Living Books About Life

Biosemiotics

Nature | Culture | Science | Semiosis

Edited by Wendy Wheeler

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Introduction

'There is a difference between skepticism and cynicism, for the former can lead to action and the latter only to passivity. So these pages have a political end, too, which is to encourage the readers not to leave science to the experts, not to be mystified by it, but to demand a sophisticated scientific understanding in which everyone can share.' (Lewontin, 1991:16)

I Mind and Nature

I'm pleased to be able to welcome readers to this Living Book titled *Biosemiotics: Nature/Culture/Science/Semiosis*. Biosemiotics – as its name suggests – is committed to science-humanities interdisciplinarity. As readers of these Living Books will doubtless know, this kind of interdisciplinarity is no mean task, but we have come a long way since C. P. Snow complained that humanities scholars knew nothing of the Second Law of Thermodynamics (Snow, 1998: 15). The sciences of modernity developed their methodological

strengths and practical successes on the basis of 'objective'1 observation and measurement, drawing on forms of description (preferentially mathematical models) as far removed as possible (which may not be that far (Pimm, 1981: 47-50; Manin, 2007; Lakoff & Núñez, 2000)) from the poetic, metaphor-rich and intersubjective language and the hermeneutical assumptions of the humanities. Although natural and cultural evolution (and, in the latter, the arts and humanities and the sciences) equally depend on continuities as well as what Thomas Kuhn called 'revolutionary' alterations,2 in the end both the practice of science and judgments concerning radical revisions of theory belong (as Kuhn noted in his 1969 'Postscript') to the relevant scientific community (Kuhn, 1996).

Despite such compartmentalization in the pursuit of knowledge, and, as Charles Sanders Peirce's semiotic philosophy suggests, there is a sort of evolutionary continuity of signs (signs grow (Merrell, 1996)) which assures us of the reality of patterns which connect mind and nature in, as Gregory Bateson put it, 'a necessary unity' (2002). This means that, in this difficult but creative interdisciplinary engagement, the arts and humanities have insights to offer to sciences: both sets of disciplines are social practices; the traffic goes both ways (Lewontin, 1991). For example, one important link that biosemiotics discovers between nature and culture is the idea of natural metaphor, which Charles Sanders Peirce called abduction, and of which Bateson made fertile use. Another is Jesper Hoffmeyer's account of 'Evolution by Natural Translation' (2003).3 The observation that

metaphor, as abduction, has an evolutionary force in *all* of nature goes back at least to Friedrich Schelling's *Naturphilosophie*. As Andrew Bowie points out, this led Schelling to the logical view that, due to the world-disclosing power of metaphor, art and literature were at least equal, and possibly superior, to philosophy (Bowie, 1993: 8, 13).4 Links to Peirce's and to Bateson's work form part of this Living Book on Biosemiotics.

Peirce's logical inference of abduction (Gk. μεταφέρω metafero – to carry; hence metaphor Gk. μεταφορά metafora – to carry away, via iconic signs, meaning from one place to another) is based on the iconicity of metaphor (and the primary 'Universe of Firstness' – see below). As I write in my own contribution to this Living Book, 'Gregory Bateson and Biosemiotics':

> abduction is the only logic which introduces newness: induction merely confirms that something is so; deduction draws out further logical implications. But a genuinely new development (let us call it an 'idea' – whether natural or cultural) requires a mysterious and incalculable move. Peirce called it informed guessing, or a hunch or animal-like intuition: a semiotic operation, but hidden from view (Peirce, 1998a: 216-8). Bateson, working out of cybernetic understandings, thought about the problem of abduction in terms of systems consisting essentially of information as positive (excitatory) and negative (dampening) feedback. Biosemiotics, of which Bateson was an important precursor, recasts 'information' as semiosis in living systems. In biosemiotic thought, living systems are thus conceived as cybersemiotic systems, and this introduces a rather different sense of 'mind' and 'idea'. A 'mind', as Bateson

> recognised, is something much more like an ecology in which 'information' (semiosis) circulates in a complex symphony of causes, feedback, and further effects (signs) (Wheeler, 2010: 41).

Not only is this abductive logic essential to science (Hanson, 1958: 85-6), it is also, Bateson argues, the very logic of life itself. Contrasting it to syllogism in Barbara (in which metaphor is confined by predicate classification in human language: All men are mortal; Socrates is a man; Socrates is mortal), Bateson called it 'syllogism in grass' ('Grass dies; Men die; Men are grass'):

> Von Domarus long ago pointed out that schizophrenics commonly talk and act in syllogisms of grass, and I think he, too, disapproved of this way of organising knowledge and life. If I remember rightly, he does not notice that poetry, art, dream, humor, and religion share with schizophrenia a preference for syllogisms in grass. But whether you approve or disapprove of poetry, dream, and psychosis, the generalization remains that biological data make sense – are connected together – by syllogisms in grass. The whole of animal behavior, the whole of repetitive anatomy, and the whole of biological evolution – each of these vast realms is within itself linked together by syllogisms in grass, whether the logicians like it or not. (Bateson, 1988: 26-7).

Günther Witzany's essay on plant communication (phytosemiosis) included here contributes to our understanding of life at its semiosic 'grassiest': even grass, it turns out, is 'mindful' in a way (Witzany, 2006).

In other words, for *creatura*, cognizable reality is made

both of mind-independent and mind-dependent objects, sign-vehicles and interpretants in sign-relations. In the same chapter, Bateson tells the following story to illustrate this point:

> I went to see the nice little pack of wolves in Chicago at the Brookfield Zoo, ten of them lying asleep all day and the eleventh one, the dominant male, busily running around keeping track of things. Now what wolves do is to go out hunting and then come home and regurgitate their food to share with the puppies who weren't along on the hunt. And the puppies can signal the adults to regurgitate. But eventually the adult wolves wean the babies from the regurgitated food by pressing down with their jaws on the backs of the babies' necks. In the domestic dog, females eventually wean their young from milk in the same way. In Chicago they told me that the previous year one of the junior males had succeeded in mounting a female. Up rushed the lead male – the alpha animal – but instead of mayhem all that happened was that the leader pressed the head of the junior male down to the ground in the same way, once, twice, four times, and then walked off. The communication that occurred was metaphoric: 'You puppy, you!' The communication to the junior wolf of how to behave is based on a syllogism in grass. (Bateson, 1988: 28)

We should also remember that, as with many *Innenwelt* processes, the immune system is often tricked by molecular mimicry and, thus, by a difference-obscuring 'idea'.5 As Denis Noble has similarly argued,

> Genetic and cultural forms of evolution share this messiness, or, to use a less derogatory term, inventiveness. For it is through a complicated series of bodges that nature has arrived at the huge diversity of

> life as we know it. Tangled intricacy is the mother of nature's invention. The idea of metaphor is important here, too. On that basis, we can say that, as the genome has developed, nature has switched from one metaphor to another. It has plundered the treasure chest of old DNA modules to form new combinations and to give old genes new functions. (Noble 2006: 103-4)

From all this, we can be certain that, however different the logics of science and the arts and humanities sometimes appear, biosemiotic investigations do uncover 'a necessary unity' between them. This discovery, too, is another step in Peirce's unending spiral of semiosis: life's vitality, from beginning to end, is marked by signs of semiosic responsiveness. In her essay, included here, on Peirce and Lady Victoria Welby's 'Significs', Susan Petrilli indicates the ways in which, for example, semiotics can open up our ways of thinking about ethical responsiveness (Petrilli, 2007). Paul Cobley's essay continues this theme of how political and ethical engagements can be thought from the perspective of a posthumanist 'global semiotics' (Sebeok, 2001), which is aware of the pitfalls of humanist voluntarism, but also alert to the abductive power of 'the event' (Cobley, 2007). What might it mean, Cobley asks, simply to be 'seized' by the communicative vitality of all living things?

II A Self-Growing System of Knowing

Peirce's semiotic philosophy is often described as architectonic. It is certainly vast and ambitious. However, as Peirce never committed his mature theory to the form

of a book, his theories, as these appear in the *Collected Papers*, will also strike those new to them as somewhat disorganized. His collected papers cover all of his adult life and, as with all creative thinkers, his ideas developed considerably. This means that the *Collected Papers* contain contradictions between the earlier and the mature thinking-through. As Peircean scholar T. L. Short writes, 'He never succeeded in bringing his ideas into systematic unity; he never published a philosophical book. The incompleteness, digressiveness, and profusion of technical detail of his writings accounts for the educated public's ignorance of his life and work and for the relative neglect of his philosophy even by professional philosophers' (Short, 2007: 2). Since the main interest here, however, is in Peirce as an important semiotic philosophical and scientific source in the development of biosemiotics, I shall confine myself to a brief account of those aspects of Peirce's semiotic (also sometimes spelled semeiotic) which seem most likely to be helpful to readers of this Living Book.

The architectonic quality of Peirce's semiotic philosophy derives from its being an attempt to offer a philosophically coherent account of what, today, we would call a complex nonlinear evolutionary emergent system: a system (of knowledge processes, and thus of science) which is capable of autopoiesis, or self-growing. Since Peirce considered that all thought (all 'mindedness') involves the use of signs, his philosophy is a complex nonlinear evolutionary emergent system of sign-relations. It thus begins with an account of the three basic types of sign (icon, index and symbol), and of the 'Universes' of

experience associated with them (referred to respectively as Firstness, Secondness and Thirdness). Whilst not (obviously) confined to any apparently linear developmental process, the identification of the 'Universes' can usefully be imagined, in order to begin to get a purchase on them, in terms of the primary emergence of consciousness itself.6 Firstness is pure feeling, without any distinctions in regard to any other. Secondness is the emergence of consciousness of otherness in the form of 'brute experience' as resistance and actuality ('The person in his inertness identifies himself with the precedent state of feeling, and the new feeling which comes in spite of him is the non-ego. He has a two-sided consciousness of an ego and a non-ego' (Peirce, 1904).) Thirdness is consciousness of the mediation (and thus of consciousness itself as constituted in communication and representation) of experience. Put crudely, the experience of Firstness (pure feeling) and Secondness (the bruteness of resistance) produces the Thirdness (communication, regulation or law, and habit) that makes us retrospectively capable of conscious (or 'minded') understanding of (at least some of) the conditions of its own emergence (Andersen *et al.*, 2000).7

This is closely tied to Peirce's triadic conception of sign-relations as constituted (concurrently) by an object (whether a thing or an idea), a representamen (sign-vehicle) and an interpretant (not so much 'an interpreter' as the change, or difference, brought about by the experience, in some living thing, of registering an object *as a sign*8). As Albert Atkin points out, Peirce was primarily concerned with the evolution of knowledge (science). This led him, towards the end of his life, to divide the object into two (the *immediate* object and the

dynamic object), and the interpretant into three: *the immediate, dynamic* and *final* interpretants. The *immediate* object is the object as we know it at any point; the *dynamic* object is the object as it will be understood when our scientific knowledge is complete. Atkin writes: 'Examining these two objects further, the dynamic object is, in some respects, the object that underlies a sign-chain. Ransdell (1977, 169) describes the dynamic object as the "object as it really is", and Hookway (1985, 139) as "the object as it is known to be [at the end of inquiry]". The aim, or teleological end, of a sign-chain, then, is to deliver a full understanding of an object thereby assimilating it into our system of signs' (Atkin, 2008).

Closely related, the *immediate, dynamic* and *final* interpretants refer to the historical process (or evolution) of understanding, or *semiotic capacity* more widely, which Jesper Hoffmeyer has described in terms of the natural evolution of 'semiotic freedom' (Hoffmeyer, 2008). Atkin notes that 'As David Savan puts it, "Peirce's intention was to identify the third type of interpretant as providing a norm or standard by which particular stages (Dynamical Interpretants) of an historical process may be judged." (Savan 1988, 62)' (2008). As Atkin also observes, 'Peirce came to see sign theory more clearly as part of the logic of scientific discovery, and central to his account of inquiry. In particular, it led him to see sign chains (like inquiry) as tending towards a definite but idealized end' (2008). It is thus unsurprising that Peirce's philosophy of semiosis (particularly his idea of abductive inference) influenced Norwood Russell Hanson and then, through him, Thomas Kuhn. Strangely though, despite his interest in scientific

creativity and innovation, Kuhn seems rather to have circled round Peirce. Instead he turned to Jacques Hadamard and to Michael Polanyi's idea of tacit knowledge and 'foreknowledge' – the latter very similar in many ways to Peircean abduction, but without any well-developed semiotic aspect (Polanyi, 1958; 1966).

III Growing this Living Book about Biosemiotics

Making the selection of what to include in this book was no mean task either. As Paul Cobley notes (Cobley, 2010), Thomas Sebeok once said that all the life sciences (and of course the humanities *in toto*) are practicing semiotics, whether they acknowledge it or not. There are now very many biologists and philosophers of biology who might count as cryptosemioticians (Sebeok, 1995). I have, of course, wanted to offer readers specifically biosemiotic or protobiosemiotic writings and videos, and it has not been possible to include even a small part of the host of interesting scientists and thinkers whose work, nonetheless, contributes to the development of the biosemiotic field. I have, where possible, mentioned some of them in this introduction.

But these are interesting times. It is the best part of a century since physicists felt their classical world of substantial physical certainties disintegrating, and a half century and more since Thomas Kuhn asked his questions. Nonetheless, biology has remained oddly resistant to any 'paradigm-altering' development. Perhaps since, relative to physics, biology is closer to so many

specifically modern concerns (the organisation of life, of mind and of purpose), and technologically more implicated in them (in AI, in understanding the genome, in artificial genetic manipulation), it has hung on to the Central Dogma (of one-way movement – from DNA to protein, and of genetic, mechanistic and material causation) much more tenaciously. The reasons for this turn out to be surprising. For Francis Crick (who coined the term Central Dogma, which he learned from 'a curious religious upbringing' (Judson, 1996: 333-4)), it was because he thought that 'dogma was an idea for which there was no *reasonable evidence*'; it was 'a negative hypothesis, so it's very very difficult to prove', and its purpose was to prevent '*unlimited* theories' (Judson, 1996: 333-34; Bardini, 2011: 211). As Thierry Bardini notes, 'this hypothesis, if it was very productive for a while, turned later into a real *dogma*, and thus prevented (for another while at least) any further inquiry along lines of thought deemed *counterproductive*' (Bardini, 2011: 211). For Richard Lewontin, it was an absolute '*a priori* adherence to material causes', not because scientific concepts in themselves demand this, but because 'that materialism is absolute, for we cannot allow a Divine Foot in the door' (Lewontin, 1997).9

Yet there were other, non-mechanistic and not wholly materialist, alternatives, and biosemiotics presents one of them: the idea that, with the emergence of life on earth, a new form of causation – semiotic causation – emerges. With this, human semiotic life (verbal and nonverbal) takes its evolutionary place amongst a general and natural history of biosemiosis. Despite the claims of

sociobiology and evolutionary psychology, and the antics of a few high-profile media biologists and philosophers, genetic determinist reductionism has not survived either the revolution in molecular biology or the disappointments, for theories of genetic and mechanistic reductionism, of the 1990s and 2000s genome projects (Le Fanu, 2009;10 Sapp, 2003). DNA (like all codes) is inert; it does nothing unless 'read' (biosemioticians would generally prefer to say 'interpreted') by the hugely complex cellular configuration. As Hoffmeyer notes below, it is the cell (and the cellular environment) which directs protein production, and the same code can produce quite different outcomes. Proteins themselves as Jan Sapp writes, are now 'acknowledged to play much more active roles in genetic regulation and heredity than the doctrines of classic molecular biology had ever allowed' (Sapp, 2003: 268). In a similar vein, bacterial activity, including lateral gene transfer, 'is rampant', and 99% of the genes which support human life belong not to us but to our live-in 'helpful bacteria' (Dupré, 2010).

Biosemiotics is part of wider theoretical shifts now challenging biological orthodoxy. As the title of David Depew and Bruce Weber's 1996 book indicates, *Darwinism* is certainly *Evolving* (Depew & Weber, 1996). This has been spurred on by dissatisfaction with the completeness of natural selection as a full explanation of evolutionary change – rather than as having what James Mark Baldwin called a sculpting effect on already existent forms. The 'Baldwin Effect' proposes that evolutionary change can, just as importantly, be driven by organisms' active creative responses to, and moldings of,

environments, not merely by passive natural selection. This has recently been explored by Terrence Deacon as a way of explaining the evolution of language by human 'self-domestication', and as a result of the 'off-loading' of semiotic capacities into the social environment, where they recursively act as a spur to the development of cognitive complexity. A You Tube video of Deacon expounding this rather brilliant theory is included in this Living Book. Gregory Bateson also believed that natural selection did not provide a complete account of evolutionary change, and that organisms took an active part (via biocybernetic organism-environment feedback looping) in their own autopoiesis. Peter Harries-Jones discusses Bateson's understanding of 'information' as bioentropy – pattern from 'noise' as *natural* aesthetic activity – in his essay here (Harries-Jones, 2010).

Clearly, these semiotic capacities result from an evolution of biosemiotic capacities belonging also to the *Umwelten* and *Innenwelten* of other organisms. Deacon (along with Kalevi Kull, Claus Emmeche, Jesper Hoffmeyer and Frederik Stjernfelt) is co-author of the 'Theses on Biosemiotics: Prolegomena to a Theoretical Biology' (also included here), which describes the biosemiotic aim as that of providing a scientific explanation of 'how life evolves through all varieties of forms of communication and signification (including cellular adaptive behavior, animal communication, and human intellect) and to provide tools for grounding sign theories' (Kull et al., 2009: 167-173). Biosemiotics thus contributes both to developments in theoretical biology and to those philosophical concerns in the humanities which are

attempting to grasp the creative evolution and vitality (as well as the 'boundary conditions') of what Michael Polanyi called 'life's irreducible structure' (1968: 1308-12). The 'boundary conditions' ('knowledge' hierarchy markers) which make 'information' and semiosis possible via recursion and re-entry are discussed in Harries-Jones' essay on Bateson (2010), and are also the subject of Deacon's 'Shannon-Boltzmann-Darwin: parts 1 and 2'.11 Bateson referred to these 'boundary conditions' as the necessary 'gaps' (for abductions) which cultures address in the experience of art and the sacred. I discuss this here in 'Gregory Bateson and Biosemiotics: Transcendence and Animism in the 21st Century' (Wheeler, 2010).

Jan Sapp's *Genesis: The Evolution of Biology* (2003) details many of these ongoing changes in biology.12 Both physics and biology have been deeply influenced by cybernetics and the information revolution. This has gone two ways in both disciplines. One is in the direction of Artificial Intelligence (as though 'mind' is encoded, like software in a computer, rather than embodied and enworlded and, above all, relational). The other is in the direction of meaning and pattern, as in the physics of John Archibald Wheeler, in which Wheeler refers to the universe as a 'self-excited circuit' (Wheeler, 1986: 304-16; Davies and Gregersen, 2010; Baeyer, 2003), and, of course, in biosemiotics itself. In the latter, the cryptosemiotic and bio-philosophical precursors are Peirce (discussed here by several contributors, but, perhaps most directly, in John Deely's discussion of the philosophical history of semiotics) (Deely, 2000), Jakob von Uexküll (discussed by Kalevi Kull of Tartu University's Jakob von

Uexküll Centre) (Kull, 2001), and Gregory Bateson (Bateson, 1988; 2000; 2002). To von Uexküll we owe the idea of the signifying *Umwelt* (the semiotic 'bubble' in which each species lives), and a very early version of biocybernetic feedback in von Uexküll's notion of the *Funktionskreis* (functional cycle) (Uexküll, 2010:49; Kull, 1998: 93-104). The move to 'information thinking' in biology can be found in the work of Susan Oyama and Eva Jablonka (Oyama, 1985; Jablonka and Lamb, 2005; Hoffmeyer, 2008: 103).13 But, despite quantum physics' forced abandonment of materialist and mechanical cause-and-effect interpretive frameworks, the materialist reductionist (and material-mechanical causality) habit still hangs on in mainstream biology.

As far as biology is concerned, 'information theory' is in something of a crisis. The Claude Shannon mathematical model of information is not interested in semantics, or meaning (Shannon, 1948: 379-423 and 623-656). It is only interested in channel- (or bandwidth-) bearing capacities and in information understood, (first order) cybernetically, as a reduction in entropy, or 'noise'. On this account, a gibberish message typed by a monkey has more 'information' than the play-text of *Hamlet*. As far as biology is concerned, it is only with biosemiotics (which, of course, deals in negentropic, or bioentropic, communicative life-sustaining sign processes) that the concept of 'information', as communication, is pushed to its evident logical conclusions – and understood as semiosis. These conclusions are, as with DNA and mRNA encodings, that information in the living sense is only *inform*ing for some-one, or some living thing (whether a

cell or an organism) that is capable of making sense of it: i.e. of *giving it meaning*. As Jesper Hoffmeyer points out,

> as we've seen in so many signal-transduction processes, different kinds of G-proteins are available for one and the same receptor – and the same G-protein may service different kinds of receptors. The cellular response to a signal will therefore depend not only on the concentration of the signal molecule, but also on which other internal sign-transduction cascades may be occurring simultaneously at the particular time. This occasions an interesting increase in the interpretive variability and semiotic freedom of the cell (freedom understood here as a loosening of the rigid causal bonding of one signal to one response). (Hoffmeyer, 2008: 154)

The problem of talking about 'information' in biology led to biologists' interest in semiotics or, more precisely, in sign relations as described in the Peircean semiotic. Terrence Deacon offers a synthetic discussion of all these different understandings of 'information' in 'Shannon-Boltzmann-Darwin: Redefining Information' Part 1 and 2 (Deacon, 2008). With such syntheses we approach the edge of the revolutionary paradigm. It is here that the elimination of formal and final causation from Aristotle's four causes (material, formal, efficient and final), leaving only material and efficient causes to account for everything in modern science, will finally be challenged. It began with cybernetics and information,14 and with Rosenblueth, Wiener and Bigelow's groundbreaking 1943 paper, 'Behavior, Purpose and Teleology' (Rosenblueth *et al.*, 1943: 18-24). Biosemiotics develops those insights into the teleologies of autopoietic semiosic systems – from first

order to second order (observer-participant) cybernetics. Søren Brier's contribution to this discussion can be found here in his essay on cybersemiotics (Brier, 2010). Sign relations are, in themselves (and as all *relations* are), ineluctably immaterial and intersubjective – however materially encoded. We know relationships by their various material, or materially derived, effects as *differences* registered, but who ever touched, saw, heard, smelled or tasted *relationship* as such? More than this – and as John Deely's written and video contributions to this Living Book discuss – a thorough understanding of sign relations undoes the 'subjective/objective', and idealist vs. realist, misconceptions of 400 years of modern philosophy and science following Descartes' mind/body dualism.

IV Semiosis and Science: The Growing of Conversations (and the importance of interdisciplinary 'feedback')

Animals (and all organisms) make use of iconic and indexical signs (visual, aural, haptic, olfactory – i.e. chemical); only human animals make use of symbolic (conventional) signs too. To recap: Peirce's theory of signs consists in the triadic sign-relation between a representamen (sign vehicle, somewhat similar to Saussure's idea of the 'sound pattern' in spoken signs often translated as 'signifier'), an object (that mind-independent or mind-dependent object which the sign vehicle represents), and an interpretant (the third phenomenon which establishes the representamen and the object in a sign relation and, in so doing, takes on the

guise of a further sign vehicle). This latter (which could also be figured as the 'meaning' pragmatically understood in terms of effect or effects) may be a 'meaning' as understood by a human interpreter of signs, but it can equally be, for example, the action of a chemical in a cell, or an endocrine response in an immune system. Put simply, Peirce's definition of a sign is the whole relation of some representamen, its object and an interpretant. Thus, anything can become a sign and, equally, nothing is a sign unless it is used as a sign. Both this, and the fact that the object can be, indifferently, either real (mind-independent, a stone for example) or unreal, an idea (mind-dependent, a unicorn for example), cuts across the philosophical distinctions between material/immaterial, realism/idealism and body/mind. As John Deely writes,

> The suprasubjectivity of triadic relations, thus, explains why objects signified need not exist in order to be signified and public as objects. For every object (in contradistinction to things which are what they are independently of being known) yet has the advantage of owing *its* being to the triadic relation which the object as object directly terminates suprasubjectively as significate, just as the sign as vehicle of that signification owes *its* being to the triadic relation, too, but by virtue of occupying *a different position under that relation* (namely, the foreground position of 'standing for another') than does either the significate or the interpretant. Whence nothing prevents what is an object from also being a thing, an independent physical reality, but nothing requires that, either. (Deely, 2010: 76-77)

Our ordinary experience of the world is that it is simply there, directly available to our senses and immediately

understood. Peirce's point, which is also supported by Jakob von Uexküll's *Umwelt* theory, is not only that the world (in its entirety of things) is not directly available to us, but also that any aspect of the world which becomes (whether consciously or unconsciously) a part of our mind, or a part of the mindedness of any living thing – whether cell, organism, or human person – does so, ultimately and *when* it does so, as a *sign* (i.e. a triadic sign-relation in which meaning is mediated). As the above discussion, however, should have made clear: inasmuch as all living things use signs, this is a *natural constructivism*, not the *social constructivism* which has been prevalent in Anglophone cultures over the last three or so decades. The latter has assumed (anthropocentrically, and flying in the face of biological evolution) that reality is a human construct made in human verbal language alone. Peirce's semiotic is in turn evolutionary and expansive: signs beget other signs in an open-ended spiral of semiosis. 'What is interpretant one time can become sign-vehicle or object-signified at another time, in the unending "spiral of semiosis" out of which experience is constituted and which lies at the core of the *growth of symbols*' (Deely, 2010: 77).

One of the most productive uses of biosemiotics lies in its contribution to the psychoneuroimmunological (PNI) study of the intimate relationship between social, psychological and bodily sign processes and illness. Thure von Uexküll, son of Jakob, has been a significant influence in the routine teaching of psychosomatic medicine in German medical schools. A link to a short obituary describing his work is included here. Others have explored the correlation between human (and

animal) 'wealth' (broadly conceived) and pathology (Marmot, 2004; Wilkinson & Pickett, 2009), although without the benefit of understanding (bio)semiotic causality. Bateson understood the reality of immaterial relations ('only news of a difference can enter into man's sense organs, his mapping, into his mind. Only difference can effect and trigger an end organ – so all our information (our universe of perception) is built on differences. Difference is 'super-natural' i.e., outside the natural world as this is seen by the hard sciences. Difference is not located in x or y or in any space between' (Harries-Jones, 2010: 2378)).

Once scientific culture has grasped the reality of semiotic relations and semiotic causality, we will find ourselves on the other, truly 'postmodern' rather than 'ultramodern' (Deely, 2000; 2001; 2003a; 2003b), side of the modern paradigm. On that other side there may also well be a new understanding of the importance of chance and play (including aesthetic play) in both natural and cultural evolution. The vitality which characterizes living relationships is precisely what is destroyed by its reduction to materiality alone or, *a fortiori*, by commodification. In a culture so close to log-jam with 'information', but low on meaning and purpose (aside from material profit), such a wider understanding of 'wealth' as richness of (bio)semiotic flexibility and responsiveness, rather than as mastery in terms of biopower, biopolitics and bioprofit, might go some way towards overcoming technological modernity's rigidifying disciplinary tendencies (Foucault, 1977; Scott, 1998).

Other questions raised by biosemiotically informed understandings concern not only the ways in which cultures rearticulate patterns in nature within their own historical cultural *Umwelten*, and the understanding of 'mind' as embodied and enworlded distributed intelligence, but also the relationship between living and nonliving nature. That the material world is legible both cenoscopically (for everyone) and idioscopically (via science) raises the topic of physiosemiosis – the fact that, for living things, matter is lively and potentially legible in living body-mind-*Umwelten*. Peirce himself thought that matter was 'effete mind' (Peirce, 1992: 293) in a 'universe … perfused with signs' (Peirce, 1998b: 394).15 Whether all this takes us in the direction of Freya Mathews' pansemiotic erotic panpsychism (Mathews, 2003), Jane Bennett's 'assemblages' and Chinese notion of shi ('the dynamic force emanating from a spatio-temporal configuration' (Bennett, 2010: 35)), Karen Barad's reconceptualisations of matter and meaning (Barad, 2007), Graham Harman's 'Object-Oriented Ontology' (Harman, 2010; 2011), or, rather differently, towards Thierry Bardini's molecular junkware culture of 'the (bio)semiotics of junk', *Homo nexus* and genetic capitalism (Bardini, 2011: 21), who can tell? That will depend on the directions of the conversations which follow and on the semiosis of the science and art which grows there. As Donald Favareau writes in the essay which opens *Biosemiotics: Nature/Culture/Science/Semiosis*, 'the real history of biosemiotics is about to get underway' (Favareau, 2006: 51).

Endnotes

1 A semiotic perspective would question this modern Cartesian distinction between 'subjective' and 'objective'. If 'objective' refers (as it surely does) to mind-independent reality, then this is an achievement of inter- or supra-subjectivity, not of the fiction which Thomas Nagel called 'the view from nowhere' (Nagel 1986). See John Deely, 'A Dialogue: "A Sign is *What*!?"' in this collection.

2 Stephen Toulmin (1970) challenged Kuhn's idea of revolutionary paradigm change because he believed that knowledge evolves in a way more akin to biological evolution. In particular, he objected to the idea that paradigms are incommensurable, since this would allow for no comparison or judgment. There is a deeper philosophical point here which touches on the Peircean notion of abduction as the only source of the generation of new ideas. Abductions are living metaphors. Kuhn describes paradigms by recourse to Wittgenstein's idea of 'games' and 'family resemblances' (1996: 44-5). Abduction (metaphor) works precisely on the basis of such (iconic) resemblances carried over, but with *significant differences*. In the abductive/metaphoric play of similarity and difference, it is, of course, 'the difference which makes a difference' which counts, and which generates new hypotheses (Bateson, 2000: 315, 459). See also 'Bateson's final reformulation of information as a difference that made a difference explicitly defined information as meaningful to a somebody or some organism that could perceive difference and interpret its perceptual significance' (Harries-Jones, 2010: 2362). A 'paradigm

change', as Kuhn puts it must, thus, always involve the abduction of resemblances (i.e. some degree of commensurability) but with *significant differences*. The idea of transduction, as used by Gilbert Simondon (Bardini, 2011), is similar; but in the latter evolution is less tree-like than rhizomatic. Both are, in fact, recursive and nonlinear, but the rhizome perhaps more obviously so. In all cases present and future 'grow' from the past via similarity and *difference*.

3 Hoffmeyer's essay is not included in this Living Book for reasons of copyright, but see: http://www.molbio.ku.dk/MolBioPages/abk/PersonalPages/Jesper/Translation.html.

4 As Bowie writes in *Schelling and Modern European Philosophy*, 'The question of metaphor in philosophy is actually a key factor in Romantic philosophy. In the work of Schleiermacher, Humboldt, Novalis and Friedrich Schlegel, all of whom were acquaintances of Schelling, and in Schelling's own early work, literary and other art is seen as having a status equal or even superior to philosophy because it can show what philosophy cannot say' (1993: 8). A few pages later he notes that 'Towards the end of the century Schelling develops the *Naturphilosophie*, which extends the notion of the activity of the subject into the idea of all of nature as 'productivity', thereby refusing, in a manner characteristic of all his work, to regard even inanimate nature as rigidly opposed to living thinking. The *System of Transcendental Idealism* of 1800, which tries to square Fichte and the *Naturphilosophie*, sees art as the medium

in which the activity of thought and the ‘unconscious’ productivity in nature can be understood as ultimately the same' (1993: 18).

5 'However, if by natural translation we understand any process whereby a potential message is made accessible to a natural system that would not otherwise be capable of making sense of this message, then nature certainly has developed many other kinds of translation processes at different scales. In one end of the scale we find receptor processes in the membranes of single cells translating the exterior concentration of signal molecules to specific biochemical activity inside the cell. This kind of translation may eventually be faked by viruses gaining admittance to the interior space of host cells by presenting an icon, i.e., a specific molecular shape "resembling" the shape of a normal signal molecule, to the receptors at the host cell membrane. In the other end of the scale we find for instance brain processes in migratory birds translating specific configurations of stars to neuro-muscular activity destined to bring the birds from winter locations to summer locations or vice versa. In this case human experimenters are capable of fooling the translation process by placing the birds in a dark space with artificial stars in the ceiling. By manipulating the configurations of the artificial stars birds may be lead to fly in directions chosen by the experimenter’ (Hoffmeyer, 2003). An earlier version of the latter essay can be found at http://www.molbio.ku.dk/MolBioPages/abk/PersonalPages/Jesper/Translation.html.

6 The idea that development (whether the growth of a foetus *in utero*, or 'learning' more generally – to which foetal growth might in some ways, biosemiotically, be compared) is, itself, a *linear* incremental process is almost certainly wrong. Developmental processes are recursive cybernetic processes in which self-reference, as Peirce's schema suggests, is an effect of other-reference, or difference, both in reference to the self-organising Innenwelt and to the Umwelt (the latter itself comprised of self-organising systems and the recursive loops between them). Together, in a web-like (or perhaps rhizomatic) configuration, these bring about the processual experience of identity (mind-body) in their 'nodes' (identifiable by being enclosed in semi-permeable membranes). Bateson's idea of 'God' (the entire ecology of mind) was equivalent to the informational relation of all past, present and future Umwelten. In 'Spiritual Emergence or How I gave up the ghost and learned to love evolution', Terrence Deacon aptly writes: 'I believe that the experience of being alive and sentient is what it feels like to *be* evolution' (2008: 13). Peter Harries-Jones (Harries-Jones, 2010) makes a similar point concerning Gregory Bateson's understanding of the similarity between learning and biological evolution.

7 This is fairly obvious in the case of human consciousness, or 'mindedness', as is its corollary: that subsequent developments can influence (whether directly or via understanding) antecedent ones. In evolutionary biology this is known as 'downward causation' (Andersen et al., 2000). An example of this can be found in research which shows that the postnatal behaviour of rat mothers

effects sex hormone development in their babies (Powell, 2009: 8).

8 For example, a book (an object) lying on a table may not be noticed (registered) at all. If noticed, it may (and this depends upon the inclinations of the noticer, not to mention whether the latter is a human or a dog) be disregarded and thought of no significance. If registered as a sign (sign vehicle), its effect (interpretant) may be a general judgment concerning – depending always on context – say, bookishness, or class, or the forgetfulness of the room's previous occupant, or a particular known or unknown scent. If registered in detail by a human (title, subject matter, for example), yet other interpretants may emerge. Each interpretant will potentially generate further signs, further interpretants, and so on ad infinitum.

9 'It is not that the methods and institutions of science somehow compel us to accept a material explanation of the phenomenal world, but, on the contrary, that we are forced by our a priori adherence to material causes to create an apparatus of investigation and a set of concepts that produce material explanations, no matter how counter-intuitive, no matter how mystifying to the uninitiated. Moreover, that materialism is absolute, for we cannot allow a Divine Foot in the door.' (Lewontin, 1997) 10 See especially 'Chapter 1: Science Triumphant, Almost'.

11 Not included in this Living Book for copyright reasons,

but available at http://www.teleodynamics.com/.

12 Sapp is one of those interesting historians of biology whose work I didn't have room to include here. An essay of his, 'The Nine Lives of Gregor Mendel', is available open access online at http://www.mendelweb.org/MWsapp.html.

13 Hoffmeyer (2008: 103) writes, 'Oyama's point – which is closely connected to the one taken in the present book – is that developmental processes depend on "inform-ation" from a range of different sources, and that genes are only one of these sources. The conception of a special genetic program that unfolds its predetermined logic through embryogenesis is mistaken because this program – if the program metaphor should be valid at all – is not self-reliant, but only works at all because it is played out in a context that is derived from elsewhere.'

14 'For God's Sake, Margaret' on the Gregory Bateson link in this Living Book.

15 See also See Xiaolei Zhang, 'The Emergence of Consciousness in the Quantum Universe' and Monendra Grover, 'The Quantum Computing Conscious Universe and the Extended Deep Ecology Hypothesis: Implications for Medicine, Agriculture and Technology' in the volume on Consciousness in this Living Books About Life series.

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