memory? Moreover, that awareness is related to a record of what the state of subject-object differentiation was at that point, without which we drown in a sea of data? The brain is above all a cognitive immune system, noting only a few hundred of the billions of bits that impinge on us every second.

According to this view, conscious experience is holographic, stored in a distributed version throughout the cortex, and content –addressable. It has qualia, and a self to whom those qualia are presented. Often, we start a memory with a global feeling of rightness of wrongness, a sense that the experience is or is not consistent with this transcendent observing Nous. In that respect, as certain schools of Buddhism argue, mind is pure awareness; that ethereal aspect of mind is sufficient to reconstruct the rest of mind.

Moreover, acts of mind transcendent to the self allow the argument that nature is knowing itself through us. We are humbled, not humiliated as we would be in the non-transcendent case; ravished, not ravishing as Donne would put it. In fact, while we can also argue that the artifacts we engage with in the transcendent are simply more interesting, we can argue that a central purpose for life is to allow Nature know itself through its Being through us in them. Penrose has repeatedly made the argument that “seeing” the truth of a Gödel sentence (Dyson, 2012) transcends cognition, and requires something non-computational.

However, the capacity of the human intellect cannot be explained without appealing to Nous, a divine spark within humans that is sensitive to a Platonic realm; such ideas are also becoming popular in biology, starting with morphology. (Penrose has speculated that this realm is smaller than the Planck scale; maybe we will know in the 4th millennium!). Moreover, there does seem to be cogency in the argument that an ethereal aspect of each cognitive process that involves the self, perhaps something more fugitive even than phase, and involving quantum process, is preserved in a “noetic” realm, one that is liminal to both mind and matter.

A “science” of consciousness will always be confronted with the greater immediacy of everyday life to science. My companion paper in the volume explores this, pointing out that there are exigent realities in which self is an object, and much else. Yet the above analysis suggests that consciousness will be related to high performance, to being “in the zone” and awareness of a Platonic reality dealt with by Popper in “world 3”.

In short, there is no single “hard problem”; the positing of such has led to a scurrying of mountebanks and amateurs to the consciousness area reasoning that, since they had feelings, they were now scientists. There are instead a slew of extremely difficult problems which we attempt to answer here. While the discourse here oscillates between extreme Gradgrindian and very speculative, and I am the first to be agnostic about its speculations, I believe these are the right questions;

1. How does the mammalian brain process the undifferentiated power spectrum presented to it, one not composed of Hubel/Wiesel segmentations, as these

- require preprocessing?
2. How can individual neurons work together to do a Fourier/Gabor?
 3. At the mesoscopic levels, how does the mass action of neurons form the content of consciousness?
 4. How do we fit our experience of self into science?
 5. What, if any, is the useful computational process giving rise to self?
 6. How do we primates know about QM and other areas clearly not cognitively penetrable?
 7. What happens when we veridically find ourselves in contact with the numinous?
 8. What is the relation between the thingless entangled realm (Herbert, 1993) and our experience?
 9. What does it mean for consciousness to be informational, given that quantum “information” may be a misnomer (Kaiser, 2012)?

To repeat; I believe that the neuroscience outlined in this paper to be correct, particularly as it is a superset of the current paradigm. Resonate and fire gives integrate and fire as a limit case when the oscillation of the membrane potential has a long period; tensor fields likewise for neural nets, which do use vector representations in their modern incarnation.

The ontology states that Herbert’s (ibid) thingless Uroboros, the quantum vacuum, is ultimate reality and, together with a principle of evolution, is what created and creates us. Our consciousness reflects an interaction between this and the explicit holographic representations of it that we primates achieve; thus, consciousness is intentional (Freeman, 1999, is emphatic on explaining how intentionality can arise in biological systems after the tiger salamander) Uroboros experiences itself, fouriered and in holographic form, through primates who need to have a single stream of attention for action; it knows itself through us. Now I wish to speculate further.

Herbert (1993) explains the work of Culbertson, who argued that conscious experience is atemporal. Strange as this sounds, this fits with the classical interpretation of QM; every observation adds a new reality to the world-that-is-the-case, Moreover, the capacity for nature to specify a recursive series of steps to create limbs is now accepted thanks to evodevo in biology. So here is the speculation; every fully conscious experience adds to the Noosphere, and telepathy, precognition and retrocausality, while rare due to the noisy nature of the brain, feature access to this type of experience. Moreover, such experience is best specified by sequences of pure frequencies like music; the fact that talented classical and ethnic musicians give their lives to a commercial backwater should surely give pause?

The resulting scenario here refutes “Advaita” in the sense that “mind=thoughts” and “body=sensations” are not taken as the only realities, leading to the recission of each in an encompassing sea of Bliss. Rather, it is accepted that there exist realities transcendent to and exigent of the self, and that final rest as pure observation/intentionality will be in a sophisticated epistemological, political as well as spiritual context.

While the viewpoint is arguably panpsychist, in that it argues that there is a transcendent Awareness underling moments of quantum measurement in the brain, it conversely suggests that much of our experience can be explained by classical psychological/neural models, as rather humdrum modulations of carrier waves that are no more magical than radio. However, the speculation that the cosmos is represented in holographic mode in the brain, after Fourier and Gabor transforms, and that holographic reconstruction is inevitably conscious lead to exploration of the idea that we are vehicles for Nature to know itself.

The super-computational power of the human brain has been credibly argued from Gödel onward; we are convinced that the egoless ability to “see” the truth of sentences outside the logical remit of a system, and the fact that we often experience moments of true self-transcendence, experienced as egoless connection to a greater Reality, is consistent with the new neural model being suggested here.

The article then will specify for areas for physicists, now that I as a neuroscientist have attempted to clear the ground for them, and given the fact that the relevant neural data will never be collected in the current BS paradigm;

1. Specifying the qualities of the holographic representation;
2. Looking at attention as a non-deterministic process, one that exploits quantum coherence (see my 2013 paper);
3. Outlining how frames of reference can give rise to subjectivity;
4. Specifying how large-scale neural oscillations may have a quantum component, one that perhaps is mediated through gap junctions and ion channels, and this allows supercomputational qualities to be associated with attention.

Finally, a few words about phenomenology are meet. In the first place, I agree with the earlier Tononi, Gurdjieff and others that consciousness is not stable; we do not think about the same thing with the same underlying affect for more than a few seconds. A possible exception is deep meditation, characterized by gamma in near-perfect phase and as contentless as human thought can be in a normal brain. This fits in well with the idea that modulation of the gamma signal determines the contents of

consciousness and the conscious state ends when too much content is present, ie we lose focus when we stop concentrating.

It is worth also commenting on Vedanta. The major technique used, the “Nan yar” goes as follows;

To whom are these perceptions being presented?

To me

Who am I?

I am not questioning that the experience of individual consciousness dissolving in a universal such like a river in the sea. However, the 20th century’s greatest exponent, Raman Maharshi, went to a standard colonial school and, following the extremity of his spiritual path from the age of 16, eventually developed an interest in practical matters in later life. In short, this is a religious experience, and as classical anthropology would insist, it should be separated from normal secular existence..

In non-dual experience, then, the markings defining the limits of subject and object are obliterated. This will lead to a particular sort of enlightenment, while making the adept increasingly unable to function in the real world. There are also states of abandon, self-transcendence available in sport (in the zone), in aesthesis and indeed in the austere spirituality of real science.

While being in a state in which space and time themselves are merely the first veils of Maya can be individually verified as veridical, this state’s reality requires a religious infrastructure- buildings, ceremonies, laws – for its sustained reality. In general, celibates working in a sensorially restricted environment and being kept busy with manual work is how monasteries historically have operated in both East and west. In the framework here, phase coherence of gamma can better be maintained with less sensory afferents; this leads to the ability to experience states of consciousness (not just wakefulness) over time in a manner very difficult in the real world in which sensory overload disrupts phase coherence.

There is a rather beautiful and much celebrated quote from Whitehead on this topic;

“It is a profoundly erroneous truism that we should cultivate the habit of thinking what we are doing. The precise opposite is the case. Civilization advances by extending the number of important actions that we can perform without thinking of them.”

The failure of classical Indian civilization (modern India is careful to train an elite in western ways at its elite IIT’s) to advance is arguably due to the insistence that everything must arise in consciousness, while the essence of science, technology and indeed the advanced arts depends on a massive amount of automation in our very

psyches and organisms.

So Descartes indeed erred in assuring us that a clear subject-object delineation could be produced for all mentation. Sankara's error is the opposite; the assumption that such clear subject-object delineations are Maya.

Therefore, it is being argued that subject/object markings work similarly to immune cells' markings. We do not know how this would be neurally implemented, and frankly may not know in the 21st century and the data currently being collected will help us with this no more than with the Pribram/Freeman/Hoffman models.

Nor will we get data "proving" the hypothesis that awareness is noetic, entangled, incessant, and suppressed in our experience only by the gain of the chatter in the brain.. On the contrary, I am led to this conclusion by an apophatic path; awareness is what is left, with these attributes, when we separate everything else that occurs in the brain, much (but not all) of which we can verify by experiment. Intriguingly, the idea that aware attention decorrelates informational fluctuations is now commonplace in science; see my 2013 paper. So awareness is a "force" that works at a metalevel to information and all informational theories of consciousness are inevitably naïve.

Finally, the "quantum neuroscience" paradigm might insist that all the brain must be put into a superposed quantum state before measurement as classical QM might suggest. The viewpoint here is other; it claims that only part of the signal is quantum, and it is this part that attention deals with. Indeed, the results from the quantum cognition field can be explained in terms of the ability of humans to effect recoherence (which is possible only in the limit) and put data back into a superposed state, as I argue in the 2013 paper.

This paper is insistent that there is no single "hard" problem, and has specified instead over a dozen very difficult ones for the next century. The implication is that, to study the mind, look at its products in the humanities to access realities external to oneself as the symbolist poets like Mallarme most recently insisted on, following the trail blazed by Erasmus.

Similarly, political realities will not be found by brain scans, even as such scans improve from their current disastrous state; they can be found by immersion in the exigent realities that politics imposes on one as object of political forces. Aesthetics is no more a matter of "feelings" than math; what arts educators do is educate affect to allow the organism sustain an objective/intentional Reality. Finally, psychotic and dissociated behaviour will only rarely be traceable to brain pathology; more normally, a full explication of the forces in society as well as the perpetrator's "private" life that created the act is one of the huge contributions on investigative journalism.

DISPATCHES FROM THE QUANTUM-CLASSICAL INTERFACE

Al-Khalili et al (2015) is a very appropriate recent summary. This is particularly the case as it contains several howlers indicative of a field in flux as they claim it to be. For example, they think that the quantum Zeno effect produces decoherence, instead of extending quantum coherence (396). Worse, they imagine that Penrose argues for humans “proving Gödelian statements” (346). On the contrary; Penrose’s point is that their truth cannot be proved, but seen in a non-computational foray of “consciousness”.

An impressionist art critic once commented that Renoir painted women in a manner that compelled one to “see Renoir women everywhere”. With some credibility, Al-Khalili et al (2015) see quantum effects in bird migration, (guided by the earth’s magnetic field), olfaction, reading of DNA, and much else. Where they signally fail to see it is in mind itself (310-353), where a view of consciousness as supervening on /emerging from an electromagnetic (EM) field is preferred.

This is largely due to their misunderstanding of both Zeno and Penrose. It is remarkable that the one area in which QM shows the mere act of observation of having “objective” effects is eschewed. They seem very convinced by Sue Pockett’s inveighing for EM against gamma coherence. While gamma coherence will undoubtedly produce an EM field, and the opposition is spurious in my belief, Pockett did NOT have access to the data described in Freeman et al (2013, P 186) on which to base her attacks on gamma (personal comm.).

That said, there is much to admire, if not to imitate, in this book. For example, the point is made that the $\text{NAD}^+ \rightarrow \text{NADH}$ event that underpins mammalian energy storage is not so different from photosynthesis (179-180). This argument could be extended much further. In the great Berkeley biologist Strohman’s final paper, one I co-wrote with him in 2006, we argued that the NAD^+/NADH ratio is continually probed by the cell through transcription factors, which then differentially alter gene expression.

Arguably, if we can access this level of our organism, we can change our metabolism permanently. Or is this what we in fact succeed in doing when we successfully will ourselves to lose weight starting by eating less? Can it be argued that the quantum realm is the one where “downward causation”, the voluntary capacity that distinguishes us from other animals, takes place, often with great suffering?

While Al-Khalili et al (2015) correctly point out that a teleological function like reading DNA involves quantum measurement, how to square that with Seth Lloyd’s argument about clumps of matter becoming galaxies arising from the Uncertainty principle? DNA reading requires that the galaxies were already there....or did systems like us with formal arithmetic (a la Gödel) complete the circuit through retrocausality?

Indeed, coherent quantum states seem also to map well onto mystical experience, with the organism described as “my house being all stilled” in John of the Cross as he sets out on the ascent to ecstasy. Now let’s speculate. Nobody can explain “downward causation”, the human will. The will wills, as the Churchmen used to say. Can it be the case that the link between the Absolute and us is this subtle quantum realm?

Here’s an emanationist scenario that may work. Let us start with an entity like the Pilot wave/the Absolute probing the environment informationally, while that environment is described in non-classical probabilities. We get decoherence as “measurement”; Seth Lloyd has forcibly argued that Heisenberg uncertainty is what gives rise to galactic “clumping”.

Now let’s go to the next level ie the biological This is essentially defined by another type of measurement in the reading of DNA; moreover, we get something new under the sun. Specifically, as Biosemiotics emphasizes, we get for the first time in nature an arbitrary code; one side of the ribosome is connected to DNA, another to trna.

The twin-slits experiment is the first time that nature responded to the effects of attention and a fully explicit representational system. In fact, this is cleaner reference than anything in natural language semantics. There may also be a final level, holographic representation. In fact, if there is such a level, conscious representation is holographic, because the original scenario can be retrieved by content addressing at a lower level of resolution. If the scenario is recursive, the signal/noise ratio problem will be less severe.

What math works for this? Post Quantum theory (PQM) is rather beautiful, but assigns qualia to a pilot wave/Absolute which is better thought of as beyond subject and object. Moreover, the intentional system in the brain is very possibly the locus wherein this Uroboros comes to know itself through a primate.

How do we know that the intentional system in the brain is up to the task? Essentially, because this system has just formulated what the task is right here in this paper. To anticipate; we are going to hypothesize that something along the lines of PQM, eschewing qualia for the pilot wave and including intentionality, or the work of researchers looked at below like Pradhan (2012) that again do justice to the math, are less wrong than the other alternatives.

Let us continue. Conscious acts etch on the Noosphere human experiences showing extension over time, and the possibility of refined expression helped by the stack depth used. So Beethoven’s 5th with its recursive ethos is a finer vehicle for the infinite to know itself that Rap.

Moreover, these etchings on the Noosphere are sometimes of a radical form as the few attested cases of reincarnation like Leininger show. In this a kid “remembered”

events from life as a WW2 pilot and the memories were largely attested; it seems that sudden death, like the pilot suffered, leads to a noosphere “upload” and “download” in restricted circumstances

QUANTUM COGNITION AND THE SELF

For reasons that are as yet not psychologically clear, human decisions tend to reflect quantum reasoning, not classical as is implicit in this discussion. I attempt an explanation in my 2013 paper cited below.

Secondly, this notion of the self must be unpacked. The socius? Gazzaniga's “interpreter”? Both of these are almost certainly classical in nature as we talk to ourselves, occasionally allowing others to listen in. (As I told Henry Stapp in fom 3 to considerable shock, I believe in Hilbert space more than in most of my experience; don't believe everything you think!) Or an observer in a correctly established QM experiment, where indeed we seem to need some non-classical reasoning?

Finally, if there is a non-classical effect in mind, it is likely to be related to attention; <http://jcer.com/index.php/jcj/article/view/311>

At this, an appeal; while the arguments are often sophisticated, the current appeals to “Self”, “mind” and so on bring us right back to *res extensa vs cogitans*. The answer is most likely to be couched otherwise, in function that are now subject, now object in a brain that is noetic and subject to timing regimes in oscillation.

If we are going to develop a computing model thereof, we also need to up our game, perhaps Fant's model where timing emerges naturally by requests placed without any clock; <http://www.karlfant.net/>

Specifically, the Von Neumann architecture begins with a central clock. Fant's architecture rejects this in favour of oscillations that regulate themselves; it is clear Fant's approach is compatible with the neural dynamics described in Pribram and Freeman. Dyson (2012) comments that the earliest developers of computers rued the day they had started with a clock, an act that ensures most of the board was idle most of the time.....

DAVID BOHM AND PSYCHOLOGY

Bohm is one of the true heroic figures of the 20th century; his refusal to name names in front of HUAC shows up collaborators like Heidegger and Kazan for the moral (and thus intellectual) pygmies that they were. Also unlike them, he was technically brilliant, and we need to explore what must be called his *Weltanschauung*.

Moreover, we need to place him in context as a Marxist who never quite left European emanationist ideas that begin with Plato's *Timaeus*, develop in Plotinus (who

influenced Arab thought), and continue in Eriugena before culminating in the great voices of Schelling and Hegel. In these voices, Geist (consciousness/spirit) emanates itself (from something like the big Bang) through the physical and biological before re-discovering itself in the human psyche. At that point it has reached its eschaton; Hegel argued that the USA was the place. It was left to Marx to remove the personal in the psychic and to argue that phenomenal states were induced by social conditions, themselves the result of economic forces.

Incidentally, the best writing on Bohm is arguably Steven Rose's review where he comments that Bohm's later flirtation with Krishnamurti etc. was very much colored by his early Marxism. In short, there is present an attempt to eviscerate consciousness, echoing the Marxist idea that there exists only class consciousness, not individuals as such.

In 1952, Bohm offered new formulation of QM; like classical physics, each particle has a definite position (etc.) derived by a global "pilot wave" informationally probing the environment. Let us further examine Bohm's schema. We need to revisit the different formalisms of Heisenberg and Schrodinger; after a period of intense examination, it emerged that they both corresponded to the same formal power in "Hilbert space". Hilbert space in turn can be any functional space, topologically complete and incorporating a regular inner product; more generally a vector space with this proviso (Zielinski, personal comm..).

We have already seen that I consider the apparatus used by Sarfatti et al for the "hard problem" to be overkill; let us see what he has to say about Bohm's later position; what many believe to be the beginning of post QM (PQM). Spacetime and classical particles are "Beables" but a quantum Hilbert space is protomind; indeed the wave function is intrinsically mental/psychic. As Kastner puts it (personal comm.), in QM the Hilbert space describes a real ontological territory, the space of possibilities. She goes further; there is math and ontological difference between a QM Hilbert space, which describes potential transactions, and a classical such limited to actualized transactions.

Pradhan (2012) puts it more simply and introduces Uroboros;

"The inevitable interplay of the subject(observer) and the object (observed) in making up Reality"

and

"The nature of Reality as a whole is neither fully objective nor fully subjective but is the result of the coming together of the subject and the object through the process of subject-object interaction."

Sarfatti argues that mapping the Hermitian operators onto Subjective and

objective is too simple, but Pradhan continues (ibid.);

“At the heart of this novel approach lies the interpretation of the complex conjugate quantities such as the conjugate wave function $\Psi^*(r, t)$, the bra vector $\langle \Psi |$, and the adjoint operator A^\dagger etc. as representing the subjective counterparts of the corresponding objective aspects represented by the wave function $\Psi(r, t)$, the ket vector $|\Psi\rangle$, and the observable A etc. respectively. This brings out the psycho-physical parallelism lying hidden in the quantum mechanical formalism in a quite straightforward manner.“

It is indeed better to conceive of this pilot wave/Uroboros entity as being beyond subject and object at some point in its informational probing, it comes across organisms with a single thread of symbolically mediated conscious attention; that would be us! Then do Qualia begin. Here again I side with Hoffman; the brain has the fibre bundle Capacity needed to back react, and perhaps also to maintain Bohn's desideratum of holographic representation.

We can now cut to the chase. Sarfatti argues for a Bohmian recursive 3-layer scheme. Yet he insists that the pilot wave / Absolute has Qualia. In Sarfatti's Byzantine recursive scheme, the classical matter fiber bundle is a base manifold for a mind-like Quantum pilot wave; at the very bottom are fiber bundles comprised of the 4 dimensional spacetime continuum. Nonlinearity emerges; the Born rule may be broken; technologies like instant decryption of RSA become trivial in this brave new retrocausal world where $P=NP$.

Of course, we have ignored biology, neuroscience, psych and much else. Is it right? Almost certainly not. Is it worth pursuing? Absolutely, yes. Sarfatti argues that the lack of back-reaction from the beable to the pilot wave in QM is akin to a mass being unable to alter spacetime in GR. Perhaps the alienated/relative mode of experience corresponds to the former situation and the transcendent to successful back-reaction? Penrose attempts a similar dichotomy with quantum gravity as a *deus ex machina* to explain the process that allows us understand Gödel sentences, etc.

If Bohm is right, then indeed psychology's domain becomes much attenuated. This is in many ways the revenge of Geist on Marx, and we should look at it. Specifically, what continues to happen is that psychologists' vocabulary of schemes, schemata, representations and so on gets totally ignored when physicists enter the area. What often happens is the positing of - to take one example - the agentive self making decisions to observe, and - ignoring hundreds of years of philosophy - the identification of this factor in a QM experiment with the socius, the persona, the Lockean punctual/masterful self etc. Add badly-understood concepts from Whitehead, the “hard problem” and we end up with the word salad we have today.

And yet cognitive psychology may ultimately get reduced to neuroscience - a

neuroscience much more sophisticated than that present in the failed EU Markram project and the probably doomed US one. For the moment, it performs a valuable function as a placeholder.

Psychologists have trouble agreeing on anything! That is not meant to malign them; it simply reflects the current state of science. A personal note; I was offered a place in Cornell's PhD program in psych twice and turned it down when realized the farmhands at home knew more psych, as distilled through culture, than I did through much academic work. (my PhD is thus comp sci) So, for example, if you look at a compilation like Random House's "The psychology book", you find a host of disparate mutually contradictory findings, with resulting quack therapies and much else.

What to do? The first move is to accept the idea that to state something is "psychological" means that we would like to fit it into science as an expression of mind, but can't do so. Alternatively, we might decide to invoke the arts with their dialog with reality using the more various means open to them; or that ennoblement of the physical that has been one of the goals of religion. These efforts are part Bionotics, which will be the theme of FOM 4, and which is outlined in an accompanying paper.

There are two easier ways out. One is to fantasize that the self in the Von Neumann schema is the same as the narrator in one's left hemisphere. That has led to the excesses of the "physics of consciousness" industry. Jacob Needleman, in his latest book, argues for two ontological levels; one that corresponds to the quantum vacuum, which he programmatically calls consciousness, and life itself. This is IMO a good direction.

If one accepts a pilot wave which omnisciently probes the environment, it is essentially game over. We do not need psychology, individual minds, anything. A beautiful comment by Einstein here; Bohm bought his results too cheaply. Moving up a level of abstraction, we get an emanationist system, with the implicate becoming explicate, and then returning to the formless. Of course, this also elides psychology.

In any case, it is clear that a new age of Platonism and radical assertion of the efficacy of mind to interact with matter is upon us. Strangely, we can maintain the transcendent perspective only fleetingly before the empirical self chugs back, unless we carefully control the environment. Such control is the real technology of consciousness! Now let's try and fill out the details of the neural schema I propose, using both computational models and real ECOG/EEG data.

BRAINS, FRACTALS, AND SELF-SIMILARITY

Here we discuss only the dynamics of conscious experience in the brain, over time, as having self-similarity. The view of consciousness taken here is that its contents are

defined by modulations (AM,FM and particularly phase) on a gamma carrier essentially phase synchronous throughout the brain. Gamma superimposed on random neural firing causes up to 4 orders of magnitude decrease in power consumption (see diagram),and this allows coherent quantum states briefly to exist in a manner we as yet don't understand.

Distribution over 20 Sec. of \log_{10} Analytic Power of Av. Sigi
across 64 Replicates Band 1/10 --1/5 NF

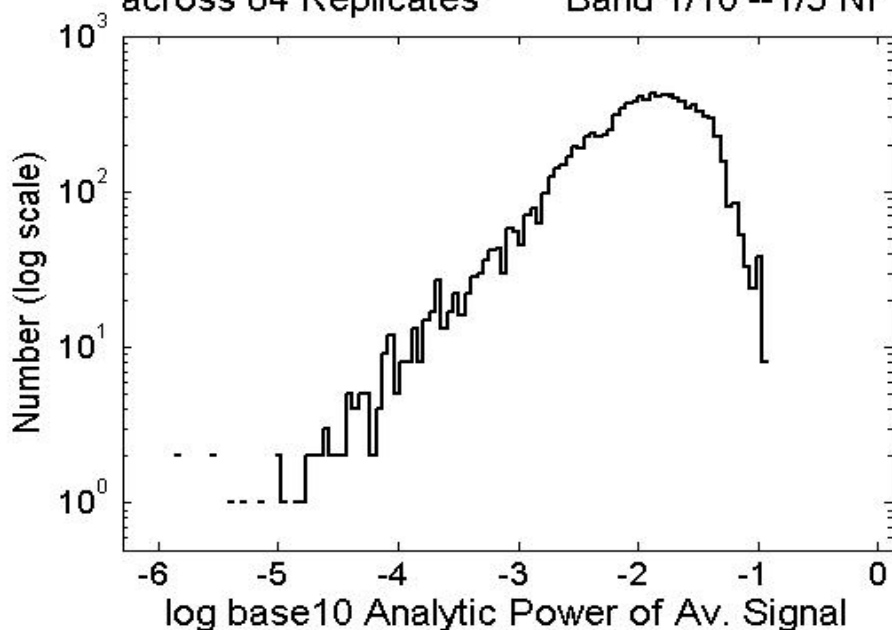


Figure 1; Power distribution in the brain as calculated by the Hilbert transform

We were assured by Tegmark at the turn of the third common millennium it was impossible to have coherent quantum states at physiological temperatures ie in biology; then Engel and others (al-Khalili et al, 2015) proved photosynthesis involved such. Engel also spoke of “dephasing” as less critical than decoherence in energy transfer; briefly, energy can be transferred more efficiently in photosynthetic systems that maintain coherence, irrespective of whether dephasing is tending to cause a reversion to the classical state.

So what is being argued is for is modulations on gamma (and perhaps other waves as we'll see) defining the contents of consciousness while the qualia are informed by the

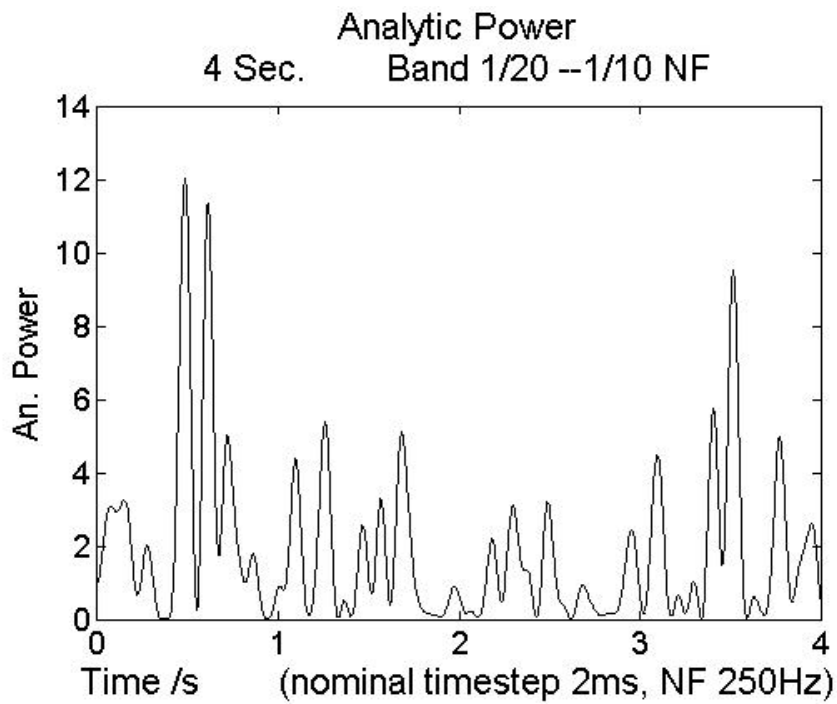
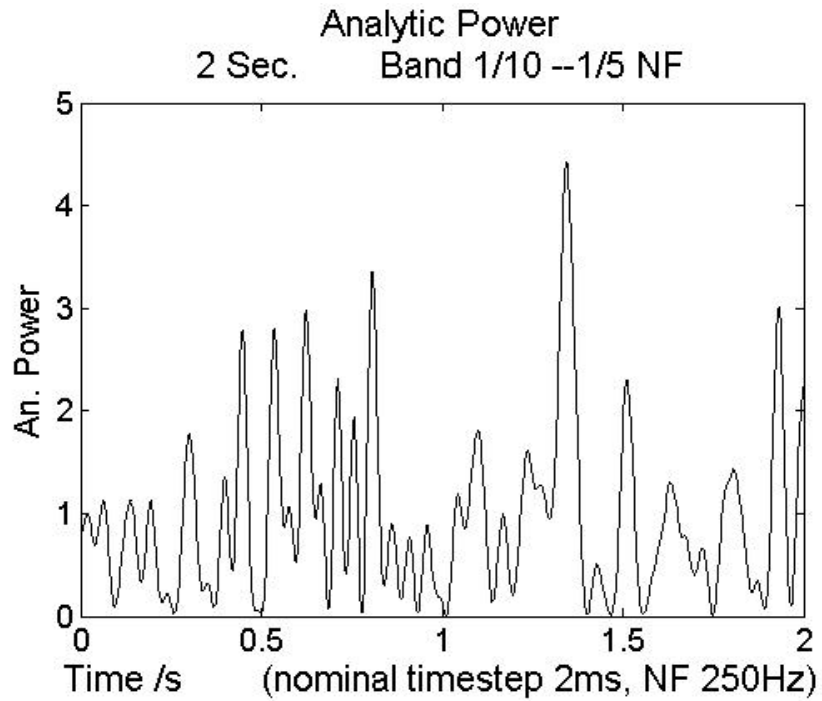
brain areas involved; for example visual-infected qualia will arise from the occipital lobe. Pure global phase synchrony may be a meditative state; slight modulations led to peak performance; and eventually we get wave absorption which can be coherent or not.

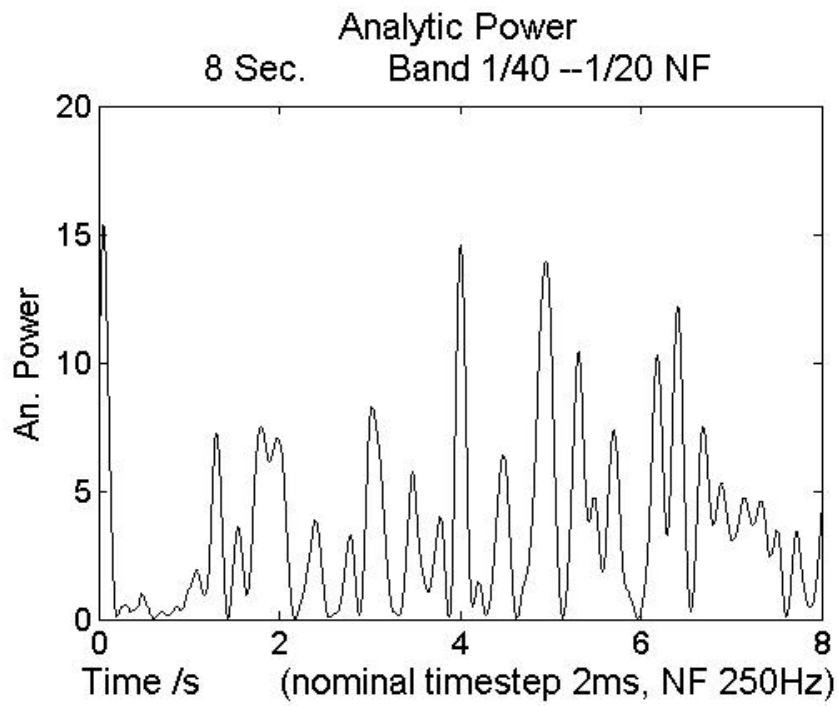
Phenomenologically, what happens to us is we experience peak, “I am”, “in the zone” and then it subsides. Does it lose global coherence as the modulations disturb the global coherence, and we return to our sordid chattering selves?

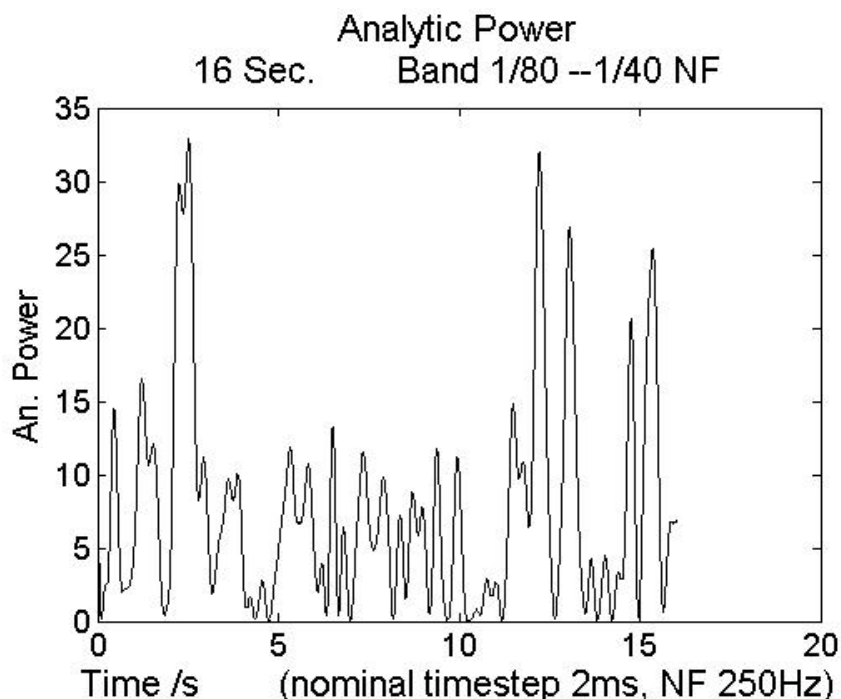
Now for the fractals; if you look at figures 2 to 5 below, you see that there is self-similarity across the various frequencies (roughly, alpha, theta, beta, gamma) when you adjust the time frame (adjusted shown and indexed). Freeman argues that this is what allowed the brain be able to move incredibly quickly from state to state. It would make sense to me that such flexibility is a rare and precious event, one we should spend our lives cultivating.

Figures 2 to 5 are listed below and the self-similarity is clear. Essentially, low theta over 16 seconds has essentially the same structure as low gamma over 2 seconds. We find this also for (roughly) alpha and beta over 4 and 8 seconds respectively. Later (figure 6) we will see this pattern be repeated with real ECOG data from Freeman et al (2008) versus the simulated data here.

The late Walter Freeman found this self-similarity causal in how the brain quickly moved between vastly different states. Here we agree with him and suggest something else; in manner as yet inexplicable by science, the relation between subject and object originally produced by a special relativity “reference frame” and retained by the “cognitive” self is preserved at each level of granularity defined by the brain wave involved. We end with a representation of the stimulus at different degrees of granularity, a hologram that can be damaged while maintaining the “gist” of what was there;







Under the influence of WJF's powerful mind, while working in his lab I used his metaphor as C as a force (2008). I think in retrospect what we meant was that to fit it in classical physics, “force” was the most analogous concept to him. However, quantum physics has a more nuanced concept in which the choice of what to observe, what to attend to, has consequences, a more fundamental idea than force.

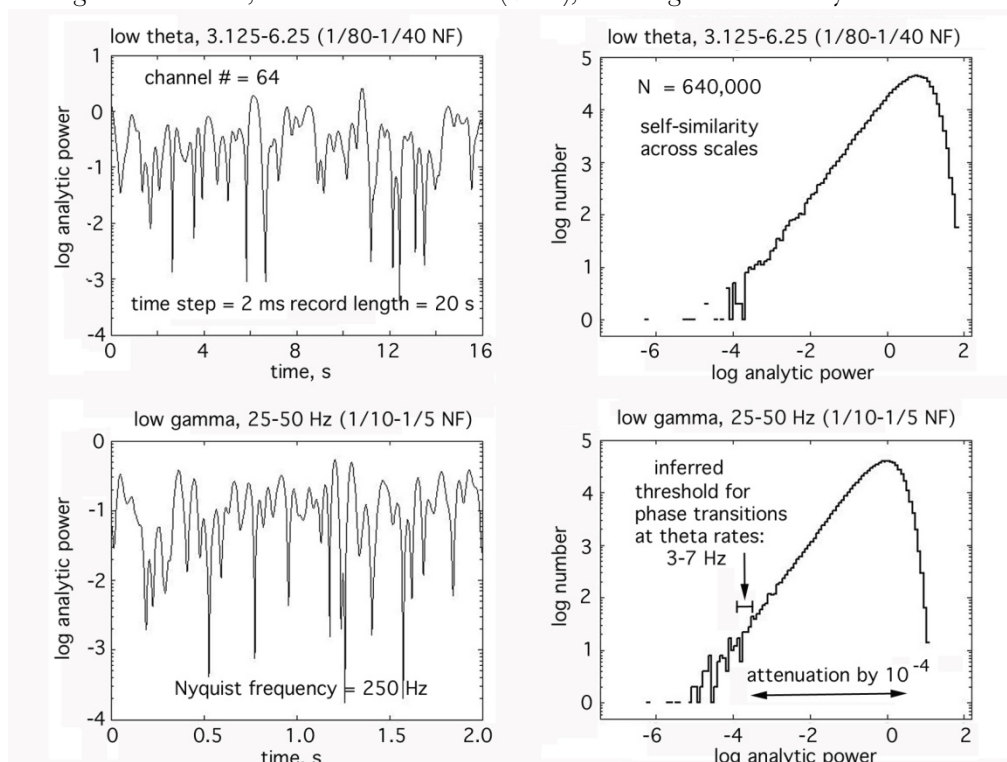
Now our vocabulary itself is failing with the strain. At this point I prefer to think that there is little problem with c as experienced; there is a global broadcast of information as in GW theory. The self that experiences can be explained as a frame of reference artifact (William Hoffman in my 1997 collection). That leaves two mysteries; attention itself, which has a definite neural signature, and that Uroboros, beyond subject and object, that Vedanta identifies as “consciousness”. I prefer to keep the term “Uroboros” and consider attention as the process of refinement of matter.....from quantum to classical , from inexpert to expert.

We really need to take subject-object differentiation into focus. In the Piagetian account as explicated in my companion paper in this volume, the child learns the limits of her physical body through subject-object differentiation, so the child indeed begins as Uroboros, beyond subject and object. Where I differ from Piaget and agree with Lonergan is that I believe that this process continues through life. In “Insight” Lonergan cites the paradigmatic example of Archimedes in the bath watching his body

displace water and suddenly it switches from subject to object so he figures how to assess sterling silver in filigree form.

If we look at the diagrams on the left we find that a few times a second the brain has “Null spikes” in which power consumption decreases by 4 orders of magnitude. This allows individual awareness to become salient, or the transcendent to exemplify itself in the quotidian, as it does when we see the Gödel sentence as true.

Figure 6 is below, from Freeman et al (2008), showing self-similarity with real data;



I am open to a notion that “null spikes” allows Being itself to become salient in us. We then compose a narrative placing our “I” in the center. As I said at FOM 3, I deeply distrust my own subjectivity, tainted as it is by the contingencies of my life, in this narrative. In meditation, or shock, this narrative may have less gain.

The stream of consciousness, may be looked at as being beads on a string. Look at the diagrams on the left again. So the “beads” are the dips in power. We sample what is salient at these moments and construct an often self-serving narrative- and recall, we

are highly social primates (and perhaps immortal souls?). Meditation is the limit case of consciousness; null spikes occurring more regularly due to a paucity of sensory afferents. Empirically useful conscious states like being “in the zone” are more evanescent.

Now we come to the central radical hypothesis of this paper; there is no such thing as an individual CONSCIOUS experience. In short, the fugitive nature of the self that the explanatory gap points out is a more interesting problem than we imagined. In the first place, from 50 years of the Freeman lab, we find that the original sensory stimulus cannot be reconstructed once it passes a preprocessing center like the olfactory bulb. We then enter a zone of what Freeman calls the “solipsistic”; my experience at this level will be different from yours, and charlatans have made fortunes calling this the “hard problem”.

What is being proposed in this paper is that consciousness allows the universality of experience to be reinstated. Planet orbits recruit and entrain each other; this is a simple fact of nature. In like fashion, what I am proposing is that the gamma oscillations entrain lower frequency such in conscious moments. The gestalt can be recovered at a lower signal to noise ratio by a sketchy sample at the beta, theta and perhaps mu levels of frequency (lower still). When so revered, the fact that gamma causes power dips means that the gestalt will become conscious.

Rupert Sheldrake has insisted for decades that nature has a memory, and there is a “World 3” or Noosphere. Alternatively, perhaps the brain is simply remembering a former state; or perhaps both are happening. What is being proposed is that this is not solipsistic experience. It is as if the empirical self, usually the horizon of our cognition, can be pushed back or forward in moments of flow, of centredness. We can then decide to become our boring old empirical selves again, or not.

A SHORT DIGRESSION ON MEDITATION

Meditation has unchallenged health effects and will be a main battleground in the consciousness wars. There is a certain controversy about meditation and battle has been joined by the Nobel laureate Elizabeth Blackburn. I should begin by stating that my biology mentor, the late Dick Strohman, was a voice in the wilderness for epigenetics when it was a dirty word; <http://www.psrast.org/strohmnewgen.htm>

His book which, alas, was unfinished due to illness was a revolutionary new paradigm. The first issue is this: “integrative biology”, invoked in the paper we are about to discuss (Epel et al, 2016), is not a new paradigm. It is a grab-bag for determinists like Blackburn who sense they're wrong, and choose to project onto a “network” that which they have adamantly refused; a violation of Crick's central

dogma.

The second is mechanism. We have one; the metabolic energy freed up by the power dips in energy consumption becomes available to the rest of the organism in a meditative state. Transcription factors sense the NAD⁺/NADH ratio thus altered as energy boosts the yield in an endothermic reaction and can alter gene expression. It is described at length here;

<http://link.springer.com/article/10.1007/s12304-011-9136-y>

I still don't understand how a genetic determinist like Blackburn can say “This highly controlled residential study showed large salutary changes in gene expression networks due to the vacation effect, common to all groups. “ (Epel et al, *ibid.*) The central dogma to which she subscribes is that dna makes rna make proteins makes the phenotype with no back-action.

Indeed she/whoever (*ibid.*) invokes the “integrative” paradigm, thus betraying determinism; integrative systems biology approaches can identify gene regulatory networks, such as immune, stress and other regulatory responses, and link them with physiologic states “How? Epigenetically? Are the changes permanent? If so, how are they implemented – invoking a “network” is simply not enough.

What I propose is three things:

1. an interaction between metabolism and gene expression
2. eventual epigenetic assimilation
3. Meditation as being uniquely metabolic (as distinct from stress-free vacations). This is distinct from the effects of stress/cortisol, which a vacation would indeed attenuate...

For example, the point is made that the NAD⁺ - > NADH event that underpins mammalian energy storage is not so different from photosynthesis and therefore open to quantum explanation. This argument could be extended much further. In the great Berkeley biologist Strohman's final paper, the one noted above I co-wrote with him in 2006, we argued that the NAD⁺/ NADH ratio is continually probed by the cell through transcription factors, which then differentially alter gene expression. Arguably, if we can access this level of our organism, we can change our metabolism permanently and the genetic mechanism would assimilate the change. As it stands, this study lacks a causal mechanism. We, on the other hand, have one as well as a much better neural model.

PHASE AND NEURAL FIRING

It is important initially to note that neural networks work best by considering a mechanism at a very high level of abstraction. Hopfield nets as Boltzmann machines

minimize an energy function; deep mind, while perhaps not really a neural network, uses a non-linear transfer function followed by gradient descent.

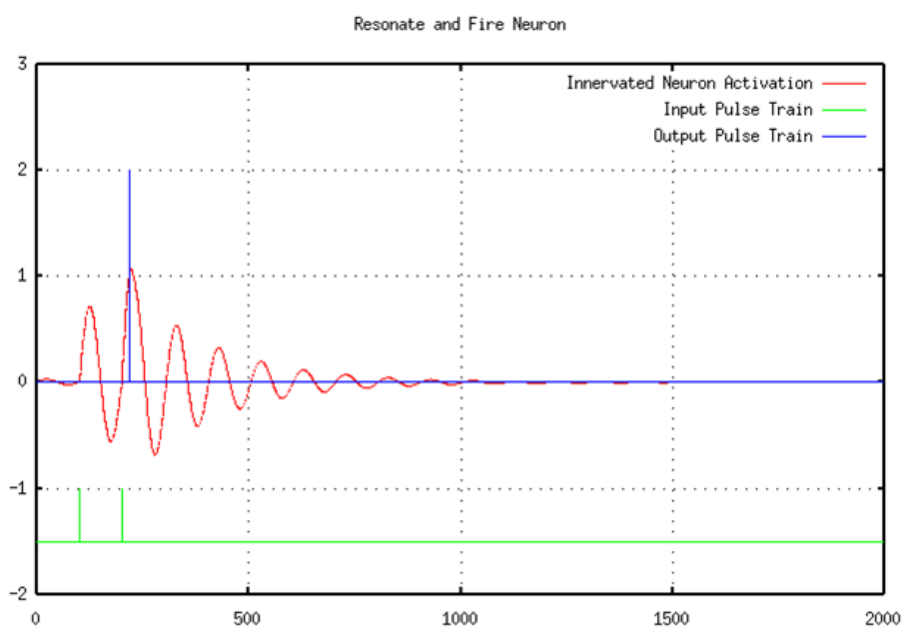
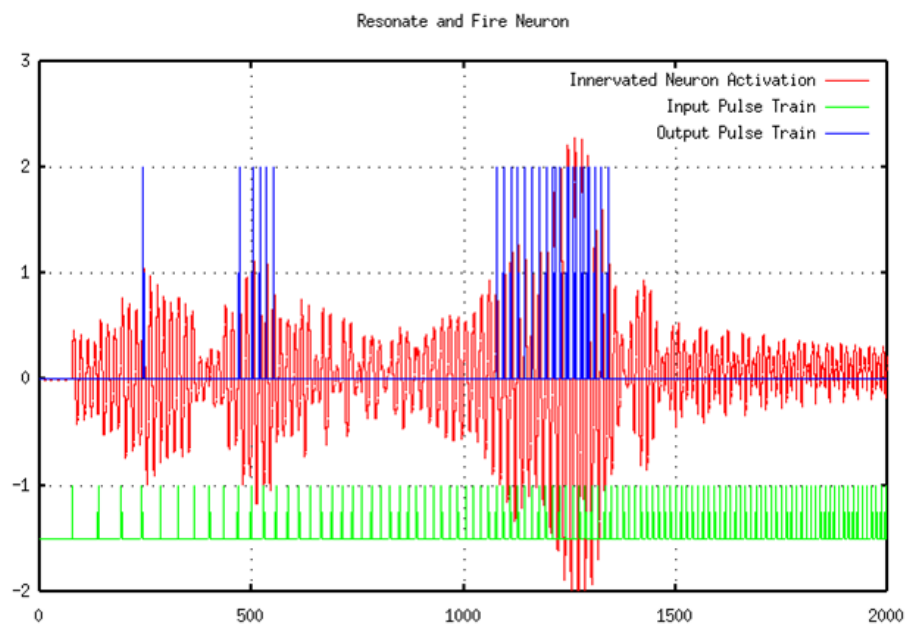
In short, we don't need what has become the bugbear of consciousness research; something called “consciousness” being invoked by a microtubule mechanism etc. What I argue for is a distinction between consciousness and its contents. One way to do this has been to look at the quite well established science that insists that consciousness is above all a global cortical experience, and is probably associated with phase synchrony of a gamma oscillation which unusually for gamma is non-local. We have a lot of experimental data showing that creates “null spikes” which result in a 4th order of magnitude decrease in metabolic demand by the brain.

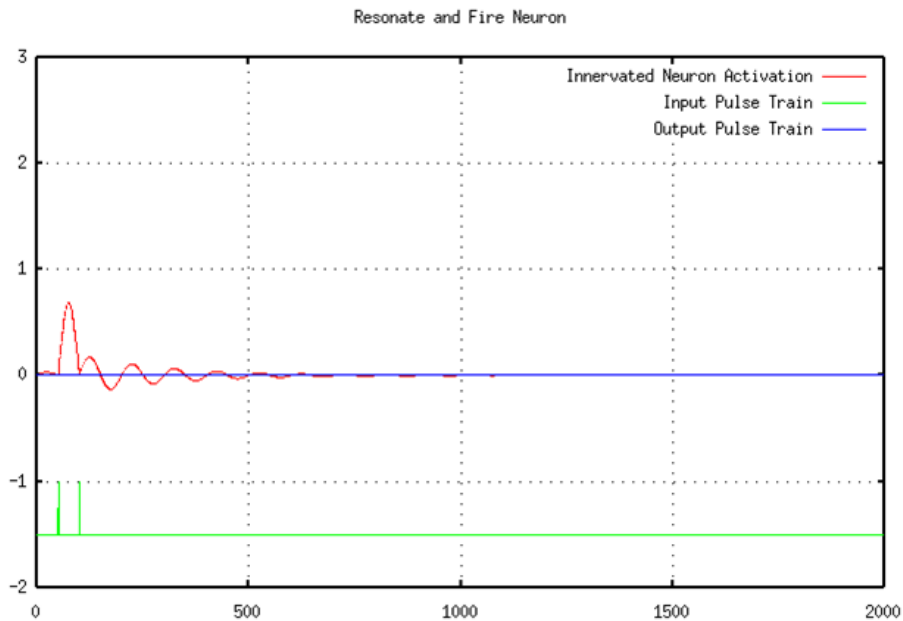
So meditation is healthy because the brain stops being so demanding on the organism. In meditation, the phase synchrony is associated with a relative absence of cognitive content. To get content going, we need to modulate the carrier gamma in some way. Amplitude modulation was identified by the late Freeman (Freeman et al, 2013) as related to meaning; frequency modulation is probably also used.

What is most intriguing is that phase modulation is by far more efficient in energy terms. Moreover, we can use phase to differentially cause neurons to fire or not. See diagrams 8 and 9; in both, the same impulses impinge on a neuron. If they're out of phase, the neuron does not fire; if in phase, it does fire. The general scenario, then; consciousness becomes a reality in what normally is the chaos of our experience when we string together “null spikes” like beads on a rosary. The best way of doing this is to eliminate content as much as possible, which is what expert meditators do. However, we can have periods of being “in the zone”, skilled performance, when modulation by content is systematic and does not affect the global coherence of the carrier gamma.

So we implemented my friend and colleague Karl Pribram's version of this. Yes, you can get neurons to perform a Fourier by a delta rule that adjusts membrane potential of the neuron. Moreover, the phase of the membrane potential is critical in the differential firing of the target neuron across the two scenarios here. Figure 7 shows a neuron exposed to a range of stimuli and the resulting output, including spikes. In figure 8, there is a “Zap” response; that is, the neuron is “zapped” with the entire range of frequencies possible.

Note that there is a peak response at middle C, about 500 Hz, and due to “octave” effects, about 250 Hz and 1000 Hz also. Figures 8 and 9 show the neuron being stimulated by inputs arriving in phase, creating an output pulse train, and out of phase, suppressing such output. The take home is that phase matters and when we develop real BS models, this kind of reasoning will be commonplace. (These diagrams are courtesy of Tom Doris, my former Ph.D. student)





Figures 7,8, and 9; individual neurons, showing phase is causative in spiking

CODA: FRACTALS REDUX

Please note we are speaking of self-similarity over time, not space. So it is not a permanent stone-like structure in the brain; it is an evanescent configuration of synchrony between processes at different rhythms that lasts at most a few seconds, just as we are unable to focus on anything for more than a few seconds. You doubt that? Put on the timer on your cell phone and look at the seconds while keeping stable a mental state corresponding to “This is me looking at my cell phone” for more than 30 seconds.

Interestingly, Tononi and Edelman had a similar concept before Tononi got caught up in the Phi nonsense ; see my 2003 book. The “integrated information” idea arising has been refuted by the data we sent him following our 2014 paper, and to which he hasn’t replied

So what is the biological purpose of self-similarity over time? Can it be a way of keeping coherent a quantum state – or a classical stimulus? This leads to a hypothesis which we’ll motivate by commenting that little of mental life is conscious. Very high gamma (100-200 Hz) seems to be the signature of a task taking place in a brain region;

such gamma is always very localized to the point of being able to refute fmri “localizations”.) Non-local phase synchronized “normal” gamma (40-80 Hz seems to be the signature of consciousness.

Now let's speculate. We do most cognitive tasks automatically. Indeed, dissociative people do much that seems conscious without other “selves” knowing about it. This is consistent also with sleep studies showing part of the brain asleep while the rest is awake; a very unpleasant experience for those undergoing it.

Conscious experience can be remembered. It may be the case that consciousness involves storing the data in self-similar ways that can be retrieved at high levels of fidelity, which is computationally expensive, as well as lower levels for a quick and dirty memory (!), or one that has faded over time. This emulates the Pribram/Bohm “holographic” model with the external world being modeled at different levels of resolution.

We now have a completely new theory of the relation between memory and consciousness. Essentially, the brain can recapitulate best those states in which there is global gamma synchrony; as it happens, they are conscious states and this recapitulation is memory. Content-addressable associative memory (implemented eg by Hopfield nets) have shown how, a la holograms; a degenerate version of a stimulus can cause the whole stimulus correctly to be assembled and here we have a more neurally realistic paradigm. So a 20 Hz version of the stimulus can result in the full 80Hz version to be recalled, causing the initial conscious experience to be recreated initially with poor signal/noise ration but gradually getting cleaner until the conscious experience is limpid indeed.

In my 2009 collection "Spatial cognition", there is a lovely insight from Logie and Pearson - consciousness is a mode of access to short term memory. Here it is reparsed - when the memory is successfully reconstructed, consciousness emerges as the original set of synch gamma transitions is recreated

Let's continue. One of the critical points about biological systems is memory. Immunity is so related to memory that adaptive immunity is hard to disentangle from innate immunity. In essence, cells remember everything

So also with the brain. It acts as a hologram in that it remembers every single set of transitions it has undergone - but will remember them at a sparser granularity if not renewed, moreover at a granularity that decreases with time. This is what we call forgetting and it is the point on which we will finish this paper.

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