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Biosemiotics and the circle of explanation in the sciences

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Abstract

Ontological discontinuities have logical and computational consequences. Physics with constraints begets chemistry; on entering the biological realm, these numerical constraints begin to transform into syntax and semantics. In this paper, we are going to focus on biosemiotics and its role in completing the circle of explanation in the sciences that is clearly necessary. We are going to look at the following points: 1. What is biosemiotics? 2. Why introduce it to biology? 3.What makes biology different? 4. Can the argument be extended to cognitive science? 5. What are the consequences for the academy and life outside it?

Key Words: Biosemiotics; Scientific Explanation; Advaita Vedanta; Biological Coding.

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Introduction

Descartes famously distinguished "*res extensa*" as matter from Mind. While oceans of ink have spilt from the 17th century onward about how this distinction cannot be maintained, the fact remains that "*res extensa*" (literally, stuff extended in space) is an egregious over-simplification of what matter is. On the one hand, matter - while subject to Newton's laws – also shows chaotic and other dynamics that we have begun to understand only since Poincare, in a moment of genius, considered the motion of three celestial bodies. Chemistry constrains what matter can do still further, in syntactic processes of gene expression. With biology, we get further complexity; the failing of data-driven approaches has been above all their refusal to consider ontological distinctions.

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Likewise, the biological is a different set of emerging categories to the "merely" physical, although it inherits prosaic qualities like inertia and more interesting ones like chaotic dynamics from the physical. To say that one is in a sea of bliss - now that the new age assumes non-dualism - is to assert that Bell entanglement is somehow being mediated through the biological. The discontinuity that the biological comprises involves hierarchy (cells are part of organs are part of organisms), codes, and much else that the entanglement must traverse.

The many recent anniversary celebrations for Swami Vivekananda and the advent of Vedanta as a religious force in the West have not obscured the fact that, on the face of things, Advaita Vedanta, the notion that there is a non-dual reality underpinning our derived experience, is a controversial thesis. Yet the classical interpretation of quantum mechanics affords it some purchase on science; the fact that our consciousness is indeed our primary reality gives it existential traction. In a world in which it is clear that successful new spiritual movements will indeed give pride of place to meditation, to the assertion of a real

personal identity even in the absence of cognitive content, we might be advised to give this view a second look.

It should be pointed out that statements like "you are one with an encompassing field of knowledge and bliss", while arguable and very comforting, presume a massive number of assertions from a variety of fields. Ontology deals with what there is, in a way that can make radical assumptions about "levels of being" subject to different orders of laws. For example, the statement just cited cuts across physical, biological, psychological and intentional categories, where the last is defined as the mind's reaching out to "intend", point at, objects in the world.

Intentionality is inexplicable in terms of anything previously seen in nature, and represents a uniquely human capacity to gain contact with a world of Ideas or Concepts. As such, it is distinguishable from more prosaic co-variation of sensory receptor and stimulus on the one hand, and non-intentional psychological states depending on brain function on the other.

These states may in turn be conscious; to be conscious does not presuppose "authentic existence", or intentionality directed at real objects. Conversely, intentionality may comprise as its target "Platonic" realities.

A major argument of this paper is that the human capacity for voluntary control of attention, coupled with intentionality toward Platonic objects, are together the main breakthroughs in human existence.

Likewise, the biological domain contains a different set of emerging categories to the "merely" physical, although it inherits prosaic qualities like inertia, and more interesting ones like chaotic dynamics, from the physical. To say that one is in a sea of bliss is to assert that Bell entanglement is somehow being mediated through the biological. The discontinuity that the biological comprises involves hierarchy (cells are part of organs, which are parts of organisms), codes, and much else that the entanglement must traverse.

While most neuroscience undoubtedly can be treated with concepts from classical physics, the recent example of quantum effects in photosynthesis has proved that quantum coherence can persist in biological systems. Can the remarkable effectiveness of our visual and auditory systems be explained under this rubric, particularly if viewed in conjunction with modern research on attention?

Of course, our ontology may be event-based rather than object-based. Our metaphysics might elide subject and object or – wisely, a la Piaget –argue that they are co-constructed. Indeed, we might radically assert that only attention and the fact that mathematical entities are referred to natural phenomena are mysterious. All of these points are topics for discussions that go beyond the scope of this paper.

In a transdisciplinary context, questions like the following can be raised: "Does the Von Neumann interpretation of quantum mechanics echoes the identity of Atman and Brahman in its suggestion of an undifferentiated state before observation in both what becomes subject and what becomes object?"

As a religious system, Advaita Vedanta claims not to be a sectarian viewpoint, but rather analogous to an algebraic formalism in which the insights of other religions can be expressed. Does its essential claim – that our true nature is divine, and that our goal in life should be to realize this divinity – offer any resources to other belief systems?

In this paper, we are going to focus on biosemiotics and its role in completing the circle of explanation in the sciences that is clearly necessary. We are going to look at the following points:

1. What is biosemiotics?
2. Why introduce it to biology?
3. What makes biology different?
4. Can the argument be extended to cognitive science?
5. What are the consequences for the academy and life outside it?

1 - What is Biosemiotics?

For Peirce, the founder of American semiotics, there is a trio of sign, object (meaning), and interpretant. Signs must signify something; conversely, meanings require signs for their completion. A

semiotic system connects meanings and signs through a code; all three elements are necessary. This contradicts Saussure, for whom a semiotic system was "sign and meaning" (O Nualláin, 2008; Barbieri, 2008a).

The biosemiotics credo 'a la Barbieri' is that organic coding requires signs, meaning, and an adaptor. This is a variation on Peirce. The physicalist notion is that "biological information" is a metaphor. This is denied by most biosemioticians; they say, for example, that genes and proteins are artefacts, made by molecular machines, and this artifactual property is the essence of life. Moreover, it refutes this physicalist idea.

Some definitions of biosemiotics have been attempted. For Sebeok (2001), life and sign science imply each other. Communication is exactly what distinguishes living from nonliving systems. An organism is a device, which communicates its structure to its offspring. For Emmeche (Barbieri, 2008b), it is a branch of general semiotics, and its place in nature has yet to be determined. For Hoffmeyer (IR), the unification of biology depends on emphasizing the semiotics nature of life.

For Sharov (largely in agreement), it should be viewed both as biology and semiotics, not as a branch of the latter (Barbieri, 2008a). Pollack (ibid.) introduces how our understanding of the genetic code, which burgeoned between the 1950's and 1970's, has unified the notion of text and organism.

Uexkull (1928), following Piaget, wrote about organisms as interpreters of their environment. Sebeok (2001) pointed out that signs used by animals are processed in the same way as humans' signs; his term, zoosemiotics, was later extended to plants as well and thus "biosemiotics", coined by Rothschild in 1962, became common currency.

The fundamental principles of biosemiotics are the following:

- Semiosis is defined by "coding", not interpretation;
- Signs and meanings are codemaker-dependent;
- They are nominable, that is they can be specified by naming their components in their natural order;
- RNA and proteins also are codemaker-dependent;
- The translation apparatus is a semiotic system. The cell is a semiotic system with genotype, phenotype, and ribotype;
- The basic processes in life are coding and copying;
- The basic processes in evolution are natural selection and natural convention;
- Classical semiosis; A (the interpretant) interprets B (the object) as representing C (the "meaning") This is called the "interpreter" model;
- The "codemaker" model has A (the adaptor, like tRNA), operating on B (the "sign", like the genes), to produce C (the "meaning', like amino acids);
- Genes and proteins are molecular artifacts because they are created by molecular machines;
- Life is "artifact-making"
- Artifacts require entities like sequences and codes to be characterized;
- Nevertheless, organic information and organic meaning are not metaphors, but as real as any "natural' process. We call their results "nominable' entities which require an ordered listing of their elements for identification;
- Any organic code links two independent worlds (e.g. genes and proteins) by a third world (e.g. RNA);
- "Sign, meaning, and adaptor" is pertinent, rather than "sign, meaning, and interpretant".

2 - Why introduce it to biology. Life and semiosis

There were two major breakthroughs in genetics; that information is contained in DNA, and that amino acids are specified by it. Shannon's concept of information, based on Boltzmann's equation about the

relationship between entropy, microstate, and macrostate, does not specify sequence subunits. However, biological information does, and is thus a nominable entity. Organic meaning mediates between molecules.

Early in the history of the biosphere, chemical "bondmakers" got created; some of them acquired the ability to join nucleotides together with a template, and are "copymakers" As proteins require mRNA, tRNA, and the ribosome: they are more complex than copymakers. There is no necessity in the relationships between DNA and amino acids, or between proteins and their eventual destination in the cell; we therefore can speak of codes.

A code is a set of rules that establishes correspondence between elements of two independent worlds. Organic information, according to biosemioticians, is objective and irreducible.

There is a plethora of codes in nature, e.g. the genetic code - the mapping from DNA nucleotide sequences to amino acids - and signal transduction codes in cells. Cells continually respond to their environment; yet, the hundreds of possible "first" messages are transformed into combinations of only four "second" messages within the cell.

The spliceosome features recognition of either end of scores of introns for each "gene". So we can talk about "splicing" codes. The cytoskeleton is anchored to the cellular structure in an arbitrary fashion There also are sugar codes, apoptosis codes, and so on.

3 - What makes biology different; An ontology of nature

My 2014 text (Ó Nualláin, 2014) outlines an ontology of nature starting with the physical. Newtonian and later mechanics, as well as dissipative systems, can be used to model it. QM, "negentropy" are all also techniques that work. The biological inherits these techniques and adds syntax and semantics (Monod/Jacob) (Ó Nualláin, 2008). The cognitive inherits all the above but must also explain how an intentional system can implement the math techniques that we know we can use as we see below.

Of course, biology (and we!) is far more than computation. Open questions in biology include types of causal explanation (including Aristotle's final and material cause as well as efficient cause), the symbolic and the field of biosemiotics as we have noted, metabolism and its interaction with the symbolic, manifest in gene expression, evolution; hoax genes and thermodynamics.

In my previous work (Ó Nualláin, 2008). I have focused on Epigenetics; where is the program? Can the argument be extended to cognition?

Cognitive Science completes the circle of explanation in the sciences. It can also hint at solutions to moral and aesthetic dilemmas, often explained away through postmodernism/subjectivism. It must obey laws of inheritance of facts and constraints; just as biology inherits facts and constraints from physics, so must Cognitive Science inherits facts and constraints from biology. These include conservation laws (physics), chaotic dynamics (both biology and physics); it is likely therefore that concepts like harmonic oscillators and bifurcations should be pervasive in Cognitive Science.

Yet the situation is more complex. For example, the concept of "information" in physics has an energetic dimension (Landauer), a spatial dimension (Susskind) and, as quantum theory teaches us, it determines to some extent what we consider objective reality. In fact, this paper is sympathetic to the position that attention has effects on the physical precisely because they are indeed part of the same entangled reality at a fundamental level. In that vein, this paper (Ó Nualláin, 2008) is an attempt to explicate exactly what that level is, and its relation to biological and cognitive reality.

Likewise, it is arguably impossible to continue discourse about biology without granting that codes/syntax are intrinsic to the subject. Cognitive Science also inherits these constraints. We must go deeper still.

We find that mathematics, the most elliptical and precise language with which we describe reality, constrains us in

certain ways. Tensors of various orders, from scalars through vectors to the Riemann and Ricci tensors, are distinct with the latter two not describable in terms of the former. Our explanation patterns in Cognitive Science must honour this. So fMRI, which specifies a scalar, cannot be an explanation of mind, nor can vectors; it is a category error to suggest they can.

Our explanation patterns in Cognitive Science must also honor what we learned in the 20th century from Gödel, Church et al about the limits of formal systems. This can paradoxically leave us open to non-deterministic thought. So we can indeed, following Gödel, Schrodinger and other greats, assert the existence of the spiritual while remaining completely scientifically responsible. However, we are not going to get a "solution" to the so-called "hard problem", an algorithm mapping all neural data to experience; that is also a category error. We are going to be able to argue for a substratum of subjectivity and indeed free will in conscious experience while remaining scientific. The job of eliciting subjective states belongs to great artists and spiritual leaders, of whom we have a decreasing number.

4 - Reparsing Nature

My "One Magisterium" (Ó Nualláin, 2014) monograph proposes a radical reparse of nature. Radical in that it argues for a complete reconstrual of what scientists are doing in various fields, but traditional in that it reasserts the notion of a "Great chain of being". Likewise, the idea that there is "One Magisterium", one locus of teaching authority encompassing both science and religion, was initially proposed in the context of 19th century evolutionary theory by Henry Drummond.

We are concerned here with the former point, the notion of levels of being, and the consequences for scientific methodology. It is argued, for example, that as of 2015 genomics has reached an asymptote, and that the study of "genes" encoding "diseases" has found all the low-hanging fruit. Much more sophistication will be required from now. Likewise, for the same reasons and other, even more fundamental ones, the incessant trawling of corpora on the web by Google and others is still yielding laughable results for natural language translation.

"One magisterium" thus insists that ontology, levels of being, need to be re-introduced to science for the most urgent practical reasons. It also asserts that proper attention has to be paid to technologies appropriate to each level, particularly when the level is showing a drive to transcend itself in an evolutionary process. To take an example, Schroedinger famously posited that negentropy was the basis of life. That turns out to be simplistic; dissipative systems show this capacity without coming alive, and we need to develop a new dynamical systems vocabulary to deal with them. We need also to resurrect Aristotle's "material" causation, effects caused by organization in the matter, and the final cause, as we cannot meaningfully discuss biology without considering the aims of the organism in its environment.

In fact, the biological realm – that of life – seems also to differ from the inorganic in that hierarchy is paramount; in that codes, with syntax and semantics, are used; and finally, in that we seem to need teleological reasoning when we attempt a third-person "objective" description. Moreover, biology inherits from the inorganic realm all the panoply of physical description, from harmonic oscillators to Hopf bifurcations, all of which seem to be useful. Finally, while Sheldrake's insistence on the "memory" of nature and "morphic fields" may be excessive, there does seem to be remarkable convergence between the morphology of – say – the fossa in Madagascar and other top predators from a completely different species like the fox.

Even John Searle admits that the intentional realm is another "gap", discontinuity, in nature. Co-variance of signal and organism is ancient; however, the existence of a representational system decoupled from the environment – however imperfect that representational system is at the edges – is indeed something new under the sun. "One magisterium" hypothesizes that a standard

account like Piaget's can perhaps take us to the point at which a representational system equivalent to standard arithmetic is created; however, at this point, a new set of categories kick in and the mind becomes the host for the kind of Platonic ideas like infinite sets that have proven otherwise both inexplicable and indispensable for math.

This intentional realm, studied by cognitive science, inherits from the inorganic and biological realms as before. Cognitive Science completes the circle of explanation in the sciences. It can also hint at solutions to moral and aesthetic dilemmas, often explained away through postmodernism/subjectivism. It must obey laws of inheritance of facts and constraints; just as biology inherits facts and constraints from physics, so must Cognitive Science inherit facts and constraints from biology. These include conservation laws (physics), chaotic dynamics (both biology and physics); and it is likely therefore that concepts like harmonic oscillators and bifurcations should be pervasive in Cognitive Science. It is also useful to think of the human mind as capable of arbitrary levels of hierarchy.

With the notion of the aesthetic/spiritual dimensions in mind, the notion that the cosmos is a "giant thought" rather than matter needs to be nuanced. While there undoubtedly exist participator effects as envisaged by Wheeler, they are more the exception than the rule. Bell's theorems were initially produced in response to what was intended to be a "reductio" argument in the EPR paper by Einstein et al. The fact, which Einstein found spooky, that there indeed are superluminal connections between entangled particles is no longer in doubt. Yet, absent some principled way of distinguishing between coupled and decoupled cognitive systems, we are stuck with cats' observations collapsing wave-functions unless we privilege representational systems of a power >= standard arithmetic, It is my view that everything then fits together.

It is illustrative also to see how the complex of concepts around information, work, and the epistemic cut between mental and physical (roughly speaking) change as one traverses the ontological divide. At the quantum level, there is arguably no distinction between the mental and physical, and "things" are interlinked by a type of information capable of superluminal speed but useless for (classical) signaling. After decoherence/observation, we have "things" and an observer in whom the mental is embedded. Moreover, signals can be sent between distinct things. Yet "information" clearly is incarnated, not just projected.

The biological realm opens up the door to codes – if you prefer the Barbieri account (Ó Nualláin, 2008) of this paper – or simply relations, if you prefer the Peircean one (Ó Nualláin, 2003). We now have relatively slow-changing symbols governing processes, rather like train tracks guide a train (an analogy I owe to Howard Pattee). When we transition to intentionality, there is a further wrinkle in that the observer wielding a representational system of a power >= standard arithmetic can collapse a wave function; and that, neurally, attention leads to decorrelation of information fluctuations (Ó Nualláin, 2013)

We seem close to acknowledgement of "information" as protean and of attention as an independent force in nature. While the former is measured in bits, it is fugitive at the quantum level where there is no concept on one "thing" informing another; it is incarnated in matter in classical physics; it has relations to work in biological systems; and it measures the effects of attention, which seems itself a new player in the cosmic landscape. So, while Vedanta tell us we are a sea of bliss without differentiation from the physical world, the ontological approach argues that differentiations exist between realms of nature like the biological others, and that attention is physically causal, turning quantum into classical reality, reducing state-vectors and perhaps creating entities in intentional space that we should learn how to characterize.

Our "normal" experience is not of an endless sea of bliss, a cosmic

consciousness that we manifest. It is mainly the result of our cognitive system lining up hypotheses for the next challenge we are about to encounter. Much of this processing is unconscious, and much is related to the social environment in which we live. In the early 21st century, that social environment includes an ever more intrusive industrial/financial/military complex that will be delighted, if plunging into premature ecstasy in a sea of being that exists only in our imagination, we ignore what if happening to us in real life.

This paper follows critical theory in philosophy in attempting to rescue those truly spiritual moments from fantasy.

5 - Coda: on Death, Taxes, and Science

Of course, the foregoing account works only if we are looking for abstract knowledge. We may alternatively seek to know reality through acting on it, in particular through good works; or we may attempt to find out something about the essence of consciousness by attention to physical movements.

Let us attempt to look at the flow of ideas in our psyche as they present themselves to consciousness. I have not found a better description than this, from 1918, as Russia was in civil war: "*You are no doubt aware of the way we think by chance associations…when everything that falls within the field of our consciousness calls up these chance associations in our thought. The string of thoughts seems to go on uninterruptedly, weaving together fragments of representations of former perceptions, taken from different recordings in or memories…our thinking apparatus weaves its threads of thought continuously from this material. The records of our feelings evolve in the same way*" (Gurdjieff, 1973).

In short, we confabulate instant to instant, creating a narrative that may bear little or no relation with reality. Yet the massive social forces in our society, those that declare war and steal from us on an epic scale, are mediated through this chaos. That of course is not the theme of this paper; it is appropriate, however, to suggest that a dark expertise in our manipulation has again been attempted as we explore below. Naomi Klein's argument (2008) is that our *status quo* emerged from experiments run in countries like Chile in the 1970's, Ireland in the 2010's, and reflects the imposition of "shocks" on societies, shocks meant to destabilize ancient civil society structures, turn citizens into subjects, all the while proclaiming "resistance is futile" and "there is no alternative".

We must be careful, then, in asserting that we are one with a sea of bliss. We do so, at times, because the American universities are producing no articulate response to this power grab. Instead of a careful interpretation of the forces involved and how they affect social and economic life, the response has been in general to obsess about how these forces present themselves to a psyche interpreted through the lens of subjectivist thought like French postmodernism or American psychologism. For these schools, exemplified by Derrida and Lakoff respectively, there is no reality, either mathematical or social, transcending consciousness.

The point that is being made in this paper is that there indeed is such a reality, sometimes a clearly objective such reality, and sometimes one that has the hallmarks of an unavoidable exigent, transcending reality. In short, both death and taxes transcend the subject, whatever we say about them in our classrooms. The subject of this paper has been science, rather than death or taxes; I leave it to the reader to decide which of the three is the most real to her, right now, Then let the search begin!

6 - What is reality?

Of course, we will never know. Essentially, there are two irrefutable yet logically mutually antagonistic positions; realism and idealism. In the case of the latter, we find Berkeley's absolute idealism kicking in as a set of replies to Hume. If we remove the concept of "substance" from Humean metaphysics, as Berkeley argues we must, cognition becomes identified with apprehension of ideal essences.

Similar moves can be found in threads of Buddhist thought. Likewise, it is impossible to refute a determined solipsist.

Realism is, in this writer's view, altogether more interesting. The conclusion we are about to come to is that, while we can never be absolutely sure of our immediate contact with a world we approach through symbolic activity, which is the essence of the realist position, we can absolutely be sure of the falsity of certain counter-arguments to realism.

In the first place, the attempt to describe our access to reality in terms of a set of formally inadequate psychological operations has been termed "psychologism" and we find a less nuanced version of this critique in Gottlieb Frege.

Conversely, the attempt by current writers like Tegmark to argue for worlds in which all possible mathematical dispositions are incarnated is similarly misguided, as we shall see; it is a cosmic manifestation of the opposite fallacy of "logicism", originally the statement that the laws of logic ARE the laws of thought.

A problem underlying all this is that we have independent accounts from psychology (particularly Piagetian genetic epistemology) that really need to be respected. So if we say "It is Heisenberg's considered view that QM is about our knowledge", we are forced into an explanatory cycle that will equate knowledge gained from sensorimotor interaction with the kind of application of math we see in QM. There is no way that Hilbert space can be handled in genetic epistemology, and there was a very serious row at UC Berkeley when George Lakoff decided to educate the mathematicians about the origins of their discipline in metaphor. I much better consider QM observations as a very refined, austere act of the human mind. We do not know how we do it, and possibly never will. What we do know is that human cognition shows quantum signatures.

Let us return to the issue of realism. What this writer believes that we can establish is that there are realities transcendent to us, and that we humans occasionally develop languages in which a purely *syntactic* operation begets new access to external realities. And so, for example, Paul Dirac proposed the positron existed as the symmetric twin to the electron on the basis of symmetry; Emily Noerther was able to rephrase nature's conservation laws as symmetric truths.

There is no language more elliptical and veridical in our apprehension of reality than math. We may never know why math works; what we do know is that it is couched in terms redolent of Platonic forms. We humans can use this language to some extent, and the joins show when we find ourselves forced to distinguish between converging and otherwise series adding up to infinity or a random integer, when we discuss the infinitesimal, or when we consider that Cantor with justification posited a hierarchy of infinities. In any case, the attempt to reduce math to psychology, under some auspices or other, will not work. Math is the language of noesis, direct access to reality, insofar as we as humans can achieve this.

Of course, math famously leads us up blind alleys even in physics; it has proved incompetent for much of biology. Its leading practitioners are often abnormal; there is evidence that Princeton dentists loved math patients as they were too preoccupied by events in their minds to notice the pain! It tells us little or nothing about *noesis* in the arts, in the rest of social life, and for many of these areas we need alternative discourses.

It could be argued that that the noetic language for emotion is music; yet some people are, like the great Michael Polanyi, as insensitive to music as many are to math. For them, there are other languages for these apprehensions of reality, both intersubjective and objective.

Conclusion

This paper proposes a modality of realism. We will never, a la T.S. Eliot, cease exploring reality; we will continue to develop new and ever more elliptical and veridical tools to investigate it. The math we now use to describe physical reality is well beyond the ken of Isaac Newton, who may have co-invented the calculus but seemed ignorant enough of its application not to use it. Where there is an attested

craft, like musical instrument-making, there is likely to be a transcendent reality.

It is reported, for example, that Stradivarius violins benefited from a cold snap in Europe, leading to trees with their rings compacted closer together being used for the violins! It is nothing less than obscene to reduce music to psychological operations couched under the current trendy sets of concepts and technologies; it is, as we have seen, absurd to reduce math to metaphor.

In this paper, a new way of parsing nature, one that starts from the fact of ontological distinctions, is proposed. Two foci are later identified; the bridge subject of biosemiotics and the quantum mind hypothesis. The latter is seen as another bridge, this time from the academy to the real world in which we are objects as much as subjects. As entanglement is to the physical, morphic fields are to the biological, and so attested telepathy (the "psi effect") is to the cognitive. There are too many attested incidents in scientific discovery, in particular involving math concepts using completely different formalisms, for this to be ignored.

In short, then:

- Biosemiotics is a start to a new parsing of nature;
- It must be augmented by a revised look at what the process of explanation is;
- By re-introducing the notion of "ontology" we get a radically new view of how scientific research should proceed.

References

Barbieri, M. (2008a) The codes of life. the rules of macroevolution. Springer, Dordrecht

Barbieri, M. (2008b) Biosemiotics: a new understanding of life. Naturwissenschaften. DOI 10.1007/s00114-008-0368-x

Bressler DW, Silver MA (2010) Spatial attention improves reliability of fMRI retinotopic mapping signals in occipital and parietal cortex. Neuroimage 53 (2): 526-33.

Bressler DW, Fortenbaugh FC, Robertson LC, Silver MA. (2013) Visual spatial attention enhances the amplitude of positive and negative fMRI responses to visual stimulation in an eccentricity-dependent manner. Vision Res. 85: 104-12.

Gurdjieff, G (1973) Views from the real world. NY: Dutton.

Klein, N. (2008) The Shock doctrine. NY: Picador

Libet, B., Gleason, C.A., Wright W. and Pearl D.K (1983) Time of Conscious Intension to Act, in Relation to Onset of Cerebral Activity (Readiness Potential) Brain 106: 623-642.

Mitchell, J.F, Sundberg, K.A and Reynolds J.H (2009) Spatial attention decorrelates intrinsic activity fluctuations in macaque area V4 Neuron 63: 879-888.

Ó Nualláin, S. (2003) The search for Mind. Third edition. England: Intellect.

Ó Nualláin, S. (2008) Remarks on the foundations of Biology. Cosmos and History: special issue on "What is life?" Vol 4 Nos 1-2.

Ó Nualláin, S. (2013) Neural Oscillations & Consciousness: Attention as a Litmus Test for the Quantum Mind Hypothesis. Journal of Consciousness Exploration & Research. 4 (7): 697-713.

Ó Nualláin, S. (2014) One magisterium. England, Newcastle: CSP.http://www.cambridgescholars.com/one-magisterium

Sebeok TA (2001) Biosemiotics: its roots, proliferation, and prospects. In: Kull K (Ed) Jakob von Uexküll: A paradigm for biology and semiotics. Semiotica 134(1/4), pp 61.

von Uexküll J (1928) Theoretische Biologie. 2te Auflage. Julius Springer, Berlin.